Saroj Pachauri
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Global Perspectives of COVID-19 Pandemic on Health, Education, and Role of Media

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Foreword

The COVID-19 pandemic disrupted every sphere of human life and activity around the world. The profound implications of this turbulence continue to shape future generations, reversing years of gains made against the Sustainable Development Goals and setting back progress. We know that while COVID-19 has affected everyone, it has not affected everyone equally due to systemic inequalities and marginalized socio-economic groups, and with lower- and middle-income countries (LMICs), in particular, suffering disproportionately.

Yet there is reason to hope. People everywhere have stepped up, and through their collective resilience and determination, the most dire, worst-case scenarios were, in part, averted. Decades of investment, planning, coordination, and joint commitment have enabled massive scientific breakthroughs such as the rapid development of COVID-19 vaccines. We continue to see significant vaccination coverage in many countries.

It is important to understand the plethora of ways a pandemic can impact human lives as the world begins to take steps toward an equitable recovery. *Global Perspectives of COVID-19 Pandemic on Health, Education, and the Role of Media is a* collection of essays that distill learning and expertise from a diverse set of contributors, who carefully document the complexity and multi-dimensionality of pandemic management into a comprehensive synthesis.

The book underscores the impact of massive interruptions from the pandemic on every country's health system, economic and political landscape, education, media and communications, and communities, especially among the most vulnerable populations. Included is a series of country case studies that surface the important issue of demographic and geographic contexts which have been critical determinants of pandemic impact and response. The book puts forth the immense challenges posed to the world and how countries have responded with models of pandemic preparedness and mitigation. What is evident from these case studies is that nations with previous experience of the SARS outbreak responded better by putting in place a robust surveillance, diagnostics, and treatment response that reduced the spread of infection and loss of precious lives. Further, a robust regulatory approval process that facilitated Emergency Use Listing (EUL) in a safe and expedited manner for

the indigenous vaccines manufactured in India ensured that over 1.8 billion COVID vaccines were administered to a large Indian population and these safe and cost-effective vaccines were distributed to millions in many neighboring LMICs. Efforts such as these made by India and by global collaborations such as COVID-19 Vaccines Global Access (COVAX), Access to COVID-19 Tools (ACT) Accelerator, and Gavi the Vaccine Alliance have been highlighted in helping to bridge the inequities in the access of COVID vaccines, tests, and treatments. Convergent efforts of a range of stakeholders, including local community leaders, faith-based organizations, civil society, NGOs, private institutions, and philanthropies that complemented the efforts of their governments, have been documented as being effective in dealing with the deadly Delta variant of COVID-19 in parts of the world.

Media and communications played a critical role in this pandemic and will continue to be important in future pandemics. Given the prevalence of digital technology, the essays put forth useful strategies deployed by public health experts and health systems to ensure that communities and the public can access accurate information to make preventive choices and decisions for pandemic mitigation.

Global Perspectives of COVID-19 Pandemic on Health, Education, and the Role of Media is a constellation of diverse country perspectives, experiences, and responses, presented by the authors, that when applied in local contexts can help to inform future decisions and build back strategies.

Dr. Christopher Elias
President, Global Development
Bill and Melinda Gates Foundation
Seattle, Washington, USA

Preface

This is the edited volume that provides a global perspective on the health, economic, political, and educational dimensions of the COVID-19 pandemic. Raging through the world, this pandemic has disrupted people's lives and livelihoods. It is continually evolving and changing making it extremely difficult for governments to cope. Over the past two years, the virus has mutated several times and new variants (Beta, Delta, and Omicron) have emerged causing widespread disease and death. This virus has wreaked havoc with already overwhelmed health systems.

Two years ago, we had no understanding of the virus or the epidemiology and pathogenesis of the disease it causes. We have since made great strides in developing diagnostics, vaccines, and therapeutics to combat it. In this crisis, unprecedented scientific collaboration has delivered in months what would normally take decades. Vaccines have been developed at lightning speed and vaccination programs are being undertaken in countries around the world. We now have several tools to address the problem. Even so, the virus is racing ahead of man in this war which has torn the fabric of our society.

Authoritative voices discuss this most pressing global problem providing evidence and real-world experience. Experts provide the latest available research on COVID-19 which is documented in this book.

New York, USA

Saroj Pachauri
Ash Pachauri

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We warmly appreciate the encouragement and support provided by our dear family as we worked on this book.

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About the Editors

Dr. Saroj Pachauri Public Health Specialist, Trustee, Center for Human Progress, New Delhi, India, and Director, POP (Protect Our Planet) Movement, New York, USA

As a public health physician, Dr. Pachauri has been extensively engaged with research on family planning, maternal and child health, sexual and reproductive health and rights, HIV and AIDS, and poverty, gender and youth. In 1996, she joined as Regional Director, South and East Asia, Population Council and established its regional office in New Delhi which she managed until 2014. In 2011, she was awarded the prestigious title of Distinguished Scholar, an honor rarely bestowed.

She worked with the Ford Foundation's New Delhi Office (1983–1994) and supported child survival, women's health, sexual and reproductive health, and HIV and AIDS programs. Before that, she worked with the International Fertility Research Program (IFRP) which was later renamed Family Health International (1971–1975) and the India Fertility Research Programme (1975–1983). She designed and monitored multi-centric clinical trials globally to assess the safety and effectiveness of fertility control technologies. During 1962–1971, as faculty of the Departments of Preventive and Social Medicine at the Lady Hardinge Medical College, New Delhi and the Institute of Medicine Sciences, Varanasi, she helped to develop this new discipline.

She has published six books and contributed chapters to 20 books. She has over 100 publications in peer-reviewed journals and several articles in print media.

Dr. Ash Pachauri Director, Center for Human Progress, New Delhi, India, and Senior Mentor, POP (Protect Our Planet) Movement, New York, USA

Dr. Ash Pachauri has a Ph.D. in Decision Behavior and a Master's Degree in International Management. He worked with McKinsey and Company before pursuing a career in the social development arena, Dr. Pachauri's experience in the fields of public health and management emerges from a range of initiatives including those of The Bill and Melinda Gates Foundation, Program for Appropriate Technology

in Health (PATH), United Nations Development Programme (UNDP), International Planned Parenthood Federation (IPPF), and Centers for Disease Control (CDC) in the US.

Acronyms

3R	Relief, Resilience, and Recovery
A&E	Accident & Emergency
AARP	The American Association of Retired Persons
ACT	Access to COVID-19 Tools
ADB	Asian Development Bank
AEFI	Adverse Effects Following Immunization
AFRANET	Advanced Research Projects Agency Network
AGI-K	Adolescent Girls Initiative-Kenya
AI	Artificial Intelligence
AIDS	Acute Immuno Deficiency Syndrome
AIIMS	All India Institute of Medical Sciences
AMREF	African Medical and Research Foundation
ANC	Ante-natal Care
ANM	Auxiliary Nurse Midwife
ANMs	Auxiliary Nurse Midwives
ARDS	Acute Respiratory Distress Syndrome
ARI	Acute Respiratory Infection
ARV	Anti-retro Viral
ASHA	Accredited Social Health Activist
ASHAs	Accredited Social Health Activists
AViD	Anthropological Exploration of Facilitators and Barriers to Vaccine Deployment and Administration During Disease Outbreaks
AWWs	*Anganwadi* Workers
BAME	Black and Minority Ethnic
BCA	Body Composition Analyzer
BCPs	Business Continuity Planning
BEC	Basic Emergency Care
BIHAN	Bihar Horticulture, Agriculture
BMC	BioMed Central
BMC	Brihanmumbai Municipal Corporation

BMG	Bill & Melinda Gates Foundation
BMW	Biomedical Waste
BYOD	Bring-Your-Own-Device
CBO	Community-Based Organization
CBP	Customs and Border Protection
CCP	Center for Communication Program
CCWGs	Critical Care Working Groups
CDC	Centers for Disease Control
CDC	Centers for Disease Control and Prevention
CECC	The Central Epidemic Command Center
CEPI	Coalition for Epidemic Preparedness Innovations
CI	Confidence Intervals
CIOs	Chief Information Officers
CISOs	Chief Information Security Officers
CLA	Collaborative Learning and Adapting
CLIPS	COVID-19 and Livelihoods in India Phone Survey
CMIE	Centre for Monitoring Indian Economy
COFEPRIS	Federal Health Commission for Protection
CONAVE	National Committee for Epidemiological Surveillance
COVAX	COVID-19 Vaccine Global Access Facility
COVID-19	Coronavirus Disease 2019
CSA	Cyber Security Agency
CSS	Centrally Sponsored Schemes
CTOs	Chief Technology Officers
DASS	Depression, Anxiety, Stress, and Insomnia
DAY NRLM	*Deendayal Antyodaya Yojana* National Rural Livelihoods Mission
DCH	Designated COVID Hospitals
DCHCs	Designated COVID Health Centers
DCPU	District Child Protection Units
DCVMN	Developing Countries Vaccine Manufacturing Network
DEF	Digital Empowerment Foundation
DfE	Department for Education
DHSC	Department of Health and Social Care
DPT	Diptheria, Pertussis, and Tetanus
DREAMS	Determined, Resilient, Empowered, AIDS-free, Mentored, and Safe
ECDC	European Centre for Disease Prevention and Control
EEA	European Economic Area
EMA	European Medicines Agency
ENSANUT	National Survey on Health and Nutrition
EOC	Emergency Operations Center
EPHI	The Ethiopian Public Health Institute
EQUIP	Ensuring Quality in Psychological Support
ESG	Environmental, Social, and Governance
ESRC	Economic and Social Research Council

EU	European Union
EUA	Emergency Use Authorization
FAME	Faster Adoption and Manufacture of Electric Vehicles
FBI	Federal Bureau of Investigation
FDA	Food and Drug Administration
FDA EUA	Food and Drug Administration Emergency Use Authorization
FDI	Foreign Direct Investment
FGM	Female Genital Mutilation
FICCI	Federation of Indian Chambers of Commerce and Industry
FRBM	Fiscal Responsibility and Budget Management
GAME	Global Alliance for Mass Entrepreneurship
GAVI	Global Alliance for Vaccines and Immunizations
GCSE	General Certificate of Secondary Education
GDE	General Directorate of Epidemiology
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GFCE	Government Final Consumption Expenditure
GFCF	Gross Fixed Capital Formation
GHS	Global Health Security
GOARN	The Global Outbreak Alert and Response Network
GoI	Government of India
GOI	Government of India
GRC	Governance Risk and Compliance
GRID	Generating Research Insights for Development
GVA	Gross Value Added
HDI	Human Development Index
HEWs	Health Extension Workers
HHS	Health and Human Services
HITECH	Health Information for Economic and Clinical Health
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information System
HPH	Health and Public Health
HPTs	Health Protection Teams
HRN/QHA	How Right Now/*Que Hacer Ahora*
HWGs	Health and Wellness Centers
ICDS	Integrated Child Development Services
ICMR	Indian Council of Medical Research
ICSPRC	The International COVID-19 Suicide Prevention Research Collaboration
ICT	Industry Communications Technology
ICU	Intensive Care Unit
IEC	Information, Education, and Communication
IFA	Iron and Folic Acid
IFPMA	International Federation of Pharmaceutical Manufacturers and Associations

IFPRI	International Food Policy Research Institute
IGM	Initiatives on Global Markets
IHR	International Health Regulations
IHS	International Health Security
IIHMR	International Institute of Health Management Research
IIP	Index of Industrial Production
IMF	International Monetary Fund
IMSS	Mexican Institute of Social Security
INDC	Intended Nationally Determined Contributions
InDRE	National Institute for Epidemiological Diagnosis and Reference
INEGI	Instituto Nacional de Estadística y Geografía
INSABI	Institute of Health for Wellbeing
IOC	Indicators of Attacks
IoT	Internet of Things
IPC	Infection Prevention and Control
IPC	Infection Prevention Control
IPCC	Intergovernmental Panel on Climate Change
IPR	Intellectual Property Rights
IPS	Indian Psychiatric Society
IT	Information Technology
ITU	Intensive Treatment Unit
IWWAGE	Initiative for What Works to Advance Women and Girls in the Economy
JAVI	Joint Committee on Vaccination and Immunization
JHU	Johns Hopkins University
JSS	*Jagadguru Sri Shivarathreeshwara*
KEPSA	Kenya Private Sector Alliance
KFF	Kiser Family Foundation
LA	Local Authorities
LCRC	London Coronavirus Response Cell
LEAD	Leveraging Evidence for Access and Development
LFTs	Lateral Flow Tests
LMICs	Low- and Middle-Income Countries
LPG	Liberalization, Privatization, and Globalization
LRP	Livelihood Restoration Plan
LRPs	Learning Resource Packages
MCH	Maternal and Child Health
MERS	Middle East Respiratory Syndrome
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MHPSS	Mental Health and Psychosocial Support
MIT	Massachusetts Institute of Technology
MOE	Ministry of Education
MOEA	Ministry of Economic Affairs
MOOC	Massive Open Online Course
MOSPI	Ministry of Statistics and Program Implementation

MPI	Multidimensional Poverty Index
MPP	Migration Protection Protocols
MSF	Médecins Sans Frontières
MSM	Men who have sex with Men
MSME	Micro, Small, and Medium Enterprise
MTUs	Mobile Testing Units
NACOSTI	National Commission for Science, Technology, and Innovation
NCERT	The National Council of Educational Research and Training
nCoV	New Coronavirus
NCW	National Commission for Women
NDC	National Development Council
NEIGRIHMS	North Eastern Indira Gandhi Regional Institute of Health and Medical Sciences
NFHS	National Family Health Survey
NGO	Non-Governmental Organization
NHI	National Health Insurance
NHM	National Health Mission
NHS	National Health System
NICD	National Institute for Communicable Diseases
NIMHANS	National Institute of Mental Health and Neuro Sciences
NISITU	*Nisikilize Tujengane*
NIV	Non-invasive Ventilation
NPIs	Non-Pharmaceutical Interventions
NPR	National Public Radio
NRLM	National Rural Livelihood Mission
NSSO	National Sample Survey Office
NTD	New Taiwan Dollars
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development
OOP	Out-of-Pocket
ORS	Oral Rehydration Solution
OTT	Over the Top
OWS	Operation Wrap Speed
PAHO	Pan American Health Organization
PAM	Privileged Access Management
PASU	The Presidential Policy and Strategic Unit
PC Kenya	Population Council Kenya
PCCE	Per Capita Consumption Expenditure
PC-GNI	Per Capita-Gross National Income
PCI	Per Capita Income
PCR	Polymerase Chain Reaction
PDS	Public Distribution System
PFCE	Private Final Consumption Expenditure
PGIMER	Postgraduate Gandhi Institute of Medical Sciences
PHC	Primary Healthcare

PHE	Public Health England
PHEIC	Public Health Emergency of International Concern
PHI/PII	Protected Health Information and Personally Identifiable Information
PICU	Pediatric Intensive Care Unit
PLA	Participatory Learning and Action
PMI	Purchaser's Manufacturing Index
PMKSY	*Pradhan Mantri Krishi Sinchayee Yojana*
PM-KUSUM	*Pradhan Mantri Kisan* Energy *Suraksha* and *Utthan Maha Abhiyan*
PNC	Post-natal Care
POP	Protect Our Planet
PPE	Personal Protective Equipment
PPP	Public-Private Partnerships
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-analyses
PSA	Pressure Swing Adsorption
PWID	People Who Inject Drugs
QMS	Quality Management System
RaaS	Ransomware-as-a-Service
RCCE	Risk Communication and Community Engagement
RCGP	Royal College of General Practitioners
RGSEAG	Rajiv Gandhi Scheme for Empowerment of Adolescent Girls
RHBs	Regional Health Bureaus
RISE	Reaching Impact, Saturation, and Epidemic Control
RKSK	*Rashtriya Kishor Swasthya Karyakram*
RMNCH	Reproductive, Maternal, Newborn, Child Health, and Nutrition
RMNCH+A	Reproductive, Maternal, Newborn, Child, and Adolescent Health
RT-PCR	Reverse Transcriptase-Polymerase Chain Reaction
SAGE	Strategic Advisory Group of Experts
SARS CoV 2	Severe Acute Respiratory Syndrome Coronavirus 2
SARS	Severe Acute Respiratory Syndrome
SBC	Social and Behavior Change
SBCC	Social and Behavior Change Communication
SDG	Sustainable Development Goals
SESEQ	Secretary of Health of the State of Querétaro
SGTF	S Gene Target Failure
SHGs	Self-help Groups
SII	Serum Institute of India
SM Net	Social Mobilization Network
SMS	Short Message Service
SNNPR	Southern Nations, Nationalities, and Peoples' Region
SOPs	Standard Operating Procedures
SPPS	Undersecretariat for Prevention and Health Promotion
SRLM	State Rural Livelihood Mission

SS	Supportive Supervision
SS	Surveillance System
STEM	Science, Technology, Engineering, and Mathematics
SWAYAM	Study Webs of Active-Learning for Young Aspiring Minds
SWO	State Welfare Organization
T&T	Test & Trace
TA	Technical Assistance
TAG	Technical Advising Group
THR	Take Home Ration
ToC	Theory of Change
ToTs	Training of Trainers
TSMC	Taiwan Semiconductor Manufacturing Company
TV	Television
UCID	Remote Consultation Units
UEBA	User and Entity Behavior Analysis
UHC	Universal Health Coverage
UK	United Kingdom
UKHSA	UK Health Security Agency
UNDP	United Nations Development Programme
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNICEF	United Nations International Children's Emergency Fund
URLs	Universal Resource Locators
USA	United States of America
USAID	United States Agency for International Development
UTs	Union Territories
UVEH	Epidemiological/Hospital Surveillance Units
VDH	Virginia Department of Health
VHNDs	Village Health and Nutrition Days
VHSNDs	Village Health and Sanitation Days
VoC	Variants of Concern
VoI	Variants of Interest
VPN	Virtual Private Network
VR	Virtual Reality
VUI	Variant Under Investigation
WGS	Whole Genome Sequencing
WHO	World Health Organization
WHO JEE	World Health Organization Joint External Evaluation
WTO	World Trade Organization

The Changing Face of COVID-19

Saroj Pachauri and Ash Pachauri

Abstract Ever since it began in 2019, the COVID-19 pandemic has been continuously evolving. Simultaneously, our understanding of the virus and its pathogenesis has advanced significantly. The authors track the changes that the pandemic has undergone over the last two years. In addition, they provide an overview of the chapters in the book which cover the health, economic, political, and educational dimensions of COVID-19 in several different countries.

Introduction

The novel human Coronavirus Disease 2019 (COVID-19) was first reported in Wuhan, China, in 2019 and rapidly spread globally to become the fifth documented pandemic since the Spanish flu in 1918. As on January 2021, COVID-19 had infected nearly 300 million people and caused more than five and a half million deaths across almost 200 countries [1]. Numbers of infections are breaking records almost every day and a constant pandemic threat with new mutations of the viral agent (SARS-CoV-2) continues to create and reveals a myriad of socio-economic and human security challenges.

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The Initial Response

The earliest cases of COVID-19 were documented on December 31, 2019. At the time, the World Health Organization (WHO) was informed of cases of pneumonia in Wuhan, China, with no known cause. On January 7, 2020, the Chinese authorities identified a novel coronavirus, which they temporally named 2019-nCoV, as the cause of the recently reported pneumonia cases. Four weeks on, on January 30, 2020, the WHO declared the rapidly spreading COVID-19 outbreak as a Public Health Emergency of International Concern. A few days later, on February 11, 2020, the novel coronavirus got its official name, COVID-19. Nine days later, the US Centers for Disease Control and Prevention (CDC) confirmed the first COVID-19 death in Washington State in the United States [2].

Emergence of the COVID-19 Pandemic

In the initial days, global health professionals, government authorities, and citizens were unsure of how the infection would spread and how it would impact daily life. On March 1, 2020, the United Nations disbursed USD 15 million to support the response to COVID-19. In just a week, on March 7, 2020, cases of COVID-19 reached 100,000. Days after that, on March 11, 2020, COVID-19 was declared a pandemic by the WHO. Thus, COVID-19 transformed from being a public health concern seemingly confined to China to a global health emergency in a matter of days.

During this period, the situation in Wuhan had been diffused to an extent following unprecedented lockdown measures affecting almost a billion people, to reign in the virus. At the start of the outbreak, China was seeing thousands of new infections a day, which had dropped to dozens by March 2020. In Europe, on the other hand, cases were rising sharply, with Italy reporting a record number of 250 deaths in a 24-h period between March 12 and March 13, 2020. As a result, on March 13, 2020, the WHO declared that Europe had become the epicenter of the COVID-19 pandemic. On the same day, the US declared a state of public health emergency [2].

The Race to Develop a Vaccine

In response to the pandemic, lockdown measures were put in place globally with varying degrees of restrictions in countries achieving different degrees of success to contain the spread of the virus. The impact of these lockdowns crippled economies. Some countries went to the other extreme adopting starkly contrasting strategies based on protecting the economy at the cost of higher infection and mortality rates. For example, Brazil, which defied lockdowns, had 50 cases of COVID-19 on 11

March, 2020 and in just 63 days this figure reached 177,589 cases [3]. Widespread social distancing and travel restrictions were enforced in March 2020 along with proper hand washing guidance issued by WHO. However, these measures promised only to slow rather than arrest the spread of the virus. Scientific and medical communities pointed to the urgent need to develop a vaccine in order to overcome the pandemic. A significant hurdle to achieving this, though, was that the fastest a vaccine that has ever developed, the mumps vaccine in 1967, took four years. Nevertheless, it was apparent that a post-COVID-19 world would certainly include some sort of an immunization program. The first COVID-19 human vaccine trials began with the Moderna mRNA vaccine on March 17, 2020.

Vaccine development is a long and arduous process often taking decades to achieve. But with imminent concern surrounding the COVID-19 pandemic putting unprecedented pressure on global healthcare systems and economies, exceptional measures were deployed to support vaccine development. Through a series of announcements beginning on March 30, 2020, the U.S. Department of Health and Human Services (HHS) started a program they called "Operation Warp Speed" (OWS), in an attempt to expedite COVID-19 vaccine development.

The crucial piece of OWS, beyond allocating large funding for vaccine development and research, was that it fundamentally changed how pharmaceutical and biotechnology companies assess the risk of conducting large-scale clinical trials on a brand-new vaccine. This was achieved through the HHS putting in place the requisite infrastructure and guaranteeing the manufacture of any successful vaccine candidates. It also bought allotments of the vaccines prior to knowing whether any of the OWS-funded companies would be successful. Since putting vast resources into manufacturing billions of doses of a vaccine which is still in the infancy of its development would be unviable for pharmaceutical companies, the HHS' decision to substantially free this process of risk in order to expedite the development of candidate vaccines proved to be a game-changer [4].

As many around the world were preoccupied with bearing the brunt of the first wave of the pandemic, COVID-19 vaccine development quickly began. It was clear that initial restrictions were not sufficient to stop the spread of COVID-19. Quickly, lockdowns in most regions became more stringent, with the UK enforcing a stay-at-home rule on March 26, 2020. Many European countries implemented their own national lockdown measures around the same time. By April 2, 2020, the total number of global COVID-19 cases climbed to one million. The seriousness of the pandemic came into sharp focus with this number, and governments raced to do what they could to slow the spread of the virus before a vaccine could be developed and declared safe for human use. On April 6, 2020, the WHO announced guidance on mask wearing, as increased evidence pointed to the role of aerosols in the spread of the disease [2].

New Variants and Changing Pandemic Dynamics

Over the Summer of 2020, many countries experienced a drop in cases, hospitalizations, and deaths as a result of restrictions imposed to prevent the spread of the virus. However, toward the end of the Summer, in August of 2020, the Lambda variant was first detected in Peru. A month later, the Alpha variant was first found in the UK in September 2020. The Beta strain surfaced in South Africa and the Gamma variant was identified in Brazil soon after. New naming conventions for the variants were established by the WHO as an alternative to names based on numbers and countries to avoid public confusion and stigma. The discovery of these variants demonstrated that the virus was evolving. As a result, symptoms, disease severity, and outcomes were changing, as well [2].

With the emergence of new variants, cases of COVID-19 began to rise dramatically in many countries. In late 2020, the Delta Variant, which was first detected in India, swept rapidly through that country and the U.K. before reaching the U.S., where it quickly spread. It was until late 2021, the predominant SARS-CoV-2 variant accounted for more than 99% of COVID-19 cases (at the time) and spiraling overwhelming numbers of hospitalizations [5]. Delta is believed to be more than twice as infectious as previous variants, and research shows that it may be more likely than the original virus to result in hospitalizations [6].

Efficacy of Multiple Vaccines

Shortly after the Delta variant was first identified, concerns over the potential increased transmissibility of the variants, fueled by a rise in cases in some counties such as the UK, forced many governments to reinstate lockdown measures. However, efforts to develop vaccines in record time, underway simultaneously, began to reap results. On November 9, 2020, trials demonstrated the Pfizer and BioNTech vaccines to be over 90% effective and safe. The Moderna vaccine was also approved just a week later. The UK became the first Western country to license a vaccine against COVID-19. The Pfizer/BioNTech vaccine was authorized for emergency use by the Medicines and Healthcare Products Regulatory Authority or the MHRA in the U.K. The vaccine was initially given to those most at risk. On November 23, 2020, the University of Oxford's AstraZeneca COVID-19 vaccine was also shown to be effective. Finally, on December 31, 2020, the WHO issued its first emergency use approval for a COVID-19 vaccine, making the Pfizer/BioNTech vaccine the first to be available for use. The emergency validation was seen as a positive step toward making COVID-19 vaccines globally available, an important move toward ending the pandemic.

Soon after, the Moderna vaccine and the Oxford/AstraZeneca vaccine were approved for use, and national vaccine roll-out initiatives began with full force. By April 27, 2021, one billion COVID-19 vaccine doses were administered. While

it is clear that continued roll-out of vaccines in all countries is vital for bringing the pandemic under control and preventing future outbreaks, vaccine inequity, vaccine hesitancy, misinformation, and denialism remain critical barriers to the uptake of the COVID-19 vaccine. People who are not vaccinated are most at risk, and the highest spread of cases and severe outcomes is happening in places with low vaccination rates. This could prolong the pandemic and also raise the risk of further mutations of the virus, possibly undermining the efficacy of existing vaccines in the process [7].

Regulators are expected to authorize, approve, and license several more COVID-19 vaccines for human use in the near future. Yet, having licensed vaccines is not enough. They also need to be produced at scale, priced affordably, and equitably distributed globally so that they are available where needed and are widely deployed in local communities while keeping with their efficacy and validity requirements. Promoting knowledge about vaccines, boosting community awareness, and building trust are essential measures needed to mitigate vaccine hesitancy and refusal. While the COVID-19 pandemic has made a significant impact on preventive healthcare through enforced distancing and lockdown measures, self-care strategies, such as mask wearing and hand washing, and vaccine mandates and penalties have been rapid and predominantly accelerated by global politics, policies, and economics. Developments in COVID-19 treatment, also underway, have been slower and largely focused on decreasing viral load and limiting disease severity.

Virus Variants Continue

On November 26, 2021, the WHO delved deeper into the Greek alphabet to declare Omicron a new SARS-CoV-2, a Variant of Concern (VOC) [8]. Limited evidence to date indicates that Omicron is more infectious, evades prior immunity to a greater degree, and causes less severe disease, all relative to the, thus far, dominant Delta Variant [9]. The WHO warns that the two variants can combine and cause what it calls a "Tsunami of infections around the world". Despite this, the Director General, Tedros Adhanom Ghebreyesus, believes the pandemic could end in 2022 if countries work together. Overcoming the acute stage of the pandemic and building on health and human security will mean sharing successes and failures faster, while ensuring equity, and wider access to vaccines and new treatments, while sharply departing from pro-nationalistic policies.

Before the emergence of Omicron, the past months have witnessed global debates about the importance of vaccine mandates, the adoption of vaccine passports, testing requirements, mask mandates, limitations on social gatherings, and travel restrictions. Societies have been trying to find consensus through the transition of the pandemic and multiple waves of infection, with some maintaining minimal public health restrictions in the face of rising case counts and others reinstating more stringent lockdown measures. Achieving some degree of global consensus on public health measures, cooperation, and global solidarity will, undoubtedly, be an important step toward curbing the pandemic, addressing its impacts, and preparing for

potential future pandemics. The future of the COVID-19 pandemic, which is in its third year now, depends on the ways in which societies respond together. Much can be learned from the story of the COVID-19 pandemic, and many hope lessons learned will prepare us for future infectious disease outbreaks to prevent future pandemics.

This book makes a unique contribution to the field to expand our understanding about the pandemic by encapsulating diverse, global perspectives and responses about the multitude of pandemic dimensions and its dynamics.

Context of the Book

The pandemic has evolved significantly since the first book on COVID-19 entitled "Health Dimensions of COVID-19 in India and Beyond" was written by the authors [10]. In this section, the multiple health, economic, political, and educational aspects of the pandemic in several different countries are summarized. In this edited volume, the authors have contributed chapters on a range of factors related to COVID-19. These include the health system response to the pandemic by improving the resilience of the healthcare workforce, employment of the systems approach, implementing women-led maternal and child health services, setting up a sustainable health system, and organizing a comprehensive care approach to stem the pandemic. The impact of the pandemic on education is examined. The economics and politics of COVID-19 are discussed with a focus on its economic impact, socio-economic disparities, and long-term impact. COVID-19 vaccination programs and vaccine equity are analyzed. The authors have contributed chapters on media and communications including media consumption and audience perceptions and concerns, the impact of social media, and communications to reach vulnerable populations. The authors discuss the special problem of vulnerable populations focusing on the unprecedented rise in suicides, experience of asylum seekers, stigma and discrimination, and the impact of COVID-19 on adolescents. In addition, the authors present the COVID-19 experiences of several countries including the United Kingdom, Ethiopia, Mexico, Iran, Brazil, and Taiwan. The chapters of this book contain data and content that were accurate up to 2021, but significant changes have occurred since then. The authors made every effort to provide the most up-to-date information related to their respective topics before submitting their final drafts to the publishers.

Health Systems Response

The COVID-19 pandemic generated an unexpected and unprecedented impact on health service systems. Its impact was greater in low- and middle-income countries where the health systems are more fragile. Governments designed several health strategies in response to the onslaught of the pandemic. The authors discuss these strategies as well as the experiences of countries with these programs.

Addressing the Urgency and Magnitude of the COVID-19 Pandemic in India by Improving Healthcare Workforce Resilience

Bulbul Sood and co-authors examine the problems caused by the sudden surge in COVID-19 cases during the second wave and highlighted India's lack of preparedness for critical care requirements in terms of infrastructure and human resources. It is the need of the hour to make efforts to build resilient and responsive health systems that are well-prepared to handle the current COVID-19 pandemic and similar future threats. The challenges in the healthcare system during the second wave of COVID-19 included overstressed human resources in tertiary facilities, lack of trained healthcare workers, inadequate infrastructure at secondary-level facilities, and a shortage of beds, ventilators, medicines, and other requirements for tertiary-level care. Other challenges were lack of resources/capacity for setting up intensive care units (ICUs), unutilized ICU equipment at secondary-level facilities, and lack of operational planning, coordination, and support.

Through the United States Agency for International Development (USAID) supported Reaching Impact, Saturation, and Epidemic Control (RISE) Program, Jhpiego is providing technical assistance in 20 states across India to respond to the urgency and magnitude of the second wave of COVID-19. It is identifying areas and modalities of implementation and aligning these to the country's response to the surge. The project's focus is on health system preparedness for present and future waves of COVID-19 including activities for strengthening critical care services, medical oxygen management, strengthening molecular testing laboratory, strengthening the health system to respond to future waves, and enabling effective planning and management of critical logistics. This is being done in coordination with the Government of India (GoI) and state governments and by involving both public and private sector/faith-based institutions and non-government organizations (NGOs).

Comprehensive Care Response and Systematic Management of COVID-19 in Querétaro, Mexico

Adriana Aguilar Galarza and co-authors analyze the health impact of the pandemic in México. They focus on the state of Queretaro and examine the social conditions of the population and health policies implemented at the federal and state levels as well as in the Universidad Autonoma de Queretaro.

The work is presented in three parts: In the first part, epidemiological data referring to the prevalences, incidence, and mortality from COVID-19 in Mexico and Querétaro are presented. In the second part, the epidemiological panorama of Queretaro is presented as an analysis tool to direct the epidemiological behavior of the pandemic in the population. And the social, economic, and health conditions in the state are analyzed. Finally, in the third part, health policies implemented by the state

university, including the experience of an integrative care model implemented in the "*Clinica de Atencion Integral COVID*" which provides multidisciplinary assessment and treatment of COVID-19, are presented.

Bridge over Troubled Waters: Women-Led Community Response to Maternal and Child Health Services in India Amidst COVID-19

Aastha Kant and Avishek Hazra discuss the problems caused by the pandemic on the delivery of essential health services in general and reproductive, maternal, newborn, child health, and nutrition (RMNCHN) services in particular. They argue that the degree of disruption varies disproportionately. It is more in low- and middle-income countries than in high-income countries. Focusing on India, the authors draw on various demand and supply side factors that hampered RMNCHN service provision and thus adversely affected many families across the country. Coupled with the gendered aspects of the social determinants of health, the pandemic intensified social vulnerabilities by impacting pregnant and lactating women and children the most. Modeling studies suggest that the progress India made over a decade on various maternal and child health and nutrition indicators could go in vain unless focused efforts are made to address this slide. Complementing government efforts to mitigate the health risks of the pandemic by strengthening disrupted health services, community initiatives have played a promising role. Some of the women-led initiatives portray how women's collectives and women in leadership could be like a bridge over troubled waters in the times of a pandemic.

COVID-19: An Accelerant to a Sustainable Health System in Kenya

Daniella Munene discusses supply chain inadequacies, human resource constraints, and pervasive false narratives that misinform the public. The COVID-19 pandemic directed our individual and collective focus on the adequacy of our health system. Was it resilient enough? Had the deficiencies that we were seeing been there all along? Why were they not noticed? Why did voices were not raised earlier about the gaps? Perhaps they were. But, why have the proposed changes not been made? Was it resource constraints? Was it poor policies? Was it weak enforcement? These were some of the questions that were going through our minds, the nature of the question reflecting the position each actor had within the system. Action was taken. People organized themselves into task forces and committees and implemented strategies and work plans. And they started to see results.

Face masks and assembling ventilators have now been manufactured in the country. Critical care capacity has been increased. Oxygen plants have been built. Policies have been drafted to spur the growth of the local pharmaceutical manufacturing sector. Drug supply chains have been diversified to prevent stock-outs. The general public has tremendously increased its health literacy. Countries are in a much better place than when it began.

Economics, Politics, and Education

COVID-19 has impacted the economic and political fabric of our society. It is expected to have long-term consequences on both developed and developing countries. The authors discuss the economic impact of the pandemic on the economy. They analyze how socio-economic disparities have amplified the disease. The impact on education is assessed. The authors also discuss the experience with vaccines in several countries as well as the intractable problem of vaccine inequity.

COVID-19 and the Economy: Constructing Roadmaps to An Inclusive Recovery

Mithali Nikore and co-authors discuss the economic impact of the COVID-19 pandemic which has driven the highest share of economies into recession in modern times and is expected to bring about the largest contraction in the global gross domestic product (GDP) per capita since World War II. The uncertainty it has spawned is driving governments and institutions into a conundrum, as they are tasked with charting out a course for recovery. While India's GDP contracted 7.3% in FY 2020–21, COVID-19 deepened and exposed the fault lines of its economy. The authors highlight the phase of slowdown in India prior to the pandemic and how COVID-19-related lockdowns reinforced the slowdown. They demonstrate historical trends for a set of indicators for three sectors: agriculture, manufacturing, and services. They display the extent of damage that the pandemic-induced economic slowdown has caused while also identifying underlying factors that existed pre-COVID. Finally, the authors present a macro-economic outlook covering trends and linkages across demand drivers, employment, and investment. They conclude with a roadmap for inclusive growth advocating strategies that seek to advance equality of access, sustainability of resources, and state capacity for governance.

Crafting Data-Driven Strategies to Understand the Amplification of Disease Spread due to Socio-economic Disparities

Ayan Paul states that as a disease whose spread is correlated with mobility patterns of the susceptible, understanding how COVID-19 affects a population is by no means a univariate problem. Akin to other communicable diseases like HIV, SARS, MERS, Ebola, etc., the nuances of the socio-economic strata of the vulnerable population are important predictors and precursors of how certain parts of society will be differentially affected by the spread of the disease. In this work, the author delineates the use of multivariate analyses in the form of interpretable machine learning to understand the causal connection between socio-economic disparities and the initial spread of COVID-19. He shows why this is still a concern in a developed nation like the USA with a world leading healthcare system and emphasizes why data quality is important for such methodologies and what a developing nation like India can do to build a framework for data-driven methods for policy-building in the event of a natural crisis like the ongoing pandemic. The hope is that realistic implementation of this work can lead to more insightful policies and directives based on real-world statistics rather than on subjective modeling of disease spread.

The Long Shadow of COVID-19

Mukesh Kapila states that the sudden arrival of COVID-19 shook the world and evoked varied—sometimes contradictory—reactions from communities, countries, and institutions around the world. The pandemic brought out the best and worst of humanity even as the complex of factors underpinning the spread of the coronavirus collided in myriad ways to both facilitate and obstruct effective responses. The experience has generated much angst that questions the way we are organized and relate to each other and, most of all, it has the potential to re-shape our fundamental premises. The effects will be profound going well beyond the pandemic itself to the notions of collective health as a common global good.

COVID-19 Vaccination: A Necessitated Drive Becoming an Unsolved Puzzle

Drishya Pathak discusses how the scientific community has achieved a remarkable feat by developing COVID-19 vaccines in a record duration of twelve months. The fastest vaccine, developed and deployed previously, had been within a time-frame of

four years to prevent mumps in the 1960s. The speedy approach to prevent SARS-CoV-2 has changed the future of vaccine science with several vaccines being developed showing excellent results in large trials. The COVID-19 vaccination strategy has crucial importance. As the vaccination mandate has been faster than information dissemination, and even faster than the clinical trial results in some regions, numerous challenges emerged during its execution. The author discusses the objectives of the vaccination drive that include reduction of overall COVID-19 severity and mortality against various strains of the virus; re-opening of society and disease elimination; reduction of pressure on the healthcare system; and equitable distribution of vaccines across all regions of the globe. While reflecting on these objectives, the author emphasizes the importance of transparency in vaccination surveillance data.

Impact of COVID on Adolescents, Nodal Teachers, and Frontline Workers

Aparajita Gogoi and co-authors emphasize that adolescence is a critical period that shapes the future of young people's lives. Young people were severely impacted by the COVID-19 pandemic. Closures of schools and non-formal education deprived them of learning opportunities and also of social engagement with their peers and educators. Prolonged lockdowns/closures and movement restrictions led to emotional and mental unrest and anxiety. Adolescents and youth, especially adolescent girls and young women, experienced higher levels of violence due to quarantine and isolation. The authors discuss the ground realities and their effect on health services and access to education of adolescents during the COVID-19 lockdown. They highlight important issues and make recommendations for policy dialogue and advocacy around key critical areas like vulnerability to COVID-19 infection, physical abuse, limited access to mobile phones, disruption of supply chains around sanitary napkins, adolescent-friendly counseling, dealing with violence, early marriage, school dropouts, and trafficking. Recommendations are made to decision-makers and program implementers for addressing barriers to ensure access to timely and appropriate care.

Impact of COVID on Our Digital Lives

Sharon Pithawalla and Anshul Chabbra discuss how the COVID-19 pandemic ripped through our society like a tornado, displacing and destroying everything in its wake. This is no different from the multitudes of pandemics that have hit throughout the history of humanity… except for one new dimension that did not exist earlier, the digital dimension. According to a Pew Research Center survey, only 7% of U.S. adults say they do not use the Internet, which means 93% use the Internet in some manner.

COVID-19 has irrevocably shifted human attitudes and technology/cybersecurity direction on our planet. Whether it is our wide acceptance of technologies like Zoom as a natural way to interact with each other in a variety of social, educational, and work settings, or the mind shift around acceptance of remote work or Zoom parties, etc., or even the boost to the upcoming virtual, augmented, and hybrid reality of a metaverse, COVID-19 marks the beginning of another epoch in the modern history of humankind. In a seemingly contradictory way, COVID-19 has further exacerbated the digital divide, while also providing a fresh new boost to further innovation and the inevitable merging of our physical and digital lives. It is at once a very anxious and a deeply exciting time that we are all living through. Those of us who lived through this pandemic will clearly remember the answer to the question—where were you during the pandemic?

Media and Communications

The authors discuss the important role that media and communications have played during the pandemic. They analyze audience perceptions and fears of the unknown that have been generated due to misinformation and discuss the impact of public health communications and of social media on the pandemic.

Unmasking Realities: Public Health Communication During India's COVID-19 Pandemic

Sonalini Mirchandani and Sunitha Chitrapu take a critical look at India's public health communications during COVID-19. The case study method is used. Data include what was gleaned from interviews with key informants engaged in outreach communications and from news reports and artefacts from select COVID campaigns as they evolved through the first and second waves of the pandemic. Learnings are drawn from previous health communication campaigns that focus on behavior change including India's successful and well-recognized communication interventions during its HIV and AIDS campaigns, as well as its remarkable Pulse Polio efforts.

Social Media in the Time of a Pandemic

Anjali Nayyar and co-authors state that social media has evolved from being a set of rudimentary tools to a complex instrument that has had both positive and negative consequences, often leading to the widespread circulation of misinformation impacting societies and institutions.

The COVID-19 pandemic, significantly, is the first health crisis, witnessed globally in the age of social media and amidst unprecedented connectivity. Throughout the pandemic, the world has witnessed widespread use of social media. Social media has not only enabled isolated people to remain connected with their friends and families but also to communicate with medical experts. At the same time, myths about COVID-19, its treatment, and its effects have circulated on the same platforms leading governments to issue guidelines in several nations including India. While social media has enabled a regular flow of information, it has also led to unverified content circulating on platforms such as Twitter and Facebook, fueling panic in people about the virus and the vaccines.

This chapter explores the role social media platforms (Facebook, Twitter, Instagram, and others) have played in enhancing and delivering evidence, connecting communities, and also in circulating myths and unverified content during the COVID-19 pandemic. Through quantitative analysis, it encapsulates trends being witnessed in different geographies. It will conclude with learnings that we have gathered on leveraging this medium which can be used going forward in instances of future health crises.

Communications Strategies for Reaching Vulnerable Populations in the US for Building Trust, Vaccine Confidence, and Digital Connections

J. Carlos Velázquez and Amelia Burke-Garcia address the communication challenges of the disparate impact of COVID-19 on vulnerable populations in the USA including Latinos, African Americans, American Indians, and older adults. They examine the barriers that mitigate vaccine confidence and testing efforts. They also highlight the successful communications strategies that engaged vulnerable populations at the grassroots level to own and organize vaccine promotion efforts in local communities and to shift the narratives about vaccine hesitancy. Three case studies are presented to provide tools and resources that can be implemented for ongoing communication interventions to promote COVID-19 vaccine uptake.

Exploring a Vaccine for the Misinformation Virus in a Global Pandemic: Media Literacy, COVID, and Science Communication

Sundeep R. Muppidi explores the questions raised at the end of his recent book on "COVID-19, Racism and Politicization: Media in the midst of a pandemic". For this chapter, he extends on that book to explore the socio-cultural, politico-economic, and digital context of media audiences' consumption of information, misinformation, and disinformation and their innate ability (or lack thereof) to distinguish factual information and/or fall prey to false and misleading information (or not). The impact of such media consumption, how it breeds irrational fears of the unknown and opposing views, and its impact on participation in civil society are explored. He concludes by suggesting possible strategies to counter this trend.

Vulnerable Populations

The authors discuss the unprecedented rise in suicides and study asylum seekers and adolescents as well as increasing stigma and discrimination during the pandemic.

Preventable Losses: Threatening Rise in Suicides During the Pandemic

Komal Mittal and co-authors argue that COVID-19 is becoming one of the worst humanitarian crises of the twenty-first century. It has unraveled the very fabric of human lifestyles with mental health at the core of its concerns. Now more than ever, suicide has become a serious public health problem worldwide. Studies published after the pandemic was declared in March 2020 estimate that suicide rates will rise globally as a result of the COVID-19 pandemic. The WHO estimates that for each adult suicide, more than 20 others attempt suicide, and suicide risk is much higher in individuals who previously attempted suicide. Hence, suicide prevention in the times of the COVID-19 pandemic has become a global priority not only due to the increased rate of mortality, but also because of exacerbation of risk factors including economic instability, poor access to healthcare facilities, basic amenities, social disconnect, and many more. The aim of this chapter is to examine the relationship between the COVID-19 pandemic and the rise in suicide rates and mental health concerns. The authors undertake an analysis of existing systems and programs put in place by the government and civil society groups to critically examine suicide prevention strategies and approaches and comment on the way forward.

We Are Not all in the Same Boat: Refugees and Asylum Seekers in the Context of COVID-19

Philo Magdalene and co-authors show that the COVID-19 pandemic exacerbated the existential risks and uncertainties experienced by refugees and asylum seekers on a day-to-day basis. Although the pandemic presents some level of risk to everyone, the world's refugees and asylum seekers bear a very heavy burden of risk in the context of COVID-19. Overcrowding in camps, lack of access to medical services, changes to the asylum-seeking process, movement restrictions, and other factors converge to disproportionately impact refugees and asylum seekers. The chapter presents a case study that looks at the experiences of asylum seekers at the US-Mexico border through the lens of a non-governmental organization (NGO) volunteer who has been working in the region throughout the pandemic. By using this case study and secondary-level research, the authors seek to provide an understanding of the ways the pandemic has aggravated the challenges refugees and asylum seekers are facing globally, with an emphasis on the US-Mexico region.

Stigma Mechanisms in a Globalized Pandemic in India: A Theoretical Framework for Stigma

The GRID COVID-19 Study Group states that stigma has been documented to act as a significant barrier to healthcare access and healthcare-seeking behavior. Traditional frameworks of stigma and discrimination have been used in the past to explain the stigma associated with diseases such as tuberculosis, leprosy, and HIV. However, increasing globalization and the unprecedented access to information via social media and the Internet have altered infectious disease dynamics and have forced a rethink on mechanisms which propagate stigma. SARS, MERS, Ebola, and more recently COVID-19 have been associated with fear in communities across the globe due to the inherent uncertainties associated with emerging infectious diseases and a concurrent spread of misinformation—an infodemic. The authors present a theoretical framework to explain the evolution of COVID-19-associated stigma by exploring the complex interplay of various international, national, and intra-national mechanisms. It is anticipated that a conceptual framework which explains the evolution of stigma in fast-spreading global pandemics such as COVID-19 may also prove to be useful as a starting point for furthering the discussion on the progenitors, pathways, and manifestations of COVID-19-related stigma. This framework should be of practical use to researchers who are interested in exploring, validating, and identifying interventions to inform other frameworks for similar diseases.

The Social, Education, Health, and Economic Effects of the COVID-19 Pandemic on Kenya's Adolescents

Julie Mwabe and Karen Austrian state that the first case of COVID-19 was detected in Kenya in March 2020. Initial government responses included several containment measures such as school closures, movement limitations, and bans on public gatherings. These measures had many follow-on effects, in particular for the country's vulnerable adolescents. Between June 2020 and February 2021, two rounds of quantitative data were collected in four counties in Kenya (Kilifi, Kisumu, Nairobi, and Wajir) via phone surveys (n = 3,921). In addition, qualitative in-depth interviews were conducted in person in November 2020 with adolescents, parents, and other key stakeholders (n = 234). Results showed that the pandemic's effects on adolescents were far reaching and often differed by gender. While 85% of students reported doing some form of remote learning during school closures, 98% of them reported considerable challenges with less than one-third using technology (i.e., computers, phones, television, or radio) to support their learning. Over half of the adolescents reported depressive symptoms and over three quarters reported skipping meals in the past week due to COVID-19. Twelve percent of girls and 9% of boys reported skipping healthcare services in the past one month, with the most common reason being lack of money to access the needed service. Once schools fully re-opened, 16% of girls and 8% of boys who were enrolled at the start of the pandemic had not re-enrolled. Given the wide, multi-sectoral nature of the impacts of the pandemic, a coordinated response involving education, health, and gender actors, as well as government and non-government partners, is needed to mitigate the long-term negative impacts for Kenya's adolescents, in particular girls and other marginalized groups.

Country Experiences

Experiences of countries including the United Kingdom, Ethiopia, Mexico, Taiwan, Brazil, and Iran are discussed by the authors.

The Public Health Response to COVID-19 in the UK: A View from the Frontline

Tania Mishra charts the experience of working on the frontline public health response during the pandemic. The UK's initial public health response to the pandemic comprised a delayed lockdown, shortages of personal protective equipment (PPE), insufficient testing capacity, and ambivalence about wearing masks.

The pandemic's first wave ravaged the healthcare sectors. Subsequently, with experience and tight testing regimes, the management of COVID-19 in the care

sector improved enormously. Hospitals reduced workload to a bare minimum initially, followed by separate pathways to facilitate elective work, underpinned by testing and infection control. In addition to the elderly and frail, those on the fringes of society—for example, homeless, refugees, asylum seekers, and prison populations—experienced high rates of infection and mortality.

Nation-wide restrictions on movement were propped by an economic support program. The new school year in 2020 began amid rising cases, as people struggled to interpret confusing policies. Workplaces did not emerge from remote working till mid-2021 and remain a hub of infection transmission.

The tussle between maintaining economic activity and education versus preventing the spread of cases continues, while the focus of the public health response moves to high vaccination coverage, rapid testing, and responding robustly to emerging variants of concern.

Social and Behavior Change Preparedness for COVID-19 Prevention: Evidence and Experience from Ethiopia

Nandita Kapadia and co-authors discuss the experience of Ethiopia which is Africa's second-largest country and had 368,106 COVID-19 infections and 6,583 deaths as of November, 2021. Social behavior change (SBC) approaches which include mass media, health worker home visits, and community engagement are the cornerstone of an effective COVID-19 prevention strategy, in addition to vaccination. The authors assess Ethiopia's SBC preparedness to prevent the increase and spread of COVID-19 cases. They make recommendations on "SBC preparedness" in the context of another wave of COVID-19 in Ethiopia. The Johns Hopkins Center for Communication Programs collaborated with the Ethiopian Ministry of Health from March 2020 onwards to implement a rapid COVID-19 prevention intervention that includes supporting national- and regional-level risk communication systems, developing mass media and other public communication materials, promoting community engagement, and managing misinformation.

A computer-assisted phone survey was conducted in three regions (Amhara, Oromia, and Tigray) in October 2020 to estimate the prevalence of COVID-19 preventive behaviors, risk perceptions, and COVID-19 knowledge levels in about 1,000 respondents. The survey showed that only a third of the respondents practiced all three major COVID-19 preventive behaviors—wearing a mask, keeping two meters physical distance, and hand washing with soap. Policy implications for COVID-19 prevention within the Ethiopian context are discussed.

COVID-19 in Mexico: How the Systems Approach Can Improve Our Response?

Oscar San Roman Orozco and co-authors cite Donella Meadows, who identifies a system as any set of interrelated things that produce their outcome. The elements in any system are highly interconnected as they continuously influence each other. Public health challenges do not exist in a vacuum but are influenced by several factors, including the social, economic, and political context. To understand any one factor, mapping out the surrounding elements and analyzing the relationships between them and other elements in the system is necessary. The authors apply the systems thinking approach within the Mexican context. A systems analysis of COVID-19 in Mexico through a systems map is undertaken to illustrate the complexity of systems and how to leverage the power of systems thinking to execute intersectoral, innovative, and highly impactful interventions for an improved response to the ongoing COVID-19 pandemic and the pandemics of the future.

Response to the COVID-19 Pandemic in Taiwan

Shikha Kukreti and co-authors state that the world has suffered a large number of infections and deaths due to the COVID-19 pandemic. Due to its proximity to China, it was initially feared that Taiwan would become the worst affected country. However, COVID-19 has been widely controlled in the region; a few local outbreaks occurred with limited cases since the pandemic began. Taiwan leveraged its experience in containing the SARS outbreak in 2003 to respond to the COVID-19 crisis with proactive measures, early deployment, prudent actions, and transparency. Most political debate in Taiwan has centered around vaccines. However, from challenges like vaccine availability to increasing people's willingness to take vaccines, the Taiwan government has succeeded well. Taiwan's National Health Insurance system is a vital component of its strategy to improve the efficiency of healthcare delivery throughout the country. And the database integrated with the Centers of Disease Control provides real-time alerts to healthcare providers about patients whenever they are identified. In response to the Delta variant spread after a community outbreak, health monitoring measures were tightened, leading the country to successfully control the spread of the infection. Other countries could draw lessons from Taiwan's response to COVID-19.

COVID-19 in Brazil: Overall impact and singularities

Antonio vaz de Macedo and co-authors discuss how the pandemic has spread at alarming rates across the globe with a case tally of over 270 million and a death toll of more than 5 million as of mid-December 2021. Ranking third among the world's

most affected SARS-Cov-2 hotspots, Brazil is by far the hardest hit among its Latin American neighbors, with over 22 million cases and a death toll in excess of 600,000. The actual death toll is likely higher. The official figure is lower because of limited testing and inconsistency in nationwide cause of death reports. Despite Brazil's continental dimensions and one of the largest developing free market economies in the world, it is tainted for harboring one of the highest socio-economic disparities of all, with roughly a fifth of its population under the poverty line. On the positive side, Brazil has the largest public funded healthcare program in the world. Despite having lagged behind vaccination roll-out initially, the country has taken a giant leap over the past six months, which has resulted in two-thirds of its population being vaccinated. There has been a tremendous drop in both SARS-Cov-2 cases and deaths. In this chapter, the authors discuss the overall impact of the COVID-19 pandemic in the country with a particular focus on underserved minorities.

Iran's Experience with the COVID-19 Pandemic: Focusing on Vulnerable Populations

Amir Mansourieh and co-authors share the COVID-19 experience in Iran. Iran was one of the first countries to be affected by the COVID-19 pandemic. The pandemic coincided with the economic problems that Iran is facing. Iranians have encountered serious problems in various aspects of their lives. According to official statistics, there were about six million infections and about 130,000 deaths due to COVID-19 in Iran. Quarantine, social distancing, and other health protocols led to a decline in the mental and social health indicators. Vulnerable groups including children, women heads of households, the homeless, drug addicts, and the disabled were at higher risk. Although initially, governmental and non-governmental organizations were not prepared to manage the pandemic, overtime they made efforts and implemented several innovative measures in the areas of education, mental health service provision, and addiction. However, the economic conditions in Iran impacted all these measures adversely. The authors discuss Iran's experiences with COVID-19 focusing on the health, social, psychological, and economic factors. They also unravel lessons learned through Iran's experience with COVID-19.

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Dr. Saroj Pachauri as a public health physician, Dr. Pachauri has been extensively engaged with research on family planning, maternal and child health, sexual and reproductive health and rights, HIV and AIDS, and poverty, gender and youth. In 1996, she joined as Regional Director, South and East Asia, Population Council and established its regional office in New Delhi which she managed until 2014. In 2011, she was awarded the prestigious title of Distinguished Scholar, an honor rarely bestowed.

She worked with the Ford Foundation's New Delhi Office (1983–1994) and supported child survival, women's health, sexual and reproductive health, and HIV and AIDS programs. Before that, she worked with the International Fertility Research Program (IFRP) which was later renamed Family Health International (1971–1975) and the India Fertility Research Programme (1975–1983). She designed and monitored multi-centric clinical trials globally to assess the safety and effectiveness of fertility control technologies. During 1962–1971, as faculty of the Departments of Preventive and Social Medicine at the Lady Hardinge Medical College, New Delhi and the Institute of Medicine Sciences, Varanasi, she helped to develop this new discipline.

She has published six books and contributed chapters to 20 books. She has over 100 publications in peer-reviewed journals and several articles in print media.

Dr. Ash Pachauri has a PhD in Decision Behavior and a Master's Degree in International Management. He worked with McKinsey and Company before pursuing a career in the social development arena, Dr. Pachauri's experience in the fields of public health and management emerges from a range of initiatives including those of The Bill and Melinda Gates Foundation, Program for Appropriate Technology in Health (PATH), United Nations Development Programme (UNDP), International Planned Parenthood Federation (IPPF), and Centers for Disease Control (CDC) in the US.

Health System Response

Addressing the Urgency and Magnitude of the COVID-19 Pandemic in India by Improving Healthcare Workforce Resilience

Bulbul Sood, Vineet Kumar Srivastava, and Nochiketa Mohanty

Abstract The sudden surge in COVID-19 cases during the second wave highlighted India's lack of preparedness for critical care requirements in terms of infrastructure and human resources. It is the need of the hour to make efforts to build resilient and responsive health systems that are well prepared to handle the current COVID-19 pandemic and similar future threats. The challenges in the healthcare system during the second wave of COVID-19 included overstressed human resources in tertiary facilities, lack of trained healthcare workers, inadequate infrastructure at secondary-level facilities, and a shortage of beds, ventilators, medicines, and other requirements for tertiary-level care. Other challenges were lack of resources/capacity for setting up intensive care units (ICUs), unutilized ICU equipment at secondary-level facilities, and lack of operational planning, coordination, and support. Through the United States Agency for International Development (USAID) supported Reaching Impact, Saturation, and Epidemic Control (RISE) Program, Jhpiego is providing technical assistance in 20 states across India to respond to the urgency and magnitude of the second wave of COVID-19. It is identifying areas and modalities of implementation and aligning these to the country's response to the surge. The project's focus is on health system preparedness for present and future waves of COVID-19 including activities for strengthening critical care services, medical oxygen management, strengthening molecular testing laboratory, strengthening the health system to respond to future waves, and enabling effective planning and management of critical logistics. This is being done in coordination with the Government of India (GoI) and state governments and by involving both public and private sector/faith-based institutions and non-government organizations (NGOs).

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Introduction

The COVID-19 pandemic ravaged health systems around the world with countries struggling to cope with the rapid surge of cases and the after-effects. India is the second worst-hit country and is on track to surpass Brazil given its massive population of 1.3 billion and the relaxation of containment measures such as lockdowns [1]. The predicted peak in India was delayed by an estimated 34 to 76 days, due to the eight-week lockdown [2]. This period allowed the government to strengthen the public health system to respond to the pandemic by shoring up resources and infrastructure. Despite a reduction in cases by 60% with lockdown measures and pandemic response preparedness, projections by some researchers indicate that there could be inadequate isolation beds, intensive care unit (ICU) beds, and ventilators within 3 to 5 months [3]. Streamlining the workflow for rapid diagnosis and isolation, triaging, clinical management, and infection prevention is important, not only for COVID-19 patients but also for other patients who are at risk of nosocomial transmission.

India had a dramatic rise in COVID-19 cases and deaths in April 2021 and in the first half of May 2021. The cases peaked around mid-May and the deaths peaked in late May. The country recorded the second-highest number of cases in the world with estimates of at least 31,613,993 reported cases and 4,23,810 reported deaths by July 31, 2021 [4]. The projections for estimated deaths due to COVID-19 till December 1, 2021, were 4,51,063 as per official estimates and 12,65,887 if the unreported deaths were included [5]. Thus, the public health system in India clearly needs to be better prepared to handle future surges.

The sudden surge in COVID-19 cases during the second wave in India highlighted the lack of preparedness for critical care in terms of infrastructure and human resources at the state, district, and sub-district levels. Efforts to build resilient and responsive health systems were the need of the hour. It was critical to ensure that the health system is well prepared to handle the current COVID-19 pandemic and similar future threats. The challenges to the healthcare system during the second wave of COVID-19 included overstressed human resources in tertiary facilities, lack of trained healthcare workers and infrastructure at secondary-level facilities, and a shortage of beds, ventilators, oxygen, and medicines at COVID care facilities. As many as 52.8% of the healthcare workers were reported to have COVID-19 pandemic-related burnout [6]. Other challenges were lack of resources/capacity for setting up ICUs, unutilized ICU equipment at secondary-level facilities, and lack of operational planning, coordination, and support.

Jhpiego's Innovative Response for Critical Care Management of COVID-19 Patients in India Through RISE Project

Through the Reaching Impact, Saturation, and Epidemic Control (RISE) Project, Jhpiego got an opportunity to work closely with various state governments to respond quickly to critical care management of COVID-19 patients in India. RISE is a 5-year global project funded by the U.S. Agency for International Development (USAID). RISE works with countries with the aim of achieving by 2024 a shared vision of attaining and maintaining epidemic control with strong local partners capable of managing and achieving results through sustainable, self-reliant, and resilient health systems.

During the first wave of COVID-19 in June 2020, USAID's RISE project provided technical assistance to 29 facilities in 15 states and 3 union territories. Two hundred ventilators were provided by the US Government through the Government of India. Since the majority of the facilities were regional, the All India Institute of Medical Sciences (AIIMS) and other medical colleges could act as centers of excellence for capacity building and strengthening critical care management of COVID-19 patients for other networked COVID care facilities. Since the care of severely ill COVID-19 patients requires a multidisciplinary approach that ensures coordinated and comprehensive utilization of skills, knowledge, and expertise of various cadres of health professionals involved in care, it was decided to create institutional mechanisms for critical care decision-making by setting up critical care working groups (CCWGs) and by establishing a mechanism for the continued utilization of ventilators. The members of CCWG were representatives from the departments of anesthesiology, medicine, pediatrics, pulmonology, psychiatry, ophthalmology, obstetrics, and gynecology among others.

A "Hub and Spoke" model was employed to train and mentor approximately 350 networked COVID care facilities for building the critical care capacity of more than 12,000 critical care providers including doctors, nurses, counselors, and technicians by the end of July 2021. This capacity-building initiative included standardizing care through hands-on training, clinical case discussions, and stress management sessions. In order to ensure the sustainability of these capacity-building and knowledge management initiatives, RISE joined hands with the World Health Organization (WHO) Collaborating Center for Emergency and Trauma. RISE also developed technical resources including standard operating procedures (SOPs) and information, education, and communication (IEC) material.

The project was able to harness and leverage the expertise of premier institutions like the Johns Hopkins University (Baltimore, USA), the WHO Collaborating Center for Emergency Care, the All India Institute of Medical Sciences (AIIMS), Delhi, several regional AIIMS, the North Eastern Indira Gandhi Regional Institute of Health and Medical Sciences (NEIGRIHMS), the Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, the Mahatma Gandhi Institute of Medical Sciences (MGIMS), Wardha, and the National Institute of Mental Health

and Neuro Sciences (NIMHANS), Bangalore, as capacity-building hubs to reach out to field-level COVID dedicated facilities that were designated COVID health centers (DCHCs) across various states.

The RISE project worked closely with the national training hubs to conduct training on various topics. A few of these are listed in Table 1.

Besides the established seven hubs, in consultation with various states, additional hubs are in the process of being developed by the RISE team in all the intervention states. The Maharashtra Government is keen to establish 8 state-level hubs to build the capacity of all public and private sector facilities using the Hub and Spoke model.

Going forward for the next two years, the USAID-RISE Project intends to support and strengthen the states' response to the impact of the current and future waves of COVID-19 across 20 states by building a resilient and responsive health system that is well prepared to handle future waves and other threats at secondary- and tertiary-level facilities.

The RISE project has a pan-India approach. It plans to work with 20 states namely Andhra Pradesh, Assam, Chhattisgarh, Delhi, Goa, Gujrat, Haryana, Himachal

Table 1 Types of capacity-building initiatives

Hub	Training	Duration	Mode of training
AIIMS, Delhi—WHO Collaborating Center for Emergency and Trauma Care	Critical care for COVID-19	3 Days	Hands-on
AIIMS, Patna	State-level training of trainers (ToTs) on critical care for COVID-19	7 days	Hands-on
AIIMS, Patna	Critical care for COVID-19	2 days	Virtual
AIIMS, Bhopal	Critical care for COVID-19	3 days	Hands-on
NEIGRIHMS, Shillong	Certificate course on critical care of adults and children in ICUs	1 month	Virtual
PGIMER, Chandigarh	Critical care on COVID-19 for nurses	2 days	Virtual
AIIMS, Nagpur	Clinical update workshop on obstetric care in COVID-19	1 day	Virtual
AIIMS, Bhubaneshwar	Update on critical care for nurses	2 days	Virtual
NIMHANS	Stress management for healthcare providers Mental health counseling for counselors	1 day	Virtual, e-learning
John Hopkins University and "Hub" in India	Clinical case series (bringing global learning)	Bi-weekly	Virtual

Source RISE

Table 2 Details of e-grand rounds conducted by RISE in collaboration with the CCWG of respective facilities, July 2020 – July 2021

Host RISE facility	Clinical cases presented	No. of participants
AIIMS, Patna	Prolong NIV (non-invasive ventilation) for COVID-ARDS (acute respiratory distress syndrome)	101
	Acute pancreatitis in COVID-19	
AIIMS, Jodhpur	Thrombo-embolic complications of COVID-19	90
NEIGRIHMS, Shillong	Management of an 87-year-old patient with COVID-19	109
AIIMS, Nagpur	COVID-19 moderate stage II/Group E patient with complications following convalescent plasma therapy	69
	Floundering to maintain glucose homeostasis while managing a COVID-19 patient with diabetes mellitus	
AIIMS, Rishikesh	Challenges and insight of self-proning in moderate/severe COVID-19 pneumonia	131
IMS BHU, Varanasi	COVID-19 pneumonia with severe anemia	95
	Prone positioning in awake non-intubated patients with COVID-19	
PGIMER, Chandigarh	COVID-19 pneumonia complicated by ICU acquired infection	156
	Post-partum collapse in COVID-19 woman	
MGIMS, Wardha	Critically-ill COVID-19 patient: Challenges in diagnosis and treatment of hospital acquired infection	210
	Total	**963**

Source RISE India training records
Note RISE collaborated with the John Hopkins University to host a clinical case discussions series

Pradesh, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttarakhand, and West Bengal and to respond to other states that emerge as high burden COVID-19 states or have an urgent need for technical assistance (TA) to respond to COVID-19. RISE is also supporting the training hubs at AIIMS, Patna, and NEIGRIHMS in Bihar and Meghalaya, respectively. Thus, apart from the 20 direct intervention states, RISE ensured capacity-building support to 8 other states (Figs. 1 and 2).

Hub and Spoke Model

The plan is to reach out to more than 4,000 secondary and tertiary healthcare facilities in both the public and private sectors by scaling up the robust and sustainable "Hub and Spoke" model that was developed to respond to the first wave of the pandemic.

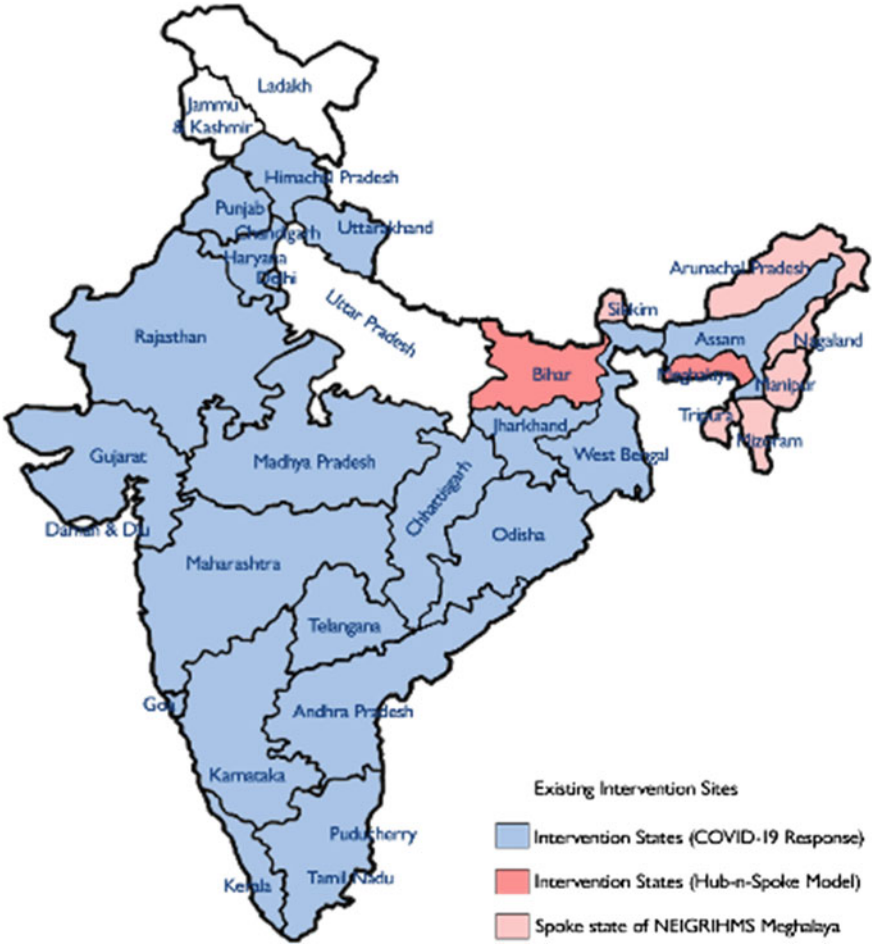


Fig. 1 RISE COVID response coverage—Intervention states. *Source* RISE COVID response coverage

During the first wave, the hubs disseminated their knowledge, practice, and experience in managing COVID-19 patients to other facilities, the spokes. In the coming months, RISE intends to provide technical assistance to secondary and tertiary care facilities through the proposed hubs to build their capacities in the areas of critical care management of COVID-19 patients, medical oxygen and oxygen delivery equipment management, and the rational use optimization of laboratory capacity and testing capabilities for COVID-19 and other emerging pathogens, strengthening vaccination sites, improving vaccination coverage, and managing biomedical waste.

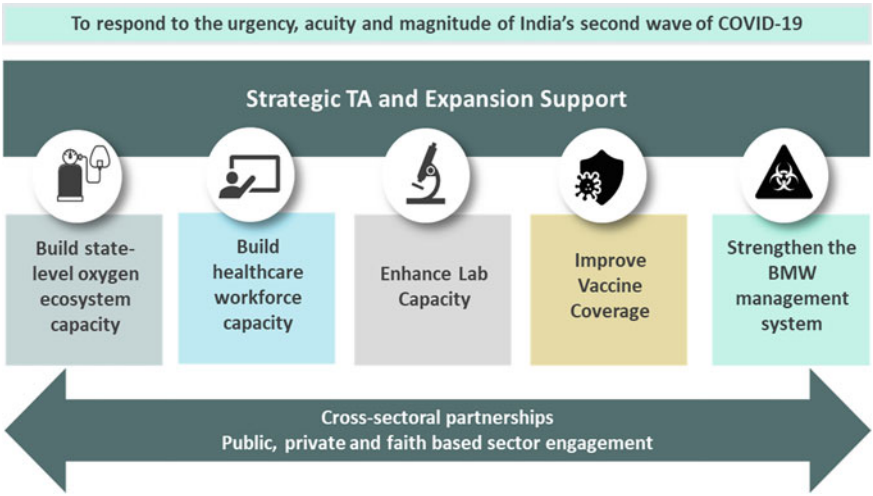


Fig. 2 RISE COVID response—Goals and objectives *In the states of Meghalaya and Bihar, the established hub of NEIGREIHMS supports the spoke facilities in the northeast, and AIIMS, Patna supports the spoke facilities in Jharkhand and Bihar. *Source* RISE COVID response

Improving Vaccine Coverage

By the end of July 2021, 420 million (26% of the total population) had received at least one dose of the vaccine. Only about 91 million (7%) had received both doses [7]. The vaccination sites were facing challenges related to session planning, vaccine supply, vaccine wastage, and adverse effects following immunization (AEFI) [8]. Additionally, many sub-populations were hesitant to accept vaccination, deterred by legitimate concerns and misinformation spread by those with anti-vaccination and other socially disruptive agendas [9]. Jhpiego's own social media research in Delhi and Mumbai showed that over 30% of social media users were hesitant because they had concerns about the side effects of vaccines.

RISE intends to improve vaccine coverage through effective planning and operational support for vaccine delivery. It will implement strategies for infection prevention control (IPC) and training programs to support the monitoring and management of AEFI. RISE is working to achieve this strategic objective in the network of intervention facilities by strengthening existing vaccination centers through capacity building with a special focus on reducing vaccine wastage, infection prevention, safe injection practices, improving AEFI management, and enhancing data use for evidence-based planning. This also includes ensuring COVID appropriate behavior by providers and beneficiaries to minimize the risk of any vaccination activity becoming a super-spreader event. RISE is working toward utilizing existing digital solutions in improving the quality of vaccination services. The project is engaging with various professional bodies to enhance the role of the private and non-government sectors and to build the capacity of the private sector in AEFI

management as per Government of India guidelines. While there is an effort to improve reporting and investigation of AEFI cases through the existing Co-WIN platform, the project is also exploring opportunities for deploying digital solutions to strengthen systems for AEFI data capture and collation. The project aims to support AEFI monitoring and improve AEFI management and referral.

As a part of the response to addressing the issue of vaccine confidence, RISE is initiating a rapid formative research/listening session/rumor monitoring of both traditional and social media as well as communication planning and evaluative research on the effectiveness of messages. RISE plans to conduct sentiment analysis and social listening focused on COVID-19 vaccination across five cities of India covering five geographical areas—North, South, East, West, and Central. Based on the findings of this assessment, RISE will identify potential informers and messages and use them for broader social media campaigns to address vaccine misinformation and improve vaccine confidence. RISE intends to engage with community-based organizations and faith-based organizations to address vaccine hesitancy and improve vaccine confidence. It will use existing communication strategies for improving vaccine confidence in the networked facilities to ensure that the messages are effective in promoting the uptake of safe and efficacious vaccines. The project is also promoting COVID appropriate behavior and respiratory etiquette through effective communication.

Strengthening Oxygen Ecosystem

Recently, the Government of India received and deployed oxygen delivery equipment including cylinders, oxygen concentrators, and pressure swing adsorption (PSA) plants. However, there are challenges related to the optimal utilization of oxygen produced and the delivery equipment because of systemic and competency gaps that could affect the management of oxygen at the facility level during future surges.

During the surge, there was insufficient production of medical oxygen and insufficient availability of containers and cylinders for transport and use of the existing supply which led to significant patient mortality [9]. There is, therefore, a need to build oxygen production and supply chain networks for a future surge.

RISE intends to build state- and facility-level oxygen ecosystem capacity by providing training and operational and coordination support. RISE is identifying partners and innovations within the oxygen ecosystem to amplify existing activities and develop data-informed management systems. RISE will work with partners in the networked facilities to understand hospital capacity including critical oxygen capacity by conducting a pragmatic assessment of the facilities. Through these partners, RISE will train technicians and healthcare workers on the operations and maintenance of the oxygen delivery equipment and will develop a toolkit for capacity building of healthcare workers on oxygen equipment and the hygienic use of equipment so that the state-level facilities can sustain this initiative beyond RISE's presence. RISE also plans to support the facilities for operationalizing and

maintaining oxygen delivery equipment that was received during the surge including that which was received from the US Government.

To ensure systemic resilience, RISE will develop modules, provide training to district and state program management units, and conduct trainings of trainers at the hub facilities for capacity building of stakeholders on the oxygen ecosystem including sources, supply, safety, maintenance, operations, costing, specifications, conversion factors, vendor landscaping, operationalization and maintenance of oxygen delivery equipment, rational and hygienic use of oxygen, monitoring of PSA post-operationalization, and oxygen quality testing protocols.

The project will develop digital solutions to manage the oxygen supply chain for oxygen equipment management, transportation, and distribution tracking while piloting initiatives on energy-efficient and environment-friendly solutions. The project will provide digital solutions such as the creation of dashboards to showcase the capacities of mapped facilities (hub and spoke facilities) for quick referrals as per need. It will also support a national oxygen grid system for private and public health facilities to ensure sustained oxygen supply during future surges.

Strengthening Competency and Resilience of Healthcare Workforce

While there has been a rapid increase in investment in the infrastructure of secondary care facilities to capacitate them to manage the surge of cases, the lack of a sufficient healthcare workforce trained in critical COVID-19 management and respiratory care (doctors and nurses) remains a critical bottleneck [10]. There is also a lack of capacitation of those working in these understaffed facilities, i.e., standardized guidelines on procedures and processes and knowledge of clinical case management for providing secondary care. There is an urgent requirement for comprehensive and technology-enabled capacity-building platforms for critical care that are scalable and sustainable. Additionally, with the pandemic stretching into the second year, the healthcare workforce is overstretched and is facing physical and psychological exhaustion [11].

The overwhelming burden of COVID-19 illness stressed the capacity of the health system and had adverse effects on healthcare workers including the risk of infection. Considering the prevailing scenario, the need of the hour is to build the capacities of the existing healthcare workforce and equip it with the knowledge and skills for providing quality healthcare. The capacity of the existing workforce can be strengthened by adopting mechanisms to establish and strengthen the training ecosystem in the intervention states for the critical care of adults and children using the Hub and Spoke model, implementing e-curricula, and creating a knowledge hub.

The primary focus of the RISE program in the first wave was healthcare workforce capacitation through training using a Hub and Spoke model. Therefore, RISE leveraged its learnings from the first phase to build healthcare workforce capacity

through training for COVID-19 and acute hypoxia. The training was provided to use a combination of hub and spoke model-based classrooms, hands-on learning experiences, e-curricula, and competency-based training approaches. RISE implemented a knowledge management strategy that integrates collaborative learning and adapting (CLA) practices during the program cycle. RISE started to engage and train providers on critical care of adult and pediatric COVID-19 patients while continuing to work with existing hubs. The project is developing and curating educational material along with the hubs to facilitate capacity-building initiatives for COVID-19 case management for healthcare providers at the spokes.

The project is working with several agencies to disseminate high-quality onsite and virtual simulation-based and skills-based learning resources (workshops and courses) such as the WHO Basic Emergency Care (BEC) Course, the WHO Essential Critical Care Course, E-mentoring sessions, and clinical case-based discussions in partnership with the JHU Center for Emergency Care and Clinical Global Health Education. Because of the fear that the third wave may affect children, many states have requested pediatric courses. RISE worked with one of its hubs, NEIGRIHMS, to develop a month-long virtual pediatric ICU certificate course series which was attended by more than 1,000 participants from across eight North Eastern states of India. RISE is also working with other agencies to curate and standardize learning resource packages (LRPs) for pediatrics critical care that can be used by other states. Workforce resilience training is also being introduced in collaboration with specialized institutions such as the National Institute of Mental Health and Neurosciences (NIMHANS).

RISE is working with a partner agency to conduct demand modeling to identify capacity-building needs during the surge and provide modeling tools to sustain the planning and preparedness process. The project aims to strengthen critical care services in the network of facilities with unutilized or understaffed ICUs and other facilities that are seeing surges in patient loads through remote ICU solutions (tele ICU). Cognizant of the involvement of faith-based organizations in the care of COVID patients during the surge, RISE plans to facilitate catalytic grant funding support to these facilities for activities such as upgrading the physical and medical infrastructure to provide COVID-19 treatment to vulnerable and marginalized communities.

Within two months of the second phase, RISE had conducted 26 capacity-building events [13 virtual and 13 onsite] reaching out to more than 3,000 participants. Apart from the one-month certificate course on Pediatric Intensive Care Unit (PICU) by NEIGRIHMS, RISE partnered with the Government of Bihar to provide training of trainers (ToT) on critical care for COVID-19 at the knowledge hub, AIIMS, Patna, for all designated COVID health centers (DCHCs) and designated COVID hospitals (DCH) of the state. By the end of July 2021, RISE had associated with 11 hubs and more than 4,000 spoke facilities in collaboration with the state governments.

Enhancing Laboratory Capacity for COVID Testing

The fundamental principle to counter any infectious epidemic is to detect/isolate/treat/manage cases early and prevent the occurrence of new cases. In the absence of an effective treatment for COVID-19, prevention is the best strategy which involves testing. In a diverse country like India, for inclusive and equitable access to testing, optimization of resources based on the evolving epidemic was an essential part of sustainable scaling up. As the epidemic evolved, India's testing strategy underwent iterative calibration to keep pace with the changing epidemiology and the extent of the infection. In the current response to COVID-19, a limited number of reverse transcription-polymerase chain reaction (RT-PCR) laboratories, lack of competent laboratory personnel, and unorganized laboratory processes led to delays in reporting. With an increased focus on the whole genome sequencing (WGS), the challenges are expected to increase in terms of sample collection, processing, transport, and testing quality [12].

RISE is working toward enhancing laboratory capacity in the networked facilities to improve efficiencies and support the scale-up of testing capabilities for COVID-19 and other emerging pathogens. The project will map RT-PCR machines in the public and private sectors that can be used for the scale-up of testing facilities, develop strategies for repurposing existing tuberculosis diagnostics, support the supply chain, undertake the gap analysis, and plan for test kits and laboratory consumables. Strategies are implemented to enhance and empower laboratories, including the dissemination of guidelines and SOPs to laboratories engaged in COVID-19 testing and training healthcare workers on sample collection safety, maintenance of samples, and the appropriate use and interpretation of test results. RISE is in partnership with several agencies for undertaking capacity-building initiatives to familiarize the laboratory workforce with the use of RT-PCR machines, collection and processing of samples, safety measures, biomedical waste management, and laboratory information management systems and also in the effective implementation of national testing guidelines including guidance on genome sequencing and quality management of laboratories.

RISE is working with partner agencies for developing and disseminating a capacity-building toolkit/SOPs/guidance document for the hubs to undertake the training of laboratory personnel on collection, storage, and transportation of samples (triple layer sample packaging, handling dry ice, and infectious clinical material) and decontamination procedures in case of sample spillage during transportation of COVID genomic surveillance. Through a collaborative effort, RISE intends to improve the efficiency of COVID testing laboratories by bridging the gaps in the supply chain and the quality management system (QMS). This technical assistance also involves helping them monitor data on testing capacity, number of tests performed, consumption of commodities, usage rates per test, stocks, and expiries. RISE is working toward the development of digital solutions to improve efficiencies in the existing testing and reporting mechanisms.

Strengthening Biomedical Waste Management

An unprecedented outcome of personal protective equipment (PPE) such as masks, eye wear, and coveralls not only for clinical and paraclinical care providers, but also for patients and their family members has been the generation of biomedical waste which rapidly overwhelmed the resources that the health system had at its disposal [13]. Apart from the fact that the generation of BMW increased exponentially, many healthcare staff who were dealing with waste management were unaware of the updated guidelines to process BMW adequately.

RISE intends to improve biomedical waste management (BMW) processes and practices by streamlining BMW collection, storage, transport, and disposal in the network of RISE facilities. The project will continue to implement existing WHO courses. It also proposes to implement case-based e-learning courses targeted at supporting applied BMW management in India. While RISE will develop appropriate Livelihood Restoration Plan (LRP), information, education, and communication (IEC) material, and job aids for capacity building and ensuring adherence, it will also support a network of facilities to plan and strengthen BMW management, national quality assurance standards, and will standardize COVID-19 SOPs and guidelines. The project will adapt the government guidelines and develop SOPs for the safe collection, storage, transport, and disposal of biomedical waste from the point of generation to the point of final processing (in-house or through common waste treatment facilities).

Building Cross-Sectoral Partnerships for Large-Scale Response

As the pandemic began to spread in India, international not-for-profit organizations like Jhpiego stepped in immediately to support the government at the national and state levels with innovative strategies, technical assistance, and field-based support to deal with this public health emergency. RISE also worked actively with other agencies to facilitate cross-sectoral partnerships with public, private, and faith-based organizations to scale up and amplify response capabilities.

A "Learning Laboratory" Approach: Model COVID-19 Care Clinics

Considering the emergency nature of the interventions, almost a pan-India presence, proposed rapid scale-up, a leaner project team structure, dependence on the hubs for the delivery of capacity-building interventions, and a large number of secondary and tertiary facilities (to be engaged through the "Hubs and Spokes" model) to

undertake monitoring, mentoring, and supervisory opportunities, made it difficult to understand the facility-level gaps and challenges and the facilitators and barriers to effectively translate capacity-building interventions into practice and eventually improve patient care [14]. RISE used a learning laboratory approach to test effectiveness and to develop a deeper understanding of the perceived limitations (mentioned above) of technical assistance to provide coordinated technical assistance and facilitate implementation support to 40–50 facilities in 3–4 districts (one district each from Jharkhand, Madhya Pradesh, Assam, and Telangana). The learning laboratories ensured coordinated and facilitated support for the implementation of proposed activities at the facility level under RISE. They were provided with one dedicated district officer per district to facilitate uniform implementation across all the identified facilities, a counselor, and a medical assessment coordinator to facilitate quick triaging and appropriate counseling of the suspected and confirmed COVID-19 cases. These human resources ensured focused monitoring, mentoring, supervisory support, and forward referral linkages for effective management and hand-holding support for periodic assessments, recordings, and reporting.

These learning laboratories provide a deeper understanding of the facility-level gaps and challenges and various facilitators and barriers for the effective translation of capacity-building interventions into practice. They also assessed the effects of coordinated and facilitated support for overall outcome/impact and for establishing a feedback loop to facilitate the iterative project development process.

Outcome and Insights

1. The capacity-building initiative through the Hub and Spoke model led by the management of hubs as well as CCWG was appreciated by the national and the state governments. It was observed that all CCWGs were actively involved in taking forward this initiative despite their very busy schedules and priorities. We strongly feel that this has now become their initiative and is, therefore, likely to be sustained beyond Jhpiego technical assistance.
2. E-grand rounds as well as clinical case discussion series were found to be very useful for both the faculty and the participants. There was the active involvement of presenters as well as of participants.
3. RISE generated tremendous interest among tertiary care facilities to develop SOPs, competency-based training, and mentoring of lower-level facilities. The State Government of Bihar (Office of Additional Chief Secretary, Health, Government of Bihar) issued an official letter appreciating the Critical Care Working Groups (CCWGs) in medical colleges, district hospitals, and sub-divisional hospitals across all the districts in the state. With the support of the CCWG team, AIIMS, Patna, and the RISE project mentors these facilities (Fig. 3).

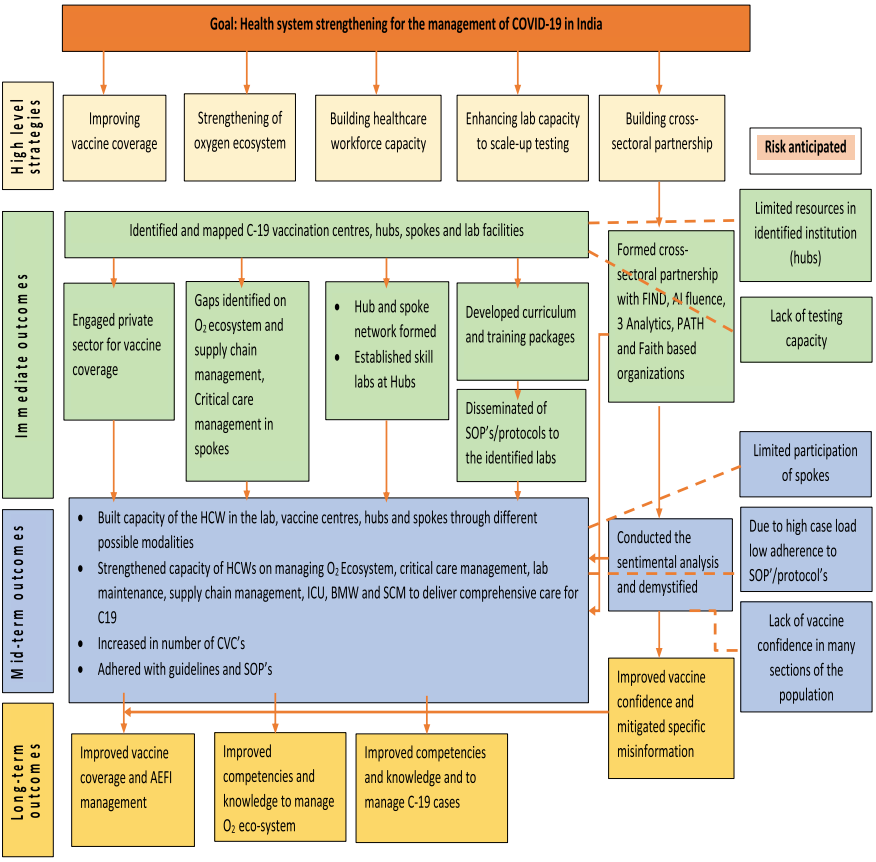


Fig. 3 RISE COVID response: Theory of change. *Source* RISE COVID response

Box 1 Training of trainers on critical care in COVID-19 at AIIMS, Patna

RISE India, in collaboration with AIIMS, Patna, organized 7-day state-level training of trainers on the critical care program for COVID-19

With the unprecedented surge of cases during the second wave of COVID-19 and the impending third wave, additional healthcare workers and nursing staff from various healthcare facilities needed to be mobilized to manage the surge more efficiently and effectively (20). With a shared vision of attaining and sustaining the control achieved over the pandemic, the All India Institute of Medical Sciences (AIIMS), Patna, in collaboration with the USAID-funded and Jhpiego-led RISE program, supported the Government of Bihar to build the capacity of healthcare providers in critical care services. AIIMS, Patna as a Center of Excellence, provided training to over six batches thus reaching out

to 234 participants across all the 38 districts in Bihar. These became master trainers for their respective districts. This training was facilitated by the Critical Care Working Group (CCWG) of AIIMS, Patna.

The 7-days Training of Trainers program for the first batch was initiated on June 16, 2021 in the august presence of Hon'ble Minister of State for Health and Family Welfare, Government of India, Shri Ashwini Kumar Choubey, Hon'ble Minister of Health, Government of Bihar, and other dignitaries. These trainings were facilitated by the AIIMS, Patna and the CCWG team and was a mix of classroom-based and hands-on ICU-indoor training for COVID-19 critical care.

This capacity building initiative was welcomed by the state government of Bihar and received appreciation from Hon'ble Minister of State for Health and Family Welfare, Government of India, Shri Ashwini Kumar Choubey, who said that the training will prove to be a milestone in the comprehensive management of not only COVID-19, but also for patients suffering from other critical illnesses.

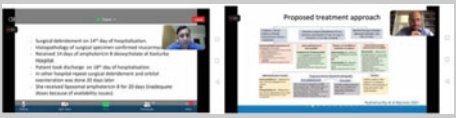
The intervention also received wide media coverage in the local media, both print and television. The news articles highlighted the importance of the training organized by CCWG team at AIIMS, Patna in collaboration with the USAID/ RISE program in preparation for the anticipated third wave of COVID-19

pandemic as well as for standardizing critical care across facilities. The capacity building initiative also received good coverage on social media, including tweets from the Minister of State for Health and the Family Welfare, GoI, and the Minister of Health, Government of Bihar. The official twitter handle of AIIMS, Patna also covered the training extensively.

Note: Images from the trainings at AIIMS, Patna.

Box 2 JHU RISE case series

The session under the John Hopkins University and USAID RISE Clinical Case Discussion Series on COVID-19 was held on July 9, 2021 in collaboration with the All India Institute for Medical Science (AIIMS), Rishikesh. It focused on COVID-19 related respiratory failure and mechanical ventilation. The bi-weekly clinical case discussion series on COVID-19 was developed with the aim to combat misinformation and lack of evidence-based practices by leading the discussion with internationally recognized thought leaders. The session was followed by a detailed review of the topic including slides and synopsis, pre- and post-session surveys. The participants were provided relevant literature sites, complementary resources, relevant reference guidelines/protocols, and job aides. The virtual session was attended by 306 participants including 270 critical care providers (90 doctors, 167 nurses. and 16 paramedics) across 27 states and 2 union territories in India.



Way Forward: Toward Resilient Healthcare Systems

Healthcare system resilience is defined as the capacity of the health system to prepare for and effectively respond to crises, maintain essential functions when a crisis hits, be informed by lessons learned during the crisis, and reorganize if conditions require it to do so (15). Health systems are resilient if they protect human lives and achieve good health outcomes for all during a crisis and in its aftermath. Response to a crisis, be it a disease outbreak or any other disruption resulting in a surge of demand for healthcare (e.g., a natural disaster or a mass casualty event), needs both a vigorous

public health response and a highly proactive and functioning healthcare delivery system.

Beyond the acute phase of COVID-19, where the focus has largely been on mitigation and preparedness for the pandemic, Jhpiego implemented the RISE program with the aim of providing technical assistance for building resilient healthcare systems through capacity building, better coordination, and more importantly, facility-level and state-level capacitation to prevent, detect, and respond to infectious diseases in line with global guidance and international health regulations. Jhpiego plans to provide technical assistance for health workforce protection by enhancing the technical knowledge and skills of healthcare teams; supporting competency development; advocating for task-shifting/task-sharing; developing an enabling policy environment; facilitating the provision of adequate personal protective equipment; and ensuring the mental wellbeing of healthcare providers.

Jhpiego's goal is to save lives, improve health, and transform the future of women, children, families, and communities. It continues to partner with governments, health experts, and local communities to build systems that guarantee a healthier future for women and families. Through these partnerships, it continues to build more resilient healthcare systems that are better prepared to deal with health emergencies and can protect all, especially the most disadvantaged and vulnerable communities.

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Dr. Bulbul Sood holds an MBBS and an MPH and is a member of the National Academy of Medical Sciences. A public health professional with more than 45 years of experience. She was Professor in the Department of Preventive and Social Medicine at the Lady Hardinge Medical College, New Delhi for 23 years.

Dr. Sood was Jhpiego's India Country Director from 2009-2020. She is a respected figure in the public health field and is known for her experience in international health and development. She has strong technical expertise in reproductive health and extensive program management experience. She is well-known in the fields of family planning, maternal, and reproductive health—both in India and internationally.

Dr. Sood was Co-chairperson of the White Ribbon Alliance for Safe Motherhood in India from 2003 to 2009 and was successful in moving the country's safe motherhood agenda forward by working collaboratively with the government, bilateral and multilateral donors, UN organizations, and international and national NGOs.

Dr. Sood has worked untiringly with the Indian Nursing Council and the Government of India at the national and state levels to strengthen the nursing and mid-wifery cadres in the country. She is a member of the Family Planning Medical Eligibility Decision-Making Committee of WHO and USAID. She is also a member of the INFO Editorial Advisory Committee of the Johns Hopkins Bloomberg School Public Health Center for Communication Programs, peer-reviewer for Continuous Identification of Research Evidence system which is a collaborative effort of WHO's Department of Reproductive Health and Research and the Centers for Disease Control, Atlanta. She is a peer-reviewer of the WHO's Medical Eligibility Criteria for Contraceptive Use and for the Selected Practice Recommendations for Contraceptive Use Guidelines.

Dr. Sood is a technical advisory group member of the Maternal Health Task Force of the Harvard School of Public Health, member of the State Innovation in Family Planning Service Agency in Uttar Pradesh and a governing board member of the International Institute of Health Management and Research (IIHMR), Delhi. Earlier, Dr. Sood served as the Country Director of the Center for Development and Population Activities (CEDPA) in India, overseeing its reproductive, maternal health, women empowerment, and adolescent health activities in the country.

Dr. Vineet Kumar Srivastava a public health professional with more than 18 years of experience in strategizing and implementing large scale national and state - level public health programs.

His experience encompasses business development, technical leadership, management including project grant, oversight, and monitoring, evaluation and learning of entire portfolios of projects related to Reproductive, Maternal, Neonatal, Child Health and adolescent (RMNCHA) and Non-Communicable Diseases (NCD).

During the association with Jhpiego India, he oversees the design, implementation, monitoring and evaluation, and quality of Maternal and NewBorn Health programs- specifically during ANC, Intrapartum and immediate postpartum care, Family Planning programs drawing the focus on Postpartum period, and NCDs with focus on Gestational Diabetes Mellitus, Cervical cancer and Breast cancer. He has spearheaded development of portfolios with increasing donor investments. Currently he is heading a national level COVID-19 response program focused at strengthening critical COVID-19 care at secondary and tertiary health facilities through a health system strengthening approach.

Prior to joining Jhpiego, Dr. Srivastava has served some of the most reputed national and international public health organizations, namely PATH, UNICEF, WHO and the World Bank Aided Project. Dr Srivastava's approach draws on his extensive education in Public Health. He is a medical graduate, with an MBA in Healthcare Management and a Master's degree in Public Health.

Dr. Nochiketa Mohanty, Deputy of Chief of Party – Health Systems Development, RISE, Jhpiego, New Delhi, India Dr. Nochiketa Mohanty is a public health professional with more than 15 years of experience in strategizing and implementing public health programs at the National, regional and state level. He holds a MBBS degree from Sambalpur University (V.S.S. Medical College) with MPH and MBA degrees from University of Alabama at Birmingham, USA. He is currently working in Jhpiego as the Deputy Chief of Party, Health Systems Development for USAID's RISE program for technical assistance for COVID Response in India.

He has worked in areas of pre-clinical and operational research, healthcare program implementation, monitoring & evaluation and mass communication on health-related issues (both prevention and treatment), especially in TB, HIV/ AIDS, Family Planning, Women's cancer initiatives and COVID response. He has more than 20 international presentations in areas of HIV and Reproductive Health. During the association with Jhpiego India, he provided oversight to state level implementation, monitoring and evaluation, and quality of Family Planning drawing the focus on Post-partum period, and NCDs with focus on Cervical cancer and Breast cancer. Currently he is supporting the national level implementation of the USAID RISE program which engages in COVID-19 response focused at strengthening critical COVID-19 care at secondary and tertiary health facilities through a health system strengthening approach.

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Owing to his engagement in state level healthcare activities in Odisha, he is also a member of the State Quality Assurance Committee, State Integrated Monitoring Team and various other technical committees in Family planning and Maternal Health in Odisha.

Comprehensive Care Response and Systematic Management of COVID-19 in Querétaro, Mexico

Adriana Aguilar Galarza, Sandra Celada Martínez, Oscar San Roman Orozco, Isidro Amadeo Gutiérrez Álvarez, Izarelly Rosillo Pantoja, and Nuri G. Villaseñor Cuspinera

Abstract The health impact of the pandemic in Queretaro, México is assessed. The socioeconomic conditions of the population and health policies implemented at the federal and state level as well as in the Universidad Autonoma de Queretaro are examined. The work is presented in three parts: In the first part, epidemiological data related to the incidence, prevalence, and mortality from COVID-19 in Mexico and Querétaro is presented. In the second part, the epidemiological panorama of Queretaro is presented as an analysis tool to assess the epidemiological behavior of the population and the social, economic, and health conditions in the state. Finally, in the third part, health policies implemented by the state university and the experience of an integrative care model, implemented in the '*Clinica de Atencion* Integral COVID', which provides multidisciplinary assessment and treatment for COVID-19, is presented.

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Introduction

In this chapter, the impact of the pandemic on health in Mexico, in particular, in the state of Querétaro, is presented. Epidemiological trends regarding incidence, prevalence, and mortality are examined. And health policies are reviewed.

On December 31, 2019, Wuhan, China, reported a conglomerate of cases of acute respiratory syndrome of unknown origin. Some of these cases were vendors in the Wuhan seafood market which was closed on January 1, 2020 [1]. On January 7, 2021, the Chinese authorities reported that a new coronavirus (nCoV) had been identified. On January 30, the World Health Organization (WHO) declared that the outbreak of 2019-nCoV was a public health emergency of international concern [2].

The first confirmed case of COVID-19 was detected on February 27, 2020, in Mexico City. The patient was a Mexican who had traveled to Italy; he had mild symptoms [3]. On March 11, 2020, the WHO declared COVID-19 a pandemic. A few days later on March 18, the first death from COVID-19 was registered in Mexico. Mexico featured among the countries with the highest fatality rates. It ranked second in terms of the fatality rate (7.6 deaths per 100 infections). Peru ranked first [4].

According to official data from the National Epidemiological Surveillance System (SS), close to 4.0 million confirmed cases and 306,062 deaths from COVID-19 have been reported in Mexico. The incidence rate of COVID-19 is 2,9860 per 100,000 inhabitants. Figure 1 shows Mexico´s epidemic curve with the number of confirmed cases and deaths according to SS. The epidemic curve presents two infection peaks. The first one was in mid-January 2021. The second, in early August 2021, exceeded the first peak in the number of cases. Sex disaggregated data shows that there is a gender difference worldwide [5]. In Mexico, at the beginning, the distribution by sex in confirmed cases showed a higher prevalence in men (58%). Currently, the number of confirmed cases is similar in men and women (49% vs. 51%) but men have higher rates of hospitalization, intensive care admissions, and deaths (Fig. 2). The median age of COVID-19 cases in Mexico is 44 years.

There were 395,000 accumulated deaths by October 2021 (Fig. 1). Mortality was higher in people with pre-existing comorbidities. Comorbidities associated with higher mortality were hypertension, diabetes, obesity, and smoking [6]. Until November 12, 2021, 38.2% of the deaths were reported in women and 61.7% in men (Fig. 2). A study of COVID-19 in eight countries in Latin America (Brazil, Peru, Mexico, Argentina, Colombia, Venezuela, Ecuador, and Bolivia) showed that hypertension (12.1%) was the most common comorbidity followed by diabetes (8.3%), and obesity (4.5%) [7].

According to the National Survey on Health and Nutrition (ENSANUT), Mexico has a high prevalence of obesity and diabetes. The prevalence of overweight and obesity in Mexico has increased in recent years. From 1980 to date, the prevalence of these diseases tripled. Currently, the weight of over 70.0% of the adult population in Mexico is above the recommended level [8]. Excess weight is one of the main risk factors in the development of chronic non-communicable diseases such as diabetes

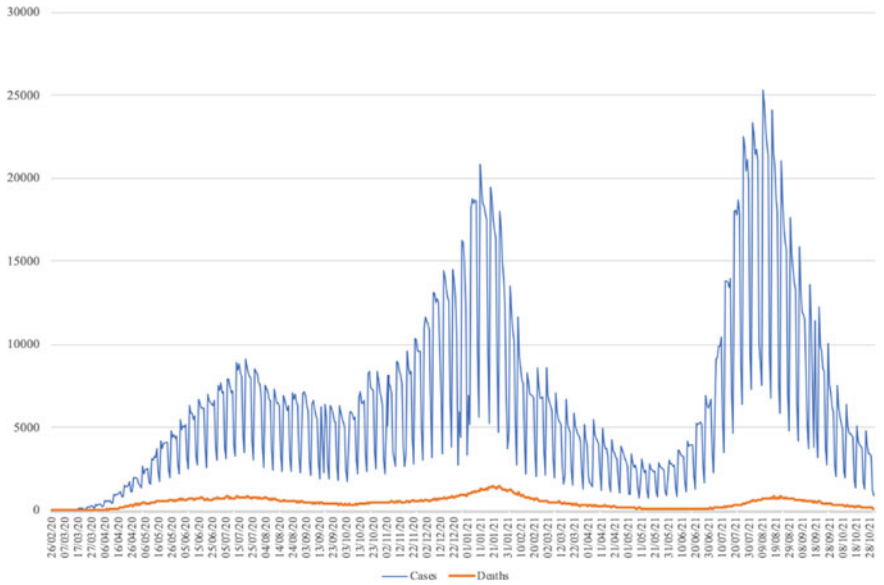

Fig. 1 Daily confirmed COVID-19 cases and deaths in Mexico. *Source* Authors' elaborated based on the General Directorate of Epidemiology (GDE) database

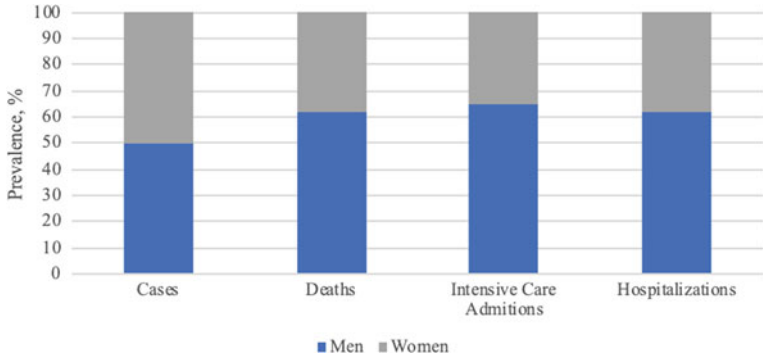

Fig. 2 Distribution of COVID-19 cases and deaths by gender in Mexico. *Source* Authors' elaborated based on the General Directorate of Epidemiology (GDE) database

mellitus, hypertension, and cardiovascular diseases. And these diseases increase the severity of COVID-19.

With a population of 2,038,372, Querétaro ranks 22 in the number of inhabitants among the states of the Federation. Queretaro represents 0.6% of the territorial extension of the Mexican Republic (Fig. 3); 175,000 of its inhabitants are over 60 years of age and so are at risk of contracting COVID-19 [9]. Regarding the Human Development Index (HDI) and health, the state of Querétaro occupies the seventh and twelfth

Fig. 3 Population distribution of the state of Querétaro in relation to the national territory. *Source* Instituto Nacional de Estadística y Geografía (INEGI), 2011

places, respectively, according to the ranking of the United Nations Development Programme (UNDP, 2015).

The state of Querétaro is organized into four health jurisdictions (Queretaro, San Juan del Rio, Cadereyta, and Jalpan). There are more than 250 public health institutions in Queretaro and San Juan del Rio. There are five second level hospitals (2 in Queretaro, 1 in San Juan del Rio, 1 in Cadereyta, and 1 in Jalpan), and approximately 200 first level healthcare centers [10]. In addition, healthcare is provided by a voluntary public program Seguro Popular which is financed by the Federal Government and private insurance (IMSS, ISSSTE). This program covers about 85% of the Mexican population [11].

The main causes of death in the state are non-communicable diseases including ischemic heart disease, diabetes mellitus, and cancer. Influenza and pneumonia are among the top 10 causes of death in the state [12]. Excessive weight is linked to several health problems [13]. Epidemiological studies suggest that obesity could have an adverse impact on COVID-19, especially in severe cases, and could increase mortality [14]. In Mexico, obesity is the strongest predictor of COVID-19 followed by diabetes and hypertension [15].

On March 11, 2020, the first confirmed case of COVID-19 was reported in Queretaro [16]. By October 30, 2021, there were more than 90,000 confirmed cases. The highest peak was in January with a second peak in August (Fig. 4). The incidence of COVID-19 was similar in women (45%) and men (55%). Although not considered a risk group, there were more confirmed cases in persons 25–34 years of age (27%) [17].

Higher mortality was reported in men than in women, 63% and 37%, respectively. Mortality was highest in persons over 60 years (57%). Comorbidities associated with deaths from COVID (n = 5,929) were hypertension (40%), diabetes (28%), obesity (21%), and chronic kidney disease (6%) [18].

Queretaro showed the lowest case fatality rate for COVID-19 in Mexico (Fig. 5). Despite having a larger number of confirmed cases in the capital of Queretaro, the fatality rate was two percentage points below the national average (Table 1).

According to the State Development Plan 2016–2020, Queretaro did not have the number of beds recommended by the World Health Organization (1 bed per 1,000 population) [19]. To avoid overburdening the healthcare system, hospitalization was

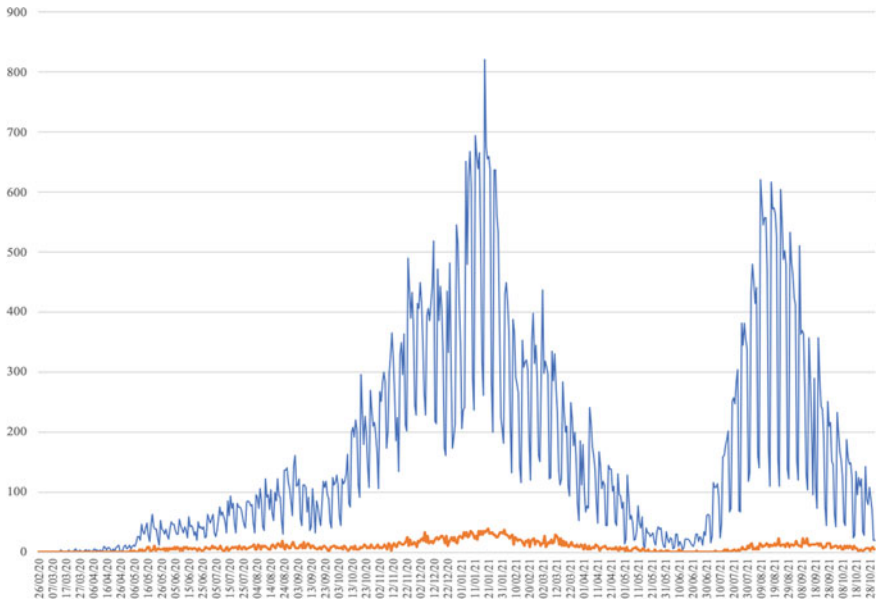

Fig. 4 Daily confirmed COVID-19 cases and deaths in Queretaro. *Source* Authors' elaborated based on the General Directorate of Epidemiology (GDE) database

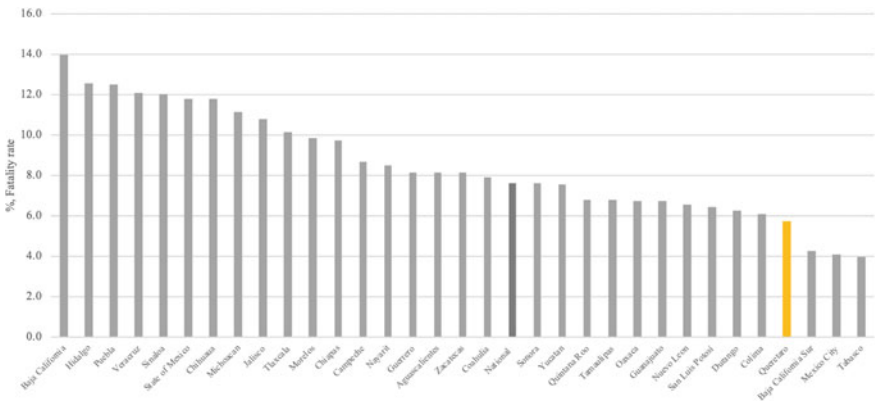

Fig. 5 Case fatality ratio in Mexico**.** *Source* Authors' elaborated based on the General Directorate of Epidemiology (GDE) database

reserved for severely ill patients. In Queretaro, 12% of confirmed cases required hospitalization which was three percentage points below the national average [17].

Table 1 Confirmed cases and deaths in Queretaro

Municipality	Confirmed cases	Deaths	% Fatality rate
Tequisquiapan	1084	134	12.4
Huimilpan	316	35	11.1
Amealco de Bonfil	655	58	8.9
Ezequiel Montes	795	60	7.5
Cadereyta de Montes	1616	119	7.4
Colon	942	68	7.2
San Juan del Rio	9170	658	7.2
Peñamiller	234	16	6.8
Pedro Escobedo	2149	135	6.3
Queretaro	65,380	3644	5.6
El Marques	5440	295	5.4
Pinal de Amoles	356	19	5.3
Landa de Matamoros	255	13	5.1
Toliman	482	24	5.0
Corregidora	6270	226	3.6
San Joaquin	311	10	3.2
Jalpan de Serra	1590	38	2.4
Arroyo Seco	356	7	2.0

Source General Directorate of Epidemiology (GDE) database.

Health Policies in Mexico and Querétaro

When the first death was registered in Mexico, the first, second, and third level Epidemiological/Hospital Surveillance Units (UVEH) in the country, members of the National Network of Public Health Laboratories, and staff of the National Health System issued a report through the National Committee for Epidemiological Surveillance (CONAVE) wherein parameters were established to identify suspected and confirmed cases of COVID-19. A suspected case was a person of any age who presented acute, mild, or severe respiratory disease and who had any of the following antecedents up to 14 days before the onset of symptoms: (1) had been in contact with a confirmed case or had been under investigation for COVID-19 and (2) had made a trip or stayed in countries with local transmission of COVID-19. A confirmed case was a person who met the operational definition of a suspected case and had

a confirmed diagnosis by the National Institute for Epidemiological Diagnosis and Reference (InDRE) [20].

On March 23, 2020, 367 cases and four deaths from COVID-19 were confirmed in Mexico: two in Mexico City, one in Durango and one in Jalisco. The Federal Government closed all schools. A program called '*Sana Distancia*' was launched by the Mexican Ministry of Health. Recommendations were made regarding basic prevention measures such as frequent hand washing, respiratory etiquette, greeting from a distance, and staying home if symptoms were present. There was a temporary suspension of non-essential activities. There was a rescheduling of mass events. And measures to protect and care for the elderly were implemented. To emphasize the importance of physical distance, a communication campaign was designed using cartoons that featured a heroine called '*Susana Distancia*' [21].

On March 30, 2020, the General Health Council declared COVID-19 a health emergency, and all non-essential activities were suspended till April 30, 2020, to mitigate the spread of COVID-19 in the community and to reduce the burden of disease [22]. Although there was a 44% increase in the number of cases [2,527 new confirmed cases], in order to reactivate economic and social activities, on May 13, 2020, the plan to reopen non-essential activities called 'New normality' was announced [23]. An epidemiological traffic light was used for monitoring. The traffic light was defined weekly according to the risk by region. Its color indicated what activities could be carried out. The regions identified with the red color represented the maximum epidemiological risk. Orange represented a high epidemiological risk. The colors yellow and green represented intermediate and low epidemiological risk, respectively. This traffic light system began on June 1, 2020, at the state level [24]. In regions identified with red color, only essential activities were allowed. In regions identified with the orange color, in addition to essential activities, non-essential activities could be reactivated although they were to be carried out at a capacity of 30% and with strict safe distance measures. In regions identified with the yellow and green colors, essential and non-essential economic activities could be conducted at full capacity as long as measures were taken to protect the health of workers [25].

On July 24, 2020, the Ministry of Health of the Government of Mexico, through the Institute of Health for Wellbeing (INSABI) and the Undersecretariat for Prevention and Health Promotion (SPPS), in collaboration with the Pan American Health Organization (PAHO), Mexico and the Secretariat of Welfare designed a strategy for promotion, prevention, care, and mitigation of COVID-19 and for monitoring essential public health actions at the community and the first levels of care within the framework of primary healthcare (PHC). The aim was to strengthen the response of the local health system to the pandemic. The following three action groups with specific action objectives were established [26]:

(1) **The Community Health Promotion Brigade**: Its function was to request information from the Director of the Health Unit about people with risk factors for COVID, generate data updates, apply general questionnaires and notify, provide information to reduce the risk of contagion, identify persons within the patient's home for follow-up, strengthen health promotion actions, and develop a directory

of public health officials according to the health problem and characteristics of the identified population.
(2) **The Specialized Brigades**: Their function was to follow-up suspected cases that belonged to the risk groups described above. Daily follow-up was conducted by telephone or in-person with people in the community with ARI (acute respiratory infection). The status of the identified persons with any health problems was evaluated. Patients suspected of COVID-19 were monitored. Blood pressure of all adults 20 years of age and older was taken. Cases that required care in remote consultation units (UCID) were identified. Patients considered in risk groups were clinically evaluated to determine if they should be isolated. Preventive actions were implemented. A 'brief mental health screening' questionnaire was completed. Patients were provided information on self-care. They were also provided First Psychological Aid if needed and were given timely information on specialized mental health services. Pregnant women were also reviewed.
(3) **The Clinical Care Team**: Its function was to evaluate and treat patients referred by the brigades, provide clear information on the evolution of the disease and its consequences, communicate with the isolated persons, provide psychoeducation, provide information on the lines of support, provide psychological support, and refer in a timely manner to Specialized Mental Health Services.

On March 11, 2020, the Secretary of Health of the State of Querétaro (SESEQ) confirmed the first case in the city. This was a 43-year-old man from Spain who was isolated at his home. He was kept under medical observation. His situation was stable. Coordination with the federal authorities was maintained in order to provide timely follow-up using protocols and guidelines and to provide adequate care. The staff of the Ministry of Health had the necessary supplies and were trained to address this situation [27].

The public was exhorted to participate in containing the disease by implementing preventive measures and visiting the doctor when symptoms of an acute respiratory disease appeared (fever, cough, respiratory distress or chest pain). Two operational criteria had to be present: (1) the patient had been contacted 14 days prior to the appearance of symptoms with a person confirmed with COVID-19 and (2) the patient had traveled to a city that had community transmission [28].

Preventive measures included: frequent hand washing with soap and water or 70% alcohol gel solution, covering the nose and mouth with a disposable tissue when sneezing or coughing or using the internal angle of the arm, avoiding spitting, but if necessary, spitting in a disposable tissue which would be put in a plastic bag and thrown away, cleaning and disinfecting surfaces and objects commonly used at home and in schools, offices, closed places, transport, meeting centers, etc. Avoiding touching the face, especially the nose, mouth, and eyes, avoiding direct contact with people with symptoms of cold or flu, visiting the doctor when there were respiratory ailments (fever greater than 38 degrees, headache, sore throat, runny nose, etc.), avoiding self-medication, staying at home when there were respiratory symptoms, avoiding going to crowded places, keeping workspaces and housing units well ventilated, and drinking plenty of fluids. Finally, the use of face masks was

recommended for patients with respiratory symptoms and people were urged to follow information provided through institutional channels [29].

The SESEQ included within its website, a COVID section on the Health Risks Directorate section and incorporated a tab called COVID-19 legislation in documents that were made available to citizens. At least 15 agreements were issued during the COVID-19 pandemic [27]. In these agreements, general recommendations were made to undertake health security measures. These were shown to the general population and to the health personnel. Other agreements focused on the suspension of economic, productive, and social activities.

During the emergency period, a Call Center for Medical and Emotional Attention was set up to inform people about physical and psychological symptoms related to COVID-19, resolve their doubts, and make appropriate referrals [30].

The Mexican Institute of Social Security (IMSS) implemented a hospital reconversion strategy in eight entities to address bed requirements which meant increasing the number of beds by 39% to reach 6,116 by the end of January 2021 in the states of Querétaro, Hidalgo, Puebla, Morelos, Guanajuato, Nuevo León, Jalisco, and Michoacán. In Querétaro, there were 380 beds and reconversion meant adding 104 to reach a total of 484 beds which was the number needed [31]. The Querétaro General Hospital shelter and the Children's and Women's Specialties Hospital were upgraded to provide medical care to COVID-19 cases that needed hospitalization.

In the second half of April 2020, the Congress Center became a Medical and Isolation Unit (UMA) to serve patients who were positive for COVID-19 but did not require hospitalization. UMA served 250 patients—125 women and 125 men. This number was later increased to 700 patients [32].

On November 28, 2020, the Secretariat of Health of the Executive Power of the State of Querétaro through the official gazette, envisioned future scenarios. In accordance with the criteria of the Technical Committee for Attention to COVID-19 and the Specialized Multisectorial Group for Epidemiological Surveillance of COVID-19, three scenarios were envisioned: Scenario A remission: hospital occupancy at 39%. Scenario B prevention: hospital occupancy between 40 and 70%. And Scenario C containment: hospital occupancy greater than 70% [33].

With a total of 30,215 accumulated cases and 2,049 deaths, on December 19, 2020, Scenario C was established in the State of Querétaro [34]. The positivity index was close to 38% and the increase in hospital occupancy in the absolute number of beds occupied by patients without the use of assisted ventilation was 48%. The percentage of patients with ventilator support was 49%. A total of 471 hospitalized patients reached 60% hospital occupancy [35]. According to the number of active cases of SARS-CoV-2 virus infection, the positivity index, and the increase in hospital occupancy, Scenario C remained in force until February 14, 2021. By then, the total number of accumulated cases was 51,162 and there were 3,371 deaths [36].

On February 12, 2021, Scenario B was established in the State of Querétaro. Sanitary security measures were implemented and remained in force until April 22, 2021. On February 10, 2021, hospital occupancy was reduced by 12% with 37% occupancy of beds with ventilator support and 50% occupancy of beds without ventilator support [37].

Local Strategies to Respond to COVID-19

The COVID-19 pandemic dramatically changed health systems around the world. It changed the way in which outpatient care was delivered to decrease the risk of transmitting the virus to patients and to healthcare workers. Vaccines and treatments were also developed [38]. On the other hand, the lockdown period imposed drastic changes in the behaviors and lifestyles of the people in terms of physical activity and quality of diet both of which are known to play an important role in disease management [39, 40].

The management of large numbers of COVID-19 patients over a short period of time disrupted the healthcare system. High demand for hospitalization beds overwhelmed the healthcare system [41]. As a response to the pandemic, the Mexican government promoted several strategies like physical distancing to limit the spread of COVID-19. However, it is important to note that very few strategies were implemented to ensure the continuity of essential health services [42]. The public and private health sectors repurposed multiple hospitals, reallocated health personnel, and diverted medical equipment and supplies to treat COVID-19 patients. There has been a lack of investment in the health sector in Mexico historically. Health expenditure in Mexico is only 5.5% of the Gross Domestic Product (GDP) [43].

Through the University Health System, the Autonomous University of Queretaro organized an integrative care clinic '*Clinica de Atencion* Integral COVID' dedicated to providing COVID-19 services and diagnosing and monitoring patients at home. The goal of this clinical service was to provide multidisciplinary assessment and treatment by a system that included virtual phone-based assessment and clinical home monitoring. The *Clinica de Atencion* Integral COVID offered a multidisciplinary care model in which physicians, nutritionists, physical therapists, pharmacological chemists, psychologists, and other staff members played a role in delivering comprehensive care. A description of the activities in each of the clinic's care areas is provided below.

Detection Area

At the beginning of the pandemic, a group of scientists from the Autonomous University of Queretaro offered SARS-CoV-2 virus detection services to the people through the use of the university's own resources. Detection was carried out by means of a molecular screening test. More than 2,000 free tests were offered to the population at risk. It was found that approximately 80% of infected people did not have symptoms or had mild symptoms. This was an important finding because it made it possible to detect and isolate carriers to prevent the spread of the virus, particularly for those most susceptible.

Clinical Household Follow-Up Program

Carriers of SARS-CoV-2 were invited for clinical follow-up which included a symptoms questionnaire to be administered by telephone screening to find out if the patient was a candidate for follow-up at home. Only patients with low and medium risk were accepted into this program. Patients with high risk were referred to a specialized care service. A series of visits were made to the patient's home to record signs and symptoms such as temperature, oxygenation, an olfactory test, and an antibody test. The first home visit was made by medical personnel. In subsequent visits, a pharmacological chemist obtained a blood sample to measure antibodies and a nutritionist performed a nutritional assessment.

Nutrition plays an important role in the management of COVID-19 [44]. Undernutrition, micronutrient deficiencies, and overnutrition increase the risk of developing serious complications [45]. The aim of the nutritional assessment was to identify nutritional risk in COVID-19 patients and assess its association with disease outcomes. In the beginning, the assessments were focused on identifying the risks of undernutrition. Nutritional assessment was later modified to assess metabolic risk factors. In patients included in this program risk factors like hypertension (30%), obesity BMI > 30 (27%), and diabetes (10%) were also assessed.

Rehabilitation: Post-COVID-19 Program

COVID-19 resulted in several medical, social, and psychological consequences like multi-organ failure of the heart and kidneys and vascular damage [46]. Specific rehabilitation needs to be undertaken for post-COVID-19 patients to achieve respiratory improvement and functional and cognitive recovery, decrease disability, and improve the quality of life [47].

Persistent symptoms were present in patients who had recovered from COVID-19 in Mexico [48]. There was no rehabilitation clinic in the private or the public sector where comprehensive multidisciplinary services could be offered for the treatment sequelae of COVID-19. A multidisciplinary team participated to address cardiopulmonary, nutritional, and psychological sequelae.

The assessment included a clinical history to obtain the patient's sociodemographic data, data related to diabetes, cardiovascular risk factors, and other comorbidities. Information on smoking and alcohol consumption and dietary intake was obtained by using a food frequency questionnaire. A battery of tests were conducted including laboratory testing, testing for respiratory conditions, functional status, quality of life, psychiatric conditions, and nutritional status.

The goal of the nutrition service was to assess the nutritional sequelae of COVID-19 and then to give personalized advice to the patients. Body composition analyses were performed by bioimpedance with a Body Composition Analyzer mBCA 514/

515 Seca GmbH & Co. KG, Hamburg. This breaks down weight into body compartments (muscle mass, body fat, and visceral fat). As would be expected, the principal nutritional risks found in patients post-COVID-19 were obesity, loss of muscle mass, and a decline in overall physical functioning. However, in our experience, after six weeks, muscle mass and nutritional status improved in these patients. It is important to note that medical and physiotherapists participated in the program.

The assessment also included circadian rhythmic features. It has been repeatedly acknowledged that the adequate functioning of the rhythmical system is essential for maintaining the homeostasis of an organism [49]. Studies focusing on the effects of lockdown as a result of the pandemic showed that human performance and health, especially quality and quantity of sleep [50], nutrition, and physical activity were affected [51]. A recent study shows that the complex pathogenesis of severe acute respiratory syndrome by SARS-CoV-2 infection is related to circadian disruption [52]. Thus, in considering the disturbances of the biological timing for nutritional assessment according to light–dark cycles, timing of food intake, light at night, nocturnal feeding, physical activity, jet lag, and shift work are of prime importance [53].

In conclusion, Mexico is among the countries that have the highest COVID-19 fatality rates. Efforts were made to expand hospital capacity. However, there were significant disruptions in the health services. The health system needs to resume essential services and should catch up on missed preventive care even as the COVID-19 crisis continues in Mexico. A comprehensive assessment is the key factor in the management of COVID-19 and in identifying specific clinical needs for comprehensive and individualized care.

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Bridge Over Troubled Waters: Women-led Response to Maternal and Child Health Services in India Amidst the COVID-19 Pandemic

Aastha Kant and Avishek Hazra

Abstract Globally, the COVID-19 pandemic has disrupted the delivery of essential health services in general and reproductive, maternal, newborn, child health, and nutrition (RMNCHN) services in particular. The degree of disruption, however, varies disproportionately. It is more in low- and middle-income countries than in high-income countries. Focusing on India, the authors draw on various demand and supply side factors that hampered the provision of RMNCHN services and thus adversely affected many families across the country. Coupled with the gendered aspects of the social determinants of health, the pandemic intensified social vulnerabilities by impacting pregnant and lactating women and children the most. Modelling studies suggest that the progress India made over a decade on various maternal and child health and nutrition indicators may go in vain unless focused efforts are made to address the slide. Complementing government efforts to mitigate the health risks of the pandemic by strengthening health services, women-led initiatives played an important role in portraying how women's collectives and women in leadership can be like a bridge over troubled waters in the times of a pandemic.

Introduction

Coronavirus disease-2019 (COVID-19) affected the warp and weft of the social fabric globally. The pandemic impacted mortality and morbidity in countries around the world. There is evidence to show that more men were infected with COVID-19 as compared to women. And a higher proportion of hospitalizations, intensive care unit admissions, and deaths occurred among men [1]. The 'tyranny of the urgent' placed

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immediate biomedical needs over existing social inequities [2]. The indirect impacts of COVID-19 had gendered effects that reverberated across sectors. Women faced the social and economic consequences of the pandemic. The virus disproportionately increased the burden of unpaid care on women. It is estimated that in the formal sector, job loss rates were twice as high among women as compared to men with a high proportion of women experiencing a loss in their earnings within the first month of the pandemic. They faced serious socio-economic consequences [3, 4]. Coupled with the gendered aspects of the social determinants of health, the pandemic intensified social inequities in low- and middle-income countries. Learnings from the Ebola outbreak urge us to go beyond the binary of biomedical and social aspects and to respond with a holistic approach to reach underserved and vulnerable populations. To mobilize this response, an intersectionality approach to the pandemic is a pre-requisite [2, 5]. This is likely to enhance our understanding of systemic inequities, role of social determinants of health, and lived experiences in the context of the pandemic.

The chapter begins with a snapshot of the global and local (Indian) context of the impact of the COVID-19 pandemic on reproductive, maternal, newborn and child health, and nutrition (RMNCHN). Using secondary data, we present the status of key maternal and child health indicators in the two decades prior to COVID-19 and discuss how various factors during the pandemic disrupted RMNCHN service provision adversely affecting many families across the country. We highlight the way community health workers supported the health system's effort. We also illustrate the gendered impact of the pandemic and how it had severe negative social and economic consequences for women. We showcase the critical role that women's groups and their federations played in underserved and marginalized communities to supplement government efforts to mitigate the health risks of the pandemic. We present these efforts through Relief, Resilience, and Recovery which we term as the '3R response'. We conclude by highlighting the potential of the '3R response' which can serve as a model for other crisis situations in amplifying the reach of health information and services to vulnerable populations.

COVID-19 and Maternal, Newborn, and Child Health

Global Context

The COVID-19 pandemic adversely affected human life in many ways worldwide. The economic and social disruptions caused by the pandemic were devastating. Tens of millions of people were at risk of falling into extreme poverty. It is estimated that the number of undernourished people, currently about 690 million, could increase by an additional 132 million by the end of the year [6]. The pandemic challenged the resilience of health systems globally. It emerged as a threat to global public health, forcing countries to adopt several different strategies including lockdowns [7].

The health sector was affected in particular—from the provision of services to access and the utilization of health services. COVID-19 posed severe challenges for implementing much needed essential health services. It disrupted the delivery of essential health services in general and MNCH services in particular which compelled healthcare systems to prioritize services provided [8]. Healthcare workers had to cope with the rising number of COVID-19 patients. The degree of disruption, however, varied disproportionately. It was more in the low- and middle-income countries (LMICs) than in the high-income countries. The World Health Organization undertook a 'pulse survey on the continuity of essential health services during the COVID-19 pandemic' to estimate its impact on the delivery of essential health services across the life course [9]. In almost every country 90% of country respondents experienced some degree of service disruption with LMICs experiencing a greater extent of service disruption compared to high-income countries.

The potential effects of the virus on mothers, newborns, and pregnancy outcomes were of significant concern [10]. Research showed that nationwide lockdowns disrupted health services in many countries. And the fear of accessing health facilities affected the wellbeing of pregnant women and their babies [4, 11, 12]. Studies which modelled the indirect effects of COVID-19 on maternal and child mortality in LMICs highlighted the consequences of disruption on routine healthcare. A recent meta-analysis shows an increase in maternal mortality, stillbirths, ruptured ectopic pregnancies, pre-term births, and maternal depression during the pandemic which had disproportionate adverse effects in low resource settings [4, 13–15]. A reduction in seeking healthcare as well as reduced provision of maternity services were noted as possible causes [16]. Pregnant women in rural, low resource, and conflict affected settings were at greater risk because they already had inadequate access to quality care [17, 18]. Limitations in the availability of skilled health workers and challenges to using the health system led to lower coverage of ante-natal care (ANC), post-natal care (PNC), and facility and community-based lactation support and counseling for women [19].

A systematic review and meta-analysis published in the Lancet Global Health indicates that the rates of stillbirths and maternal deaths rose by about a third during the COVID-19 pandemic with outcomes showing considerable disparity in stillbirths between high and low resource settings [15]. The review also acknowledged that unequal digital access in LMICs made remote consultations less feasible leading to disruptions in preventive ante-natal care for vulnerable groups. Increase in domestic violence during the pandemic was assumed to be a contributing factor that increased maternal mortality.

The Lancet series of papers highlight the concern on maternal and child nutrition. It was noted that despite some progress, maternal and child undernutrition were a major global health concern as improvements since 2000 may have been countered by the COVID-19 pandemic [20]. The pandemic indirectly threatened breastfeeding practices such as timely initiation, exclusive, and continuous breastfeeding. Reduction in breastfeeding practices during the pandemic were due to limitation in the provision of information and advice and disruptions to the enabling environment [14]. Overall, economic, food, and health system disruptions resulting from the

pandemic are expected to exacerbate all forms of malnutrition [21]. Estimates by the International Food Policy Research Institute (IFPRI) suggest that because of the pandemic an additional 140 million people will be thrown into extreme poverty (less than USD 1·90 per day) by 2020 [22].

The Indian Context

The reproductive, maternal, newborn, child, and adolescent health (RMNCH + A) program is at the core of the country's flagship program, the National Health Mission (NHM). Following a call to action summit in 2013, the Government of India took an important step to fulfil its commitment to improve maternal health and child survival through the articulation of a comprehensive approach linking together a set of initiatives and strategies that address each life stage [23]. This was a milestone in the country's health planning for improving the availability of and access to quality healthcare, especially for people residing in rural areas, the poor, women, and children. Innovative strategies were evolved under the national program to deliver evidence-based interventions to various population groups [23]. These included selecting poor-performing districts, prioritizing high impact RMNCH + A health interventions, engaging development partners, and institutionalizing a concurrent monitoring system. This strategy helped in the development of an integrated systems based approach to address public health challenges through a comprehensive framework, defined priorities, and robust partnerships [24].

Over the past two decades, India noted significant improvements in the RMNCH indicators. Data from the National Family Health Survey showed a sharp increase in several indicators including ANC, institutional delivery, newborn care, PNC, child immunization, and child nutrition practices (Fig. 3) [25].

RMNCH services were disrupted in India after March 2020 because of the COVID-19 pandemic induced lockdown and movement restrictions. The health management information system (HMIS), which tracks indicators on the utilization of health services from over 200,000 health facilities—primary health centers to district hospitals in every district of the country and is updated nearly every day—showed that health services were severely curtailed in March 2020 as compared to previous months [26]. There were reports of supply chain disruptions due to the lockdown and associated movement restrictions resulting in medicine and vaccine stock-outs. Village health and nutrition days (VHNDs), which are the prime platforms for routine ante-natal and child immunization services, were suspended during the lockdowns. As per the HMIS data, routine check-ups of pregnant women and associated ANC tests that are important for ensuring healthy and safe pregnancy reduced during March 2020 and in the following months (Fig. 4).

Anganwadi centers stopped distributing food grains and mid-day meals services were paused as schools were stopped. Mobility restrictions also posed a severe challenge in providing post-natal care to mothers and newborns and monitoring

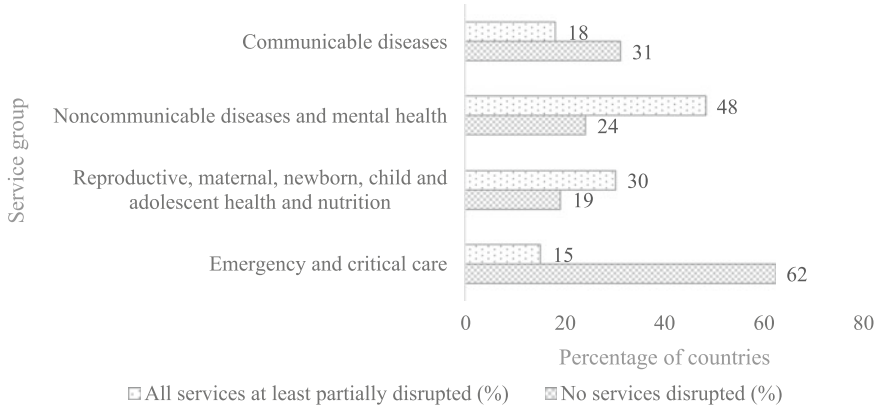

Fig. 1 Percentage of countries reporting disruption across entire service groups (n = 105). *Source* World Health Organization. Pulse Survey on Continuity of Essential Health Services During the COVID-19 Pandemic: Interim Report, 2020

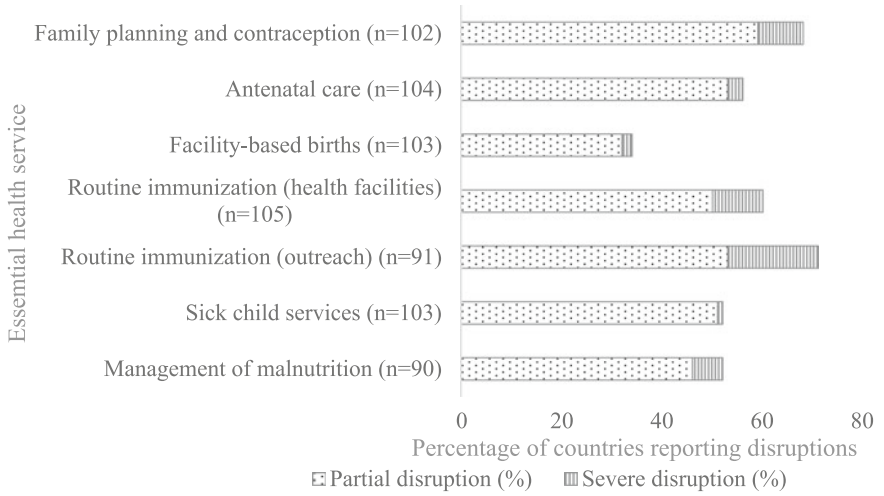

Fig. 2 Percentage of countries reporting disruption in reproductive, maternal, newborn, child and adolescent health, and nutrition services. *Source* World Health Organization. Pulse Survey on Continuity of Essential Health Services During the COVID-19 Pandemic: Interim Report, 2020

the growth and development of children. The HMIS data indicated that there were reductions in child immunization (Fig. 5).

Multiple barriers decreased service utilization. These barriers were initial movement restrictions and decreased demand due to fear of COVID-19 infection. Several steps were taken by the government to respond to the disruptions caused by the early lockdowns. It moved to a sub-nationally driven localized containment approach that replaced widespread lockdowns with micro-pockets of restrictions determined by the

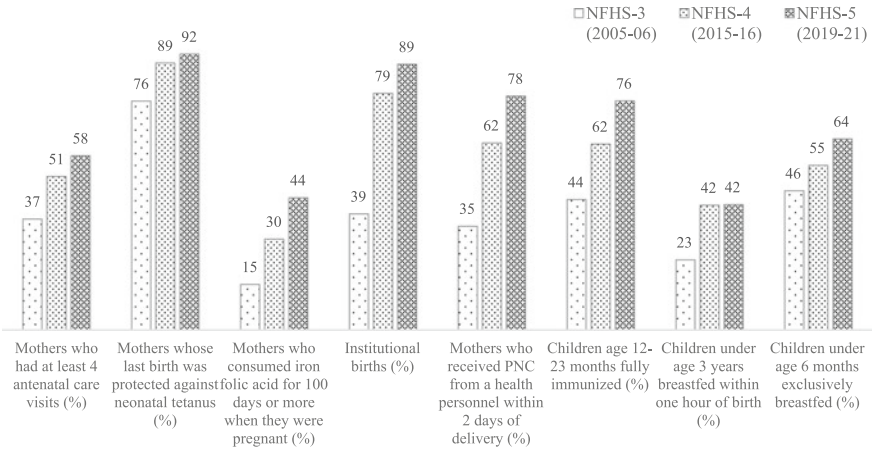

Fig. 3 Improvement in key RMNCHN indicators in India (2005–2021). *Source* NFHS-4 and NFHS-5 factsheet

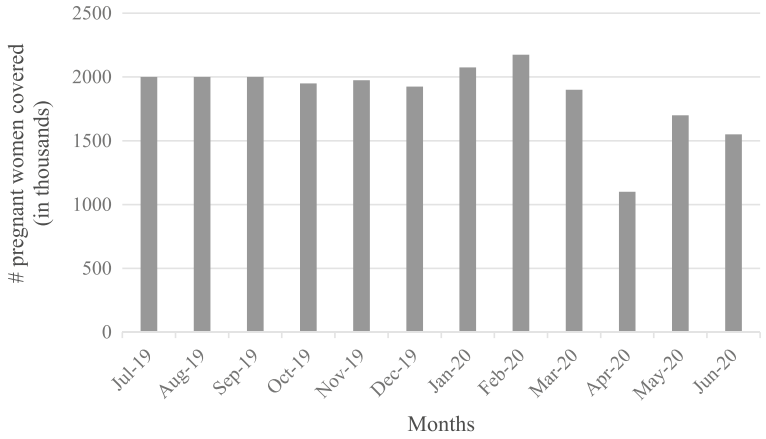

Fig. 4 Routine ANC check-up during pregnancy in India, July 2019 to June 2020. *Source* Calculations based on HMIS data

states [27]. There was also greater emphasis on utilizing community health workers in multiple ways which we describe below.

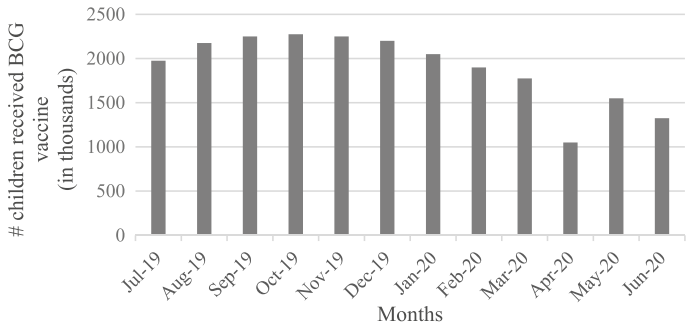

Fig. 5 Routine immunization for BCG vaccine in India, July 2019 to June 2020. *Source* Calculations based on HMIS data

Community Health Workers' Support to the Health System's Efforts

Community health workers or frontline health workers—accredited social health activists (ASHAs), a*nganwadi* workers (AWWs), and auxiliary nurse midwives (ANMs)—are women cadres that constitute the healthcare workforce at the grassroots level. It serves as an interface between communities and the public health system. Two million frontline health workers have been engaged in strengthening primary healthcare outreach and community nutrition programs across the country. ASHAs, who are women residents of the village with communication skills, leadership qualities, and social capital were mobilized to engage with the community. They are the first point of contact for maternal and child health related information and services. They mobilize women for ANC services, accompany pregnant women for health facility deliveries, and play an important role in mobilizing women and children for post-natal care services including immunization. In short, ASHAs' mandate is to generate health awareness and mobilize the community for promoting health [28].

AWWs are key personnel under the government's flagship Integrated Child Development Services (ICDS) at a*nganwadi* centers. ICDS aims to promote child development and enhance the capabilities of mothers to look after their children's health and nutrition. The service delivery framework of ICDS includes supplementary nutrition, immunization, health check-ups, and referral services for pregnant and lactating mothers and children below six years of age [29]. ANMs and ASHAs bear the responsibility for immunization services for pregnant women and children, ANC, PNC, basic management of early childhood diseases, and basic services for communicable and non-communicable diseases including disease surveillance. ANMs identify vulnerable populations, assess their needs, and support national and state program activities. Along with ASHAs and AWWs, ANMs organize VHNDs once a month in villages [29].

Community health workers play a vital role in the community by providing access to healthcare especially in the domain of maternal and child health services. There is evidence to suggest that door-to-door counseling and community outreach improved outcomes in health and nutrition behaviors and service uptake such as routine immunization, contraception, and feeding practices of infants and young children [30]. As noted earlier, in the unprecedented times of COVID-19, there was a mandatory lockdown resulting in disruptions in the RMNCH + A services. In this critical situation, the pool of women community health workers was given the additional responsibility of community surveillance by conducting door-to-door visits to identify suspected COVID-19 cases and trace contacts. They were also engaged in providing information about the virus—mode of transmission, symptoms, prevention, and COVID-19 appropriate behaviors. Community health workers were engaged in building community support networks by coordinating with women-led self-help groups (SHGs), youth networks, and *gram pradhans* (village heads) and in connecting them with essential health resources.

During the pandemic, *anganwadi* workers were involved in stitching masks for children and pregnant women. In Vizianagaram, Guntur, Kurnool, and Chittoor districts of Andhra Pradesh. *Anganwadi* workers delivered supplementary nutrition to pregnant and lactating mothers and children below six years of age. In addition to their core mandated responsibilities, *anganwadi* workers were also involved in ensuring the safety of women during the lockdown. Reports show that there was an increase in domestic violence in this period. The government of Tamil Nadu initiated a response system in which the *anganwadi* became the first point of contact for receiving calls about domestic violence and referring those to the concerned officials. In the Rajouri district of Jammu and Kashmir, women could register their domestic violence complaints either at the *anganwadi* center or directly through the distress helpline [29].

Despite the critical role played by frontline women health workers, their own situation had been dismal. Frontline health workers had repeatedly raised their voices regarding inadequate masks, sanitizers, gloves, and personal protective equipment (PPE) kits. In several cases, ASHAs faced violent resistance from the community and so they required protection for their own safety. This was further compounded by delays in receiving their salaries. ASHA workers earn incentives for completing over 60 tasks ranging from Re 1 for every oral rehydration solution (ORS) packet distributed to Rs. 600 for each institutional birth [31]. Due to the pandemic related disruptions in many routine activities related to maternal and child health, ASHAs experienced a decline in their earnings, in some cases to half of their usual income. A study conducted by *Behan*Box between October and December 2020 on the role of frontline workers fighting the COVID-19 crisis in ten states—Assam, Bihar, Haryana, Jharkhand, Karnataka, Maharashtra, Madhya Pradesh, Delhi, Telangana, and Uttar Pradesh, revealed that on an average, work hours for ASHAs increased from 6 to 8 to almost 12–15 h a day during the pandemic [32]. Community health workers were overworked and underpaid during the pandemic.

The Gendered Impacts of the Pandemic

Women contribute a predominant share to the 'care economy' with almost 75% of unpaid care and domestic work at home [33]. Women also engage in the paid economy with high participation in industries. Several of those industries were affected by the pandemic [34]. It is estimated that in the formal sector, job loss rates were twice as high for women than for men [3]. Globally, in the year 2020, women represented 38.8% of all participants in the labor force [35]. As per the Organization for Economic Co-operation and Development (OECD) Center's Gender Index, globally women engaged three times more in care work than men [36, 37]. It is estimated that in the health sector women contribute 5% to the global gross domestic product (USD 3 trillion) annually, of which almost 50% is unrecognized and unpaid [38]. Occupational de-segregated by gender in the health sector is universally seen with a predominance of women health workers belonging to lower social strata. Therefore, they are paid comparatively less and are often in unpaid roles—facing the harsh realities of gender bias. In the health sector, the gender pay gap exists globally affecting women's health outcomes. Women in the healthcare sector earn on an average 28% less than men [39]. The occupational distribution of women tends to be skewed in favor of nursing and midwifery and other 'care' professions such as community health workers. Globally in 2019, of 28.5 million nurses and midwives, about 24 million were women, making them a key stakeholder in the delivery of health services [38].

In India, female labor force participation was on the decline even in the pre-COVID era. Women's earnings were about one-fifth of men's earnings. This situation was further intensified in the informal sector constituting almost 91% of women. Unequal structures, power relations, and societal norms worsened for women during the pandemic. More women lost their jobs and became primary caregivers at home [40]. During the first lockdown in the first quarter of 2020, 47% women lost their jobs and did not return to work by the end of the year as compared to 7% men who lost their jobs and were able to make a recovery. In the informal sector, between March and April 2021, rural women in informal jobs accounted for 80% of the job losses. Overall, in India, the trend shows that men slipped into informal employment while women were forced out of the workforce—further pushing households into poverty and destitution [41].

Extended lockdowns and social distancing norms imposed to curb the pandemic made women more vulnerable to domestic violence. Emerging evidence shows that since the outbreak of COVID-19, reports of violence against women increased in countries where there were lockdowns. Employment insecurity and stress resulted in an increase in gender-based violence. The National Commission for Women (NCW) corroborates that domestic violence complaints almost doubled after the nationwide lockdown was imposed in India. Based on NCW data, a total of 1,477 women complained of domestic violence during the first lockdown between March 25 and May 31, 2021. The highest number of complaints in the last 10 years were recorded in this 68-day period. Among cities, Delhi recorded the highest complaint rate with 32 complaints. Uttar Pradesh recorded the highest number of complaints

(600) among all the states in India [42]. Community managed initiatives were undertaken to support civil society organizations along with DAY-NRLM under the Initiative for What Works to Advance Women and Girls in the Economy (IWWAGE). The latter also supported the Study Webs of Active–Learning for Young Aspiring Minds (*SWAYAM)* Project [43]. A center was established to help women voice their grievances. A physical *Lok Adhikar Kendra* (Gender Justice Center) was established with the support of the non-governmental organization *ANANDI* in the Karhal and Sheopur blocks of Sheopur District of Madhya Pradesh. Project Concern International initiated tele-counseling services for women at the Gender Facilitation Center in Odisha [44].

Women-led Initiatives to Enhance Maternal and Child Health Services: The 3R Response

In this section, we showcase the critical role played by women's groups in underserved and marginalized communities to supplement government efforts to mitigate the health risks of the pandemic. These efforts can be viewed through the lens of a '3R response'-Relief, Resilience, and Recovery. We explain this briefly as follows:

- **Relief**: from the socio-economic and health impacts of the pandemic
- **Resilience**: against the overburdened and overstretched health infrastructure
- **Recovery**: from the pandemic induced disruptions in maternal and child health services.

The underlying essence of the '3R response' can be understood through various community initiatives that women proactively initiated to address maternal and child health (MCH) needs at the community level during the COVID-19 pandemic. Through the '3R response', we discuss the proactive, innovative, and dynamic responses to the pandemic by women-led initiatives; resilience through collective solidarity by women's groups as they selflessly committed themselves to generating awareness about COVID-19 appropriate behaviors and bridging the supply gap for vulnerable populations. We also sustained efforts of women's groups in facilitating the social and economic recovery of vulnerable populations.

Decentralized and Integrated Ways to Generate COVID-19-Related Awareness at the Grassroot Level

Local responses to the pandemic included generating awareness using creative outlets and digital media. For example, while some SHGs were engaged in graffiti in villages in Chhattisgarh, others made *rangoli* (colored designs) for sensitizing the public about the virus in Uttar Pradesh [45]. In Uttar Pradesh, SHGs of the State Rural

Livelihood Mission (SRLM) '*Prerna*' marked the roads with *rangoli* to educate the community about the COVID-19 protocol of physical distancing. They also generated awareness through wall paintings. Women in SHGs used online platforms like TikTok videos and songs to generate awareness about COVID-19 appropriate behavior [46]. In Kerala, *Kudumbshree* disseminated information and checked for misinformation through WhatsApp groups [47]. In Bihar, *JEEViKA* used the mobile *Vaani* platform, an interactive voice response system to spread preventive messages about COVID-19 [47]. *JEEViKA* SHGs developed an innovative comic series, '*Badki Didi*' (big sister), for delivering messages on COVID-19 prevention. In Assam, a vehicle with an amplifier was used by the SHGs to spread messages in the community. In Nagaland, SHGs introduced an innovative method to promote hand hygiene in the community by using locally made bamboo poles [43]. In Jharkhand, a group of rural women journalists called *Patrakar Didis* (journalist sisters) disseminated information on staying safe and accessing healthcare services [43].

SHGs were also involved in enhancing livelihood opportunities for women. In Assam, women were engaged in weaving *Gamusa* (cotton cloth having a cultural significance) fabric for making masks in anticipation of high sales during *Rongali Bihu*, an Assamese festival [43]. Similarly, in the Etawah District of Uttar Pradesh, triple layered masks were made from *khadi* (handloom). In Lucknow, women *chikankari* (embroidery) artisans were involved in making masks. SHGs in the Narayanpet District of Telangana were engaged in making masks from their traditional fabric, *Pochampally*. These products were subsequently marketed by the State Rural Livelihoods Missions [48].

Through their vast networks, SHGs were involved in producing 16 million masks, 500,000 L of sanitizers and 500,000 PPE kits. They also promoted 120,000 community kitchens [49]. Community kitchens provided nutritious food to vulnerable populations, especially to pregnant and lactating mothers and children. Various initiatives were seen across states. Jharkhand initiated the *Mukhya Mantri Didi* Kitchen and *Dal Bhaat Kendras* that were run by *Sakhi Mandals* (SHGs) to provide free meals to vulnerable populations. Bihar started the *Didi Ki Rasoi* and Uttar Pradesh catered to *Prerna* canteens. In Odisha, around seven million women members of 0.6 million Mission *Shakti* SHGs provided necessities like dry rations, groceries, and cooked food to vulnerable populations through community kitchens [45]. In Chhattisgarh, SHGs were engaged in making disposable plates and bowls from paper and dried leaves for the quarantine centers [50]. They also prepared and delivered ready-to-eat *Poshan* (nutrition) kits to pregnant women in quarantine centers in the rural areas of Bemetara District [43].

SHGs also played an instrumental role in crises situations. In Rajasthan, during a crises caused by a drought, the SHG platform was utilized to spread information on capacity building and livelihoods [51, 52]. There are success stories portraying how community-led initiatives for health and food security set an example during the Nipah outbreak in Kerala and cyclone *Phani* in Odisha [51]. Women's collectives have a deep understanding of local communities. They are trusted by the communities which enables them to implement successful initiatives at the community level. At the beginning of the pandemic induced lockdown in India, women SHGs were agile

and proactive in pivoting COVID-19 crisis management by reaching out to the last mile and using their social capital to support communities [46]. During the peak of the lockdown, women's collectives, in the form of SHGs, rose to the occasion to provide a decentralized and integrated approach for addressing the health needs of the community. This included generating awareness among pregnant and lactating women as well as among other vulnerable groups to follow COVID-19 protocols and stay safe. They helped in providing nutrition and health services that had been disrupted during the pandemic.

SHG and Their Federations in Disseminating MCH and Nutrition Messages in the Community

In 2011, as part of the National Rural Livelihood Mission, the SHGs and their federations, which were functioning with the support of non-governmental organizations, got a structured government platform. In 2015, the Mission was renamed as *Deendayal Antyodaya Yojana* National Rural Livelihoods Mission. The aim of the Mission is to reduce poverty through gainful self-employment of women. There are 89.91 million households that are mobilized into 8.34 million SHGs. They work across 742 districts and 7073 blocks in 34 states and union territories of India [53].

A systematic review shows that participatory learnings and actions are a cost-effective strategy for improving maternal and neonatal survival in low-resource settings [54]. Studies in India show that health interventions with women's groups such as SHGs and their federations helped in improving maternal and child health practices that are supply independent through health behavior change communication interventions [55]. A quasi-experimental study in Uttar Pradesh showed that discussions on key maternal and newborn health practices by trained peer-educators in SHG meetings and community outreach activities organized by SHGs and their federations helped women follow correct healthcare practices [56]. Studies in Bihar demonstrated the effects of pilot interventions around behavior change communication through women's SHGs on improving healthy practices [57, 58]. In three states of India—Bihar, Chattisgarh, and Odisha—*Swabhimaan*, an initiative integrated within the Government of India's flagship poverty alleviation program-*Deendayal Antyodaya Yojana*-National Rural Livelihoods Mission (DAY-NRLM) aims to mobilize women through SHGs to address the nutritional needs of adolescents and women in their communities. Findings from its mid-line evaluation revealed a reduction in thinness among adolescent girls and in women with children under two years of age and an increase in the average mid-upper arm circumference of pregnant women [59].

SHGs were engaged in developing nutri-gardens to promote sustainable ways to boost the immunity of the women and children. This was done by encouraging women to have kitchen gardens in their backyards. They were encouraged to sow different vegetables to address the nutritional needs of pregnant and lactating women and

children aged six months to three years. Under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), women farmers encouraged families with pregnant women to develop nutri-gardens in their homes in the Koraput District of Odisha [48]. The NRLM advised that *Krishi Sakhis* (agricultural community resource women) support women in making their own kitchen gardens and also engage in poultry as sustainable ways to address their nutritional needs [43]. In Bihar, *JEEViKA* SHGs distributed seeds to households with pregnant women and children who had kitchen gardens. Similarly, in Jharkhand, seeds of pulses and cereals were provided to SHGs. In a few blocks of the Deoghar District in Jharkhand, the district administration distributed sewing machines to women for weaving fishing nets [43].

Another innovative initiative that was undertaken during the lockdown was 'Vegetables on Wheels'. Women in SHGs took it upon themselves to reach fresh vegetables to the vulnerable especially new mothers and children. *Kudumbashree* started 'floating supermarkets' in the Alappuzha District in the backwaters and canals for delivering essential goods. Five members of two *Kudumbashree* units started operating a 'supermarket' ferry to provide essential daily food supplies. They raised about USD 2,000 for procuring supplies [60]. Ferrying on the *Pampa* river, the supermarket catered to over one hundred families in Kuttanad. In Mizoram, community-operated transport vehicles were used for providing essential services and commodities to underserved areas [48]. In the Bastar District of Chhattisgarh, *Poshan Sakhis* (nutrition sisters) started a tele-counseling service for women on COVID-19 appropriate behaviors, hygiene, and healthy diets. They organized monthly review meetings to assess if appropriate nutrition was being made available during the lockdown to pregnant women, lactating mothers, and children [43].

Extending Support to Community Health Workers for Delivering Maternal and Reproductive Health Services

The lockdown saw a suspension of reproductive, maternal, newborn, child, and adolescent health (RMNCH + A) services across various states of the country. Because *anganwadi* centers were closed, SHGs and other women's collectives stepped in to ensure that pregnant and lactating mothers and children received the services that they needed. Apart from addressing their nutritional needs, SHGs also supported the over-burdened frontline health workers to provide ANC and PNC. They provided iron and folic acid and calcium supplements to women. More than 4,000 pregnant and lactating mothers were reached by over 2,000 SHGs in the states of Bihar, Odisha, and Chhattisgarh. As part of the 'Take Home Ration' (THR) Program, SHGs supported AWWs, ASHAs, and ANMs in Odisha and Chhattisgarh to distribute eggs to children below five years of age and to pregnant and lactating mothers [44]. In some blocks of Odisha, SHGs served the community by tracking pregnant women, lactating mothers, and children to provide routine immunization [61]. They contacted pregnant women who were due for ANC check-ups and extended their

support in facilitating ANC visits at health centers [43]. *Kudumbashree* in Kerala ensured that the health supplement *Amrutham* Nutrimix powder reached all infants and children across all the districts of Kerala [43]. The *Swabhimaan* Projects in Bihar, Odisha, and Chhattisgarh was run by the United Nations Children's Fund (UNICEF) and the *ROSHNI* Center for Women Collectives Led Social Action where frontline health workers were supported by SHGs for the delivery of ANC and PNC and for providing micronutrient supplements to under-nourished pregnant women and lactating mothers [44].

Poshan sakhis in Bastar, Chhattisgarh worked closely with ASHAs, ANMs, and *Anganwadi* workers in providing counseling on nutritional practices to adolescent girls, pregnant women, and mothers of children under two years of age. They also monitored the beneficiaries receiving essential nutrition services like THR as well as micronutrient supplementation such as iron and folic acid (IFA) and calcium at VHNDs. *Poshan sakhis* in Chhatisgarh and Odisha distributed sanitary napkins, soap, and sanitizers to adolescent girls and generated awareness regarding hand washing with soap [62]. In the Angul District of Odisha, *poshan sakhis* mobilized communities to observe VHNDs while wearing masks and maintaining social distancing [61]. In the Purnea District of Bihar, *kishori sakhis* were engaged in working with adolescent girls through participatory learning and action (PLA) sessions on hygiene and hand washing to prevent COVID-19 infection [43].

Closely associated with SHGs, *poshan sakhis* (friends of nutrition) in Bihar, Chhattisgarh, and Odisha aimed to improve the nutritional status of girls and women through a life cycle approach—starting before conception and ending after childbirth. This included ANC and PNC services and providing micronutrient supplements to malnourished pregnant and lactating mothers [44].

Women in SHGs in Maharashtra distributed sanitary pads through *Asmita* Plus to help meet the demand for sanitary pads during the lockdown. During the lockdown, an SHG from Pune, *Gyaneshwari Samuh Sahayata Samuh* supplied 10,000 packets of *Asmita* Plus sanitary pads to the *Shindhwane gram panchayat* [62]. SHGs under the Chhattisgarh Rural Livelihoods Mission, Bihar Horticulture, Agriculture (BIHAN)—prioritized the distribution of sanitary pads. SHGs also worked very closely with other government initiatives in delivering services to the community during the lockdown. They put their own health at risk as they distributed rations under the Public Distribution System and Take-Home Rations Project implemented through ICDS program [62].

Addressing Breastmilk Pleas: Women's Initiatives

Collaborating with the government, development agencies and civil society organizations provided pathways and opportunities to further the efforts of the women collectives to overcome pandemic related barriers. The second wave of COVID-19 in the country was characterized by a huge shortage of oxygen cylinders, beds, and medications. Thousands of families lost their loved ones. Several pregnant women

and new mothers infected; some succumbed to the virus. This led to an increase in pleas for breastmilk. Several community-led organizations came forward to address this concern. Lactating mothers came together voluntarily to support families individually or through human milk banks. Some prominent NGOs, such as *Bachpan Bachao Andolan* and *Protsahan* India Foundation, made efforts to ensure that breastmilk was available to infants in rural and urban areas in the midst of the COVID-19 crisis [63].

In the digital domain, women-led initiatives like *Prachi Pendurkar's Snugbub* and *Adhunika Prakash's* Facebook group Breastfeeding Support for Indian Mothers posted COVID-related posts on social media for those who were asked to isolate from their babies. Doctors in Mumbai conducted online training in safe breastfeeding for *anganwadi* supervisors in rural Maharashtra. They also set up a helpline for mothers to address their questions on breastfeeding. In addition, they developed a series of Do-It-Yourself tutorials for new mothers [64].

Some state governments also launched initiatives to support breastfeeding. The Delhi Commission for Protection of Child Rights launched a helpline to support children whose caretakers were not available owing to COVID-19 and offered to connect them to women who could donate breast milk. Kerala launched the state's first human milk bank called 'Nectar of Life' at the Ernakulam General Hospital. This facility ensured the availability of abundant breast milk for newborns who could not be breastfed by their own mothers because they were deceased, unwell, or unable to produce sufficient milk [65].

Conclusion

While we recognize the gendered nature and impact of the COVID-19 pandemic, we celebrate the resilience, commitment, and perseverance shown by women-led initiatives in India. Women-led collectives played a critical role in bridging development deficits that were further exacerbated by the COVID-19 pandemic. We believe that the India story was characterized by the '3R response'-Relief, Resilience, and Recovery, led by community women to protect vulnerable groups including pregnant women, lactating mothers, and children who could not receive essential services during the COVID-19 pandemic. The '3R response' can serve as a model in other crisis situations. Women-led initiatives, especially at the grassroots, were able to amplify the voices and priorities of vulnerable groups by bringing them and their concerns center stage. In addition, women's collectives emerged as a sustainable, inclusive, and self-governing community. They demonstrated the effectiveness of participatory development and decentralized governance for building a sustainable gender responsive environment to address the ante-natal and nutritional needs of pregnant women, lactating mothers, and children. Throughout the COVID-19 crisis and the associated lockdowns, these women's groups consistently demonstrated proactive and swift responses and resilience through their selfless dedication and altruism to meet the needs of vulnerable women and children. Pan India narratives of

efforts and initiatives of women's collectives discussed in this chapter illustrate that women's leadership can offer hope in times of the COVID-19 humanitarian crisis and beyond—that no matter how troubled the waters are, women champions will continue to build bridges—longer, higher, and stronger—and create pathways for sustainable and inclusive development by serving the underserved and most vulnerable.

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COVID-19: An Accelerant Toward a Sustainable Health System in Kenya

Daniella Munene

Abstract In the face of supply chain inadequacies, human resource constraints, and pervasive false narratives that misinformed the public, the COVID-19 pandemic directed our individual and collective focus on the adequacy of our health system. Was it resilient enough? Had the deficiencies that we were seeing been there all along? Why were they not noticed? Why were voices not raised earlier about the gaps? Perhaps they were. But, why have the proposed changes not been made? Was it resource constraints? Was it poor policies? Was it weak enforcement? These were some of the questions that were going through our minds, the nature of the question reflecting the position each actor had within the system. Action was taken. People organized themselves into task forces and committees, and implemented strategies and work plans. And we started to see results. Face masks and assembling ventilators have now been manufactured in the country. Critical care capacity has been increased. Oxygen plants have been built. Policies have been drafted to spur the growth of the local pharmaceutical manufacturing sector. Drug supply chains have been diversified to prevent stock outs. The general public has tremendously increased its health literacy. Countries are in a much better place than when it began.

The Beginning

Kenya confirmed her first case of COVID-19 on March 12, 2021, in a 27-year-old lady who had traveled from the United States via London [1]. Three days later it was announced that the two passengers that had sat next to her on the airplane had also tested positive. In addition to the trepidation that came with these announcements and given the significant traffic between Kenya and COVID-19 hotspots at the time such as China, there was a healthy skepticism as to whether this was indeed the prime case in our country. Many told of serious 'colds and flus' in the months preceding the announcement. This was the first confirmed case, but in all likelihood was not the

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first case. The concern that coronavirus may have been spreading among us already as the announcement was being made, was valid, and not at all comforting.

Evolution of the Pandemic

Prior to the big announcement, we had been keenly following international news and had heard about the epidemic that had ravaged Wuhan, China as well as Northern Italy. Now our focus shifted to our local networks as daily updates of case numbers were announced by the Ministry of Health in the most somber, and often times stern manner. Numbers of confirmed cases were climbing fast rising to 3,305 in three months. By this time, 90% of cases were locally transmitted [2]. It was no longer an imported disease. There was an established local transmission.

Containment Measures

Strict containment measures followed. Travel by non-residents of Kenya from any country with any case of coronavirus was restricted. Schools and higher learning institutions were closed in March, 2020. People were advised to work from home unless they were providing essential services. Cash transactions were discouraged.

In-person meetings were banned. Visits to hospitals were highly restricted. Every private and public facility was to provide soap and water/hand sanitizers to its patrons. On March 25, 2020, all local and international flights were banned. We were cautioned that if we behaved normally, the coronavirus would treat us abnormally. We were urged to practice hand hygiene, social distancing, and wearing face masks to curb the spread of the virus.

Confirmed cases, whether they were symptomatic or not, were isolated in health facilities. Mandatory quarantine at one's own expense was instituted for case contacts. Dusk to dawn curfew was imposed. Televised cat and mouse games between commuters and police at curfew time became a source of amusement in a tense time. Those arrested were subjected to forced quarantine, a practice that was later abandoned due to its obvious counter-productiveness in preventing the development of stigma to the novel illness.

Life as we knew it changed dramatically. We stocked up on what supplies each person could afford. We worked from home. Our kids stayed home for nine months.

COVID-19 response committees and task forces at national, county, public and private sector levels were constituted. The tasks at hand were risk communication, health promotion, disease surveillance, infection prevention and control, case management, health facility preparation, and resource mobilization.

Risk Communication, Health Promotion, and Public Education

Pervasive false narratives that had already begun to emerge when the disease was first announced by World Health Organization (WHO) in late 2019 began to take root in our country, spreading like wildfire and growing out of proportion. 'The disease was a plot to wipe out the elderly'; "the developed West had hatched a plot to annihilate the populations of poorer countries". On and on the narratives went. They were evocative, emotive, and confusing.

Later when vaccines became available, the perceived fast pace with which they were developed came into question. A new wave of misinformation ensued. It became apparent that it is difficult indeed to have a common understanding when it comes to complex science such as vaccine science.

Science and scientific research for that matter is not a public facing field. Healthcare is visible to the public, sure, but health science and pharmaceutical science are not. Most scientific breakthroughs are attained after years of work by hundreds of scientists working in numerous laboratories, publishing pieces of their work in peer-reviewed scientific journals that are available only to paid subscribers and are presented only in scientific symposia and whose titles do not catch anyone's attention (except the attention of the scientists themselves!).

There was a vaccine that seemed to have come out of the woodwork mysteriously and quickly. How was the scientific establishment to plausibly explain that there had been decades of work leading to the timely breakthrough? 'Nobody had heard' of these 'so called' mRNA vaccines. Attempts to bridge the information gap between the scientists and the public became a challenging undertaking indeed. How can one package the science of nucleic acid therapeutics in public-friendly and believable language?

Efforts to combat the pervasive false narratives were notable but not as effective as expected. This was largely because they were undertaken by the same 'suspect' people from the health science 'establishment'. Vaccine experts could then not successfully advance effective counterclaims to the misleading propaganda as this would further alienate the intended audience. Influencers from the entertainment industry and community lay leaders had much better success. We enlisted them in our risk communication and public education strategy.

Disease Surveillance

In those early days, contact tracing was paramount to disease surveillance. Once a case was identified, all contacts were tested and quarantined. There was also active surveillance in hot spots, which led to useful information that guided geographically limited interventions such as cessation of movement. Quarantine was expensive, and in the early days also fearful, for the quarantined. Later, when self-quarantine and

self-isolation were encouraged and people felt trusted to comply, the stigma of being quarantined diminished. It became common for people to state publicly that they were in self-managed quarantine due to possible exposure.

Public Health Cultural Tension

The country enlisted the help of trained public health officers that had participated in the containment of Ebola in West Africa. This was a prudent move that meant we did not have to reinvent the wheel or unnecessarily use our resources to provide extensive training to new public health teams. At the very onset, we had a trained army of fighters. This, however, had its challenges. Given their experience with the Ebola epidemic, their approach to handling both live cases as well as the remains of COVID-19 patients was, at least at the onset, overreaching. Families were not allowed to view the remains of their departed loved ones if they had succumbed to COVID-19. Public health teams, in full protective suits, buried bodies in hurriedly dug graves, sometimes in the cover of night and without participation of the deceased's family members. Video footage of such burials quickly made the rounds. People were appalled. Affected families, lay leaders, and even Members of Parliament protested to the authorities, questioning whether such drastic measures were warranted. WHO released guidelines on handling COVID-19 human remains and the strict burial practices were relaxed. The period of time allowed between death and burial still remained 72 h—a period that is way too short for burial rites which would otherwise last up to two weeks in some communities.

Impact on Mental Health

Kenya has a high burden of mental illness due to ill health, psychosocial disability, and premature mortality. Depression and anxiety disorders are the leading mental illnesses in Kenya. Huge gaps exist in access to mental healthcare. This bleak scenario was exacerbated by the effects of COVID-19 [3]. Lost livelihoods, the fear of contracting COVID-19, the out-of-reach hospital bills for families of those hospitalized with COVID-19, sudden deaths of colleagues and loved ones, and the disrupted social order where children were not going to school, were some of the factors that had a negative impact on mental wellbeing.

Cases of suicide rose. It was reported that more than 500 people in the country took their lives in the first six months of 2021, more than in all of 2020 [4]. Judging from the timing of this sharp rise, it is imaginable that the disheartening trend was due to the deleterious effects of the pandemic.

His Excellency the President had ordered the formation of a task force on mental health in June 2019, mandating its members to study the status of this issue and make appropriate recommendations for health system reform to better address mental

health problems. The task force report in October 2019 made strong recommendations around mental health. The principal recommendation was to declare mental ill health as a national public health emergency. Other key strategies recommended were to raise mental health awareness and to increase the capacity to detect and treat mental health illness.

In terms of COVID-19 and mental health, the task force report observed that COVID-19 containment measures, particularly restriction of movement, threatened the already marginal access to mental health services. This was resulting in undiagnosed mental illness as well as the worsening of existing disease particularly in rural communities.

The mental health impact of COVID-19 was notable amongst healthcare professionals. There was a new infectious disease, about which so little was known. They were expected to have answers for the inquisitive public while their own practice guidelines were constantly changing due to the evolving, and sometimes contradictory, published findings. There were times when the supplies of personal protective equipment were so strained, they had to improvise with non-optimal methods of protection to keep themselves safe. Many lost their jobs due to the decline in the business of healthcare establishments. For those who kept their jobs, their workload particularly during the surges, was grueling. Even as the disease was taking out their most valiant frontline soldiers, they were expected to relentlessly carry on the battle. They were concerned for themselves but most of all for their families. Some would spend the night in their vehicles for fear of passing on the virus to their loved ones.

Impact on Availability of Medicines and Health Commodities

One of the first negative impacts of the pandemic even before it arrived in our country was a strain on global medical supplies availability. As a country, we import more than half of our medicines and medical supplies, largely sourced from India and China. Hubei Province, China, a global hub for pharmaceutical raw materials, was locked down for months. A lot of medicines sourced from India are dependent on China for their active pharmaceutical ingredients. India ring fenced threatened supplies for their local use. The effect of this double jeopardy was a shortage of pharmaceuticals and other health supplies in our market.

This shortage revealed our over-dependence on imports for our pharmaceutical and medical device supplies. We were faced with the inadequacy of our capacity to locally produce not just complex medicines, but even simpler technologies like personal protective equipment. There was also a self-induced artificial shortage of essential medicines when we scrambled to buy and hoard perceived coronavirus therapies, a behavior fueled by misinformation on the internet.

The pandemic necessitated massive procurement of commodities such as hazmat suits, ventilators, and personal protective equipment that would otherwise be procured in much smaller quantities. The rushed procurement process bypassed established protocols of public procurement, for good reason, but naturally attracted

shrewd business entities wanting to benefit from this state of a public health emergency. Public procurement scandals ensued, revealing gaps in the governance of our public health institutions.

Oxygen Woes

The third and fourth waves of COVID-19 saw a sharp rise in hospitalizations and consequently in the number of patients needing oxygen. The life-saving gas that is the mainstay of managing hospitalized COVID-19 patients was in ultra-high demand. Hospitals began to look for ways to increase their oxygen capacity. It was not easy to do this overnight.

Effect on Human Resources for Health

No country in the world has adequate human resources for health. According to estimates by the World Health Organization, the global health worker shortage is estimated to rise to 18 million by 2030. This has led to policy initiatives around task shifting and task sharing in order to maximize the utilization of each cadre of health workers.

The pandemic brought these issues to the fore. There was heightened demand for intensive care nurses, anesthetists, pulmonologists, medical officers, pharmacists, laboratory technologists, and many other healthcare workers. The need for health workers was compounded by the need to quarantine COVID-exposed health workers. We had to urgently assess our health human resource capacity if we were to adequately combat the ravaging pandemic.

Health Facility Preparedness

Initially, all confirmed cases of COVID-19 were isolated in health facilities. Later on, as we embraced home-based isolation and care, we reserved hospitals for moderately to severely ill patients. As each wave came, more wards were converted to isolation wards, or new ones built from scratch. Building and equipping more intensive care units was, however, not that easy. We had a few sleepless nights having realized that we had less than 500 critical care beds during the first three months of the pandemic, and even less ventilators. We however breathed a collective sigh of relief when the first wave did not overwhelm our capacity. Estimates by experts showed that we would have several waves of infection before we could achieve herd immunity, and so we still needed to quickly expand our critical care surge capacity.

Economic Impact

During the initial months of the pandemic, business slumped in many sectors. The private for-profit sector suffered the most. Many establishments shut down. Hotels closed their doors for lack of customers. Private schools could not keep up with the overheads needed to maintain the schools in the absence of students. People were afraid to go to the hair salon, to the open-air market, and even to the hospital. The hospitality industry suffered the biggest blow. Airlines downsized. Staff were subjected to pay cuts—these were the lucky ones. Many people lost their livelihoods altogether.

A World Bank report in November 2020 indicated that most households had lost income with unemployment increasing five-fold between October 2019 and October 2020. Families were mitigating this lost income largely by reducing consumption such as by skipping meals. One in four adults did not have enough food to eat and female-headed households were disproportionately affected. COVID-19 was not just a medical issue, it was a social and economic issue [5, 6].

Impact on Health Targets

Contraception

Family Planning (FP) 2020 goals support the rights of women and girls to freely decide for themselves when, whether, and how many children they want to have. Kenya had made FP2020 commitments which they exceeded. Kenya surpassed its target of contraceptives prevalence rate among married women of reproductive age of 58%, attaining 61% by November 2019 [7, 8].

There were concerns that the gains made in our family planning strategy would be lost due to the negative effects of COVID-19 on the availability of health commodities as well as the hesitancy of family planning clients to access health facilities for fear of contracting COVID-19.

HIV

By 2020, 90% of all people living with HIV will know their HIV status. By 2020, 90% of all people with diagnosed HIV infection will receive sustained antiretroviral therapy. By 2020, 90% of all people receiving antiretroviral therapy will have viral suppression. These were the ambitious global targets to help end the AIDS epidemic. By mid-2020, Kenya had made significant strides in achieving these targets, performing at 90%, 82%, and 92%, respectively [9, 10].

Kenya has 1.2 million Kenyans on life-long anti-retroviral (ARV) medication, the mainstay of HIV treatment [10]. There was a period of time in 2021 when due to insufficiency of supplies, patients would get a one-month dose or less of ARVs, rather than the usual 90-to-180-day dose. This was because supplies were stretched but thankfully had not run out. Patients had to make more frequent trips to the clinic to pick up refills.

COVID-19 clearly affected every facet of our lives, impacting us socially, and economically, and not sparing our mental and physical health.

Collective Action to Build Back Better

The response to the pandemic, though it was largely led by government ministries of internal security and health, enlisted input from all of the government and all of society. Individuals, families, communities, health professionals, civic leaders, lay leaders, religious leaders, and the private and public sectors continue to combine efforts to minimize, mitigate, and combat the negative effects of the pandemic.

The giant telecommunication companies donated their expertise in providing mass communication on protective measures and public health education. They sponsored text messaging that gave tips on how to report a suspected case of COVID-19, where to get psychosocial support, and how to protect oneself from contracting the disease. In a country with pervasive use of mobile phones, this method of mass communication was effective and far-reaching.

Religious leaders, in an act of self-regulation, penned the guidelines by which their faithful would safely gather for congregational worship. They spoke together as a unified voice regardless of their creed, collectively negotiating with the government to allow in-person worship services. They bargained successfully and were allowed to open places of worship in strict conformance to the guidelines they had developed, bearing the responsibility of enforcing the guidelines on their faithful. This demonstrated the power of unity and the appeal of self-regulation.

To address mental health among healthcare professionals, various health professional associations combined efforts to ease the mental and psychosocial burden of COVID-19 on health workers by setting up a call center manned "by health workers for health workers". This call center provided psychological first-aid and directed health workers to further care as needed. It raised the morale of health workers a great deal and was a heartening example of inter-cadre collaboration.

The way healthcare is delivered evolved. Digital health interventions were embraced as a way to contain the spread of the virus in the process of accessing healthcare. The 'call a doctor' types of mobile and web-based applications proliferated, and hospitals, pharmacies, and laboratories increased their home care services. A notable innovation was the Wheels for Life Initiative which was formed to respond to pregnancy-related emergencies during curfew hours and across the locked down county boundaries. This initiative brought together private sector partners and healthcare professionals to provide a hotline for pregnant women to consult an obstetrician

and to get a paid cab or ambulance should they require to visit a health facility. By October 2021, 10,570 mothers had been assisted by doctors through telehealth consultations, 1,322 cabs were dispatched, and 899 emergency ambulance trips were done, resulting in hundreds of women having safe deliveries [11].

Kenya is second only to China in the usage of mobile money for financial transactions [12]. The already pervasive mobile money grew by leaps and bounds fueled by reduced transaction charges and the demand for cashless modes of transacting money. Mobile money transactions rose to USD 32.6 million between January and June 2021 compared to USD 30.6 million between July and December 2020 [13].

To ease the financial strain on businesses occasioned by COVID-19, the government committed to expedite pending bills owed to the business community. These were the bills of monies owed by the government to the private sector for services and products rendered. These bills would accrue and accumulate a great deal due to the bureaucratic nature of government. The need to cushion businesses against the effects of COVID-19 caused a positive shift in the speed of settling these debts. One hundred and forty million dollars in pending bills were cleared by the government between January and March 2021, easing cash flows and injecting life into numerous businesses that were on the brink of collapse.

The Kenyan textile industry rose to the rising demand for face masks. The government placed orders for masks with local suppliers who had passed quality checks from the Kenya Bureau of Standards. By the end of April 2020, we were able to locally produce as many surgical and cloth masks as were required, without a need to import. In addition to this, local entities began to manufacture full personal protective gear such as aprons, face shields, goggles, and full-body suits at prices comparable to imported ones. Furthermore, with partnerships between institutions of higher learning and the private sector, we started to assemble ventilators.

Oxygen Supply

It takes significant investment to install an oxygen production plant—some reports put the initial minimum capital outlay at one million US dollars. Hospitals could not install oxygen plants overnight to take care of patients already in their isolation wards and intensive care units. They needed quick and innovative solutions.

As hospitals scrambled desperately for oxygen to manage the surge of moderate to severe COVID-19 patients during the second and third waves, it was realized that steel manufacturers produce high quantities of oxygen as a necessary part of their production process and they had plenty of industrial oxygen gas to spare. They generously offered the life-saving gas free of cost to hospitals in need. All that the hospitals needed to do was to find cylinders and the steel plants would fill them with oxygen. Medical gas regulators worked with the steel industry to put in place an abbreviated set of requirements to ensure that the donated gas was safe for medical use. Meanwhile, medium to large-sized hospitals began the process of oxygen plant

installation and piping, and smaller hospitals purchased more cylinders to refill from their larger counterparts.

Donor Support

During the time of the pandemic, we experienced diminishing support from donors for our health programs, in part due to our achieving the status of a lower middle-income country, and in part due to the global economic shrinkage occasioned by the COVID-19 pandemic. This brought the idea of sustainable financing of our health system to the fore. The triple threat of non-communicable diseases, communicable diseases, and epidemics needed to be largely funded by our exchequer. Advocacy was in high gear to ensure that we took care of some of the previously heavily donor-dependent budget lines in our health sector. This was even more important seeing as we are at the last mile of reaching several important targets across many health areas including contraceptive prevalence, neglected tropical diseases, and HIV. We must be in control of our pace at this critical time to reach these targets.

Going Forward

Multi-stakeholder collaboration continues. The private sector, organized under the Kenya Private Sector Alliance (KEPSA), which is the apex body of the private sector in Kenya, continues to donate both cash and health equipment to national and county governments as well as to private and public health facilities. KEPSA also continues to support the government in the procurement of vaccines by raising funds from members to complement the government's orders of vaccines. As a result, tens of thousands more vaccines were shot in the arms of Kenyans.

Local COVID-19 vaccine production plans began in earnest, aimed at easing access amidst global supply constraints. This production will start in the form of 'form and fill' where we will package already made vaccine into primary and secondary packaging [14].

Efforts are intense to ensure gains made in meeting health targets prior to the pandemic are not eroded. For instance, to preserve the upward trajectory of the prevalence of modern contraception and to mitigate the effects of fear of accessing health facilities, the Ministry of Health directed that women be given longer refills of their preferred contraceptive method.

A lot continues to be done to achieve greater self-reliance in medicines and medical commodities. Looking into the future, we have drafted policies to spur the growth of our local pharmaceutical manufacturing sector and have diversified our drug supply chains to prevent stock outs.

The general public tremendously increased its health literacy. Vaccine hesitancy dramatically declined. As of October 30, 2021, a total of 5,307,181 COVID-19

vaccine doses were administered across the country, with demand outstripping the supply [15].

COVID positivity rate went below 1% in October 2021, a clear indication that containment measures were successful. A concerted effort by a multiplicity of stakeholders created a sense of national pride in increasing our self-sufficiency in managing the pandemic. COVID-19 has been a rough and painful journey for our health system. One thing, however, is certain; we are in a much better place than where we began. The lessons we have learned have made us build back better, stronger, and together.

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Politics, Economics, and Education

COVID-19 and the Indian Economy: Constructing Roadmaps to an Inclusive Recovery

Mitali Nikore, Charmi Mehta, and Akshay Kanikar

Abstract The COVID-19 pandemic has driven the highest share of economies into recession in modern times and is expected to bring about the largest contraction in global GDP per capita since World War II. The uncertainty it has spawned is driving governments and institutions into a conundrum, as they are tasked with charting out a course for recovery is immense. While India's GDP contracted 7.3% in FY 2020–21, COVID-19 deepened and exposed the fault lines of the economy. The authors highlight the phase of slowdown in India prior to the pandemic and how COVID-19-related lockdowns reinforced the slowdown. They demonstrate historical trends for a set of indicators for three sectors: agriculture, manufacturing, and services and display the extent of damage that the pandemic induced economic slowdown caused while also identifying underlying factors that existed pre-COVID. Finally, the authors present a macro-economic outlook covering trends and linkages across demand drivers, employment, and investment. They conclude with a roadmap for inclusive growth advocating strategies that seek to advance equality of access, sustainability of resources, and state capacity for governance.

Introduction

The COVID-19 pandemic has caused unprecedented damage to the global economy, pushing over 160 countries into recession, the highest in the history of recorded economic data [1]. Several differences exist in the challenges posed by the pandemic when compared to previous crises like the Global Financial Crisis in 2008. First,

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there were regions (East Asia and Pacific, South Asia, and Sub-Saharan Africa) that managed to maintain or marginally grow their gross domestic product (GDP) even during the crisis year of Financial Year (FY)09.[1] In 2020, however, every region suffered slowdowns. Second, recovery trajectories are likely to diverge. All regions (barring developed nations where the crisis originated in 2008) experienced growth in FY10, but recovery post-2020 is expected to be slower and uneven. Finally, the magnitude of the pandemic's impact and associated uncertainty complicate a return to normalcy.

COVID-19 has severely impacted lives and livelihoods. Over 4.4 million deaths occurred globally and are rising. An estimated, 130 million people were pushed back into poverty. And, there is an ensuing global recession. Countries relied on fiscal packages to power economic activity through 2020, as vaccine precarity kept demand revival expectations low. Consequently, successful vaccine trials made returning to normalcy the target for 2021. The global economy is poised to grow at 5.6% in FY21 [2]. There were strong rebounds by China and the US, but output is still expected to remain at pre-COVID-19 levels, largely due to emerging market economies where slow vaccination rates are holding up recovery.

No different from the rest of the world, India was also hit hard by the pandemic. Long drawn lockdowns magnified the ongoing economic slowdown. Of the four instances of national income decline seen in India (FY58, FY66, FY73, and FY80), FY80 was the worst at a 5.2% contraction [3]. This steep GDP plunge of 23.4% for the April-June, 2020 quarter and with the overall economy contracting by 7.3% in FY21, makes 2020 the year that underwent the severest economic contraction in the country's history. Sustained vaccine shortages in early 2021 meant that both the health of dense, unvaccinated populations and economic hardships from a prolonged pandemic were neglected.

After an urban centered first wave,[2] India faced a devastating second wave which affected most of rural India. In this chapter, the authors study the impact of COVID-19 on the economy in the context of India's pre-pandemic economic slowdown. Even as India's vaccination program offers a path to ease the health crisis, there is a need to actively address the pandemic's medium-term economic impact to spur green, resilient, and inclusive growth while safeguarding macro-economic stability [4]. The authors also highlight concerns regarding imbalanced growth while illustrating the lack of inclusivity in economic opportunities and threats posed by climate change.

[1] Financial year (FY): A 12-month period beginning on 1st April and ending on 31st March. For instance, FY04 indicates the period 1 April 2003–31 March 2004.

[2] Time periods for the first and second wave are as follows: First wave—Mar–June 2020; Second wave—Mar–June 2021.

Methodology

This chapter follows a mixed methods approach. Secondary data analysis was undertaken to capture historical trends for macro-economic indicators. All India time series data over the last seven decades (1950–2018) was analyzed to examine trends across the Gross Domestic Product (GDP), consumption, investment, public investment, exports, and imports. This data was obtained from numerous sources such as the Ministry of Statistics and Program Implementation (MOSPI), Government of India (GOI), the Center for Monitoring Indian Economy (CMIE), Economic Outlook Database, and the States of India Database.

Studies by Dvara Research, Azim Premji University (State of Working India Report-2021), Information Handling Services (IHS) Markit Economics, and Pew Research Center on the impact of COVID-19 on India's economy were used to demonstrate the same. Extensive analysis by Nikore Associates on gendered and differential employment statistics is also referenced. A literature review, complemented by consultations with agricultural bodies, industry groups, non-governmental organizations (NGOs), and sector experts assisted in contextualizing the findings and developing a progressive policy outlook.

Unearthing Realities–A Review of India's Macroeconomic Performance Since Liberalization

The culmination of demand supply shocks, mobility restrictions, and a high degree of uncertainty makes recovering from COVID-19 the greatest defining challenge of the 2020s decade so far [1]. Multilateral organizations like the World Bank, Asian Development Bank (ADB), and the International Monetary Fund (IMF) are constantly revising their growth outlooks, due to vaccine-coverage being slower than anticipated and consecutive infection waves. Table 1 shows wide-ranging estimates. Even the January 2021 estimates are unable to predict growth and recovery trajectories.

The pandemic emerged as a health crisis that placed great strain on public and personal resources in India. Wage laborers and temporary workers bore the brunt of unemployment as mobility restrictions constrained their ability to overcome joblessness. Successive waves brought to the fore deep inequalities within society, caused by rising income inequality and a shrinking middle class [5]. Poverty is estimated to have more than doubled with numerous estimates forecasting 75–230 million Indians falling into poverty post the first wave of the pandemic, thereby reversing decades of efforts toward poverty reduction [6–8]. This, combined with a large informal workforce, poor public health indicators, and a collapsing health infrastructure left the average Indian extremely vulnerable to pandemic induced shocks [9].

As the pandemic continued, the world was also grappling with climate disasters caused by global warming and catalyzed by human impact. India, alongside the rest of the world, must now not only recover from the pandemic, but must also do so

Table 1 Estimates of Indian growth: FY21

		Estimate 1	Estimate 2	Estimate 3	FY21 outlook	GDP growth (actual)
		(Jan'20)	(June'20)	(Sept'20)	(Jan'21)	
ADB	FY21		−4	−9	4	−7.3
	FY22		5	8	6.2	?
World Bank		(Jan'20)	(June'20)	–	(Jan'21)	
	FY21	5.8	4.2		−6.4	−7.3
	FY22	6.1	−3.2		2.3	?
		(Jan'20)	(June'20)	(Oct'20)	(Jan'21)	
IMF	FY21	5.8	−4.5	−10.3	−8	−7.3
	FY22	6.5	6.0	8.8	11.5	?

Source Asian Development Outlook (ADB figures), Global Economic Prospects (World Bank figures), and World Economic Outlook (IMF figures) release

sustainably to meet its Intended Nationally Determined Contributions (INDC) and net zero targets.

Growth in GDP and Per Capita Income

India's GDP grew six times post-liberalization from USD 507 billion in 1990 to USD 2.9 trillion in 2019 [10]. During the same period, per capita-gross national income (PC-GNI) only grew 3.5 times from USD 574 in 1990 to USD 2131.8 in 2019 [10]. This growth was primarily the result of two high growth spells: FY04 to FY08 and FY14 to FY17 (Fig. 1). The first spell of growth was powered by exports and investments which grew at an average rate of 17.8% and 15.3%, respectively. The second growth spell of FY12 and FY17 was driven by Private Final Consumption Expenditure (PFCE).

GDP growth had been declining between FY17 and FY20 reaching 4% prior to COVID-19 induced shocks. This was primarily attributed to governance and policy shocks such as demonetization. Although secondary to structural shocks, cyclical trends of lean economic activity based on seasonality and business cycle flows also impacted growth [11].

India's GDP drastically declined by 23.4% in Q1 of FY21 as an immediate effect of COVID-19 related mobility restrictions resulting from nationwide lockdowns (Fig. 2). Recovery stagnated through FY21. Strong rebounds in consumer spending through a surge in automobile sales, fuel consumption, exports, and core imports enabled a V-shaped recovery with 20.1% growth in Q1-FY22 despite a coinciding second wave [12].

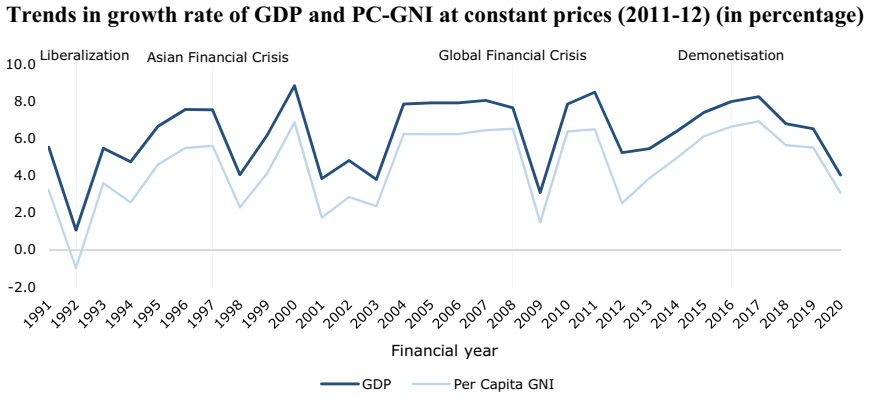

Fig. 1 Trends in growth rate of GDP and PC-GNI at constant prices (2011–12) (in percentage). *Source* Ministry of Statistics and Program Implementation, Government of India [10]

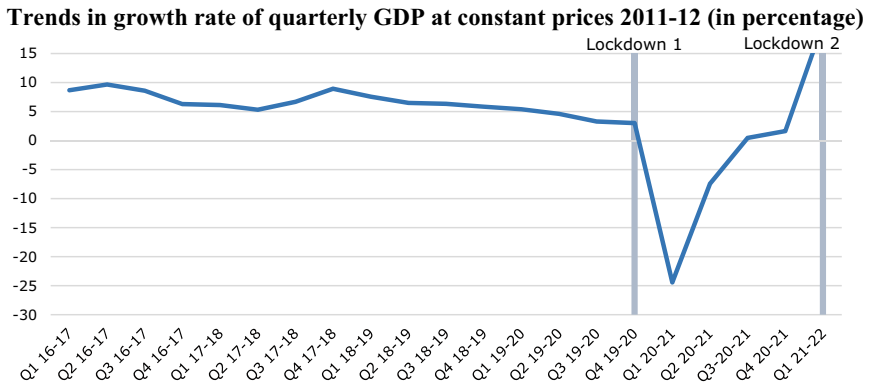

Fig. 2 Trends in growth rate of quarterly GDP at constant prices 2011–12 (in percentage). *Source* Ministry of Statistics and Program Implementation, Government of India [10]

Sectoral Time Series Trends

The economic impact of COVID-19 was not experienced equally across all sectors of the Indian economy. The share of agriculture and industry in overall Gross Value Added (GVA) declined between FY04 and FY21, with the service sector overtaking the erstwhile dominant sectors (Table 2). Service-led growth was aided by liberalization, privatization, and globalization (LPG)-era reforms from 1991 onwards [13], which eased the influx of Foreign Direct Investment (FDI) and private sector growth to create a favorable business ecosystem (Tables 3 and 4).

Despite its shrinking share in the GVA, agriculture, which employs 48.3% of all Indian households, was largely insulated from the debilitating impact of the first national lockdown. Proactive and timely exemptions from lockdown restrictions

Table 2 Sectoral share in GVA and growth rates over the years (in percentage)

		First growth spell	Post-global financial crisis (GFC)	Second growth spell	Pre-COVID-19	Pre-COVID-19	COVID-19 Years
		FY 04–08	FY 09–13	FY 14–18	FY 19	FY 20	FY 21
GVA	Growth rate	7.7	6.4	7.1	5.9	4.1	−6.2
Agriculture	Share in GVA	19.3	18.2	18.2	17.6	18.4	20.2
	Growth rate	4.5	3.1	3.9	2.6	4.3	3.6
Industry	Share in GVA	32.3	32.7	29.9	29.0	26.7	25.9
	Growth rate	7.9	7.4	6.8	5.3	−1.2	−7.0
Services	Share in GVA	48.3	49.1	52.0	53.4	55.0	53.9
	Growth rate	7.9	7.4	8.3	7.2	7.2	−8.4

Note Shares are in current prices and growth in constant 2011–12 prices
Source Calculations based on Ministry of Statistics and Program Implementation data [10]

facilitated uninterrupted cropping making agriculture the only sector to show positive growth across all quarters (Fig. 3), successfully riding out shocks from the first wave and recording a 3.6% growth (year-on-year (Y-o-Y)) in FY21 [14, 15].

On the other hand, industry and service sectors were severely impacted owing to mobility restrictions and the contact intensive nature of services (Fig. 3). Overall, the growth in industry declined by 7.0% and the growth in services declined by 8.4% in FY21. Mining saw negative growth across FY21 and manufacturing saw capacity utilization falling to 47.3% in Q1 FY21 (Y–o-Y) [16]. Trade, hotels, transport, and communication shrank by a massive 48.1% in Q1 FY21, with an estimated 30–35% of restaurants closing permanently by the end of the second wave [17]. The hospitality sector, severely damaged by the pandemic, also showed significant growth from the previous quarter. The industry and services sub-sectors bounced back only in Q3 and Q4 of FY21 [10].

Comparing Q1-FY22 (June 2021) growth to the average Q1-growth over FY15-FY21, reveals that all three sectors were performing below FY17 and FY18 levels (Fig. 4). Sub-sector level analysis illustrates that that mining, manufacturing, construction, hotels, and transport suffered the greatest declines and were most susceptible to growth shocks.

Table 3 Sectoral share in GVA and growth rates over the year for industry sub-sectors over the years (in percentage)

		First growth spell	Post-global financial crisis (GFC)	Second growth spell	Pre-COVID-19	Pre-COVID-19	COVID-19 Years
		FY 04–08	FY 09–13	FY 14–18	FY 19	FY 20	FY 21
Mining and quarrying	Share in GVA	3.2	3.2	2.5	2.2	1.9	1.6
	Growth rate	5.2	0.01	4.9	0.3	−2.5	−8.5
Manufacturing	Share in GVA	17.8	17.9	16.6	16.4	14.7	14.4
	Growth rate	9.6	6.4	8.3	5.3	−2.4	−7.2
Electricity and other utility services	Share in GVA	2.6	2.3	2.6	2.6	2.6	2.7
	Growth rate	7.1	5.8	7.3	8.0	2.1	1.9
Construction	Share in GVA	8.8	9.4	8.2	7.9	7.4	7.2
	Growth rate	12.8	6.4	4.3	6.3	1.0	−8.6

Note Shares are in current prices and growth in constant 2011–12 prices
Source Calculations based on Ministry of Statistics and Program Implementation data [10]

The Services Purchaser's Manufacturing Index (PMI)[3] nosedived to its lowest level of 5.4 in April 2020 recovering to 56 only in March 2021, indicating dismal prospects for the sector in the near future (post the first wave) [18]. The Index of Industrial Production (IIP) for Core 8[4] also reached record lows in April 2020 recovering to pre-COVID-19 levels only in February 2021.[5]

[3] The Services PMI provides investors an insight into business conditions and economic trend for markets within the sector. IHS Markit Economics carries this out by surveying about 350 PSEs. A PMI reading over 50 indicates growth and that under 50 suggests contraction as compared to the previous month.

[4] The Eight Core Industries comprise 40.27% of the weight of items included in the Index of Industrial Production (IIP). They are coal, crude oil, natural gas, refinery products, fertilizers, steel, cement, and electricity.

[5] Economic Survey 2020–21 calculations based on Ministry of Statistics and Programme Implementation and Office of Economic Advisor's data.

Table 4 Sectoral share in GVA and growth rates over the year for services sub-sectors over the years (in percentage)

		First growth spell	Post-global financial crisis (GFC)	Second growth spell	Pre-COVID-19	Pre-COVID-19	COVID-19 years
		FY 04–08	FY 09–13	FY 14–18	FY 19	FY 20	FY 21
Trade, hotels, and transport	Share in GVA	18.0	17.4	18.3	18.7	18.9	16.4
	Growth rate	9.4	7.3	8.8	7.1	6.4	−18.2
Financial and real estate services	Share in GVA	18.6	19.1	20.5	20.6	21.2	22.1
	Growth rate	7.6	6.1	8.7	7.2	7.3	−1.5
Public administration	Share in GVA	11.7	12.6	13.2	14.1	14.9	15.4
	Growth rate	6.3	10.2	7.2	7.4	8.3	−4.6

Note Shares are in current prices and growth in constant 2011–12 prices
Source Calculations based on Ministry of Statistics and Program Implementation data [10]

Growth Drivers of the Economy

Consumption[6] and investment[7] have been the major drivers of India's growth over the last fifteen years. The average share of private final consumption expenditure (PFCE) in GDP stood at 58% in the 2010's decade, while that of investment was 34%. However, these have been in decline since FY12. The share of government final consumption expenditure (GFCE) remained flat, averaging 11%, while the average share of exports was 21.5% for the same period.

The Global Financial Crisis of 2008 resulted in accumulation of corporate debt and over leveraged financials. The impact of this was worsened by the twin balance sheet crisis that exposed growing non-performing assets of the banking sector, together reducing the scope for corporate borrowings. Table 5 shows the tapering of investments and exports post FY09 as a result of both crises.

Following the COVID-19 crisis, PFCE contracted by 9.1% in FY21 (Table 5). PFCE showed negative growth in the first three quarters of FY21, recovering marginally in Q4 (Fig. 7). Most notably, per capita consumption expenditure (PCCE) fell below FY18 levels (Fig. 8). Government expenditure was the only component of the GDP which registered positive growth at 2.9% for FY21, crucially aiding recovery.

[6] Consumption is indicated by 2 variables: Private final consumption expenditure (PFCE) and Government final consumption expenditure (GFC).

[7] Investment is indicated by gross fixed capital formation (GFCF).

Sectoral Impact of COVID-19: trends in quarterly growth rates (Y-o-Y) of sectoral GVAs at constant prices (2011-12) for the year FY20 and FY21 (in percentage)

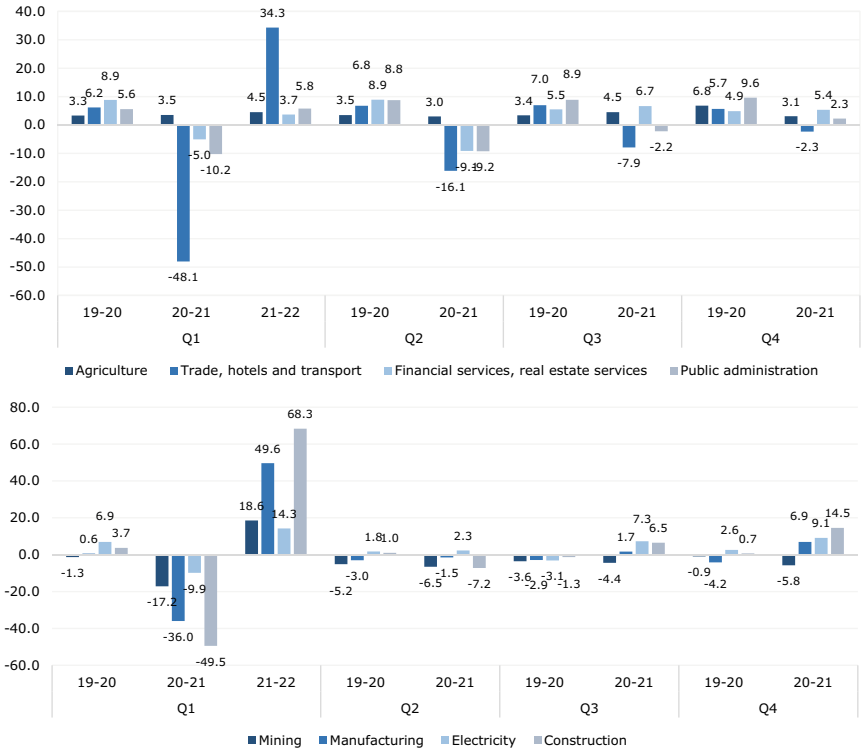

Fig. 3 Sectoral Impact of COVID-19: trends in quarterly growth rates (Y-o-Y) of sectoral GVAs at constant prices (2011–12) for the year FY20 and FY21 (in percentage). *Note* Year-on-year growth rates are calculated, compared to previous year's same quarter figures. *Source* Ministry of Statistics and Program Implementation, Government of India [10]

Gross fixed capital formation (GFCF)[8] declined by 47.7% in Q1 FY21 and contracting overall by 10.1% in FY21 (Table IV, Fig. 6). Announcements of new domestic investment projects fell by 23.5% in FY21 (Fig. 9), where barring Q2, all quarters saw this fall on a Y-o-Y basis (Fig. 10). Revival in investments will depend on an upswing in demand and capacity utilization which were below 70% throughout FY21 [15].

[8] Domestic investment is a measure of the amount of money that domestic businesses invest within their own country, whereas foreign investment involves capital flows from one country to another, granting the foreign investors extensive ownership stakes in domestic companies and assets. Here, the changes in investments refer to both domestic and foreign investment combined.

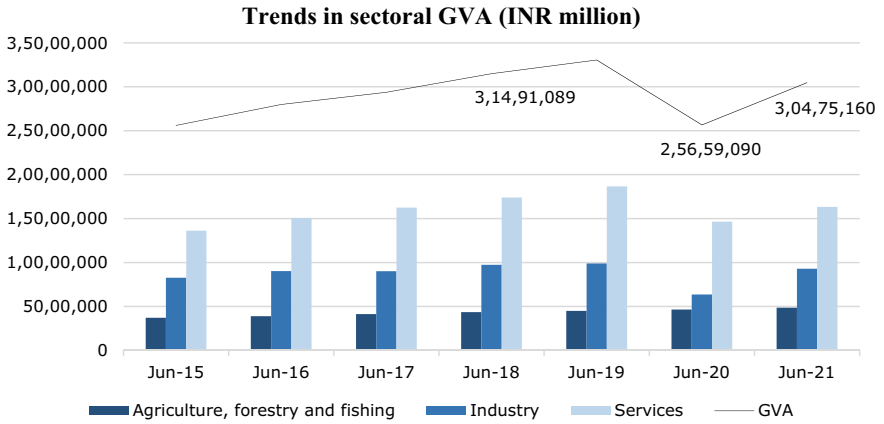

Fig. 4 Trends in sectoral GVA (INR million). *Source* Ministry of Statistics and Program Implementation, Government of India [10]

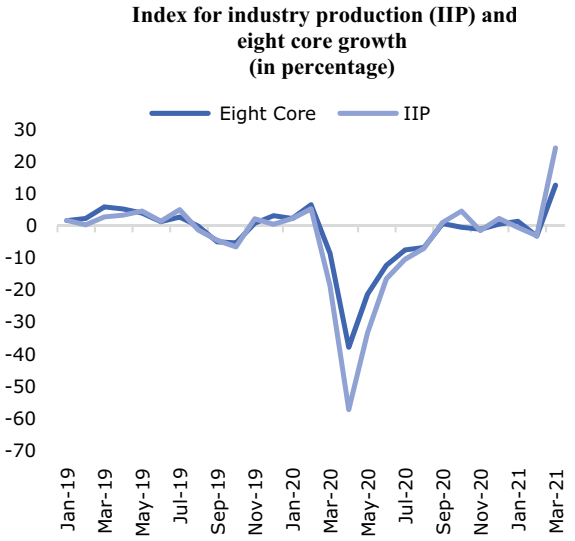

Fig. 5 Index for industry production (IIP) and eight core growth (in percentage). *Source* Economic Survey 2020–21 calculations based on Ministry of Statistics and Program Implementation and Office of Economic Advisor's data [10]

Fig. 6 Services purchasing managers' index (PMI) (in percentage). *Source* Press Release, IHS Markit Economics, August 2021 [19]

Though domestic investment was weak, India emerged as a preferred investment destination for foreign investors attracting USD 81,722 million foreign direct investment (FDI) flows in FY21. This figure was up 10% from the previous year, of which FDI equity inflows grew by 19% [21]. Singapore was the highest equity FDI investor, followed by USA, Mauritius, and UAE [21]. Computer software and hardware saw the highest equity FDI inflows followed by construction, services, and infrastructure sectors. Among states, Gujarat (35.6%), Maharashtra (26.3%), Karnataka (12.5%), Delhi (8.9%), and Tamil Nadu (3.8%) received an overwhelming majority of the equity FDI inflows [21] (Fig. 11). Gujarat and Maharashtra were the first ones to recover in speed and volume while other states experienced gradual FDI inflows.

Imports and exports contracted by 40.9% and 21.9%, respectively in Q1 FY21 remaining negative through Q2 and Q3 and only recovering in Q4 (Fig. 12). Overall, imports shrank more than exports in FY20 generating a current account surplus equal to 0.9% of GDP. Trade deficit in goods widened from 1.9% of GDP in Q1 FY20 to 4.4% in Q1 FY21 while the trade surplus in services grew by 8.1% (Y–o-Y) in Q1 FY21, down from double digit growth a year earlier [22].

When comparing Q1-FY22 (June 2021) growth to the average Q1-growth across FY15-FY21, it was evident that consumption and investment in FY21 were below FY15 levels. Even in FY22, these levels remained below those of FY18 (Fig. 11). Exports and imports, on the other hand, recovered, remaining just below FY19 levels despite disruptions associated with the second wave.

Table 5 Components of GDP and growth across the years (in percentage)

		First growth spell	Post-global financial crisis	Second growth spell	Pre-COVID-19	Pre-COVID-19	COVID-19 Years
		FY 04–08	FY 09–13	FY 14–18	FY19	FY20	FY21
GDP	Growth rate	7.9	6.0	7.4	6.5	4.0	−7.3
PFCE	Share in GDP	57.8	56.0	58.6	59.4	60.5	58.6
	Growth rate	6.2	5.8	7.2	7.6	5.5	−9.1
GFCE	Share in GDP	10.3	11.0	10.5	10.8	11.2	12.5
	Growth rate	5.8	7.6	6.7	6.3	7.9	2.9
GFCF	Share in GDP	36.9	39.1	32.3	32.1	30.7	29.3
	Growth rate	15.3	7.2	4.6	9.7	2.3	−10.1
Exports	Share in GDP	18.9	23.2	21.2	19.9	18.4	18.7
	Growth rate	17.8	10.3	2.7	12.3	−3.3	−4.7
Imports	Share in GDP	21.4	28.9	23.9	23.7	21.0	19.2
	Growth rate	20.0	12.6	1.7	8.6	−0.8	−13.6

Note Shares are in current prices and growth in constant 2011–12 prices
Source Calculations based on Ministry of Statistics and Program Implementation data [10]

Impact on Employment

COVID-19 shocked a country where approximately 83% of the labor force works in the unorganized sector in low-productivity, low-income jobs. Despite rapid economic growth over the last two decades driven by high-skilled service sectors, India did not witness significant employment growth. Since the economic reforms of 1991, employment in the informal sector as compared to the formal sector had widened. Besides the agriculture sector, the construction sector created the second highest number of jobs During the COVID-19 crisis, millions of informal and casual laborers were among the worst affected groups as they were unskilled and without social security safety nets.

As India recovers from the lasting effects of COVID-19, policy priorities are shifting from securing health to reviving economic growth. India needs to avoid a

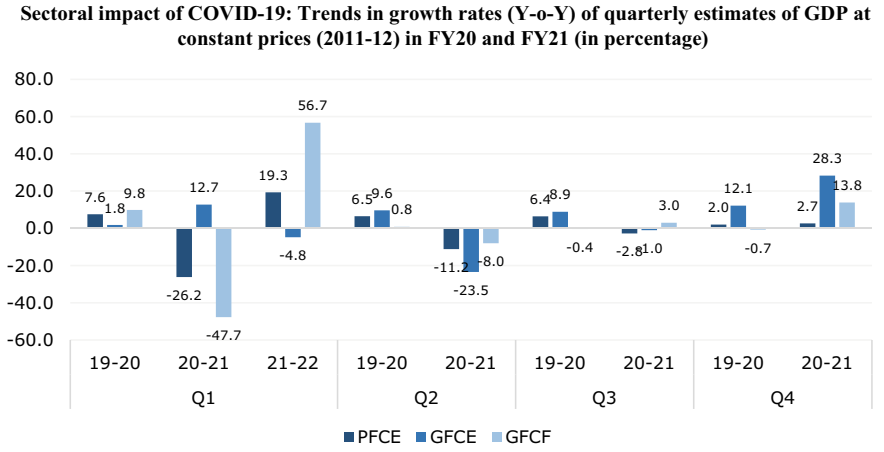

Fig. 7 Sectoral impact of COVID-19: Trends in growth rates (Y–o-Y) of quarterly estimates of GDP at constant prices (2011–12) in FY20 and FY21 (in percentage). *Note* Year-on-year growth rates are calculated compared to previous year's same quarter figures. *Source* Ministry of Statistics and Program Implementation, Government of India [10]

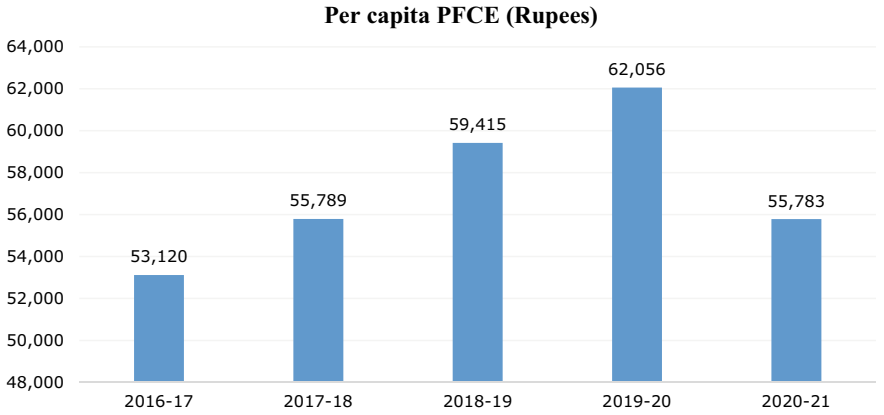

Fig. 8 Per capita PFCE (Rupees). *Source* Ministry of Statistics and Program Implementation, Government of India [10]

K-shaped recovery in which white collar sectors bounce back while other sectors are left to languish. The focus must shift to expanding the formal job market and enhancing social security for informal workers.

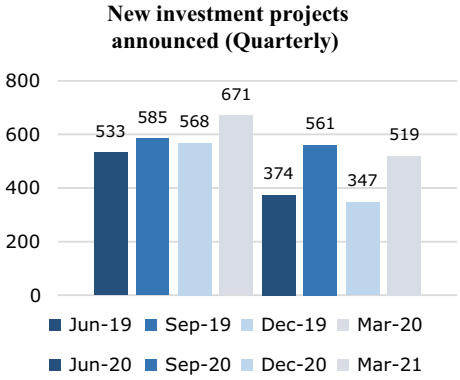

Fig. 9 New investment projects announced (Quarterly). *Source* Economic Outlook Database 2020–21, Center for Monitoring Indian Economy (CMIE) [20]

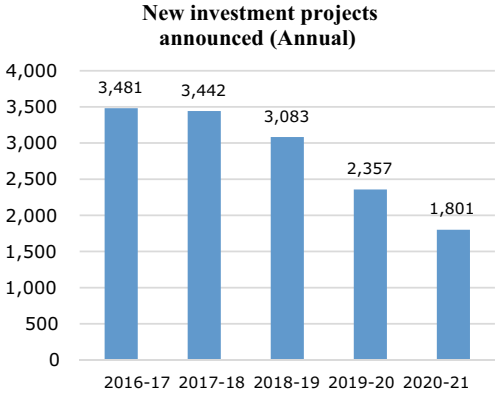

Fig. 10 New investment projects announced (Annual). *Source* Economic Outlook Database 2020–21, Center for Monitoring Indian Economy (CMIE) [20]

Pre-COVID-19 Employment Structure

Between 1977 and 2017, India's economy witnessed a surge in output from services (39% to 53%) and a decrease from agriculture (39% to 20%) and industry (33% to 27%) [23]. Structural changes in sectoral outputs were complimented with cross-sectoral shifts in employment. However, this structural transformation[9] was far greater for men as compared to women (Fig. 14) [24].

[9] Structural transformation in the context of a developing country involves two distinct processes—a decline in the share of agriculture in employment (and a rise in non-farm work) and a decline in the share of the informal sector (and a rise in the scale of production).

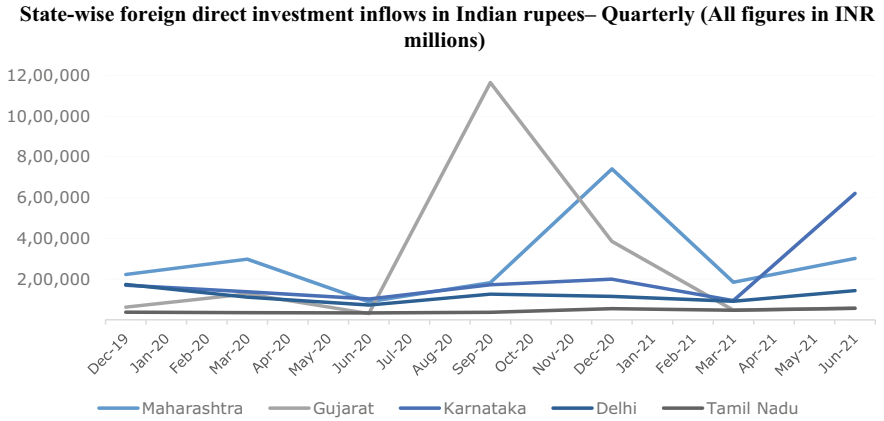

Fig. 11 State-wise foreign direct investment inflows in Indian rupees– Quarterly (All figures in INR millions). *Source* Department for Promotion of Industry and Internal Trade, Ministry of Finance 2021 [21])

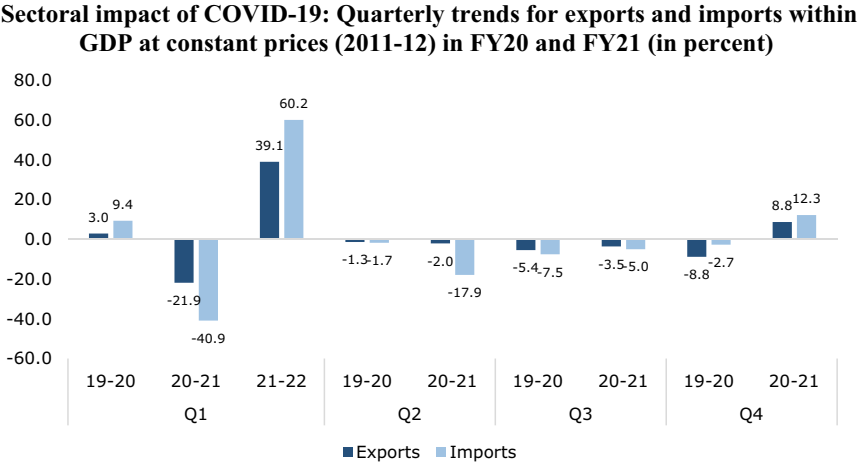

Fig. 12 Sectoral impact of COVID-19: Quarterly trends for exports and imports within GDP at constant prices (2011–12) in FY20 and FY21 (in percent). *Source* Ministry of Statistics and Programme Implementation, Government of India [10]

In the 15 years between 1994 and 2010, women received less than 19% of all new employment opportunities generated in India's ten fastest growing occupations [25]. This had profound implications for rural women, for whom the proportion of employment in agriculture fell by just 13% in the last 42 years (88.1% in 1977–78 to 75.7% in 2019–20), while it reduced by 25% for rural men (80.6–55.4%) for the same period. Construction and hospitality absorbed a large proportion of rural males.

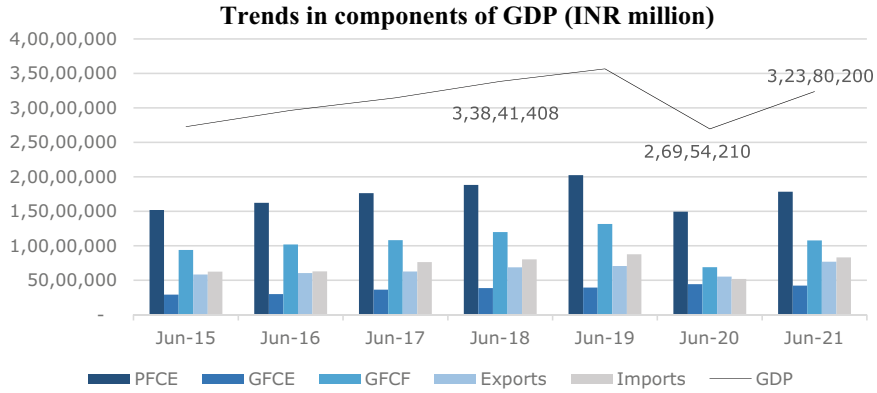

Fig. 13 Trends in components of GDP (INR million). *Source* Ministry of Statistics and Programme Implementation, Government of India [10]

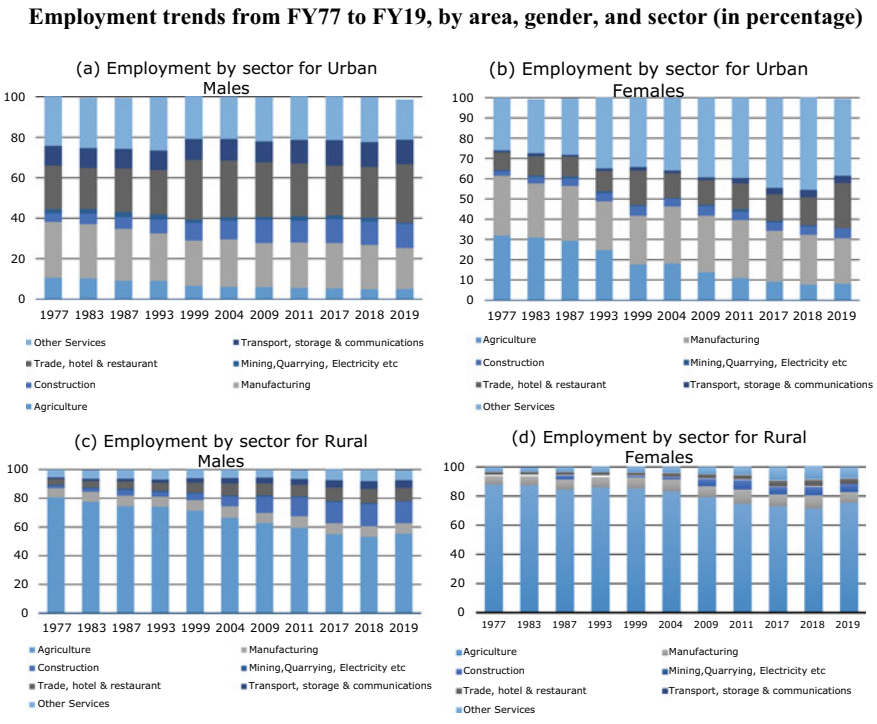

Fig. 14 Employment trends from FY77 to FY19, by area, gender, and sector (in percentage). *Source* Ministry of Statistics and Program Implementation, Government of India [10]

The unavailability of steady employment opportunities and social stigma restricted rural women to agriculture [26].

Thus, the absolute increase in female employment primarily occurred in low productivity sectors (agriculture being one such example). If women had access to the same work opportunities as men, the absolute increase in female employment would have been upto three times higher for this period [27].

The influx of youth in the job market from FY12 to FY18 [28] highlighted the dearth of non-agricultural jobs for this group as 30–59-year-old men took up 92% of all new non-agricultural jobs, disadvantaging women and young job seekers.

Impact of COVID-19[10]

Following the nationwide lockdown, the labor force contracted from 433 to 369 million i.e., by 14.7% between March and April 2020. The labor force recovered to March 2020 levels only in February 2021 (427 million), before contracting to 425 million in April 2021 due to the second wave of COVID-19. Recovery from the second wave was observed in August 2021 (434 million), a labor force figure which matched pre-COVID-19 levels in March 2020.

About 113.6 million persons lost their jobs as the number of employed individuals contracted from 396 million in March to 282 million in April 2020. By September 2020, the number of employed individuals were back to March levels at 398 million. The impact of the second wave was felt between April and May 2021, when the number of employed persons shrank by 15 million. The recovery was quick. The total number of employed individuals was back at 398 million in August 2021. The unemployment rate rose to 23.5% in April 2020 compared to 8.8% in March 2020. Unemployment gradually declined, recovering to March 2020 levels by July 2020 and declining further to 7.4% by August 2020. Following the second wave, unemployment rose again in May 2021 (11.8%). However, it recovered soon thereafter. In August 2021, the unemployment rate stood at 8.3%.

Impact on Employed Persons by Gender and Area

Of the 113.6 million workers who suffered job losses between March and April 2020, 15.4 million were women. The proportionate fall for women was higher as 37.1% of women lost their jobs, versus 27.7% men. Unlike the first wave, women bore not only a higher proportion but also a higher number of absolute job losses during the second wave. About 7.4 million persons suffered job losses in April, 2021, 5.4 million women versus 1.9 million men. Thus, women suffered 73% job losses (Fig. 15).

[10] This section utilizes Center for Monitoring Indian Economy (CMIE) data.

Fig. 15 Total number of employed persons during 2019–2021, by area and gender (in millions). *Source* Center for Monitoring Indian Economy (CMIE) Economic Outlook [20]

Urban female employment fell from 11.8 million in March 2020 to 8.3 million in April 2020, a drop of 29.2%[11] versus 32.4% for urban men. By March 2021, the number of employed urban women was also 20.9% lower than in March 2020, whereas the corresponding decline was only 0.3% for urban men. Rural female employment shrank by 40.2% versus 25.5% drop for rural men. Box 1 presents the results of consultations held with women's groups, enterprises, farmer producer organizations, and informal workers on the impact of COVID-19 on their employment.

[11] The change in employment between two months has been calculated in relative sense using the rate of change formula: {{previous month/current month} * 100}

Box 1

Impact of COVID-19 on working women: Women's perspective

Women's overrepresentation in the sectors hardest hit by the pandemic, such as accommodation, food services, and the manufacturing sector, led them to suffer disproportionate job and income losses during COVID-19. Nikore Associates conducted consultations during the first and second waves with over 50 NGOs and community-based organizations (CBOs) that work to empower women.

In rural areas, women working in the agriculture sector were displaced due to the reverse migration of men to the city. Even if they held onto their jobs, it was difficult for them to sell their produce due to disrupted supply chains.

The presence of male relatives and children at home (due to closure of workplaces and schools) led to an increase in unpaid care work for women. The double burden of household chores and office work led to difficulties for women entrepreneurs and women in the corporate sector. For example, self-help groups (SHGs) mobilizer in Telangana shared that the women in her community were unable to attend trainings and SHG meetings owing to domestic work.

Women employed in the urban, informal sector faced prolonged income losses negatively impacting their family income. For example, a CBO in Madhya Pradesh revealed that families were reluctant to employ domestic helpers due to the fear of virus transmission. Flower vendors in Tirupati lost their livelihoods due to the absence of devotees at the temple.

Finally, the pandemic broadened the gender digital divide. As most activities shifted to the online sphere, consultations showed that low ownership of smartphones and a lack of digital literacy affected the economic participation of women. For example, a Mumbai based NGO shared that large family sizes necessitated mobile sharing. Coupled with financial constraints that limited the purchase of internet packages, male members of the family were given preferential treatment for usage of these facilities, leaving women behind.

Impact on Employed Persons by Occupation Groups

Between March and April 2020, small traders and wage laborers were the worst affected group, losing 79 million jobs, of which 59 million were in rural areas and 19 million in urban areas. Among salaried workers, 14 million jobs were lost, of which 10 million were in rural areas. About 18 million fewer urban business persons were employed, while 3 million fewer rural business persons were employed. While urban farmers increased by about 2 million, a similar number of rural farmers lost their jobs.

As trade and mobility restrictions eased, employment for small traders, wage laborers, and farmers recovered and crossed March 2020 levels by July 2020. In comparison, recovery in the business sector was slow as jobs could only recover above the March level by August 2020. On the other hand, urban salaried workers reached March 2020 employment levels only in January 2021, while rural salaried workers remained below March 2020 level even a year later.

Farmers faced the immediate impact of the second wave, where six million farmers lost their jobs between March and April 2021. Urban salaried employees were least affected by the second wave and their employment actually grew, whereas 3 million rural salaried employees lost their jobs. Impact on the business sector reflected in May 2021 as businesspersons fell to 68 million as against 74 million in March 2021. Impact on small traders and wage laborers was felt in June 2021 when 20 million lost jobs between March and June 2021. Of these, about 17 million were from rural areas (Fig. 16).

Impact on Employed Persons by Industry Groups

The number of persons employed in the industry sector contracted by 66.7% between March 2020 (96 million) to April 2020 (32 million). About 15 million persons lost their jobs in the agriculture sector (10%) compared to 33 million (22.1%) in the service sector (Fig. 17).

Recovery in the agriculture sector was swift as compared to the service and industry sectors. Agriculture recovered above the March 2020 level by June 2020 while the industry sector matched March 2020 level only by September 2020 and the services sector recovered only by October 2020.

The impact of the second wave was observed in the agriculture sector between February and March 2021 when the number of employed fell by 14 million. In the service sector, employed persons shrank by 10 million compared to 14 million in industry between April and May 2021. Recovery in agriculture and services was quick as they could reach March 2021 levels by May/June 2021. However, employment in the industry sector could not recover to February/March 2021 levels even by August 2021.

When considering industry sub-sectors, it can be seen that real estate and construction suffered the deepest job losses between March to April 2020 with employment contracting by 87.3% from 55 to 7 million. The manufacturing sector saw the number of employed individuals contract by 44.7%. Within manufacturing, the number of employed individuals contracted in cement and construction (57.3%), textile and leather (42.5%), and handicraft (38.1%) between March and April 2020. The real estate and construction sectors recovered soon as the number of employed persons matched March 2020 levels by July 2020. The impact of the second wave was observed in May 2021 as the number of employed people contracted in mining (<1 million), manufacturing (3 million), real estate, and construction (12 million)

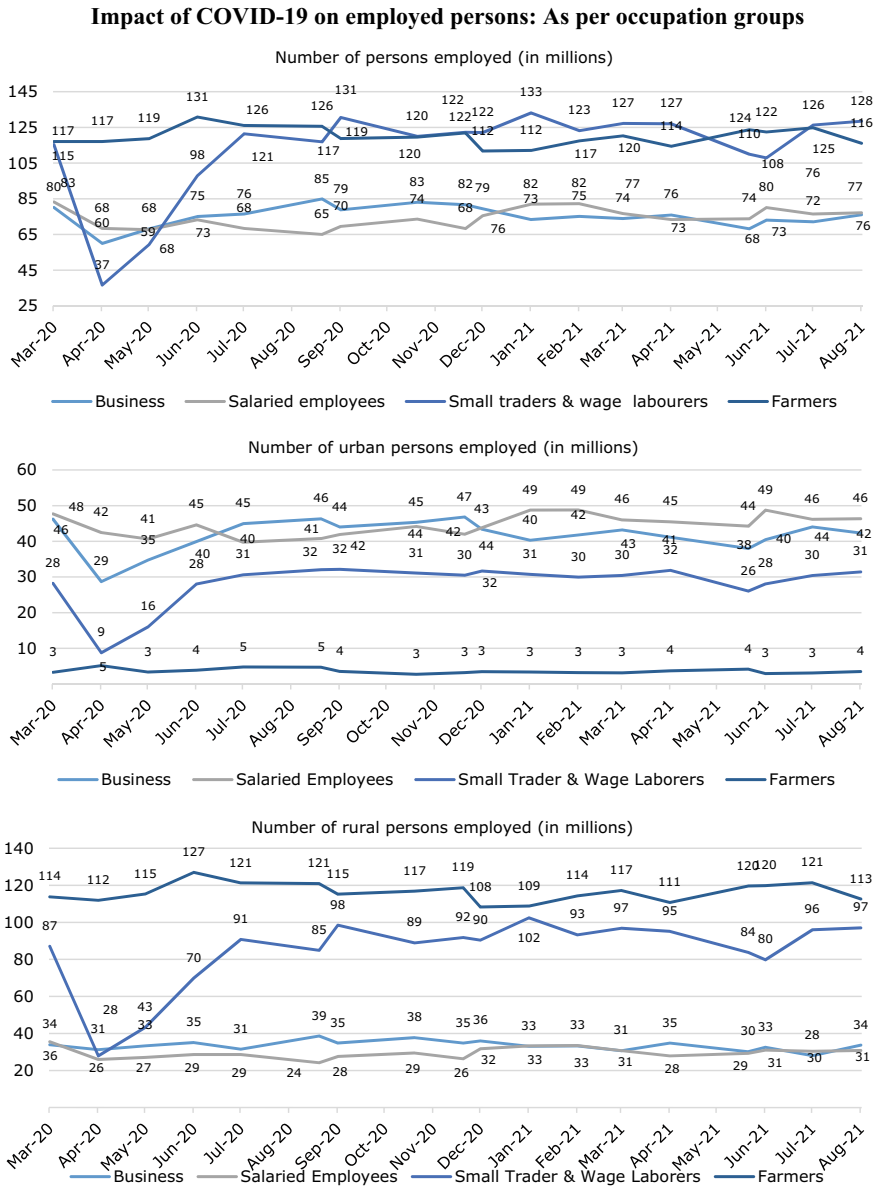

Fig. 16 Impact of COVID-19 on employed persons: As per occupation groups. *Source* Center for Monitoring Indian Economy (CMIE) Economic Outlook [20]

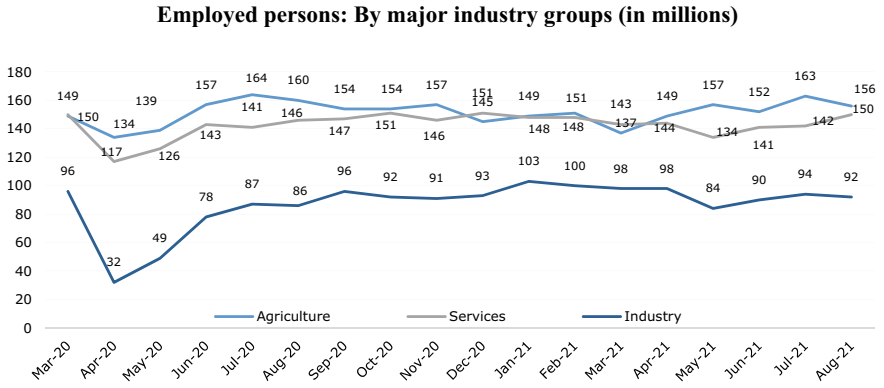

Fig. 17 Employed persons: By major industry groups (in millions). *Source* Center for Monitoring Indian Economy (CMIE) Economic Outlook [20]

between April and May 2021. Notably, manufacturing did not recover to March 2020 levels even by August 2021 (Fig. 18).

Alternatively, among the sub-sectors of the services sector, it can be noted that employment in the hotel and tourism industry contracted by 40.7%, education by 28.1%, and wholesale and retail trade contracted by 20.2% between March and April 2020. Employment in the wholesale and retail trading industry recovered above March 2020 levels by August 2020, whereas the hotel and tourism industry could only recover by October 2020. Employment in the education sector continues to be lower in August 2021 than in March 2020. Following the second wave, employment in wholesale and retail trade fell by 13.9% and in the hotel and tourism industry by

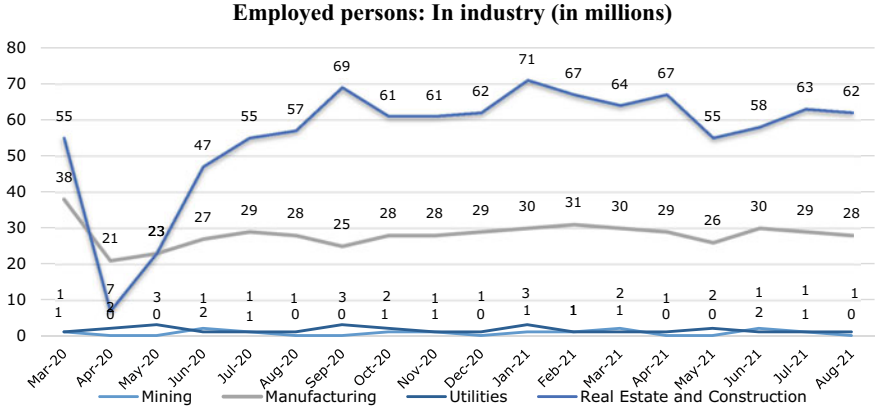

Fig. 18 Employed persons: In industry (in millions). *Source* Center for Monitoring Indian Economy (CMIE) Economic Outlook [20]

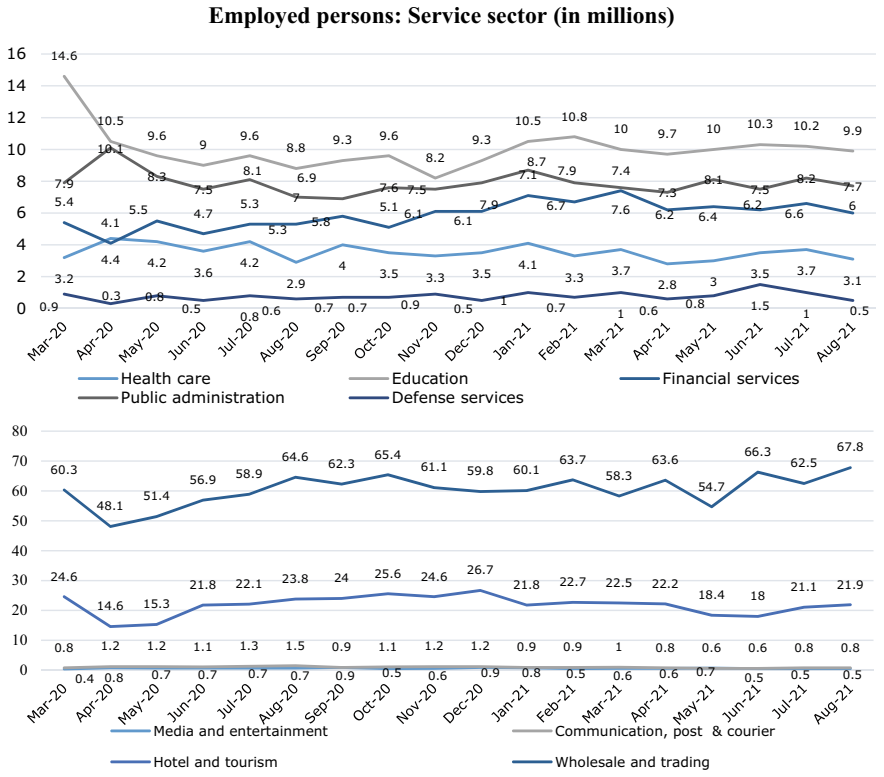

Fig. 19 Employed persons: Service sector (in millions). *Source* Center for Monitoring Indian Economy (CMIE) Economic Outlook [20]

17.1% between April and May 2021. However, employment in both sectors recovered by June 2021 (Fig. 19).

The wholesale and retail trading industry recovered above March 2020 levels by August 2020, (64.6 million in August compared to 60.3 million in March), whereas the hotel and tourism industry could only recover by October 2020, 25.6 million in October compared to 24.6 million in March.

The impact of the second wave was observed on the number of employed individuals in wholesale and retail trading (contraction of 8.9 million) and the hotel and tourism industry (contraction of 3.8 million) between April and May 2021. However, recovery was rapid as hotel, tourism, wholesale, and trading sectors added to the job market.

Micro, small, and medium enterprises (MSMEs) were among the worst hit in both the manufacturing and services sub-sectors; they suffered heavy job losses. Box 2 presents a closer look at the industry perspective of the impact on MSMEs.

Box 2

Impact of COVID-19 on MSMEs—Industry perspective

Pre-COVID, the MSME sector faced a lack of cost competitiveness and many small firms were stuck in cycles of low productivity and informality. The sector was already struggling with demonetization, GST, and a slowing economy when COVID-19 hit.

The pandemic dealt a heavy blow to MSMEs stunting their growth and exacerbating pre-existing issues. The size and scale of MSMEs led to lower bargaining power resulting in delayed payments for goods and services supplied. This malaise continued to plague the growth of the sector in spite of legal remedies. Further, delayed payments resulted in a working capital crunch. Thus, MSMEs had to utilize cash reserves to resolve payment issues with difficulties in borrowing from formal sources.

The Global Alliance for Mass Entrepreneurship LEAD micro-enterprise survey found that 57% of micro-enterprises had no cash reserves, while 65% had to dip into personal savings to manage their operations [29]. Another issue plaguing MSMEs was order cancellations [30]. This added to the inventory stock and to the cost of managing piled up inventory, further leading to working capital constraints.

An April 2020 survey by The Federation of Indian Chambers of Commerce & Industry (FICCI) found that 73% of MSME businesses reported a drop in orders, while 50% indicated that their inventory levels were up by over 15% [30]. The pandemic also disrupted the expansion plans of MSMEs. Many had to restructure their operations and plan a new trajectory for growth. Plans for their future also remained uncertain due to the lack of safety nets.

While some MSMEs used creative methods such as technological upgrades to survive, many had to shut down due to disrupted supply chains and transformed consumer habits; 30–40% of MSMEs in India may cease to exist as the pandemic continues [31].

Personal Protective Equipment (PPE) manufacturing emerged, on the other hand, as a key growth driver for MSMEs. Nearly 1,100 indigenous manufactures from textile clusters across India pivoted toward PPE manufacturing. This led to India emerging as the second largest manufacturer of PPE in the world within just two months of the onset of the pandemic—with a daily production rate of over 500,000 kits by May, 2020 [32].

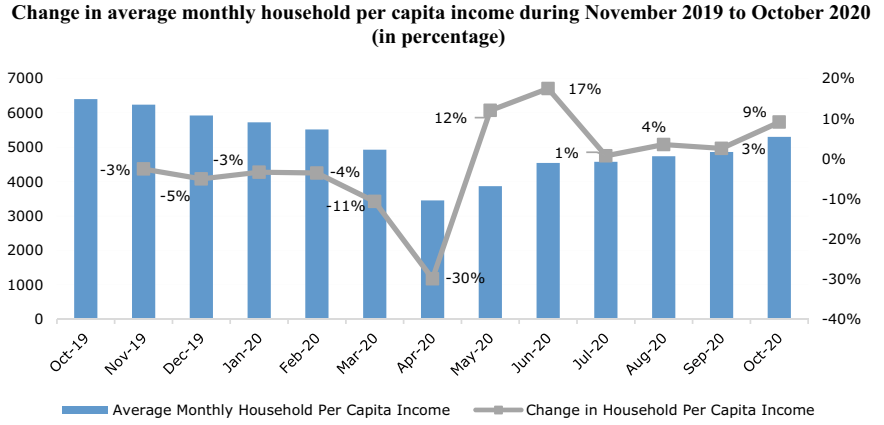

Fig. 20 Change in average monthly household per capita income during November 2019 to October 2020 (in percentage). *Source* State of Working India 2021 calculations based on CMIE-CPHS data [33]

Impact of COVID-19 on Incomes

Average monthly household per capita income (PCI) showed a declining trend even before the COVID-19 lockdown, falling from INR 6,401 in October 2019 to INR 4,929.6 in March 2020. Per capita income then fell sharply to INR 3,453.6 in April 2020. It only recovered by October 2020 (Fig. 20).

While the permanent salaried class was shielded, with their monthly incomes dropping only 5%, casual workers saw their monthly income shrink by 13% in 2020. This was the outcome of lay-offs and no social security safety nets. Similarly, the incomes of self-employed and temporary workers also shrank by 18% and 17% (Fig. 21).[12]

Mobility restrictions and shortage of essentials due to disrupted supply chains had an immense impact on the prices of essential commodities. Rising inflation and higher cumulative income losses among the vulnerable workforce segments worsened the effects of income disparity creating a survival crisis (Fig. 22).

[12] Temporary salaried workers are predominantly support staff, industrial workers and non-industrial technical employees as compared to permanent salaried who are engaged in primary activities of the firm. Casual/daily wage workers are those depending on freelance jobs. Self-employed are those not drawing salaries from another entity.

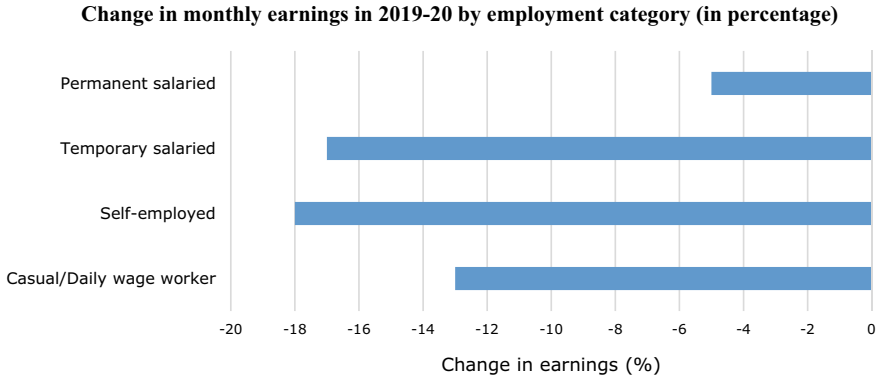

Fig. 21 Change in monthly earnings in 2019–20 by employment category (in percentage). *Source* State of Working Capital 2021 calculations based on CMIE-CPHS data [33]

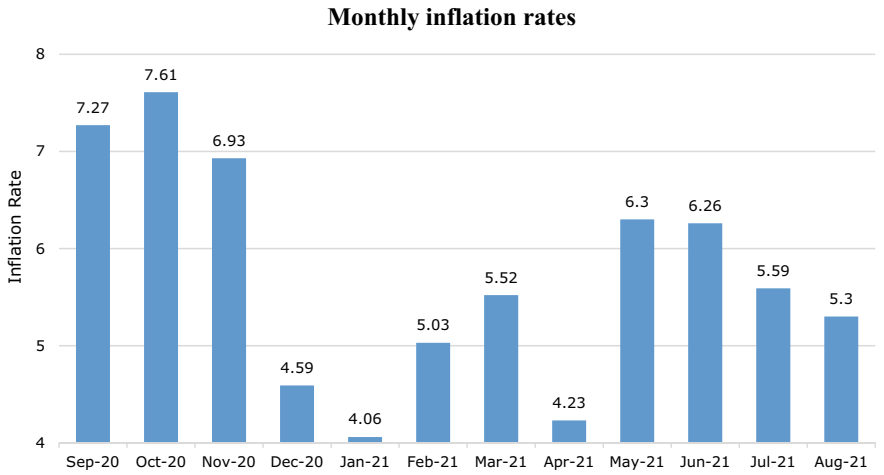

Fig. 22 Monthly inflation rates. *Source* Ministry of Statistics and Program Implementation, Government of India [10]

Poverty and Increasing Inequality

Rising Poverty

Between FY10 and FY11, the proportion of the population earning less than USD 1.90/day fell from 63% to 22.5%. India was among the only fours countries which halved their Multidimensional Poverty Index (MPI) value in a span of

Table 6 Estimates for number of people pushed into poverty in 2021

Organization	Region	Poverty line	Number of poor
World Bank	South Asia	USD 1.9/day	49–56 million
Asian Development Bank	Asia	USD 1.9/day	75–80 million
Azim Premji University	India	INR 375/day	230 million

Note Extreme poverty is measured as the number of people living on less than USD 1.90 per day; 2017 was the last year with official global poverty estimates
Source Poverty and Shared Prosperity 2020, PovcalNet for Global; State of Working India 2021, Azim Premji University, Author's calculations based on Consumer Pyramids Household Survey (CPHS) data by the Center for Monitoring Indian Economy (CMIE) for India [40–43]

10 years (FY06–FY16) with the greatest drop of 273 million in its number of multi-dimensionally poor people [34, 35]. The infant mortality rate[13] dropped from 66.7 per 1,000 live births in 2000 to 28.3 in 2019 and literacy rates rose as access to primary and secondary schooling accelerated. Secondary school enrollment increased from 45% in 2000 to 74% in 2019 [10]. This facilitated inter-generational impacts on education and healthcare.

Post-COVID-19, however, initial estimates suggest that South Asia and India in particular will witness rising poverty. The World Bank estimates that global poverty[14] will rise for the first time in twenty years, with South Asia contributing to 49% of this increase [36]. Estimates from the Asian Development Bank show that number of poor are set to increase by 75–80 million across Asia [37]. Researchers from the Azim Premji University estimated that poverty in India was expected to drop by 5% in rural areas and 1.5% in urban areas between 2019 and 2020, lifting approximately 50 million people above the national minimum-wage threshold-line of INR 375/day [38, 39]. Instead, the pandemic led to an anticipated rise in poverty by 15.6% in rural areas and 19.7% in urban areas, respectively pushing an additional 230 million persons into poverty [39] (Table 6).

Growing Income Inequalities

India's growth experience has been in line with cross-country evidence[15] wherein income inequality has risen in good and bad times.[16] The share of national income accruing to the top 10% of the population increased from 36% in 1992 to 57% in

[13] Deaths per 1,000 live births of children under one year of age.

[14] As per the USD 1.90/day line.

[15] OECD three-part flagship series on trends, causes and remedies to growing inequalities.
Part 1—Growing unequal? (2008).
Part 2—Divided we stand: why inequality keeps rising (2011).
Part 3 – In it together: why less inequality benefits all (2015).

[16] Incomes of the richest 10% when compared to the poorest 10% stood at a ratio of 7:1 in the 1980's, growing to 8:1 in the 1990's, and to 9:1 in the 2000s.

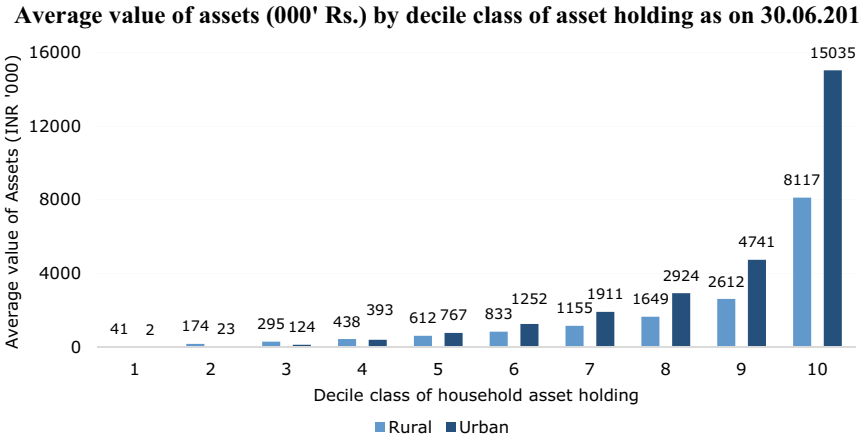

Fig. 23 Average value of assets (000' Rs.) by decile class of asset holding as on 30.06.2018. *Source* All India Debt and Investment Survey, NSSO 2019–20 [48]

2019. In the same period, the share of the middle 40% fell from 46 to 30% and that of the poorest 50% dropped from 21 to 12%—indicating polarized post-liberalization growth [18, 46]. As of 2019, the richest 10% in India owned over 50% of the total assets, whereas the bottom 50% owned 10%. The average value of assets owned also demonstrates exceptionally large disparities not just between the top and bottom decile classes, but also between decile 8 or 9 and decile class 10 (Fig. 23).

Following this trend, income equality and divergence also increased post-COVID-19, and the middle classes were among the worst affected. India's middle class is estimated to have shrunk by 32 million in 2020 (Fig. 24) [42]. This roughly accounts for 60% of the global reduction in the number of people in the middle-income categories (incomes of USD 10–20 a day) [5, 6]. On average, 84% of Indian households reported declines in incomes in May 2020. Households in second and third quintiles, whose monthly per capita incomes ranged between INR 3,801 and INR 5,914 and between INR 5,914 and INR 8,142 were the worst hit, with 91–93% of respondents in these categories reporting a loss of income, higher than the proportion (85%) in the INR 0 and INR 3,814 categories [43].

The cumulative loss of income was more severe for lower-income households those that fall within higher income categories. The percentage of households reporting zero income post the onset of the first wave increased drastically by 10.1% in April 2020 and 8.3% in May 2020 [45] (Fig. 25).

Evidence regarding the differential impact on urban versus rural households was mixed. Bertrand, Dizon-Ross, et al. (2020) found that rural households were disproportionately impacted with 88% of rural households reporting a fall in income under the lockdown compared to 75% of urban households in May 2020 [43]. On the

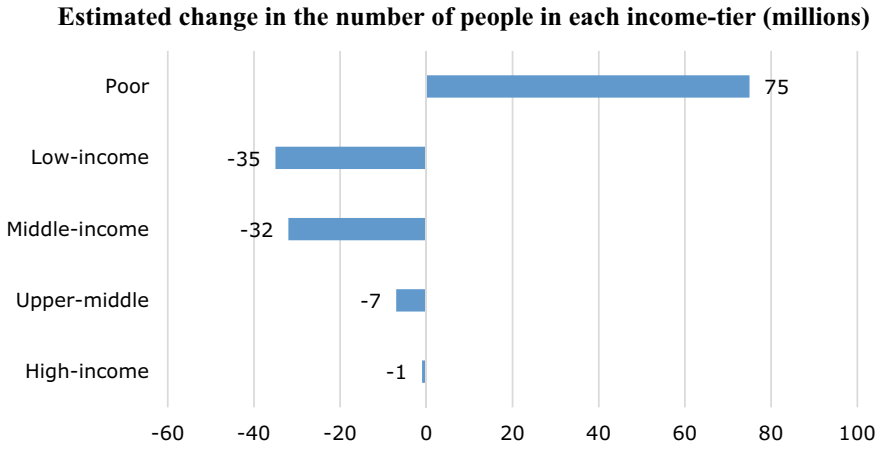

Fig. 24 Estimated change in the number of people in each income-tier (millions). *Source* PEW Research Center Analysis of data from the World Bank PovcalNet Database [41]

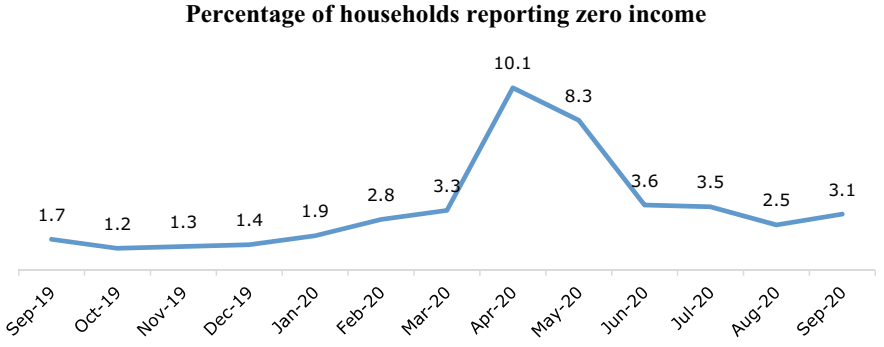

Fig. 25 Percentage of households reporting zero income. *Source* Household savings in the time of COVID-19, Dvara Research, 2021 [45]

other hand, the first COVID-19 and Livelihoods in India Phone Survey (CLIPS)[17] conducted by Azim Premji University in April and May 2020, found that 83% of urban versus 73% of rural households were consuming less food than before and 64% of urban versus 35% of rural households did not have enough money to purchase a week's worth of essentials [44].

Overall, between March to October 2020, a 10% decline in mobility was associated with a 7.5% decline in household income across states. There was a fall in aggregate income with 90% of the decline stemming from reduced earnings and

[17] In Azim Premji University CLIPS (panel of 2,778 respondents from vulnerable households across 12 states); 90% respondents reported that households had suffered reduction in food intake due to lockdown.

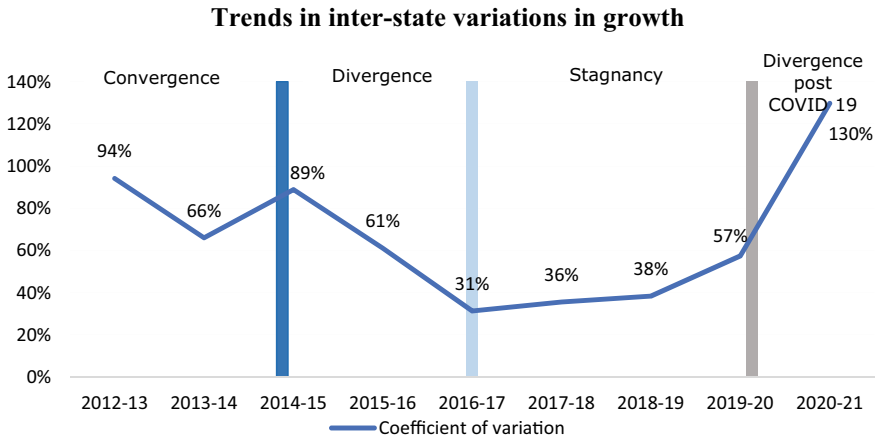

Fig. 26 Trends in inter-state variations in growth. *Source* CMIE, States of India

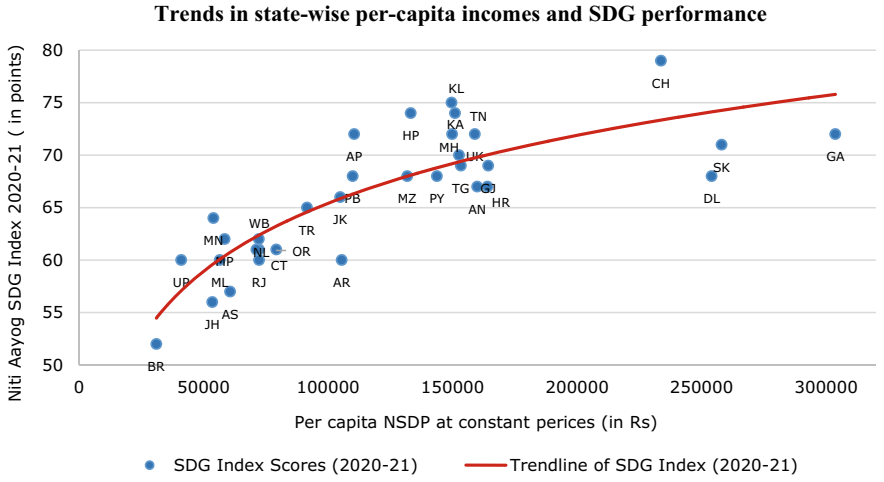

Fig. 27 Trends in state-wise per capita incomes and SDG performance. *Source* SDG Index NITI Aayog [52], Ministry of Statistics and Programme Implementation [10]

10% from job losses. This suggests that while most workers could return to their jobs eventually, they had to settle for lower wages. Households adjusted to the pandemic by borrowing, reducing food intake, and selling assets [40]. Moreover, the second CLIPS survey in October-December 2020 found that for 60% of households, food intake had not recovered to pre-lockdown levels.

The divides witnessed in income and asset holdings distribution are an indication of growing disparity and imbalances in growth patterns: across states, regions, gender,

and income classes. This evidence breaks down notions of the trickle-down effect working for the benefit of all.

A Roadmap to Recovery: Key Principles to Ensure an Inclusive Agenda

The pandemic had a catastrophic impact on the economy reversing decades of policy and action on sectoral transformation, job creation, and poverty alleviation. Though the second wave prompted international institutions to downgrade India's growth prospects for FY22, recent GDP estimates show a record high growth rate of 20.1% in Q1-FY22. Even though this is a result of a low base year, it is an indication of the country embarking on a path of recovery.

However, even as GDP growth partially recovered, recuperation in employment was slow and uneven. Of the ~ 20 million jobs lost on account of COVID-19, ~17 million were from rural areas compared to ~2 million from urban areas. Over 10% of the affected rural services workforce still faces income losses. As a response, the job market shifted toward informalization. Laid off workers moved to more precarious and informal forms of employment, indicated by nearly half of the formal salaried workers moving to informal work over FY20-FY21. It is critical that the growing informal workforce is protected through restructuring their debt and improving their access to formal credit and employment.

The number of households earning zero incomes rose, accompanied by huge losses for low- and middle-income groups. As a result of savings being dented to afford treatment, borrowings of poorer households were at a much higher multiple of their pre-pandemic incomes compared to richer households[18] [35].

Predictions for the future hinge on the coverage achieved by vaccination drives. So far about 25% of the total adult population has been fully vaccinated. However, the pace significantly improved in the latter half of 2021 [49]. Bearing this in mind, the next section aims to highlight three key principles that place inclusivity at the heart of the recovery agenda, as the Center and the States embark on economic revival post-COVID-19.

Promoting Balanced Growth and Attainment of Sustainable Development Growths (SDGs) Across States

An analysis of state level growth trends over the last two decades (1990–2020) demonstrates a high variation of economic growth across states. Madhya Pradesh,

[18] For instance, median income of bottom 25% in Feb 2020 was 4,000 and the loan that they had taken to finance their food, health etc. was 12,000. Whereas top 25% households with median income of 18,000 took loans on average of 30,000.

Maharashtra, and Gujarat recorded the highest growth rates over the last decade, while the densely populated states of Uttar Pradesh, Bihar, Punjab, and Rajasthan among others recorded below national averages for the same period. This continued post-pandemic resulting in the Y-o-Y inter-state variation[19] at an unprecedented rate of 130% [50].

States are entering a post-COVID-19 phase having differential resources and capacities to recover from the effects of the pandemic. The contraction of economic activity meant that states had close to zero growth in revenue and an enhanced burden of expenditure [51]. High-income states and those with greater institutional capacity had an advantage, as recovery driven growth tends to be concentrated in these states. This is indicated by the fact that the high-income states attracted a greater chunk of incoming FDI post the first lockdown [21]. Similar trends were also evident from the *NITI Aayog* Sustainable Development Goals (SDGs) Index, which demonstrated that high-income states of Maharashtra, Gujarat, Tamil Nadu, Karnataka, Kerala, Himachal Pradesh, Telangana, and Uttarakhand outperformed others in the achievement of the SDGs [52].

Consequently, there is a need to ensure that channels for inter-state convergence are provided by the central government in the form of interregional capital mobility and redistribution of incomes aided by renewed grants to low-income states [54]. Centrally planned schemes like the Smart Cities Mission and the Aspirational Districts Program provide an impetus to growing cities, incentivizing states to improve. An upgradation of these schemes can either expand the scope of work undertaken, or widen the coverage of urban areas and districts covered, to incentivize participation of lower-income states.

There is a strong focus on long-term infrastructure development through central government initiatives such as the National Infrastructure Investment Pipeline (2020–2025), the National Industrial Corridor Development Program (with industrial projects identified till 2027), the National Maritime Vision 2030, and the National Rail Plan 2050. However, it needs to be ensured that the investments made by the public sector and leveraged by the private sector reach underserved districts and do not remain concentrated in specific geographies.

To tackle the issues of social inequity, enabling access to and mobilizing public and private investments in sectors like healthcare and education are vital. For education, expanding the coverage of telecom infrastructure and subsidized data plans for people in rural and remote areas can help address digital divides [56]. For healthcare, higher allocations are required to expand rural healthcare capacities to contain the spread of contagious diseases, provide emergency care, and reduce rates of infant,

[19] The coefficient of variation (relative standard deviation) is a statistical measure of the dispersion of data points around the mean. The standard formula for the coefficient of variation is expressed in the following way:

Coefficient of Variation $= \sigma/\mu \times 100\%$

Where:

σ – the standard deviation.

μ – the mean.

maternal, and neonatal mortality [52]. Universal health coverage, including financial risk protection and access to quality essential health services, medication, and vaccines for all, are some measurable ways to achieve this [53]. Enhancing the state of preparedness across states is critical. Investing in well-established oxygen logistics systems, and healthcare backup facilities, especially in rural areas, would help the readiness for emergency time responses [55].

Facilitating Gender-Inclusive Economic Recovery

An analysis of data over the last seven decades shows that women's work is largely informal, invisible, and labor-intensive [57]. Women's labor and work force participation declined and consistently remained below that of men. There was an exodus of women from the labor force, particularly in rural areas. There is a preponderance of women in traditional sectors with low labor productivity such as agriculture, handicrafts, handlooms, and textiles. Despite improvements in education, rising household incomes, liberalization, and increased linkages with global value systems, the exodus of India's women from the labor force continues.

In this context, the COVID-19 pandemic came as a shock resulting in massive job losses for women—especially informal workers—and the slower recovery of women-led micro-businesses. It also increased domestic work, deepened gender digital divides, exacerbated gender-based skills and educational gaps, and placed millions of female health workers at risk. It is essential to take concerted policy action to bring women back to work, not only because bridging these gender gaps can add USD 770 billion to India's GDP by 2025 [58], but also because financial independence is a key tool for breaking the cycles of violence, discarding antiquated social norms, and ensuring that women have a voice.

To chart a gender-sensitive socioeconomic recovery in India, governments, the private sector, media, and the social sectors should work along three common areas: (i) expand gender budgets at the central and state levels; (ii) invest in creating a care work economy; and (iii) enhance efforts to boost women's workforce participation.

India's Gender Budget between 2005–06 and 2020–21 remained in the range of 4–6% of the total expenditure and less than 1% of GDP. In 2021–22, despite the disproportionate impact of COVID-19 on women, the Gender Budget fell to 4.4% of the total budgetary expenditure and 0.7% of GDP. Progress on gender budgeting at the state level remains uneven. Moving forwards, the Central Government should undertake a gender needs assessment study to recalibrate the total fiscal envelope available for the Gender Budget, broaden allocations across ministries, and target finances toward emerging priority areas post-COVID-19. Gender audits of centrally sponsored schemes (CSSs) and flagship programs such as the *Atmanirbhar Bharat Abhiyan* should be undertaken to signal the importance of reporting gender impacts. In addition, the Gender Budget Statement should include measurable outcome and output indicators and their annual progress should be reported. Most importantly, the

collection of gender disaggregated data should be mainstreamed as a basic minimum requirement across dashboards of all CSSs [59].

India spends less than 1% of its GDP on care work, infrastructure, and services including pre-primary education, maternity, disability and sickness benefits, and long-term care [60]. A medium-term plan to increase public investment in Care Economy Infrastructure offers India a credible instrument to meet multiple policy objectives including job creation for women, enabling gender inclusive economic growth, and reducing gender-based income inequalities. Estimates suggest that investing an additional 2% of the GDP in the Indian healthcare sector has the potential to create 11 million additional jobs, nearly a third of which would go to women [61]. Investing in care infrastructure can also prevent 'occupational downgrading' so that women become less likely to end up with lower pay when looking for flexibility or part-time roles owing to care work responsibilities. Recognizing *anganwadi* workers (AWWs), auxiliary nurse midwives (ANMs), accredited social health activists (ASHAs), and domestic help (among others) as formal sector workers would allow their economic contribution to be counted in the GDP. Investment in care infrastructure and services can also be in the form of public private partnerships (PPPs) to develop and leverage the expertise of the private sector.

Governments can work to increase the proportion of women in the workforce. They can establish gender-based employment targets for urban public works, introduce wage subsidies to incentivize hiring women in small enterprises, increase preferential procurement from women's enterprises, and introduce gender targets across skills training institutions so that a pipeline of workers is created across varied job roles. Corporate entities should track the proportion of women employed at different levels of seniority and in different job roles. Government and private sector organizations must increase investment in the care economy and support measures to bridge the gendered digital divide including distributing mobile handsets and improving digital literacy programs for girls. Employers, community organizations, and the media should promote the anthem of making men equal care work partners.

Transitioning to a Green Economy

Unless immediate cuts on global greenhouse gas emissions are enforced, limiting warming close to 1.5 °C or even 2 °C is beyond reach. The Intergovernmental Panel on Climate Change's (IPCC's) Sixth Assessment Report of 2021 reveals that the average surface temperature of the earth will cross 1.5 °C above pre-industrial levels by 2040 and 2 °C by the middle of the century without a sharp reduction of emissions. This is the first time that the IPCC has reported that the 1.5 °C warming is inevitable even in a best-case scenario. Reaching global net zero emissions by 2050 is the minimum required to keep the temperature rise to 1.5 degrees Celsius. It signals a code red situation for the pace of climate change in 2021. However, the world has already depleted 86% of its available carbon budget. This has catastrophic implications for the warming of seas and sea level rises, rainfall patterns, and agriculture disadvantaging

those unable to afford means of individual resilience and creating millions of potential climate refugees [62].

India submitted an ambitious nationally determined contribution statement (INDC) in 2015 targeting a reduction in the emissions intensity of its GDP by 33–35% by 2030 from 2005 level [63]. In line with these targets, numerous sectoral interventions that promote greening of the economy were introduced in the last few years such as the PM- *Krishi Sinchai Yojana* for micro-irrigation and groundwater conservation [64], PM-*KUSUM* for solar pump subsidization and the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme for greater integration of electric vehicles in transport systems [65]. Improved agricultural practices like crop suitability studies, flood management protocols, and crop insurance schemes are now widespread enhancing agricultural resilience.

Moving forward, climate resilient sectoral plans should become the norm with environmental considerations being woven into every area of policy rather than an isolated policy or legal measure. Sustainable development must be integrated into mainstream economic urban and rural governance.

The integration of environmental goals in strategic planning, budgeting fiscal and financial sector policy coupled with SDG aligned budgeting—known as green budgeting—can help with better alignment of government spending on environmental objectives and incentivizing green industries and infrastructure [66].

The agricultural sector has huge opportunities for micro-irrigation systems to improve water efficiency with the support of institutions among the nodal departments implementing PMKSY schemes [64]. Providing subsidies in this area would encourage more farmers to adapt to these systems thereby revitalizing groundwater conservation efforts. The dependence of rural economies on agriculture requires improved practices that include crop suitability studies, flood management protocols, and crop insurance schemes to minimize the damage done and faced by agriculture. This can be further augmented by harnessing big data to improve information availability and accuracy of monitoring and prediction systems.

While coal was used to meet Indian energy demands over the last few decades, transition toward reduced usage requires significant public investment and long-term planning in order to develop comprehensive guidelines for the systematic closure of coal assets, local restoration, and skills training to optimize renewable energy consumption and to mobilize financial resources to transform energy production and consumption patterns. In order to swiftly move away from coal, funding is required to support coal dependent communities to repurpose former coal production facilities and decommission polluting coal fired power plants [67].

Additionally, India's public procurement market (20–25% of its GDP) holds great potential as a sphere of interaction between the public and private sectors. Enhanced green standards and procurement conditions can be built into contracts to incentivize the private sector to upgrade manufacturing practices and transition towards low emission, water efficient industrial processes. Green public procurement can, therefore, assist in the larger transition toward green manufacturing [68].

Similarly, infrastructure sub-sectors including housing, waste management, and transport are important areas for climate action. The uptake of electric vehicles in the market has already been prioritized with nineteen states releasing mobility plans that focus on emission cuts and with incentives for those producing and purchasing electric vehicles (EVs) [69]. Corporate entities should begin to abide by environmental, social, and corporate governance (ESG) accounting standards that enable them to monitor their impact on the environment. Government and private sector organizations must increase investment in the green economy and support measures to enable transitions for MSMEs and traditional manufacturers.

Concluding Comments

India's GDP grew six times post-liberalization from USD 507 billion in 1990 to USD 2.9 trillion in 2019 [10]. For the same period, per capita-gross national income (PC-GNI) only grew 3.5 times from USD 574 in 1990 to USD 2131.8 in 2019.

Of the four instances of growth decline seen in India over the last few decades (FY58, FY66, FY73, and FY80), FY80 was the worst at a 5.2% contraction. However, with the overall economy contracting by 7.3% in FY21, 2020 has become the year of the most severe economic contraction in the country's history. The impact of the pandemic induced slowdown was uneven bringing about growth divergence and resulting in disproportionate job and income losses among the poor, women, and other disadvantaged groups.

The services sector led the contraction with growth in gross value-added decelerating by 8.4% in FY21. The industry showed a GVA contraction of 7%, with construction showing the largest decline at 8.6% and manufacturing declining by 7.2%. Agriculture was the sole sector to show positive growth of about 3.6%, cushioning some of the harsh macro-economic shocks through FY21, despite its shrinking share in output for the last two decades. The sector also absorbed returning urban migrants and the transitory unemployed workforce in 2020, providing a safety net to a vast majority of the population.

Consumption and investment were the major drivers of India's growth over the last fifteen years. However, in FY21, private final consumption expenditure contracted by 9.1%, and gross fixed capital expenditure by 10.1%. The increase in government expenditure (by 2.9%) and reduction in imports (by 13.6%) could not stem the overall impact of the massive fall in these growth drivers. However, despite weak domestic investment, foreign direct investment flows rose to their highest levels over the last fifteen years, signaling a positive outlook for recovery.

The human impact of the COVID-19 crisis is best gauged by studying its impact on labor markets. For nearly 1.5 years, labor markets were in a flux with workers losing jobs owing to the two waves of the pandemic. Following the nationwide lockdown, the overall size of the labor force shrank from 433 to 369 million, i.e., by 14.7% in April 2020 and nearly 114 million persons lost their jobs. The labor force recovered to March 2020 levels by February 2021. But contraction was witnessed

again following the second wave. Recovery from the second wave was seen only in August 2021, when both labor force and employment levels were slightly higher than in March 2020.

Women were among the first to lose their jobs and the last to get rehired. In April 2020, women formed about 14% of the job losses even though a higher proportion of women lost their jobs. However, in April 2021, women suffered 73% of the overall job losses. Small traders and wage laborers suffered the highest job losses during the first wave, while farmers were the worst affected during the second wave.

The pandemic also created reversals in the process of poverty reduction with estimates showing that upto 230 million Indians could fall back below the poverty line of INR 375/day (USD 4.97/day) in 2020. Moreover, the share of national income accruing to the top 10% of the population increased from 36% in 1992 to 57% in 2019. During the COVID-19 pandemic, the richest 10% of Indians owned about 50% of total household assets. In this context, COVID-19 came as a shock which hit the middle classes and the poorest the hardest with estimates suggesting that 32 million middle-income persons (incomes of USD 10–20 per day) and 35 million low-income persons (incomes of USD 2–10 per day) could fall into poverty (below USD 2 per day).

The culmination of demand–supply shocks, mobility restrictions, and the unique defining feature—the extremely high degree of uncertainty made post-COVID-19 recovery the defining challenge of the 2020s decade. Over the past year, economists from across rating agencies, business houses, and even multilateral organizations revised their growth outlook for India (and other economies) multiple times because of this persistent uncertainty.

The recession will deepen if the process to bring the pandemic under control is prolonged as accumulated financial stress will trigger defaults and tougher recoveries [70]. While most advanced economies achieved this, long-term effects were apparent in emerging market economies that faced larger outbreaks. The future outlook for India is, therefore, largely dependent on how the pandemic evolves. Pathways to steady and uninterrupted economic recovery lie in the success and speed of the country's vaccination drive necessitating continued co-operation between central, state, district, and *panchayat* level agencies (as was displayed in 2021).

The second wave dissipated quicker than anticipated with the Indian economy displaying some resurgence. The GDP grew at record levels of 20.1% for Q1-FY22 as states lifted lockdowns and travel patterns returned to normal. The economic impact of a third wave, if it occurs, is expected to be limited now that vaccination programs are progressing as planned [22] and that nationwide serological surveys find that two-thirds of the population has some antibodies against the virus [71].

Looking forward, it is necessary not only to make up for these economic shocks, but also to resume the task of nation building. While the government has taken several measures by way of fiscal stimuli and interventions to improve health related outcomes to tide over the immediate crisis, a greater focus is required to reduce inequalities at several levels. First, inter-state divergence in economic growth and SDG performance needs to be bridged, with a great focus on ensuring that public investment is directed toward lower-income regions, especially in light

of constrained state fiscal resources post-COVID-19. Second, a gender-responsive economic recovery strategy is required to ensure an increase in women's representation in the workforce necessitating investments in the care economy for job creation. And finally, India needs a long-term transition plan toward a green economy which reduces dependence on fossil fuels and spurs new investments in renewable energy, electric vehicles, waste water management, green manufacturing, and climate resilient agricultural practices.

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Appendix 1: List of Definitions

Terminology	Definition
Decile class	A decile is a quantitative method of splitting up a set of ranked data into 10 equally large subsections
Gender budgeting	Gender Budgeting is a process of identifying gender specific barriers across all sectors of development
Intended Nationally Determined Contributions	Intended Nationally Determined Contributions are (intended) reductions in greenhouse gas emissions under the United Nations Framework Convention on Climate Change
Multidimensional Poverty Index	The global Multidimensional Poverty Index is an international measure of acute multidimensional poverty covering over 100 developing countries. It complements traditional monetary poverty measures by capturing the acute deprivations in health, education, and living standards that a person faces simultaneously
Twin Balance Sheet challenge	The twin balance sheet problem refers to the ballooning of debt on the books of corporate entities and the estimated INR10 trillion of stressed assets that have piled up at banks because of the inability of borrowers to repay
Coefficient of variation	The coefficient of variation (relative standard deviation) is a statistical measure of the dispersion of data points around the mean

Appendix 2: List of Tables and Figures

Table 7 Breakdown of economic stimulus package

Economic Package (INR billions)	Monetary	Fiscal	Total
RBI Liquidity measures (Feb–April 2020)	8,016	0	8,016
Pradhan Mantri Garib Kalyan Yojana (March 2020)	0	1,700	1,700
Emergency support for health sector (March 2020)	0	150	150
Revenue lost due to tax concessions (March–May 2020)	0	78	78
Atmanirbhar Part 1 (MSME)	5,346	600	5,945
Atmanirbhar Part 2 (Migrants, street vendors, etc.)	3,065	35	3,100
Atmanirbhar Part 3 (Rural)	0	1,500	1,500
Atmanirbhar Parts 4 and 5 (reforms)	0	481	481
Total	**16,427**	**4,544**	**20,970**

Source Analysis by Nikore Associates (2021)

Table 8 Comparison between number of employed persons in FY21 by occupation (in millions)

Industry Group	Region	2020						2021					
		Mar	Apr	May	Jun	Jul	Aug	Mar	Apr	May	Jun	Jul	Aug
Business	Urban	46	29	35	40	45	46	43	41	38	40	44	42
	Rural	34	31	33	35	31	39	31	35	30	33	28	34
Salaried Employees	Urban	48	42	41	45	40	41	46	45	44	49	46	46
	Rural	36	26	27	29	29	24	31	28	29	31	30	31
Small Trader & Wage Laborers	Urban	28	9	16	28	31	32	30	32	26	28	30	31
	Rural	87	28	43	70	91	85	97	95	84	80	96	97
Farmers	Urban	3	5	3	4	5	5	3	4	4	3	3	4
	Rural	114	112	115	127	121	121	117	111	120	120	121	113

Source Center for Monitoring Indian Economy (CMIE) Economic Outlook [20]

Table 9 Comparison between number of employed persons in FY21 by industry groups (in millions)

Industry Group	Region	2020						2021					
		Mar	Apr	May	Jun	Jul	Aug	Mar	Apr	May	Jun	Jul	Aug
Agriculture	Urban	4.3	6.6	5.1	4.9	6.3	6.9	4.5	6.5	6.0	3.9	4.4	5.5
	Rural	145	128	134	152	158	153	153	142	151	148	159	150
Mining	Urban	1.0	0.0	0.2	1.3	0.00	0.00	1.0	0.0	0.1	1.4	1.0	0.0
	Rural	0.2	0.2	0.2	0.2	0.0	0.0	0.6	0.2	0.1	0.2	0.0	0.0
Manufacturing	Urban	21.0	12.4	11.0	17.7	13.8	14.4	17.6	17.4	13.6	17.9	16.6	16.5
	Rural	17.4	9.0	12.4	9.8	15.1	13.2	12.5	12.1	12.2	11.8	12.2	11.5
Utilities	Urban	0.8	1.0	1.8	0.81	0.74	0.89	0.74	0.76	1.85	0.47	0.57	0.6
	Rural	0.5	1.1	0.8	0.6	0.5	0.6	0.8	0.3	0.4	0.3	0.5	0.5
Real Estate	Urban	15.2	1.9	7.0	14.9	18.2	19.3	17.3	17.1	14.0	16.1	18.4	18.2
	Rural	39.7	5.5	15.9	32.2	37.3	37.9	47.1	49.9	41.5	41.6	44.7	44.3
Services	Urban	83.1	63.2	69.7	76.7	79.9	82.2	81.6	80.3	77.0	80.3	82.7	82.7
	Rural	67.4	53.4	56.1	65.9	61.5	63.6	61.6	63.8	57.5	61.1	59.2	67.7

Source Center for Monitoring Indian Economy (CMIE) Economic Outlook [20]

Table 10 Change in average monthly household per capita income during FY20

Month	Average household per capita income (INR)	Percent change (%)
Oct-19	6401.0	
Nov-19	6236.6	−3
Dec-19	5922.5	−5
Jan-20	5723.2	−3
Feb-20	5518.5	−4
Mar-20	4929.6	−11
Apr-20	3453.6	−30
May-20	3869.1	12
Jun-20	4545.7	17
Jul-20	4578.5	1
Aug-20	4739.8	4
Sep-20	4860.8	3
Oct-20	5303.8	9

Source State of Working India 2021 calculations based on CMIE-CPHS data [29]

Table 11 Change in monthly earnings in FY20, by employment category

Employment category	Monthly earnings (INR)		Percent change
	2019	2020	
Casual/Daily wage worker	9,135	7,965	−13
Self-employed	15,831	12,955	−18
Temporary salaried	11,422	9,441	−17
Permanent salaried	29,226	27,697	−5

Source State of Working Capital 2021 calculations based on CMIE-CPHS data [29]

Table 12 Change in monthly earnings in FY20 by employment category

India	Total	413	411	406	409	387
	Male	359	362	361	365	348
	Female	54	49	45	44	39
Urban	Total	132	132	130	129	121
	Male	115	117	117	118	111
	Female	17	15	14	12	10
Rural	Total	281	279	276	280	266
	Male	244	246	244	247	237
	Female	37	34	31	32	29
Years		2016–17	2017–18	2018–19	2019–20	2020–21

Source Center for Monitoring Indian Economy (CMIE) Economic Outlook [20]

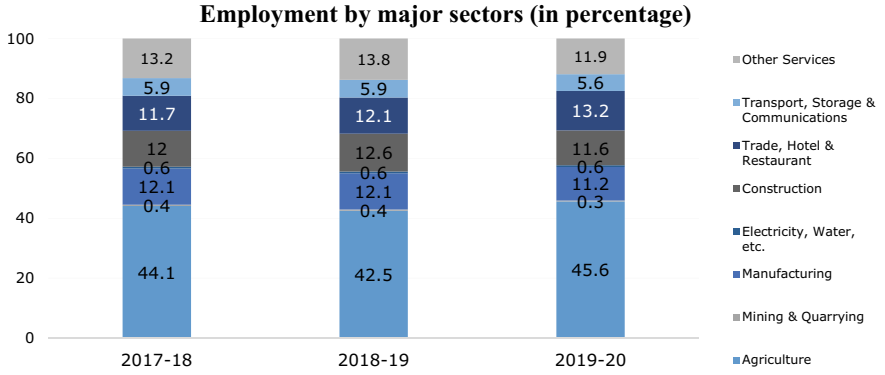

Fig. 28 Employment by major sectors (in percentage). *Source* Periodic Labor Force Survey (PLFS), NSSO 2019–20

Comparison between number of employed persons in FY21, by industry groups and area (bars in percentage, data-labels in millions)

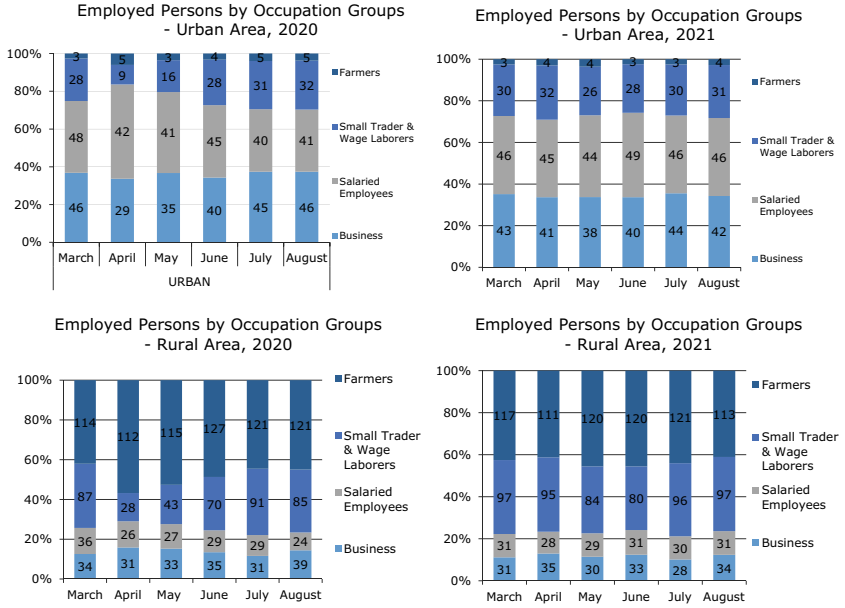

Fig. 29 Comparison between number of employed persons in FY21, by industry groups and area (bars in percentage, data-labels in millions). *Source* Center for Monitoring Indian Economy (CMIE) Economic Outlook [20]

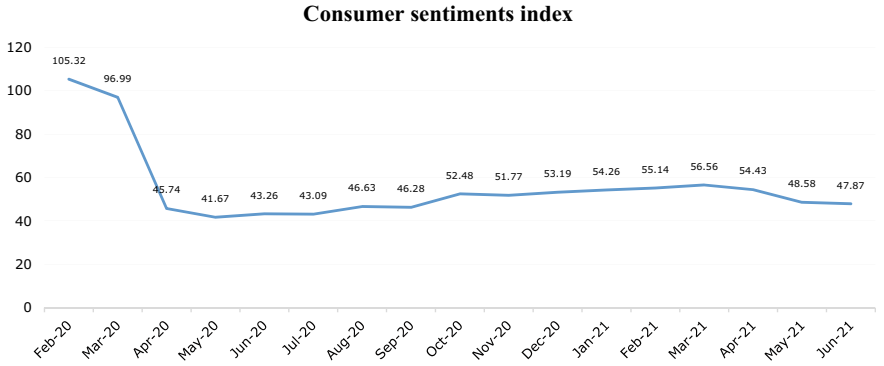

Fig. 30 Consumer sentiments index. *Source* Center for Monitoring Indian Economy (CMIE) Economic Outlook [20]

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Crafting Data-Driven Strategies to Disentangle Socioeconomic Disparities from Disease Spread

Ayan Paul

Abstract As a disease whose spread is correlated with mobility patterns of the susceptible, understanding how COVID-19 affects a population is by no means a univariate problem. Akin to other communicable diseases caused by viruses like HIV, SARS, MERS, Ebola, etc., the nuances of the socioeconomic strata of the vulnerable population are important predictors and precursors of how certain components of the society will be differentially affected by the spread of the disease. In this work, we shall delineate the use of multivariate analyses in the form of interpretable machine learning to understand the causal connection between socioeconomic disparities and the initial spread of COVID-19. We will show why this is still a concern in a developed nation like the USA with a world leading healthcare system. We will then emphasize why data quality is important for such methodologies and what a developing nation like India can do to build a framework for data-driven methods for policy building in the event of a natural crisis like the ongoing pandemic. We hope that realistic implementations of this work can lead to more insightful policies and directives based on real world statistics rather than subjective modeling of disease spread.

Introduction

Better data, better lives—United Nations.

The spread of SARS-CoV-2 amongst the human population since the end of 2019 was rapid and has been relentless. As we write this chapter, well over five million lives have been lost to COVID-19, several hundreds of millions have been directly affected, and the entire population of the world is indirectly affected by the pandemic. A natural crisis of this scale has not occurred in the recent history of mankind, and we have scrambled to contain outbreaks all over the world. Needless to say, like several

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other diseases, COVID-19 has disproportionately affected the most vulnerable in society [1–7]. These vulnerabilities were both medical and socioeconomic in nature.

Tracking medical vulnerabilities to a disease is a well-defined task that progresses through clinical observations and data collection in addition to scientific studies of varying complexities that span several branches of life and medical sciences. However, tracking socioeconomic vulnerabilities to a novel disease is, to say the least, an ill-defined task. This is aggravated by several and severe variations in socioeconomic demographics that are often rooted deep in unquantifiable sources that are cultural, economic, geographic, geopolitical, etc., each bringing about its own set of vulnerabilities on to the population of concern. Moreover, performing controlled experiments to collect data from any subsystem of society in a manner in which the experiment will not perturb the subsystem itself is almost impossible regardless of which part of the socioeconomic demographics one wishes to study [8].

Thus, the urgency to understand how socioeconomic disparities amplify the spread of a novel disease, which in turn amplifies the disparity itself, translates into a requirement of developing mathematically novel and robust methods to glean out patterns from available data. This urgency also requires a rethinking of the means and methods with which data is collected and made available as a greater participation of the scientific community is imminent given the complexity of the problem in hand and its essential interdisciplinary nature where the subtleties of the social sciences combine with the rigor of mathematical sciences and, in addition, requires an understanding of medical and life sciences to capture the nuances of this predator prey game that is being played between two species. The primary goal of this work is to present an initiation into data-driven methods focused on analyzing the effects of disparities on disease spread and vice versa. Computational socioeconomics is an emerging field in which large data and advanced multivariate methods help us to understand the nuances of socioeconomic structures and their interactions in a far more mathematically detailed manner than was previously possible [9]. However, these methods also bring with them the burden of increased complexity of the analyses often resulting in lower interpretability that makes them less appealing to those who are looking for an understanding of the underlying social dynamics rather than just simple data-driven predictions. To this effect, we would like to point out the three necessary conditions for building a credible data-driven framework for disease mitigation. While these are necessary for any data analyses, these become particularly important when addressing problems that affect human lives. These are:

- **Representative data**: During the normal course of science, data collection is often designed to be able to answer a concrete scientific question about the real world. In such experiments it is sometimes possible to have a dataset that is quite representative of the system itself. However, this is not the case when data needs to be sourced to solve problems where experiments with interventions cannot be designed. This is true for an unexpected natural crisis like the ongoing pandemic. There is simply no time or means to design experiments to collect data for most socioeconomic studies. In such cases, one has to rely on established sources of data and make accommodations for data that is not present or collectable. So,

the question of the how representative the data is, or can be made, needs to be addressed at the beginning of any such studies.

- **Reproducible analyses**: If any analysis has to stand the test of time and prove its scientific rigor, it should necessarily be reproducible. For data-driven analyses, this requires that all data and codes related to the analysis be made public and accessible. This is often overlooked by authors who publish their work in the scientific literature and choose to keep their codes and data proprietary. This is to the detriment of future works and often comes in the way of ironing out errors that might have crept into the analysis.
- **Robust conclusions**: Data-driven methods often lead to conclusions that are true within a certain periphery or are subject to assumptions made about the system under study. These boundaries might have been established due to the limitation in the coverage of the data or assumptions made during the analysis. This is especially true when socioeconomic data is used since this data is extremely contextual and cultural. Hence, the robustness of conclusions require that the domain of applicability of the analysis be a part of the statements of conclusions. These boundaries should be clearly delineated and the boundaries beyond which the conclusions do not hold good should be clearly stated.

From the perspective of a scientist vested in mathematics and algorithms, it is quite easy to meander about in the theoretical possibilities of crafting various analyses assuming that sufficient data exists or can be collected. This, however, clearly excludes the democratization of data-driven methods since the costs of performing such analyses might be too great for a set of concerned individuals or an institution to invest in regardless of the perceived benefits of doing so. Hence, it is also important to not only lower the costs of data-driven strategies by making them accessible but also, as a long-term goal, gradually build expertise and resources that can support such data-driven strategies. The discussion in this work should not only be taken as an exposition of possibilities but also as a herald to start building infrastructure, where possible, so that we can envisage a future where data-driven methods can be democratized and made available to even those parts of the world that are economically marginalized.

Where Can Data be Found?

Data-driven methods for any analysis that delves into the perturbations made to the socioeconomic strata by the onset of a disease face great challenges even without the problem one wants to address being excessively challenging by itself. The onset of a *novel* disease, of course, makes matters much worse. As expounding on these challenges in the general context of disease mitigation is too large a focus for this chapter, we will focus on what challenges arise specifically in the context of COVID-19 because of the details of its transmission dynamics. Many of these challenges are relevant in the context of other diseases as well, especially communicable diseases.

The nature of the data necessary for an analysis, being dependent on the details of the analysis being performed, can be broadly classified into data in aggregation and data at the individual level, the former being a statistical composition of the latter. We shall discuss the ethical considerations of collecting human data later in the chapter. A comprehensive overview of data and methods for computational socioeconomic can be found in Refs. [8, 9]. For now, let us describe the different types of data needed for building socioeconomic analyses related to the spread of COVID-19.

Disease Revalence Data

At the beginning of the pandemic several institutions, both private and public, started collecting data on COVID-19 prevalence, deaths, hospitalizations, admissions in the intensive care unit (ICU). One of the first institutions that started collecting data worldwide was the John Hopkins University [10]. Initially, data was available for countries as a whole but was later made available at the county level for the USA and with some geographic granularity for some other countries. Following suit, several nations started maintaining publicly available data repositories that provided COVID-19 prevalence data at high geographic granularity. The amount of data made available on COVID-19 prevalence is unprecedented and very decentralized. This is an optimal model for maintaining data on disease prevalence and should be adopted for several other diseases. While a centralized database always has the advantage of a fixed schema for the data, by making it more easily accessible increases the burden of data collection on one agency. The optimal model for data collection would be decentralized data collection adhering to a single schema.

A question naturally arises as to how detailed this data needs to be and what all should be made available. For certain, the various sources of data for different countries neither follow the same protocols nor is presented in the same schema. There are variations in what is reported as the date of occurrence. Some use the test date while others the test report date and some others provide both. This variation does not significantly affect any socioeconomic analysis since the differences are, at best, a few days. Moreover, there are large variations in the protocols used to declaring a positive infection detection and in testing strategies that can seriously misalign the data when compared among different nations.

At the initial stage of the COVID-19 pandemic, all nations were scrambling to implement a coherent strategy for testing and preparing protocols for identifying COVID-19 as the cause of death for a decedent. These factors severely affect the recording of the progression of the disease in the population. Ironically, it is at the advent of a new health crisis that the most vulnerable are differentially affected. This often includes persons of racial and religious minorities, the poorer fraction of the society that might have lesser access to healthcare and educations, live in regions with higher pollution, etc. More often than not the infrastructure in regions inhabited by a larger fraction of minorities and people living in poverty are subpar. These factors make it iteratively difficult to mitigate the spread of the disease in these regions or

deploy enough resources to trace the spread of the disease also affecting the quality of the data that is collected in these regions. This, in turn, has a cascading effect on how the disease differentially affects these fractions of the population as was evident from the beginning of the COVID-19 pandemic. These problems can be nationwide problems in low- and middle-income countries. We shall discuss this separately later in the chapter.

The best way to address these challenges to data collection is to setup a standardized method for tracking diseases, old and new, with the basic tenets established for creating new resources in the event of a new epidemic arising in the future. For certain, some protocols need to be left open to accommodate for the variances between diseases and their scale of spread. However, having the basic protocols established will go a long way in avoiding the confusion and the resulting loss of data at the critical point when a novel disease is spreading. Of course, the gold standard would be to establish an international protocol to send data to a centralized database for all diseases of concern maintained by a global collaboration such as the United Nations and institution dedicated for such data maintenance.

Health Data

There are two distinct kinds of health data that can be relevant for socioeconomic analyses designed to understand the spread of a disease. The first one stems from medical literature. Any disease differentially affects people with certain medical conditions referred to as comorbidities. These comorbidities are often correlated to the socioeconomic background of individuals or collectives. As an instance, individuals who are affected by obesity are at higher risk of hospitalization and death due to COVID-19 [11, 12]. Obesity also correlates with socioeconomic disparities and mental ill health [13]. Thus, the interdependence between physical or mental health and the risk from COVID-19 is inherently tied to socioeconomic disparities.

To understand how a disease differentially affects a certain fraction of the society, one must understand the distinct signatures that each disease has which correlate with and aggravate the disparities already present in the society. As another example, it is a medical fact that COVID-19 spreads through contact which implies that it spreads much faster in crowded regions. In the USA, we know that counties with higher poverty rates are likely to have less single family homes and more areas zoned for multi-family homes or are likely to contain inner cities and thus have a greater density [14, 15]. In such dense areas, there are likely to be shorter commutes and a larger transit network due to these areas being more populous [16, 17]. This implies that not only will COVID-19 spread more in these areas due to household contact, a major manner in which the disease spreads, but also due to a larger fraction of the population using the transit systems to commute [18–20].

Given these intricate correlations, the first health data that should be collected should encompass an extensive study of the medical literature to understand quantitatively the medical conditions that aggravate the risk from a disease and the transmission dynamics of the disease. For a novel disease both of these form a part of the emerging knowledge at the beginning of the spread of the disease. Therefore, it is difficult to root out differential spreading of the disease due to socioeconomic disparities from the beginning although this should not, by any means, discourage any attempts to do so based on a minimal set of metrics that are available in real-time.

The second kind of health data that is necessary to set up most analyses is data on medical conditions, both individual and as distributions in the population. Individual data is necessary to perform any controlled tests that give insights into differential spread in a particular segment of the population. The fact that there were racial and ethnic disparities in the way COVID-19 deaths occurred in the USA can be understood by collecting individual data on the race and ethnicity of the decedents [21]. However, this does not provide an insight into whether this is because of a physiological predisposition to a severe infection of the disease or whether it is because of some disparity that exist within the socioeconomic strata. To understand causalities one need population wide distribution of factors that can contribute to these differentials in the death rates including population wide comorbidity data [22, 23].

The collection of health data is possibly the most complex part of the data collection process. It is clear that the number of variables can become quite large and difficult to glean. Moreover, the need to understand correlations between these variables necessitates that a large amount of data be collected which can get quite challenging either because the data itself might not be available or the infrastructure necessary for its collection might be absent. The latter is particularly challenging for developing nations.

Mobility Data

While the other data sources are, in general, relevant for computational socioeconomics analyses involving any disease, the spread of COVID-19, in particular, requires a mapping of human mobility within the population because of the dynamics of the disease spread. It is true that mobility data can play a role in analyzing the dynamics of spread of any communicable disease. However, it is particularly important for COVID-19 because of two reasons:

- SARS-CoV-2 transmission is driven by pre-symptomatic spreading like the influenza virus [24–26]. This is not necessarily true for other similar communicable diseases spread by viruses like Variola, SARS-CoV, MERS-CoV, Ebola, etc. which primarily spread in the symptomatic phase [27–30].
- The pathogen can be transmitted through the air in high contamination regions and through contaminated dry surfaces for several days leading to its high transmission

rates [24, 31, 32]. This brings about additional challenges when the disease cannot be contained within an isolated envelope of a healthcare system. While a similar spreading pattern is seen in SARS-CoV and MERS-CoV, this makes SARS-CoV-2 more easily transmittable than some other diseases like Ebola.

The first reason makes the tracking of COVID-19 transmission extremely difficult even with the help of automated contact tracing or manual contact tracing [33, 34]. The second reason highlights the importance of information on how people interact with each other at the local scales. Hence, to make coherent predictions about the spread of the disease or to understand causalities, mobility data is of utmost importance.

Individual mobility data is used in the construction of Individual-Based Models of disease transmission which are specialized agent based models constructed for predicting disease transmission taking into account the details of the entire population of a region or country[35–38]. Mobility data in aggregation can also be used to model disease spread across large geographical areas [39, 40]. What is even more relevant for this work is that mobility data contains signatures that can be directly connected with socioeconomic disparities and how the mitigation methods affect the most vulnerable parts of the society [41]. The latter in turn can give us an understanding of how effective certain mitigation methods are in areas in which the socially disadvantaged live.

Even with all these advantages and scientific possibilities that access to mobility data can bring about, it is not easy to find mobility data. The highest quality mobility data comes from anonymized signals collected from cellphones. There are several commercial institutions that harvest these datasets but are mostly restricted to a few countries where they have commercial interests. Some of these commercial institutions have made their data available for academic research related to COVID-19. One of the most notable ones is Safegraph which provides Point-of-Interest data for the United States of America. It provides raw data for several years broken down to census block groups and with significant granularity in place types and foot traffic at all locations and between pairs of locations. This brings about significant scope for modeling mobility be it at the aggregated level or more detailed models based on mobility networks [41]. Safegraph data can be requested from https://www.safegraph.com/publications/academic-research, and the page includes a list of publications that have used the data.

The other source of mobility data is Google. The advantage of its dataset is that it is available for almost all nations and, for some, are broken down by states and districts (counties). However, Google does not provide the raw data but only gives numbers relative to a baseline that it computes using historical data. It only provides aggregated data for a few place types and not details of foot traffic data like the one that is available from Safegraph. Hence, this dataset, while being useful, is of limited utility. The datasets can be found at https://www.google.com/covid19/mobility.

Demographic Data

The final piece that ties together human behavior and disease dynamics to factors that encode socioeconomic disparities is demographic data. While being the easiest data to access through public databases, it is the most challenging to deal with in terms of variable selection, the understanding of confounding factors, modeling interventions, and real-time data collection. Focusing on the USA, demographic data is easily accessible through the US Census Bureau. However, there are two questions that one must address when designing what socioeconomic metrics should be derived from this data.

Firstly, the question of confounding variables is of prime importance in determining the variable set that needs to be used. This decision often boils down to what factors affect the phenomenon that is under study. For example, in the case of the spread of COVID-19, it is evident that factors like population density, mobility amongst the population, poverty, access to healthcare, etc. matter in determining how much the disease affects the population in terms of its spread and deaths due to it. However, one must understand whether factors like education, access to insurance coverage etc. actually affect the spread of the disease and are the determining factors. This is necessary because the variable that is causally connected to the outcome must be identifies to develop any intervention.

The second question follows naturally from the first one. It is the question of correlations between variables. It is well understood that using common linear methods to understand causation gets entangled in correlations because highly correlated variables cannot be used simultaneously in an analysis based on liner models. A move towards non-linear models, like those used in machine learning, allows one to escape the curse of correlations but at the price of losing the interpretability of the model. We shall address this in a later section. However, these two considerations are paramount in deciding what variable set to consider amongst demographic data since any set of variables can be highly correlated given that several aspects of the society are indeed interdependent and belie any explicit separation of causation.

Multivariate Methods

Possibly the greatest challenge in computational socioeconomics is the definition of variables that need to be focused on in any analysis. However, in this work we will not focus on the complexities and methodologies involved in the choice of variables. Rather we will assume that this choice has already been made and the analysis at hand includes several exogenous variables and one or many endogenous variables. Any mathematical structure that is used to tackle this analysis quantitatively can be

called a multivariate method. Just as everything comes at a cost, multivariate methods also have costs associated with them.

- Higher dimensional analyses typically require much larger datasets. Often this is not possible to obtain in an experiment or source from existing data. Several multivariate methods tend to be less interpretable because of their inherent mathematical complexity. This is certainly true when applied to machine learning frameworks as they are some of the most complex mathematical structures that can be used to find patterns in data and hence, sometimes the most effective ones.
- Given one finds a large enough dataset and is willing to use complex algorithms to find pattern in the data, computational costs can become a concern specially if the analyses needs to be done by individuals who have lesser access to computational facilities.

Machine Learning

Machine learning has become a very loaded class of statistical methods used to understand patterns in complex datasets. The breadth of machine learning covers everything from linear regressions to decision trees to neural networks. Depending on the data type that is used for an analysis, a suitable machine learning method can be chosen to perform the analysis. It should be noted that more often than not, real-world data shows linear and higher order correlations amongst the exogenous variables. These correlations cannot be probed by all machine learning methods. Moreover, the relations between the endogenous and exogenous variables can be far from linear. Hence, advocating linear systems is not always the best choice although they are the most interpretable ones.

To incorporate possible non-linearities in the data one can use decision trees to build models [42]. These are simple rule based algorithms that can be trained using data. Simple decision trees might be insufficient for modeling all the complexities in a dataset but are very highly interpretable. Much better regressors can be created from ensembles of decision trees like boosted decision trees or random forests [43–46]. While they are much better at explaining the patterns in a dataset, they lack the simple interpretation that a single decision tree has to offer. Methods derived from ensembles of trees are quite popular in the physical and life sciences and also widely used in clinical research. However, they must be used with much caution when dealing with social data [47, 48]. There are no good reasons to use neural networks on tabular data, be it cross-sectional or panel data. Neural networks are universal function generators that outperform tree based algorithms for several applications like image recognition, sequence to sequence analyses, time series analyses, natural language processing, etc. However, these kinds of analyses are almost never used in the study of disparities and disease except for special cases, e.g., where large social network datasets are being used to understand sentiments and trends [49]. So, we will limit our discussion to tree based algorithms here.

One of the greatest challenges that the application of machine learning faces in the social sciences is their reliance on large data sets. Machine learning algorithms are statistical learners and require a sufficient set of examples from the system being studied to model the patterns that lie within the system. The definition of "sufficient" relies completely on the complexity of the problem in hand. There are two factors that must be taken into consideration here:

- An increase in the number of exogenous variables requires an increasingly large data sample.
- The complexity of the relation between the endogenous and exogenous variables determines how large a dataset is necessary to perform a reliable regression of the data.

While most machine learning algorithms (other than linear regressions) do not typically suffer from multi-collinearities in data, since the parameters of the model built by these algorithms does not hold a quantitative or qualitative meaning in terms of the relation between the exogenous and endogenous variables, this can certainly pose to be a hurdle in terms of explaining the machine learning models post hoc. We will discuss this in some detail below. Whether one should consider examining multicollinearities in the analysis also depends on whether one wants to build a predictive algorithm or understand how the exogenous variables determine the endogenous one(s). For the former case, the existence of multicollinearities can be mostly ignored since the details of the model built by the machine learning algorithm does not matter. For the latter case, one has to deal with it individually for each analysis and a general prescription cannot be made.

Interpretability of Multivariate Methods

The greatest push against the use of machine learning algorithms for analyses that can directly affect decisions or policies made for humans has been because of the lack of interpretability of machine learning models. These models are made to find patterns in data and often require a degree of mathematical complexity that do not allow for a direct interpretation of the outcome in terms of the input variables. To make the results coming from machine learning models intelligible, explainability of these models is becoming increasingly important from the ethical, legal, security, transparency, and robustness standpoints, especially when they are used to make decisions that can affect human lives [50]. This has fueled the development of interpretable machine learning or explainable AI [51–53].

Interpretability in machine learning has several facets. Sometimes it is necessary to interpret the reason why a certain prediction is made. This is more useful for predictive modeling rather than when descriptive modeling is the aim. To be able to explain each prediction, a *local* explanation of the model is necessary which tells how a certain prediction depends on the input by creating a hierarchy of importance of the input variables in making that prediction. There are several measures of local

explanations that can be used for machine learning models. Amongst them, the two most popular are LIME and SHAP [54, 55]. The latter is based on Shapley values which we elaborate on below. The other kind of measure that explains the machine learning model as a whole to understand which input variables are more important in shaping the outcome in general are called *global* measures. Amongst the several popular global measures, the one that is most deeply rooted in mathematics is the global SHAP measure which is simply the mean of the absolute values of the local SHAP measures [56]. This connection between the local and the global SHAP measures comes from exploiting the additive property of Shapley values which are one of the four axioms that defines it.

In the applications that we propose here, interpretability of machine learning algorithms goes beyond being just something that is good to have to make responsible decisions. We will use interpretability to understand the interdependence of socioeconomic metrics and the spread of COVID-19. This is possible by doing what is commonly known as calculating "feature importance" in machine language parlance. The goal of feature importance is to understand which variables are important overall, or *globally*, in determining a certain outcome.

To do this we introduce the Shapley values [57, 58]. Formulated by Shapley in the mid-twentieth century, this is a measure in coalition game theory of how important a player is in a game of n players and a preset outcome defined as the objective of the game. A simple way of looking at Shapley values is to imagine what the outcome could have been without a particular player. Now, if one brings the player in the game, the outcome might be changed. The Shapley value provides a measure of the change of the outcome due to this player on an average over several possible combination of players playing the game. In essence, the Shapley value tells us how important the presence of a variable is in determining a certain outcome when compared to its absence from the multivariate problem being addressed. The process naturally and mathematically lends itself to studying the correlations between different variables since all possible combinations of variables can be taken out of the game to check the outcome.[1]

An Early Insight into Disease Spread in the USA

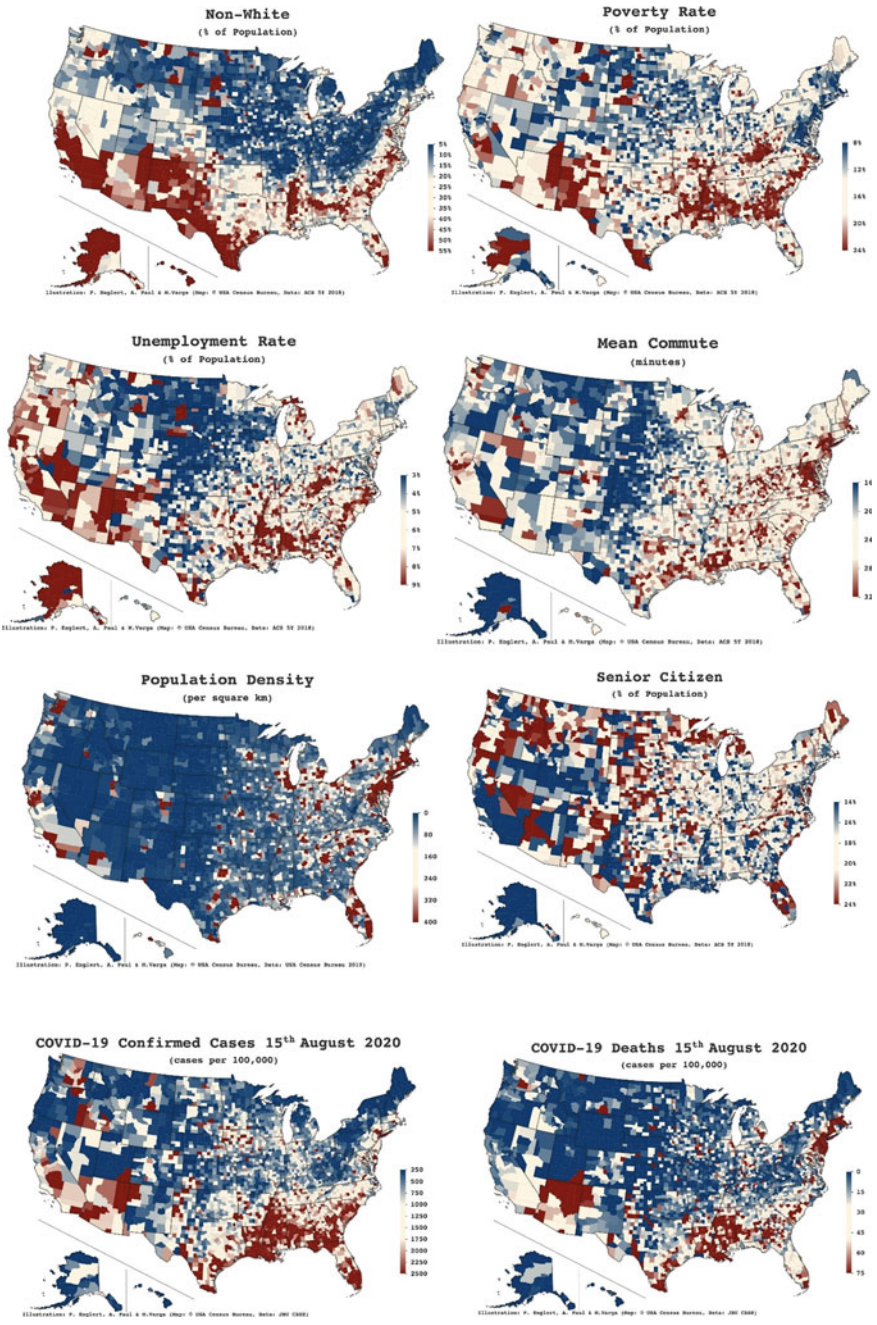
The early stages of the spread of COVID-19 in the United States have highlighted how socioeconomic disparities lead to the disproportionate prevalence of the disease in certain sections of society. This is a pattern previously observed in the spread of several diseases caused by pathogens like HIV, MERS-CoV, SARS-CoV, Ebola, etc. [60–63]. Beyond variations in socioeconomic conditions, ethnicity is a contributing factor to differences in health care, and more so for health conditions requiring intensive and long-term care [2, 64–67]. These disparities may also include racial

[1] More clarity on Shapley values and interpretable machine learning in general, along with their application can be found in Interpretable Machine Learning by Christoph Molnar [59].

and ethnic stereotypes within the healthcare system [68]. Taking concrete measures to limit the spread of disease among the most at-risk populations requires a thorough understanding of the causal links between socioeconomic disparities and the spread of disease.

It is known that communities of racial minorities, both black and Hispanic, have been disproportionately affected by COVID-19 [69–77] from the very early stages of the pandemic. A study of 1,000 children tested for SARS-CoV-2 showed that minority children had a higher probability of testing positive with non-Hispanic blacks being more than twice as likely and Hispanics being over six times as likely over non-Hispanic white children [78]. Socioeconomic differences can also come forth in the form of challenges in imposing shelter in place leading to the inability to effectively mitigate the spread of the disease [79, 80]. A study of COVID-19 outbreak in Wuhan in the first two months of 2020 focused on the effects of socioeconomic factors on the transmission patterns of the disease [81]. This study shows that cities with better socioeconomic resources that allows for better infrastructure and response were better able to contain the spread of the disease. An extensive study of the effects of a large set of socioeconomic conditions that affect the transmission of COVID-19 can be found in ref. [82]. This work studied the importance of various socioeconomic metrics and their correlations in determining disease spread. In Ref. [3], it was shown that the spread of COVID-19 was correlated to various socioeconomic metrics averaged at the county level during the initial stages of the pandemic. The authors of that work introduced the use of Shapley values within a machine learning framework to model how socioeconomic disparities affect the spread of the disease. However, Shapley values probe only the correlation between the endogenous and exogenous variables and do not provide a causal inference.

Reference [3] considers different regions of the United States to give a clear understanding of how different socioeconomic metrics affect the spread of COVID-19 in communities with different demographics. On the one hand, looking at differences across the entire nation provides a larger picture that can be important at the national level. On the other hand, there are significant differences in some important factors, and different characteristics may be emphasized when different regions are considered separately without these characteristics being lost to aggregation. For example, there are states which have a large average population density and this can drive the spread of infections in a manner different from the ones in which the population density is low. From Fig. 1, it can be seen that population density is the primary factor driving the spread of COVID-19 in East Coast states. The prevalence of the disease in dense urban areas has overshadowed its prevalence in rural areas of these states. However, this does not apply to states in the southern United States. Moreover, while high population density states were severely affected by the first wave of the pandemic, southern states were severely affected by the second wave. West coast states have been affected throughout the pandemic. We can see that the disease was prevalent in less densely populated areas. It is this variation that needs to be explored, focusing on different clusters of states in order to identify traits that are more important regionally.


Non-White
(% of Population)
Poverty Rate
(% of Population)
Unemployment Rate
(% of Population)
Mean Commute
(minutes)
Population Density
(per square km)
Senior Citizen
(% of Population)
COVID-19 Confirmed Cases 15th August 2020
(cases per 100,000)
COVID-19 Deaths 15th August 2020
(cases per 100,000)

◀**Fig. 1** Distribution of some socioeconomic metrics at the county level along with population density distribution. *Note* The two bottom panels show the COVID-19 confirmed cases and deaths per 100,000 individuals in each county, respectively up until 15th of August 2020. The lower and upper bounds are set by 10 percentile and 90 percentile of the distributions respectively. *Source* Plots made with the Highcharts Maps JavaScript library from Highcharts.com with a CC BY-NC 3.0 license

The regions are subdivided so as to have certain similarities in socioeconomic distribution within a region. The northeastern states have several urban areas in close proximity. However, urban areas are spread apart in the southern states, with a significant portion of the population living in rural areas where socioeconomic conditions differ from urban areas. On the other hand, the states on the west coast have a mixture of urban and rural areas, and their socioeconomic structures are very different. The three different regions used this study are:

- **High population density regions**: States with population density over 400 individuals per sq. km: District of Columbia, New Jersey, Rhode Island, Massachusetts, Connecticut, Maryland, Delaware, and New York
- **The southern states**: States in the south with the exception of Delaware and the District of Columbia which are already included in the previous category. The states included in this category are Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.
- **The west coast**: The three states along the west coast: California, Oregon, and Washington are included in this category.

The data used in this work is collected from three primary sources:

- The 2018 American Community Survey 5-years supplemental update to the 2011 Census found in the USA Census Bureau database for constructing the socioeconomic metrics.
- The population density data that reflects the 2019 estimates of the US Census Bureau.
- Data on COVID-19 prevalence and death rate is obtained from the Johns Hopkins University, Center for Systems Science and Engineering database through their GitHub repository [10].

The metrics that were used in this analysis can be motivated as follows. Population density and intra-population mobility are two factors considered a priori important to the spread of COVID-19. Mobility has to be studied indirectly, as the focus is on populations rather than individuals. The measure of mobility within a population can be considered as an aggregate measure of population age. On average, populations with a lower median age are more mobile than those with a much higher median age. Given that COVID-19 tends to affect older people preferentially, the fraction of the population that falls into the senior category [65 years and older] quantifies both

the mobility and the degree to which age plays a role in determining the spread of COVID-19.

To understand the relevance of economic conditions on the spread of COVID-19, we focus on metrics that quantify income, poverty, the fraction of the population that is employed, and the unemployment rate. The latter two are not perfectly correlated as the percentage of the population that is employable varies from county to county. To further explore the impact of mobility, the average commute time for each county and the percentage of the population that uses public transportation (transit) are used. Certain occupations are also known to put individuals at greater risk because they are exposed to a larger number of people. This includes those employed in service industries, construction, supply, labor, etc. increase. Therefore, a metric is used to quantify the proportion of the population working in these industries. Finally, the proportion of counties without health insurance is included as a metric to quantify how it affects the prevalence of disease. The list of socioeconomic metrics for each county that were used in this work are as follows:

- **Population density**: population density data taken from 2019
- **Non-white**: fraction of non-white population in any county including Hispanics and Latinos
- **Income**: income per capita as defined by the US Census Bureau
- **Poverty**: fraction of the population deemed as being below the poverty line
- **Unemployment**: unemployment rate as defined by the US Census Bureau
- **Uninsured**: fraction of the population that does not have health insurance
- **Employed**: fraction of the population that is employed
- **Labor**: fraction of the population working in construction, service, delivery, or production
- **Transit**: fraction of the population that takes the public transportation system or carpool excluding those who drive or work from home
- **Mean commute**: mean commute distance for a person living in a county in minutes
- **Senior citizen**: fraction of the population that is above 65 years of age

The total number of confirmed cases and deaths up until the 15th of August 2020 are considered for the data on COVID-19 prevalence and the following rates are defined:

- **Confirmed case rate**: The total number of confirmed cases per 100,000 individuals in any county.
- **Death rate:** The total number of deaths per 100,000 individuals in any county.
- **Fatality rate:** This is the naive fatality rate and is not adjusted for the delay between case confirmation and death. The rate is defined as the total number of deaths divided by the total number of confirmed cases in any county. The naive fatality rate is mostly uncorrelated with the socioeconomic metrics. The naive fatality rate represents the fraction of infected people that died after being infected

with COVID-19 and this seems to be mostly homogeneous and independent of the socioeconomic metrics and population density.

The primary conclusions from the study are:

- The spread of COVID-19 can be understood as an 'urban phenomenon' when the population density is very high. In this regard, large dense cities require special attention for the mitigation of the spread.
- In lower population densities areas such as suburban and rural areas, the spread of the disease is not governed by the population density of the region.
- Regions with a larger fraction of racial and ethnic minorities were affected the most. This is evident from the data and is a conclusion supported by several other studies. This is particularly true for the southern states while being less relevant for the states on the west coast. What this study proves in particular is that these disparities are manifested not only at the individual levels (as seen from the clinical data) but also at the regional level where aggregation of counties does not average out the effect. This points at the necessity for large scale intervention at regional levels to stop a differential spread of the disease.
- While, at an individual level, COVID-19 preferentially affects the elderly, the spread of the disease is dependent on human mobility within a region. This leads to an anti-correlation between the age of a population in a county and how easily the disease spreads as seen in both the southern states and in the west coast states. In other words, while the elderly are most affected by COVID-19, the disease spreads more easily in regions where the population is relatively younger.
- Fatality rates are mostly uncorrelated with socioeconomic metrics and population density. This implies that death due to COVID-19 amongst the infected population does not depend on the socioeconomic class.
- This spreading characteristics of COVID-19 does not show representative trends at the national level as the study including all the states considered in this work fails to highlight the different drivers in different regions. Hence, studies must be undertaken at regional levels.
- The results of the work should be taken as descriptive or, at best, prescriptive and by no means predictive about the spread of COVID-19 although some models do show quite high accuracy that can fall in the predictive regime.

It should be noted that certain subtleties in the data were not fully addressed in Ref. [3]. Data on confirmed cases and mortality were collected in the early stages of the pandemic. In the confirmed case rate, inadequate testing primarily affected the data. In this work, it was implicitly assumed that there were no testing biases correlated with the socioeconomic indicators we considered. People at higher risk of severe infections and those with more pronounced symptoms may be have been prioritized for testing, which is known to be correlated with age. Some bias is possible because of these conditions in this analysis. However, mortality is less susceptible to implicit bias from such correlations. This is because mortality is better captured and is not affected by variables such as testing strategy.

Understanding Causation

When trying to build a path to coherent policy decisions based on data, a causal analysis is indispensable and just a simple analysis of correlations is often insufficient. We get only a picture of the correlations and not of causation when using Shapley values to understand how a socioeconomic metric affects the spread of a disease. Hence, a mathematical structure that is better developed for causal analysis is required.

The framework for Causal Shapley values advocated by Heskes et al. [83] accounts for indirect effects in order to take the causal structure of the data into account when estimating Shapley values. The approach is based on the assumption of the impracticality of computing interventional probabilities to account for indirect effects and, instead, proposes a causal chain graph. A directed acyclic graph, as shown in Fig. 2, represents the (partial) causal ordering in the data as a causal chain graph. The causal ordering depends on a hypothesis of how the socioeconomic metrics form subgroups that are causally connected. Within a subgroup, the metrics are assumed to have no causal connection. However, they can be cyclically connected or share confounding variables. There are no fixed prescriptions for constructing these partial causal orderings. Therefore, domain knowledge has to be used to assume how the metrics affect each other in order to build causal orderings. We show three causal ordering in Fig. 2.

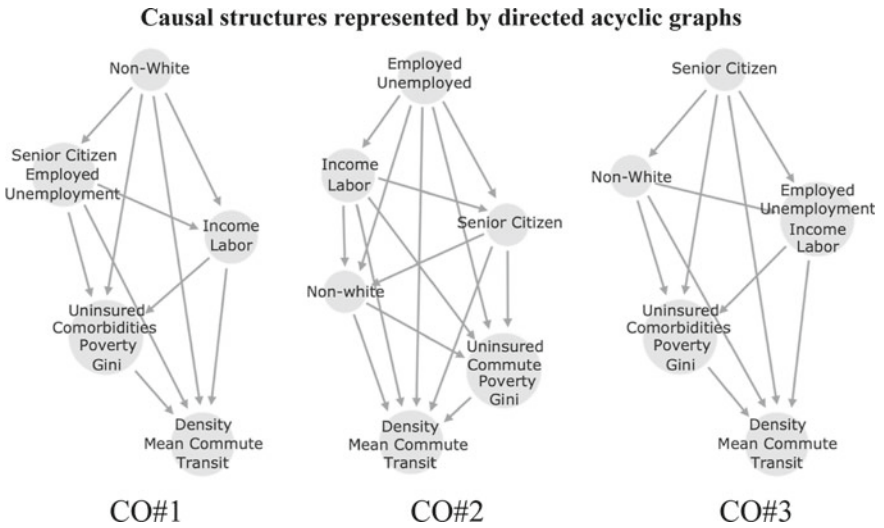


Fig. 2 Causal structures represented by directed acyclic graphs. *Note* The arrows indicate causal flow. The variables in each cluster marked with a gray circle are not causally connected between themselves. *Source* Compiled by the author

CO#1: The rationale for the first causal ordering is as follows.

- Areas with a higher fraction of non-white population tend to have higher unemployment rates and a lower fraction of employed workers [84].
- Areas with higher unemployment rates may have higher fraction of senior citizens if there is low economic mobility and younger generations move out of the area [85].
- Areas with higher unemployment and lower total employment tend to have more people working in construction, service, delivery, or production, or are rust belt areas that have a declining manufacturing industry [86, 87].
- Areas with higher unemployment tend to be poorer with the households having lower incomes [88].
- Areas with more senior citizens who are on Medicare or those with individuals having higher incomes who receive insurance from their employer tend to have less faction of uninsured individuals in the population [89, 90].
- Counties with higher average incomes tend to have more income inequality and a higher Gini index [91, 92].
- Areas with a higher percent of people working in construction, service, delivery, or production are likely to have more poverty [93].
- Counties with higher poverty levels are likely to have less single family homes and more areas zoned for multi-family homes or are likely to contain inner cities and thus have a greater population density [14, 15]. In such dense areas, there is likely to be shorter commutes and better transit due to these areas being more densely populated [16, 17].

CO#2: The second causal ordering, CO#2, has unemployment, employed, income per capita, and fraction working in manufacturing or manual labor as causing the proportion of senior citizens and non-white fraction of the population. This causal ordering takes into account the fact that senior citizens are more likely to stay in areas with a declining manufacturing industry and small economic mobility [85]. A higher fraction of senior citizens results in a lower proportion of non-whites since senior citizens are less likely to be non-white [94].

CO#3: The third causal ordering, CO#3, has the fraction of senior citizens causing the fraction of non-whites. Since senior citizens are less likely to be non-white, a higher fraction of senior citizens results in a lower fraction of non-whites [94]. This causal ordering also has income per capita, the fraction of people in a county working in professions classified as labor, unemployment, and employment on equal footing since manual labor jobs are less temporary and pay lower wages [95].

Using these causal structures the authors of Ref. [96] examine causal relationships between socioeconomic disparities and the spread of COVID-19 in the United States during two different phases of the pandemic. The first phase is from February 2020 to July 2020, and the second phase is from July 2020 to January 2021. These two stages define the early and late stages of the pandemic. They used demographic data collected by the U.S. Census Bureau and the COVID-19 prevalence data from Johns Hopkins University to fit a regression model using an interpretable machine learning

framework. By extracting causal Shapley scores from these regression models, inferences can be made about causal relationships between socioeconomic metrics and prevalence of COVID-19 at the county level. The primary conclusions of the analysis are:

- The effects of socioeconomic disparities on the spread of COVID-19 was more pronounced at the beginning of the pandemic than at the later stages.
- While in the more densely populated parts of the USA, the spread of COVID-19 was driven partially by the population density, socioeconomic metrics like the fraction of non-white population in a county also showed significant causal connection with the spread of the disease. In fact, population density was not causally connected to the spread of the disease in the west coast region.
- Of particular note is the relationship between the proportion of senior citizen in the county and the prevalence of disease in the West Coast and Southern states. An inverse correlation between Shapley scores and confirmed COVID-19 case rates meant that counties with younger populations experienced greater spread of the disease. Since it is known that the probability of COVID-19 infection increases drastically with age, the results imply that while the older fraction of the population were being differentially affected to a larger extent, the disease was being spread more widely by the younger and more mobile fraction of the population.

While stressing on the causal nature of various metrics, this works reaffirms what was discussed in Ref. [3] for the first phase of the pandemic. A major limitation of this work is that the machine learning framework requires sufficient data to model the underlying patterns, thus requiring aggregation across regions. Therefore, this state-level analysis cannot be replicated at county-level granularity. Also, the data is very noisy and falls into the "small data" regime, so machine learning models are not very accurate and cannot be used for prediction. The causal structure obtained from the analysis depends somewhat on hypotheses about the causal structure of exogenous variables. These causal structures are well motivated by prior knowledge, but contain a degree of subjectivity that influences the conclusions drawn from the results of the analysis. However, it was found that the degree of variance of the most important causes due to variation in causal plots is of lesser importance and can be used to draw robust conclusions.

Data in Developing Nations

Data-driven methods face special challenges in developing countries. Ironically, these are the nations that would most benefit from data-driven methods since a well-defined path from observation to policy-making is not usually present in these nations and the socioeconomic demographics can be rapidly changing in a manner that policies have to respond in shorter time frames. In this section we will try to emphasize on the importance of maintenance and accessibility of data in developing nations so

that they can be used to understand the progression of a health crisis and help in the structuring of mitigation policies.

The primary hurdle in developing nations is sourcing of skills necessary for processing and understanding data and the cost of maintaining the infrastructure that is necessary to make this a continued process. With limited resources available and, often, the necessary skills missing within the population, analysis of data within the oversight of a national governance is almost impossible even if data is collected coherently. One possible solution to this problem is the maintenance of open data that can be publicly accessed so as to appeal to a broader set of experts available domestically and globally who are willing to carry forward such analysis voluntarily.

The model of open data started in the developed world with the United States opening the data.gov portal to make data more accessible to the public. The Open-Data Barometer[2] reports indicate that as far back as 2016, 79 out of the 115 countries surveyed had a data portal run by a government agency but not all of them maintained similar quality or quantity of data. In several cases data was available through sources other than portals run by government agencies. A study of the most comprehensive databases available publicly showed that developed nations were far more comprehensive in making data available than the developing nations. In several instances, the datasets existed but were not publicly accessible and an estimate by OpenData Barometer showed this to be the case for almost 90% of the data.

According to the Open Data Charter[3] which advocates the maintenance of publicly available data by government agencies and private organizations so as to be able to respond to socioeconomic and environmental challenges more effectively, the following six principles should be followed by those agencies that wish to maintain open data:

- **Open by default**: All data collected by governments should be made open by default.
- **Timely and comprehensive**: All data must be kept up-to-date and complete.
- **Accessible and usable**: The data must be made publicly accessible, preferably in a machine-readable format, with little overhead and be clearly defined to be of maximal usability.
- **Comparable and interoperable**: Data standards and protocols must be adhered to ensure data quality and consistency.
- **For improved governance and citizen engagement**: The data should allow for transparency in governance and should also allow for its citizens to be able to use data for accountability.
- **For inclusive development and innovation**: The data made available should be used to promote inclusion of minorities and encourage studies that reduce socioeconomic disparities. These studies can also be used for entrepreneurial efforts and to drive innovations which contribute to the general upliftment of the society.

[2] https://opendatabarometer.org.

[3] https://opendatacharter.net.

As discussed earlier in the chapter, to understand how and why disparities get aggravated during a health crisis and to identify their existence, a lot more data than just disease prevalence data is needed. Collecting such data must fall into the long-term goals of any government with special care taken to make the data capable of addressing marginalized groups by providing higher granularity data disaggregated by sex, income level, age, religion, etc. Such data can not only help in the times of crises, but can also be instrumental in understanding how health disparities affect different strata of society [97, 98].

There are clear reasons why the cost of maintaining open data is justifiable for developing nations. The availability of data encourages studies by academic institutions, independent parties, and private organizations and can lead to insights about pockets of needs in the society which, in turn, can drive policy-making in local and national governments. For instance, due to the availability of data in the USA, the UK, and several countries in the European Union like Germany, France, Belgium, etc. a comprehensive study of the progression of the pandemic could be undertaken which drove several policy decisions with short response times. Such data-driven policy decisions were not possible in countries like India where data was not made readily available during the onset of the pandemic. Indeed, a recent estimation of excess mortality [99] shows that the actual mortality rate in India is more than a factor of 8 higher than the reported rate. This is in contrast with the excess mortality rate being a factor of less than 2 higher than the reported rate for most of the developed nations with some exceptions. This trend is seen in several developing nations pointing to the fact that the pandemic was under monitored and the data delivered by the government was faulty.

Another clear example of data-driven methods aiding predictions of COVID-19 case rates and hospitalizations lies in individual based models (IBM) created for the population of Australia and the UK separately [35–38]. IBMs are agent-based models with each agent representing an individual in a population with the number of agents being representative of the population as a whole. The design of these IBMs requires a complete knowledge of the demographics and mobility of the population which was openly available for both the countries prompting academics to put in effort into build the IBMs. The predictive power of these IBMs is extremely good often extending to several weeks into the future and these models allow for modeling of intervention measures adding to the accuracy of the predictions. The importance of these predictions and the role of open data in making these predictions possible cannot be overemphasized.

Data Ethics

A discussion of data-driven methods is incomplete without a discussion of data ethics surrounding the data that is being used. This is of particular importance when it concerns health data and decisions that can possibly affect human subjects. Moreover, COVID-19 being a global pandemic, the sheer scale of decisions and the number

of lives that can be affected by the analysis of data is quite imposing. A long list of applications of data derived both in real-time and of historical nature was proposed by several national and private institutions and was, in some cases, used for surveillance of the citizens or to make decisions on who can have the privilege of mobility while others be quarantined. Basing decisions of such gravity requires that the entire decision-making process, including the data that a decision might be derived from should be subject to strict ethical standards and there should be a clear understanding of the source, structure, and implications of the data being used.

The fears of the nationwide government sponsored surveillance were ignited even in the USA and in the European nations with the proposal of voluntary automated contact tracing [34, 100–102]. Even in Germany, where the acceptance of the "Corona-Warn" app was one of the highest in Europe, several psychological factors stacked up against its population wide acceptance [103]. Without large acceptance, voluntary automated contact tracing was bound to fail [3]. In India the uptake of the contact tracing app was about 13% only leading to its complete failure [103]. This proves how clearly defining the bounds of ethics in collecting and distributing data, be it centralized or decentralized, is of prime importance if a digital decision instrument driven by data is to be considered for population wide distribution.

The implementation of data ethics should begin at the initiation of the design of any analysis. Even the choice of data and the design of the analysis can lead to conclusions that are possibly unethical when taking fairness and equity into consideration. Often the choice of variables is limited by the analysis and the scope of data discovery leading to biases in the data and an oversimplification of the conclusions that can be drawn from the analysis [48]. The design of a study is further complicated when addressing studies related to minorities in the population. Beyond the potential hurdle of having insufficient data, or an elevated hesitance to participate in studies seen amongst the minorities population, the dangers of misjudged conclusions adversely affecting the already vulnerable part of the population, or the danger of affecting them in the process of collecting the data) is a risk that should be assessed with great care [104–106].

Given the nature of this fallibility of data, methods that are primarily data driven inherit the biases that might exist in the data leading to an inevitable lack of fairness and equity in the decisions that are made using these methods. All data-driven analyses, however explainable they might be, required intervention to ascertain whether any biases have percolated from the data to the decision. Moreover, as the complexity of the analysis increases, the trust in the methods used decreases due to a lack of apparent transparency and explainability of the methods used due either to their mathematical complexity or the disconnect between the structure of the model and the variables as in a neural network. This invariably leads to a lack of trust in the decisions made by what is perceived as a 'black-box'. In the recent past, questioning biases in machine learning methods and implementing a path to fairness has become a subject matter of research in a rapidly growing community [107]. Nowhere is this more important that in the domain of public health and healthcare. Hence, policy decisions, guidelines, and mandates should be set to ascertain that AI algorithms and models are built with fairness and equity as they are used as guiding principles.

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The Long Shadow of COVID-19

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Abstract The sudden arrival of COVID-19 shook the world and evoked varied—sometimes contradictory—reactions from communities, countries, and institutions around the world. The pandemic brought out the best and worst of humanity even as the complex play of factors underpinning the spread of the coronavirus collided in myriad ways to both facilitate and obstruct effective responses. The experience has generated much angst and questions about the way we are organized and relate to each other. And, most of all, it has the potential to reshape our fundamental premises. The effects will be profound going well beyond the pandemic itself to the notions of collective health as a common global good.

If a denizen of outer space had been reading the trillions of signals related to COVID-19 flying around Planet Earth, it would have been alarmed at our imminent demise. But we are still here and this is not the first time that an infectious agent has caused such turmoil.

Our Fate is Intertwined with that of Microbes

In human history, pestilences have wiped out more lives than famine and violence [1]. And the cost of infectious diseases is somewhere between staggering and incalculable: around USD 8 trillion and 156 million life-years lost in 2016 alone [2].

Our own generation has seen HIV, Ebola, MERS, Zika, and swine flu, to name the well-known ones, apart from influenza which comes around every cold season. Our history is also replete with past pandemics and epidemics including smallpox,

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bubonic plague, and cholera as well as the likes of malaria and tuberculosis that continue to extract huge tolls. We now face the pandemic of antimicrobial resistance—a much greater and more pervasive threat to global health that is not amenable to simple public health tools and tactics [3].

How Bad is COVID-19?

Depending on the school of public health to which you subscribe, COVID-19 is either just a passing scare or humanity's biggest challenge. And the world's political leaders either follow science, or get their wisdom from social media feeds. So where does COVID-19 rank in the global rankings of disease catastrophes?

In its first two years, the pandemic took more than five million lives but by including other indirectly-caused deaths, the excess mortality was around 10 million [4]. To put that in context, some 120 million people died from all causes over the same period [5]. Thus, COVID-19-related deaths are not insignificant but, in the population-wide demographic sense, a blip. Although several countries had modest declines in life expectancy in 2020, they were already recovering in 2021 thanks to increased immunity after infection or vaccination, as well as more effective treatments [6].

A more serious picture emerges if the metric of prematurely lost lives is used. On that basis, over 20.5 million years of life had been lost globally by January 2021 [7]. Each one was a personal tragedy, regardless of the fact that around 80–90% of deaths were in much older people with very few life years left to them [8]. But equally significant are the many millions of disability-adjusted life years lost from poorly understood long-term physical and psychological symptoms that afflict perhaps half of all COVID-19 survivors [9]. This has been dubbed as long COVID [10].

When will the Global Pandemic Finish?

The pandemic will not be over until over 90% of the world is either vaccinated or has acquired immunity through natural infection [11]. That is because the dynamics of the spread of SARS-COV-2 mean that unvaccinated vulnerable people are not protected from acquiring the coronavirus by the mass of vaccinated people. In other words, herd immunity is not possible.

Achieving near universal vaccination is a tall order, as we know from endeavors with childhood and other vaccinations. It is not going to happen in the next year or two despite targets set by the World Health Organization, COVAX, and promises by world leaders.

In addition, the current generation of newly invented vaccines does not have 100% efficacy. They also have a short immunity duration. So, booster and repeat vaccinations are going to be needed. Meanwhile, vaccination programs must also

plan to include future generations, with the age of first vaccination trending toward younger and younger cohorts. Further, like all other living organisms, the coronavirus will continue to mutate. The arrival of the highly contagious Omicron variant at the end of 2021, just as the world was getting to live with the previous Delta strain, has created more uncertainty. Will COVID-19 become more dangerous or, based on the experience of some other pathogens, less so? Probably the latter, but that will take much more time and, meanwhile, it is highly risky to bet everything on that.

Meanwhile, vaccine-makers have continued their efforts to improve current efficacy. But they will always be one step behind the virus. That is because it takes time to determine the significance of new variants and sequence their genome, especially in developing countries with limited surveillance and sequencing capacities where a large population of non-vaccinated people is more likely to generate variants. It then takes many weeks to re-engineer existing vaccines, manufacture them at scale, and distribute them around the world.

It is more encouraging that a number of treatments are coming along to reduce COVID-19 mortality and morbidity. These range from the re-purposing of existing drugs to the creation of brand-new molecules [12]. There is also some indication that some may be used prophylactically to ward off severe illness in case of coronavirus infection. This is somewhat comparable to prophylaxis against AIDS given to people with HIV infection. Further to that, perhaps pre-exposure prophylaxis may become possible to be taken by people who are unable to avoid entering high-risk environments such as crowded places. There is a parallel here between prophylaxis against malaria and among high-risk sexual behavior groups wanting to avoid HIV. However, on the flip side, widespread use of such drugs will inevitably lead to resistance and new molecules will need to be engineered.

Therefore, is the glass half-full or half-empty when it comes to future prospects? Optimistic and pessimistic views abound in equal measure, saying more about the personality of the commentator than the known science. The more hopeful view is that, in time—perhaps over the next five years—COVID-19 will become a largely preventable and treatable condition. Meanwhile, new social norms of distancing and masking have contributed a great deal to the reduction of virus spread. These self-protection measures will regress when legal mandates are withdrawn. But many of the habits will get internalized to a significant level, as part of a new culture of preventive hygiene.

The link between coronavirus infection and hospitalization and death has been weakened. Nevertheless, some people will continue to die from COVID-19 because of their extra vulnerability combined with vaccine hesitancy or failure. Society will have to accept this, as we accept many other causes of disease and death—even when they are preventable.

This pandemic is more likely to fizzle out progressively, rather than to exit with a big bang. Declaring pandemics over is not an exact science as they are also a social construct decided by populations and politicians when they feel they can live with a certain level of continuing morbidity and mortality. So, we will know when this pandemic is over not just when WHO says so, but when the composition of our media feeds trends away.

In time, as other microbes create outbreaks and epidemics or even pandemics, COVID-19 will take its place in public health history—and enter the annals of a great collective mythology. We will write and talk about it in the way we do now about the Great Flu Pandemic of a century ago [13].

Best of Times and Worst of Times

The words of Charles Dickens in A Tale of Two Cities are apt for the age of COVID-19: "It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of light, it was the season of darkness, it was the spring of hope, it was the winter of despair" [14].

This encapsulates the opportunities and contradictions that accompanied the pandemic and is bringing out the best and the worst of our life and relations, from personal to global. Of course, this is true of all mega crises which are often necessary to shake us out of our daily complacencies by stirring our senses and sensibilities [15]. We also rationalize our fears by constructing complex causality to explain over-whelming or peculiar phenomena.

But is COVID-19 the game-changer that the accompanying hype suggested? Assessing that involves acres of commentary from which mountains of lessons must be extracted. Punching 'lessons from COVID' into Google throws up billions of results. These extensive narratives consolidate around a few key themes.

Toward Co-existence with the Coronavirus

Have certain public health approaches and political choices derived there from affected the differing pandemic trajectory for particular countries? Strategies have varied from the zero-tolerance policies and rigid lockdowns of China, Australia, and New Zealand, to the less strict approach in various European countries, including the permissive Swedish way.

Most other countries in Africa, Asia, and the Americas fall somewhere within this spectrum of national policy choices. They titrated their levels of restrictions and controls to what their publics would tolerate and perceptions around reported or measured incidence.

Staying ignorant has also been a strategy. It is the default for many conflicts affected countries such as Syria and Yemen that have limited capacities to test, track, and manage infection. Enhanced ignorance, i.e., downright denial has been the preference of authoritarian states such as North Korea. Finally, there has been the path of doing as little as possible for as long as possible, as in Brazil.

The jury remains out on which strategy will eventually prove to have been the most effective in terms of health outcomes. This is for a number of reasons. First, the

evidence is tainted as different countries have different standards around case definitions, validation, and comprehensiveness of data collection and reporting. Second, the almost infinite variety of the mix-and-match approaches taken by different countries mean that their experiences are quite difficult to compare with consistency. Third, the underlying demographic and vulnerabilities of populations at risk are highly variable, encompassing as they do, different population age structures, and social and behavioral risk factors. Fourth, public health and clinical care capacities and protocols, as well as health system resilience have been variable based significantly on the development status of countries.

While broad global patterns can be detected, it is the subtle differences between nations that are often most enlightening in terms of cause-and-effect conclusions. These have not been studied so well.

Meanwhile, the pandemic's epidemiology has been progressing toward convergence at different rates through different waves of the coronavirus and restrictions to counter them. There is a high probability that, over a relatively short while, prevalence and incidence will ultimately equilibrate toward a generally similar magnitude across the globe. This will be regardless of who got first to the vaccination party or how severe and prolonged were the lockdowns. The arrival of new variants such as Omicron—and future ones yet to emerge—will also 'level the field' for all countries, if previously acquired immunity from vaccination or infection is not sufficiently protective.

Tolerating Inequality

While COVID-19 has affected all socio-economic groups, it has not afflicted everyone equally. Those who were older and had underlying chronic conditions such as diabetes, cardiovascular, and lung conditions fell away in greater numbers. The prevalence of such non-communicable diseases is greater in poorer people everywhere. In Western nations, this included Black and Asian ethnic minority groups. Elsewhere, they included undernourished, crowded, environmentally polluted communities with limited access to adequate means to practice hygiene and physical distancing.

Thus, it appears that the coronavirus unerringly found the fault lines in society. But this is nothing unusual as most diseases afflict the poor and disadvantaged ahead of others. The inequalities persisted and deepened into the prevention and treatment phases as the COVID-19 saga progressed. The poor—in every continent—were much more impoverished by draconian lockdown measures that meant the loss of employment, especially of the more precarious casual type that the poorest depended on.

That has meant that COVID-19 healthcare-related costs pushed millions of people into deeper poverty on top of the half billion that were already impoverished pre-pandemic because they were paying at least 10% of their income on meeting their basic healthcare needs [16]. The dream of universal health coverage has been set

back at least two decades [17]. But quite a lot of this will have been due not to the direct effects of the virus but restrictions that policy-makers hastily imposed, stopping people from accessing routine healthcare.

Meanwhile, the rich saved money and added to their capital stock. Entrepreneurs with disposable wealth could invest rapidly in biomedical industries related to COVID-19 be it in the manufacturing of personal protective equipment (PPE) kits or in companies making vaccines, medicines, and test kits. Many profiteered from supply shortages and bottlenecks that also pushed up prices [18]. In contrast, poor people—in slums in Africa or refugees everywhere— struggled to access sufficient soap and water to maintain personal hygiene. It is unsurprising that income and wealth inequalities increased sharply and significantly over the first two years of the pandemic [19].

Learning to live with this coronavirus implies, therefore, having to accept the differing fates of rich and poor communities. Therefore, 'long COVID' has another meaning in terms of drawn-out worldwide economic and social impacts. Measuring the direct and indirect global financial losses from the coronavirus is inherently difficult, not least because life and other losses are valued differently in an unequal world. Nevertheless, a rough and ready global estimate suggests a price tag of USD 3.4 trillion annually without universal vaccination. The cost is still in the billions as vaccination proceeds [20].

It is uncomfortably true that while some countries will quickly co-exist with the virus, others will continue to die for longer, as waves of the pandemic strike against their fragile public health and medical defenses.

From an economic perspective, it makes sense—harsh as that may sound—to vaccinate the rich first because they are worth more, and therefore, have more to lose. Also, their recovery is essential so that they can get back to traveling, purchasing goods and services, and investing to drive the recovery of the rest of society.

The slogan that 'no one is safe until all are safe' is true in public health terms but strictly speaking, not fully so, in economic terms. Of course, that is unfair but unavoidable, at least in the medium term until more effective and acceptable resource-sharing dispensations have been negotiated across and between our diverse nations.

The world was unequal before the pandemic came along and indications are that it will be even more so—afterwards. It is unrealistic to expect the coronavirus response to trigger some massive re-set in hearts and minds, however desirable that is in terms of the ideals around the sort of world most decent people want to live in. Many think that the pandemic shock will be a moral and practical stimulus to make a fairer world. But indications to date are that that may be a task too far for the pandemic response and recovery strategies that have come into play.

Our Private Angst

Public health, for all its other wider population characteristics, is still made up of and measured by the sum total of the health of individuals. Ultimately, we fight all ailments, one person at a time. Thus, the person cannot be glossed over or subsumed into an amorphous and impersonal collective. Particularly noteworthy, therefore, are the personal emotions, attitudes, and behaviors evoked by this pandemic. When our lives are upended on a massive scale, it is normal to seek personal sense from shock. Perhaps a special, even spiritual private message amidst the general damage and disruption? Perhaps a hope for something good for us emerging from a terrible disaster?

These sentiments may lead to bargaining with the gods of our misfortunes who need to be pacified by making all sorts of pledges. So, in return for being spared by the virus, we may promise to live more wisely and behave decently toward others. Or, depending on our own underlying personality traits, our lived or observed experiences will have confirmed that the world is nasty and brutish. And some of us may even get self-satisfaction from confirming that we are right to be skeptical or cynical about everything. Our disparate feelings are often powered by the mistrust that we perceive to have grown everywhere, stimulated by a combination of factors.

Alongside matters of life and death, the loss of our most cherished liberties on public health grounds brings existentialist questions to the fore. That means confronting human vulnerability, fragility, and uncertainty. The notion of eternal progress in our affairs has been upended. As our best laid plans made with the greatest circumspection, to travel or make business, for example, come adrift time and time again, often at short notice through dictates from authorities, we are left to ponder: are we really in control of our own destinies?

The more introspective personalities may even start asking basic questions about our own place and contribution to the universe. We may start questioning the worth of our own achievements and the nature of our relationships. It is then but a short step to questioning the meaning of life, and whether it is worth living. It is unsurprising that mental health dysfunctions have abounded in all cultures and societies [21].

These have been manifested in many different ways including increased depression and suicide, as well as domestic abuse and violence that have disrupted many families. Loneliness became a pandemic in its own right as many people died in hospitals without being allowed the comfort of their loved ones around them. On the other end, mothers gave birth without their partners and relatives in attendance. In between, numerous people were incarcerated in care homes, many uncomprehending because of dementia. They were reduced to looking at their loved ones through windows and computer screens.

When the physical act of expressing comfort and compassion is prohibited during peoples' hours of greatest need, it is unsurprising that the world, as a whole, feels as if it is suffering from a post-traumatic stress syndrome. This is quite difficult to treat and may have long-term intergenerational impacts.

Our Muddled World

The coronavirus has behaved like a complex jigsaw where all the pieces are thrown up at the same time and, while certain pieces are missing, we don't know which ones without trying to first order the picture.

To start with, science itself has struggled to understand the virus and its implications. While a lot got known in a short time, this was not sufficient or fast enough to satisfy the hunger for information and understanding around the world, at a moment in history when we expect science to provide instant and clear answers. Instead, we have seen nuanced and publicly-debated answers with probability estimates attached that are difficult for the statistically illiterate publics and politicians to comprehend.

A classic illustration of the 'evolving science' problem was an early technical argument over the utility of facemasks. Do they protect the user more than the person in front of them? This mattered because it highlighted the selflessness/selfishness tensions that run through all COVID-19 narratives. It was not helped by other messages asking people to use lower standard and home-made masks, so as to preserve limited stocks of surgical masks for clinical workers. The justification that risks are higher for doctors and nurses tending to sick people than the rest of us was lost as the world panicked. The debate got further snarled up in cultural wars, as the masking idea came from Far Eastern societies where it was more traditional even in pre-COVID times, and ridiculed as such by Western societies.

There were other charged debates around wholescale and long-lasting border closures which public health experience over centuries has shown as being of limited utility against disease spread. Subsequently, the realization that heavily pushed two dose vaccinations are not going to be enough and boosters—perhaps frequently— are needed has challenged people's acceptance.

Meanwhile, confidence in scientists and leading institutions such as the World Health Organization (WHO) also took a knock. The worldwide scientific debate around the clues revealing the origins and spread of the coronavirus was hampered by China's hesitancy in sharing all data in a timely manner. Meanwhile, the public and media wanted clear answers and were otherwise untrained in the nuances and interpretations of incomplete and inconsistent data.

They also did not understand that WHO is always bound to be late in issuing its definitive guidance to the world, because the high-quality evidence on which universal action can be recommended takes a long time to accumulate, apart from the time-consuming process to get its diverse range of global experts to agree on a common position. But national health authorities could not wait. Hence, WHO's well chewed guidance on a range of issues, although proved correct over time, was often ignored or adapted, leading to a plethora of different national health policies. That was not aided by the politicization of international health cooperation as COVID-19 became a heavily contested geo-strategic issue.

All these factors have played out in real time to sow confusion and skepticism in public minds. These were then magnified by social media algorithms that shaped the misrepresentations and fake news that spread across a hyper-connected world.

These have undoubtedly contributed to the high prevalence of vaccine hesitancy in all societies and fueled battles between the skeptical publics and concerned public health authorities.

The argument has not been limited to the health sector. As COVID-19 collided with the simultaneous climate crisis, we have been forced to grip the new notion of 'one health', i.e., the interconnectedness of human, animal, plant, and planetary health [22].

But we are not good at dealing with interconnected challenges. And so, we have tended to rationalize COVID-19 by externalizing and rendering abstract our own personal sense of the losses and traumas suffered. Perversely, we have sought comfort by blaming others for our travails—be they failing leaders, institutions, or foreign countries. Thus, we blamed uncontrolled *environmental change* for boosting zoonotic transmission and over-crowded *urbanization* for magnifying vulnerabilities. Chinese *authoritarianism* was pilloried for the original unleashing of the coronavirus and cheap *world travel* for its rapid spread. Rampant *capitalism* was accused for the pandemic's obscenely unequal impacts and the *food industry* for making us fat and vulnerable to the virus's complications. *Social media* was charged with spreading mischief and misinformation. Unchecked *globalization* was arraigned for hollowing out nations who can't produce their own paracetamol or PPE, profiteering *pharma* for not making enough affordable vaccines for everyone, and *geopolitics* for styming multilateral cooperation.

Mood Swings

COVID-19 has also messed up our feelings. The global mood has swung between self-flagellation at our perceived sins of commission and omission, and self-pride that comes from battling with and mastering the pandemic.

Images of desperately sick patients gasping for breath went viral on social media around the world. As well as videos of people plugged into tubes and machines of all types. Their suffering was pitied as well as admired. And if they survived, their resilience was applauded.

We also applauded health workers battling against the odds. We were shocked to see photos of doctors and nurses emerging after long hours on duty with deep rings under their eyes. We marveled at social workers caring for the most vulnerable. And humanitarians helping isolated or forgotten people. The kindness business has, indeed, thrived as countless neighborhood and community schemes emerged to bring succor to the housebound [23]. This appealed to the better angels of our nature because 'we are in it together', and urged to show solidarity. To be altruistic after the initial panic triggered by the rapid spread of the virus, the world marveled at the speed with which the coronavirus was identified, sequenced, and vaccines invented. Also, how quickly treatments improved. All within little more than eighteen months. In some senses, we succumbed to the narrative on how clever we are, how innovative,

and ingenious [24]. Many key scientists who were responsible for the breakthroughs became superstars. No doubt, some will get Nobel Prizes.

While regretting the many tragic losses of lives and livelihoods, perhaps we regretted even more the passing of an old 'normal' which will never return. Gone was the easy world where we could kiss and shake hands without second thoughts, or pack our bag to go anywhere at a moment's notice, without tests, vaccinations, and passes. Even a trip to a restaurant or shopping mall became a major pre-planned logistic exercise.

We also grieved for lost freedoms that we took for granted, even as despots around the world rejoiced in the legitimacy that the coronavirus has provided to curb basic liberties, in the name of public health. In our heart of hearts, we know that those freedoms will never be fully reclaimed. We also fear that with the next pandemic caused by some other weird bug, the precedents that have now been established are likely to be used to justify further restrictions on human rights, in a world that is, anyway, trending toward authoritarianism, even in the more democratic states.

But also astonishing has been the overturning of policy orthodoxies. This was when governments and international financial institutions overturned economic orthodoxy to print trillions of dollars to prop up businesses and expand social safety nets [25]. We marveled at the many adaptations that companies, communities, and families made to carry on as best as they can—be it home schooling or zoom connecting. It seemed that we are astonished at our own adaptive resourcefulness [26]. That included our willingness to tolerate lockdowns and other extraordinary limitations to basic freedoms, even though many grumbled and protested.

Future Hopes and Dreams

The virus also goaded us to improve the way we live. To better organize our health and social systems so as to avoid or deal better with future disasters. Even a new international Pandemic Treaty has been proposed to tackle COVID-19's successors although we are not too good at honoring numerous other existing agreements such as the recently strengthened International Health Regulations [27, 28].

Becoming wise with hindsight also became a thriving industry. There were several sub-texts. One was the launching of investigations into the origin, cause, and mishandling of the pandemic [29]. Another was on forecasting the future. These may help to defuse criticism of present difficulties by time traveling to a safely forgettable past, or to a safely distant 'build back better' future [30].

Often these analyses have had a comparative aspect. They looked at the relative performance of cultures, governance systems, and institutions. As there is always someone worse than us, this helps to shift blame. Another way to divert us from current realities is to invoke distal influences that are so broadly cast as to render real-time decision-makers unaccountable.

There has also been prolific *punditry* around the post-pandemic world. Most projections envisage a digital takeover of life, even as large elements of distancing

continue in our minds and hearts [31]. The emerging world may be a somewhat colder, more robotic place. It may also be much more fearful and cautious as we await the next pandemic or climate disaster. Thus, one enduring legacy of the coronavirus may be our permanently altered perception of risk [32]. Public policies and private practices will default to more risk-averse attitudes. Could the precautionary principle take all the joy out of living?

Damaged Values

The contradictions exposed by COVID-19 cast a dark show on our core values around health. This will persist long after the pandemic is over. The consequences may be pervasive and profound. To unpack that concern, we need to go back to the beginnings of our global health journey.

For millennia and across all cultures, health has been perceived as an inherent good, i.e., its pursuit was seen as desirable in itself. This got codified as the 'right to health' in the 1948 Universal Declaration of Human Rights and subsequent international laws and covenants [33]. At the same time, the essence of the Hippocratic Oath, dating from 500–300 BCE was universally incorporated in every healthcare system [34].

In the modern era of biomedical ethics, these concepts got summarized into four basic moral principles: autonomy, beneficence, non-maleficence, and justice. Or put another way: healers must respect the individual patient's rights and choices, act in their best interests, do no harm, and be fair in distributing limited healthcare resources to do the best for most people. In time, as globalization evolved, these orientations stimulated the noble notion of 'health for all'—whether our neighbor or a distant stranger. Nowadays, this is called Universal Health Coverage that, over the course of repeated tellings, has become a holy grail [35].

Therefore, it is particularly striking to observe how national and international responses to the pandemic have unwittingly served to largely violate these historical precepts. The 'autonomy' of people was ridden over roughshod by draconian lockdowns and, later on, increasingly coercive attitudes toward vaccination while, simultaneously, restricting the rights of people unwilling to get vaccinated. Favoring the 'beneficence' of reduced negative health impacts of COVID-19 came at the cost of 'maleficence' toward those who suffered greater mortality and morbidity from other conditions—such as tuberculosis and cancer to name just a couple—that were deliberately neglected as service priorities shifted. Whatever the public health justifications, whether pandemic responses have been 'just' is debatable, depending on the perspectives of the winners and losers of this lottery of life and death.

Hence, the notion of health which was an instinctively unifying sentiment for millennia, became a deliberately politicized and highly divisive issue, during this pandemic. This has inevitably led to a wider erosion of the values and principles underpinning international cooperation in this sector. The specialty of global public health is traditionally projected as a moral mission to do the greatest good for the

greatest number of people with priority given to the poorest and most vulnerable. Which reasonable person can disagree with this, not least as it appeals to our own self-image of decency? But COVID-19 has tainted the humanitarian impulse of selflessness with the virus of calculated self-interest. We have been told to wash hands and wear masks to protect our own selves, even as we do this to also protect our loved ones. For most people who do not have advanced saintly attributes, this gets translated into securing your own good first, with the protection of others as a happy side benefit [36].

That is why solidarity messaging around COVID-19 has often fallen in a semi-deaf no man's land, exemplified well by the struggles of the COVAX facility to get enough vaccines to poorer countries or exhortations to pharma to share their intellectual knowhow to scale-up vaccine manufacturing [36, 37]. Also by the debate on border closures and travel restrictions that has been a hallmark of COVID-19 response. We have long realized that diseases don't stop at the front door or national frontier, even if their entry gets delayed for a short period of time. Therefore, to ensure our own safety, conventional public health policy usually required exerting much greater effort in securing the safety of others, rather than in locking yourself in and locking out all others. But this has been trumped by the coronavirus.

In olden days, when health was a matter of individual chance or, at best, an uncertain partnership with one's healer or god, selflessness predominated. Perhaps that was seen as akin to a 'spiritual vaccine' that earned us some heavenly points. That was prudent insurance at a time when the chances of dying from all sorts of diseases were very high. But with tumbling mortality rates came the possibility of longer, healthier lives; doing good to others became optional.

At the same time, a broader backdrop of change has been occurring in the health sector. Our progressive technocratic world has required greater institutionalization of the health notion and its incorporation into domestic and global economies. With that came an increasing array of health professionals, bureaucrats, plans, strategies, objectives, budgets, and metrics. Thus emerged the modern organizational set-up, whether under health ministries in the public sector or as corporate businesses. In either case, all institutions are rationally incentivized to serve their own set missions, i.e., their behavior is geared toward self-interest even if they are composed of many selfless individuals. Perhaps that is why we see so much COVID-19 nationalism in relation to border restrictions and vaccine hoarding: national health missions must do what they are obliged to do: look after their own first.

As health became more and more of an institutionalized business, nations were encouraged by the global multilateral enterprise to compete on the Millennium Development Goals and now, Sustainable Development Goals [38, 39]. These paradigms see health as an outcome, but even more, as input toward creating stronger nations. That necessitates the further instrumentalization of health. For example, health expenditure is required to be justified by demonstrating a return in terms of more productive societies [40].

Therefore, slowly but steadily, health has come to be visualized, no longer, as an intrinsic good that is to be enjoyed for its own sake. Instead, it has become an input to a process that must generate wider economic benefits. For example, better

maternal and child health services mean healthier babies (intrinsic good) who grow up to be strong workers (instrumentalized good). A similar calculation is implicit in COVID-19 responses.

Ultimately, if healthy and strong workers are seen to make strong nations, it is then but a short step for policy-makers to postulate health as a strategic security concern that is legitimate fodder for geo-political rivalry. Also, when a disease breaks out and spreads widely, the country that recovers faster gets an advantage over others. The pandemic has provided the perfect case study for such rivalry among nations.

It explains why the global COVID-19 response has been marked by so much contention and acrimony right from the very beginning. Which country is to be blamed for the origins of the virus? The coronavirus has driven us apart and not brought us together because the underlying health moral base has been instrumentalized and securitized. COVID-19 did not cause this. It has simply accentuated the trajectory we were already embarked upon.

On this analysis, what does the post-COVID future hold for global health? The positive aspect of a securitized health field is more investment in medical science, discovery, and invention, including via the fields of artificial intelligence, health surveillance, and big data collection and analytics [41–44].

The negative aspect is that these are the same security-related technologies that can infringe basic human rights and liberties, make wars more effective and efficient, hollow out democracies, and keep autocrats permanently entrenched [45–47].

Whether good or bad, our health is now a matter of national security, and all of us are conscripted as soldiers. We are duty bound to be healthy so as to be strong. Just in case we are required to compete more fiercely—even fight—others.

So, there is indeed a 'long COVID' syndrome that is not just the many months of persistent viral symptoms that millions suffer from. It is a permanent shift in our previous benign and uncritical notions around our personal and collective health. This will never be the same again.

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COVID-19 Vaccination: A Necessitated Drive Becoming an Unsolved Puzzle

Drishya Pathak

Abstract The scientific community has achieved a remarkable feat by developing COVID-19 vaccines in a record duration of 12 months. The fastest vaccine developed and deployed previously was within a time-frame of four years, to prevent mumps in the 1960s. The speedy approach to prevent SARS-CoV-2 has changed the future of vaccine science with several vaccines showing excellent results in large trials. The COVID-19 vaccination strategy is of crucial importance for controlling the pandemic. As the vaccination mandate was faster than information dissemination, and even faster than the clinical trial results in some regions, numerous challenges emerged during the implementation of the vaccination strategy. The author discusses the objectives of the vaccination drive that include: reduction of overall COVID-19 severity and mortality; re-opening of society; disease elimination; reduction of pressure on the healthcare system; and equitable distribution of vaccines across all regions of the globe. While reflecting on these objectives, the author discusses the importance of transparency in vaccination surveillance data and the way forward.

Background

As of March 28, 2022, 6.12 million confirmed deaths and 484 million confirmed cases of infection with SARS-CoV-2, the virus causing COVID-19, were reported globally [1]. When the World Health Organization (WHO) declared COVID-19 as a pandemic on March 11, 2020, the entire world went into a panic trying to figure out possible strategies to adopt in order to control the spread of COVID-19. During the last 20 months, we have come a long way. State administrations have been busy strategizing pre-emptive measures to control the rapidly spreading pandemic

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including lockdowns and strengthening the healthcare system. International organizations have framed directive steps for countries to follow. At the same time, scientists all over the world have been busy developing vaccines and therapeutics. Scientists have spent the past year developing vaccines and ensuring their safety and effectiveness. On December 3, 2020, the first ever COVID-19 vaccine, AstraZeneca, was approved by the United Kingdom. And on December 31, 2020, WHO approved the first vaccine, the Pfizer vaccine. To date, WHO has approved ten vaccines. And many are in the pipeline [2].

Although scientists have successfully developed vaccines, making them available to people has been an immense challenge. Vaccine deployment required resources, large manufacturing plants, and efficient supply chains to reach the remotest areas of the world and to overcome vaccine hesitancy. Vaccine development and an effective vaccine deployment strategy, as part of the pandemic response, are critical for achieving comprehensive vaccination coverage across countries.

Table 1 Authorized vaccine in countries

	Vaccine name	No. of countries where the vaccines are used	WHO approved or not	Manufacturing capacity	No. of manufacturing sites
1	Oxford-AstraZeneca	181	Yes	15 countries	25
2	Pfizer-BioNTech	141	Yes	1 country	42
3	Sinopharm-Beijing	90	Yes	3 countries	NA
4	Moderna	85	Yes	2 countries	2
5	Johnson & Johnson	108	Yes	1 country	1
6	Gamaleya (Sputnik V)	50	Not yet	17*	NA
7	Sinovac	54	Yes	2 countries	5
8	Bharat Biotech (Covaxin)	14	Yes	1	2
9	CanSino	7	Not yet	4	4
10	Sinopharm-Wuhan	90	Yes	1	1
11	Novavax	36	Yes	1	NA

Source COVID-19 Pharmacovigilance [3]
Note * Approximate number

There are no shortcuts to building vaccine development capacities. The differences in vaccination rates in high-income and low-income countries underscore that. However, low-income countries must adopt advanced technologies and combine them with a human touch to reasonably respond to this and future crises. “Charity is good, but we cannot rely on charity alone,” says Peter Singer, adviser to the Director General of the World Health Organization (WHO) [4]. Wealthy countries led the frontline and secured enough vaccines. However, the inequitable and inefficient

skewed production and distribution of COVID vaccines in favor of rich countries left low- and middle-income countries dangerously unprotected [5]. Governments and companies that have developed highly effective vaccines must share patented knowledge and technology so that manufacturers in poor countries can produce vaccines for their populations. Existing vaccines like Pfizer et al. deployed in over 100 countries, if patented to be manufactured in the global South, could tame the pandemic and build vaccine confidence [4]. Health advocacy organizations have pointed to the deployment of Sputnik V vaccine as a model of pandemic diplomacy as Russia broadly licensed the vaccine outside its borders to 34 drug companies.

Table 2 The countries that are vaccinating people above 12 years of age

Country	Age group
France	Above12 years
Spain	12–19 years
Italy	12–15 Pfizer and 12–17 Moderna
Netherlands	Above 12 years
Sweden	16–18 years
Germany	12–17 years
US	12–17 years

Source The Guardian. Which countries are vaccinating minors against COVID [6]

"High and upper-middle-income countries represent 53% of the world's population but have received 83% of the world's vaccines. In contrast, low and lower-middle-income countries account for 47% of the population but have received just 17% of the world's vaccines", says the WHO Director General, Tedros Adhanom Ghebreyesus [7]. Table 3 shows the ranking of high to low-income countries based on their population size. To understand the trend of COVID-19 vaccination, data from 15 countries with the highest populations was analyzed. Of the 15 countries, only four high and upper-middle-income countries (China, the United States, Brazil, and Japan) had fully vaccinated 50% or more of their populations in 2021. On the other hand, countries like the Philippines, India, and Bangladesh with the highest population densities 368, 464, and 1,265 per square kilometer of land area, respectively were able to vaccinate only 25% of their populations [8, 9]. This gap increased with the emergence of COVID-19 variants. One such situation was seen in India when the country reported 3,876 deaths in every 24 h in April 2021 with the B.1.617 variant, designated as a 'Variant of Concern'.[1] The country expressed its concern about the short supply of vaccines despite producing 70 million vaccine doses per month. India demanded that the time-table of supplies be made public to ensure transparency so

[1] Variants of Concern are SARS-CoV-2 variants with the following concerns Increase in transmissibility or detrimental change in COVID-19 epidemiology; or increase in virulence or change in clinical disease presentation; or decrease in the effectiveness of public health and social measures or available diagnostics, vaccines, and therapeutics.

that people can patiently wait for their turn [7]. The B.1.617 variant of SARS-CoV-2 increased rapidly with WHO reporting its spread in over 44 countries by May 2021. This variant catalyzed the third wave in the United Kingdom (UK) in June 2021 [10, 11]. This situation that the world has experienced demands that there should be equitable vaccine distribution.

Since vaccines were developed and deployed, more than 3.65 billion (47%) people worldwide received one dose of the COVID-19 vaccine. But only 36% of the people were fully vaccinated. Countries with fewer people are leading the charts of fully vaccinated populations. Sixteen countries successfully vaccinated 75% of their populations with both doses [9]. When the vaccination rate was analyzed, the picture began to look brighter for high-income countries like the United States and Europe as new COVID cases started to decline in these countries. However, in the Global South, COVID seemed to have become a disease of low-income countries, especially African countries [5]. While 6.2 billion vaccine doses were administered worldwide by October 2021, only 20% of the population in low and lower-middle-income countries received one dose of the vaccine. When compared to 50% of adults fully vaccinated in high-income countries, only 2% of adults in Africa were fully vaccinated [12, 13]. This vaccinated population includes the age group of 18 years and above.

Although there is a much lower risk of severe COVID-19 in children, it is important that they are vaccinated. The Pfizer vaccine, approved by the Food and Drug Administration (FDA) in the United States for children 12 years or older, will soon be approved for children aged five years and above. Clinical trials, already underway, have shown that it is 90.7% effective in preventing COVID-19 in children. The Moderna and Johnson & Johnson vaccines are authorized for the age group 18 and above. There is, however, concern regarding adverse events post-vaccination. Studies are being conducted in 5–11-year-old children to test the vaccines before initiating vaccination programs [14]. The UK started vaccinating the population of 12 to 15 years with the recommendation of the Joint Committee on Vaccination and Immunization (JCVI) and strategized to initiate a school-based immunization program with parental, guardian, or carer consent. This strategy is similar to a previously tested way of administering vaccines to children to prevent HPV and diphtheria, pertussis, and tetanus (DPT) [15]. Countries across Europe, the Asia Pacific, the Middle East, the Americas, and South Africa have started to design strategies to vaccinate children above 12 years of age [16]. A survey conducted by the Angus Reid Institute in Canada showed that 50% of parents plan to get their children vaccinated when vaccines are approved and made available [17].

As high-income countries started to plan vaccinating children 5–11 years of age, international organizations, governments, and international NGOs came forward to support low-income countries. Inequitable distribution and its impact on low-income countries were evident. The WHO urged companies and countries to prioritize the supply of COVID-19 vaccines through the COVID-19 Vaccine Global Access

Facility, COVAX[2] [16]. Working in partnership with developed and developing countries, COVAX is the only global initiative that is working with governments and manufacturers to ensure that COVID-19 vaccines are available to low-income countries [18]. COVAX is pooling buying power from participating economies to provide access to COVID-19 vaccines. But pooling resources was challenging as COVAX needed unprecedented cooperation from governments, researchers, manufacturers, and multilateral partners. Over 1.2 billion doses were pledged to be donated by COVAX and G7 as bilateral supply donations by mid-2022. However, till September 2021 only 12% were delivered [19]. The commitment of highly vaccinated countries to vaccinate the rest of the world has yet to be realized.

Table 3 Population size-wise distribution of countries and percentage of populations vaccinated by 2021

Rank	Country name	Population size	Income level	No. of doses administered	Vaccinated population (percentage)	Fully vaccinated population (percentage)
1	China	1,439,323,776	Upper Middle	2,240,550,000	79	75
2	India	1,380,004,385	Lower Middle	1,009,945,663	52	22
3	United States	331,002,651	High-income	411,963,025	66	57
4	Indonesia	273,523,615	Upper Middle	177,812,708	41	25
5	Pakistan	4,327,022	Lower Middle	99,335,067	31	17
6	Brazil	212,559,417	Upper Middle	263,093,138	75	52
7	Nigeria	206,139,589	Lower Middle	8,188,833	2.7	1.4
8	Bangladesh	164,689,383	Lower Middle	58,438,612	24	12
9	Russia	145,934,462	Upper Middle	1100,030,674	36	33
10	Mexico	128,932,753	Upper Middle	113,957,610	55	41
11	Japan	126,476,461	High-income	183,344,047	76	69
12	Ethiopia	114,963,588	Low-income	4,048,361	2.7	0.9
13	Philippines	109,581,078	Lower Middle	54,444,161	26*	23

(continued)

[2] COVAX, a COVID-19 vaccine portfolio with nine CEPI-supported candidate vaccines has a goal to bring the pandemic under control via equitable access to COVID-19 vaccines.

Table 3 (continued)

Rank	Country name	Population size	Income level	No. of doses administered	Vaccinated population (percentage)	Fully vaccinated population (percentage)
14	Egypt	102,334,404	Lower Middle	23,177,181	15	17
15	Vietnam	97,338,579	Lower Middle	68,809,880	51	20

Source World Meter. Countries in the world by population in 2022 [8]. The New York Times. Tracking coronavirus vaccinations around the world [20]

"In the scramble for a vaccine, countries can act alone—creating a few winners and many losers—or they can come together to participate in COVAX, an initiative which is built on enlightened self-interest but also equity, leaving no country behind," said Richard Hatchett, Chief Executive Officer of the Coalition for Epidemic Preparedness Innovations (CEPI).

As the crisis exposed significant fragilities in the world's capacity to prevent and respond to health emergencies, countries took informed decisions with the help of extraordinary scientific advancement. To ensure that we gain from this momentum of innovation, there is a need to analyze and capture every step of this scientific journey to build capacities, prevent and respond to health emergencies, and strengthen the health system. The author of this chapter aims to capture the progress that has been made by countries by adopting various strategies. The author discusses COVID vaccines developed and the challenges faced by countries during vaccine deployment. An attempt is also made to analyze vaccination rates and vaccine equity based on the country's population density and income level.

Vaccination Rates of Countries

As countries prepared to implement COVID-19 vaccination programs in November 2020, a three-step framework was developed by the Strategic Advisory Group of Experts (SAGE). This framework provides a prioritized roadmap for vaccination programs. It makes recommendations for allocating vaccines for countries and prioritizing various population groups. The framework also addresses ethical issues. To vaccinate the population based on priority, several stages were defined. In Phase 1, 1% to 20% of the country's population should be vaccinated. As the vaccine supply increases, vaccines can be made available to 20% and more of the population [21]. The framework defines the COVID-19 vaccine as a global 'public good'[3] and

[3] The use of the term 'public good' in global health means a good that should be available universally because of its critical importance to health.

requires that the vaccine should contribute to the equitable protection and promotion of human wellbeing among all the people of the world [22].

Since SAGE published its guidelines almost 12 months ago, most countries have made some progress. Taking the SAGE prioritization framework as a beginner's guide, countries developed their vaccination strategies and vaccinated their populations based on priority groups. Vaccination programs were rolled out by most of the countries in early 2021. Four Variants of Concern emerged resulting in a surge of cases. This led to a rethinking of herd immunity and short-and long-term immunity. As we are still learning the science and the math of population immunity, it is difficult to say how many people need to be vaccinated against COVID-19 to attain herd immunity [23]. Some experts estimate that herd immunity will be reached when 70% to 90% of the population is vaccinated [24].

Box 1 Principles

1. **Human wellbeing**: Protect and promote human wellbeing including health, social and economic security, human rights, civil liberties, and child development

2. **Equal respect**: Recognize and treat all human beings as having equal moral status and their interests as deserving of equal moral consideration

3. **Global equity**: Ensure equity in vaccine access and benefits globally among people living in all countries, particularly those living in low and middle-income countries

4. **National equity**: Ensure equity in vaccine access and benefit within countries for groups experiencing a greater burden of COVID-19 infection

5. **Reciprocity**: Honor obligations of reciprocity for those individuals and groups within countries who bear significant additional risk and burden of COVID-19 infection

6. **Legitimacy**: Make global decisions about vaccine allocation and national decisions about vaccine prioritization through transparent processes that are based on shared values, best available scientific evidence, and appropriate representation of affected parties

Source World Health Organization SAGE Values Framework for Allocation and Prioritization of COVID-19 vaccination.

Data recorded worldwide shows that more than 16 countries were able to vaccinate 75% or more of their populations by October 2021. Figure 1 shows the trend of fully vaccinated populations from West to East irrespective of population size. It shows that the northern and western countries are rapidly immunizing their populations against the COVID virus [25]. By July 2021, four billion vaccine doses were administered of which less than one percent were administered in low-income countries and eight out

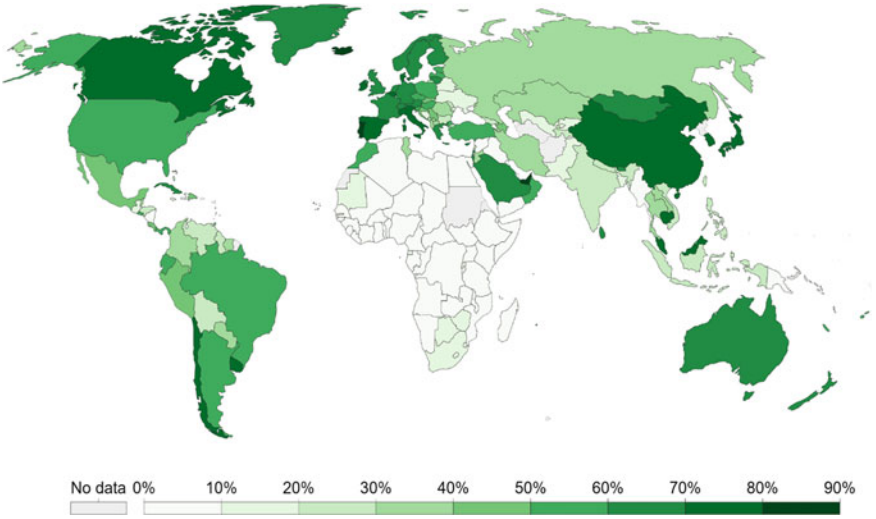

Fig. 1 Share of the population fully vaccinated against COVID-19 by October, 2021
Source Official data collated by World in Data (October 26, 2021)
Note Total number of people who received all doses prescribed by the vaccination protocol divided by the total population of the country

of ten doses were used to vaccinate people in wealthy countries, ultimately, putting the low-income countries in a vulnerable position [26].

Countries with highly vaccinated populations, high density, and large populations were grouped together in Table 3 to analyze the success of vaccination strategies and to understand the effectiveness of the national COVID-19 response. Among these countries, only China, Brazil, and Japan were able to fully vaccinate (75%) of their populations. These countries are stepping towards population immunity and will develop herd immunity based on the claims that some of the researchers have made. Countries with large populations were specifically picked to understand the path of vaccination and how they managed to vaccinate large populations. The population density of countries was assessed to understand how it can impact vaccination strategies and how far are we in our efforts to end this pandemic.

In earlier research conducted on smallpox comparing population densities in the Indian subcontinent and Africa showed that the impact of population density was significantly linked to the impact of immunization programs. The analysis showed that the percentage of the population with pockmarks[4] in densely populated areas was higher when compared to those that were not densely populated [27].

Viruses usually spread at the local level. This statement is well supported by how measles was declared to have been eliminated from the U.S. in 2000, but reappeared

[4] Pockmarks are deep scars on the skin that do not usually go away on their own. They are often caused by severe acne but can also be the result of skin infections, chickenpox, and smallpox.

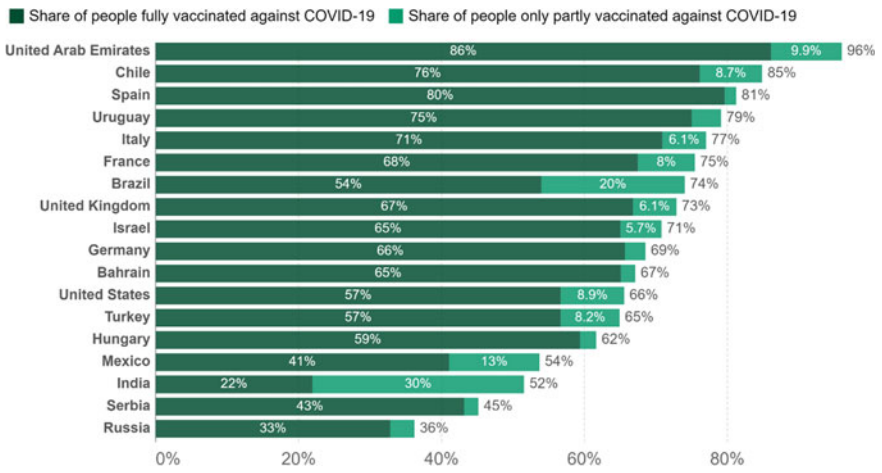

Fig. 2 People vaccinated fully and partially against COVID-19 by country
Source Official data collated by World in Data, October 25, 2021
Note Alternative definitions of a full vaccination, e.g., having been infected with SARS-CoV-2 and having 1 dose of a 2-dose protocol, are ignored to maximize comparability between countries

in recent years because vaccination rates were low in some pockets of the country which was where measles outbreaks occurred [28].

To analyze progress made towards achieving population immunity, countries with large population sizes were placed along with countries that were performing exceptionally well in their COVID vaccination programs. The countries selected are presented in Table 1 along with their population size ranking. Figure 3 shows COVID-19 vaccine doses administered to the population of the country as on October 24, 2021. It shows that India and China have already crossed the mark of administering one billion vaccine doses. This was achieved in a period of nine months in India. This was shorter for India than for all other countries.

Since April 2020, high-income countries have been asserting that 'no one is safe until we are all safe'. They have been 'promising to make vaccination a truly unique, global public good'. And yet, these countries have consistently undermined proposals to achieve equitable production, supply, and distribution of vaccines. And while commitments of making the vaccines are touted by these countries, only a fraction of the doses needed have, in fact, been shared.

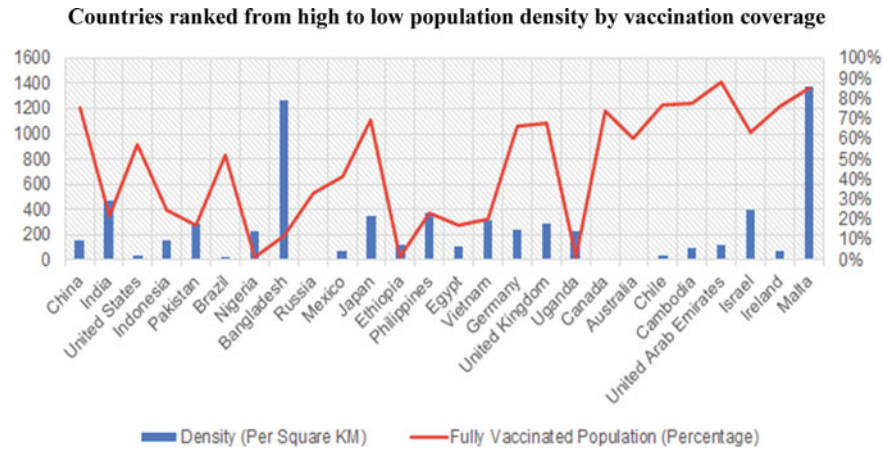

Fig. 3 Countries ranked from high to low population density by vaccination coverage
Source Compiled by author
Note Countries with fully vaccinated populations in the order of high to low population density

Challenges

Patents on COVID-19 Vaccines

During the early days of vaccine development, patents on COVID-19 vaccines retarded vaccine development in low-income countries. There was a lot of debate about whether or not rich countries should waive their intellectual property rights on vaccines. Various international forums established panels to discuss this issue involving European and US economists. One such forum called the Initiatives on Global Markets (IGM) undertook a survey in which 87% of the panelists agreed that rather than waiving their intellectual property protection, rich countries should pay for 12 billion vaccine doses to pharmaceutical companies to manufacture and distribute vaccines to developing countries. The majority of the arguments were in favor of rich countries. It was found that many of the respondents were worried about the effects on future innovations of waiving patents today. In the same poll, 89% of the panelists agreed that even the benefits of providing vaccine for free outweigh the costs that the rich countries would have to bear if the pandemic does not end sooner [29].

"The problem with waiving patent protection is that the manufacturing components may not be available to low-income countries" says Carol Propper, Imperial College [29].

Box 2 What does waiving of intellectual property rights on the COVID-19 vaccine mean?

A patent is a powerful intellectual property right that grants an exclusive monopoly to the inventor for a limited, pre-specified time. It is granted by the government and provides an enforceable legal right against copying of the invention. There are product and process patents

Product patent: A product patent ensures a right to the final product during a specified time-period even if the product is made using a different technology

Process patent: A process patent prevents any person, other than the patent holder, to manufacture the product by modifying the manufacturing process

With Emergency Use Authorization (EUA), the waiving of intellectual property rights (IPR) means that vaccines—such as those developed by Pfizer, Moderna, AstraZeneca, Novavax, Johnson & Johnson, and Bharat Biotech—open up space for the production of vaccines on a larger scale in middle-income countries through licensing and technology transfer [30].

"Vaccinating the world has a strong positive externality: it reduces the scope for future virus mutations. Gains exceed costs for rich countries" by Kjetil Storesletten, Professor Department of Economics, University of Oslo [29].

Falsified Vaccines

Falsified vaccines are fake vaccines that are designed to mimic real vaccines. These vaccines do not comply with intellectual property rights (IPR) and the infringe trademark law. The WHO published an alert on its website related to the falsified COVID-19 Covishield vaccine identified in Africa and Asia [31]. This is a serious issue for countries receiving help from COVAX and bilateral tie-ups. It is only now that high-income countries have started providing promised doses to low- and low-middle-income countries. A lot of resources, from procuring to dissemination and administration, are consumed to make vaccines available. Falsified vaccines are delivered at vaccine sites because of corruption at the regional level. This calls into question the credibility of vaccine donors and leads to vaccine hesitancy.

Fig. 4 Falsified COVISHIELD batch identified in Uganda
Source Twenty-second report by Pan America Health Organization. Consolidated regional and global information on adverse events following immunization (AEFI) against COVID-19 and other updates (2021)

Waning Immunity and Need for Booster Shots

Studies suggests, there is a steady decline of antibody level among vaccinated individuals overtime. This means that there is waning immunity. The healthcare records of countries show decreased protection than was initially. This has given rise to the much-needed booster shots which are particularly for the elderly and vulnerable groups. However, all these efforts could be wasted as SARS-CoV-2 becomes endemic with seasonal outbreaks. With insufficient vaccination coverage in developing countries depends on developed countries providing adequate COVID vaccine doses [32].

Vaccine Administration

Half the world's population has received at least one dose of the COVID-19 vaccine. But figures vary widely among countries. For example, in July 2021, four billion vaccine doses were administered, of which less than one percent went to low-income countries and eight out of ten went to people in wealthy countries. Vaccine inequity and surging COVID variants have placed low-income countries in a vulnerable situation. Increasing availability of safe and effective vaccines gives hope of bringing the pandemic under control with very low mortality. However, the probable trajectory for SARS-CoV-2 is to become endemic with seasonal outbreaks. Because of

waning immunity, insufficient vaccination coverage globally, and/or the emergence of new viral variants that current vaccines do not prevent, additional epidemic waves are likely, particularly in countries with low vaccination coverage [32]. The Global Health Summit report includes 10 critically urgent recommendations for global health threat prevention, preparedness, and response:

1. End the acute stage of the pandemic and leave no one behind: Ensure equitable access to medical tools to fight COVID-19.
2. Invest in scientific research and development before, during, and between health crises.
3. Actively and genuinely involve research groups from low- and middle-income countries.
4. Strengthen integrated disease surveillance, data collection, analysis, and sharing at all levels.
5. Strengthen and protect science advice.
6. Be ready for the next health crisis: invest in strengthening health systems and the workforce for preparedness and response.
7. Strengthen regional manufacturing capacities and hubs.
8. Empower people and earn their trust.
9. Collaborate and coordinate at all levels; strengthen relevant governance structures and leadership, and ensure adequate financing.
10. Scale-up production and promote equitable distribution of vaccine doses worldwide [32, 33].

Scaling Up Vaccine Production and Distribution

More than 200 clinical trials and close to 300 partnerships and collaborations among manufacturers have resulted in increasing the production of vaccines from zero to 7.5 billion COVID-19 vaccine doses in just ten months. The International Federation of Pharmaceutical Manufacturers and Associations (IFPMA), headquartered in Geneva represents research-based pharmaceutical companies, has official relations with the United Nations and helps to develop and provide medicines and vaccines worldwide. IFPMA has described five steps to help scale-up vaccine production and maintain vaccine equity [34, 35].

1. Stepping up production and dose sharing
2. Maximizing COVID-19 vaccine output without compromising its safety and quality
3. Eliminating trade barriers
4. Supporting countries, especially LMICs and LICs, to deploy available doses of vaccines
5. Developing new and next generation COVID-19 vaccines [36].

With the current manufacturing scale, IFPMA believes that 12 billion vaccine doses will be produced by the end of 2021 and 24 billion by 2022 provided there are

no bottlenecks. However, these will be insufficient if low and lower-middle-income countries are not provided with enough support [34]. Airfinity indicates that there will be enough vaccines with G7 countries to vaccinate teenagers and adults and give booster doses to at risk populations in 2021. In addition to this, 1.2 billion doses will be available for redistribution [37]. However, timing for the scale-up and scale-out of vaccine manufacturing remains uncertain if there are bottlenecks in the supply of raw materials.

Surplus Doses

Airfinity's analysis report on vaccine stocks in Western countries that include the U.S., UK, European Union, Canada, and Japan predicted that 500 million vaccine doses were available for redistribution in September 2021. Out of that stock, 360 million doses were not earmarked for donation. This prediction was made based on the available supply of vaccines within countries and the amount of vaccines that were available to be sent elsewhere [38]. The report showed that high-income countries are stockpiling plenty of vaccines which could otherwise be supplied globally. As vaccines have a shelf life, this could result in wastage of stockpiled vaccines without meeting the global demand.

Extra Doses

Airfinity collected data based on three main inputs for each manufacturing facility globally—the company's stated production, the real observed production, and assumption of time needed for scaling up—to determine vaccine production and delivery to each site. In May 2021, Airfinity predicted that production could exceed 10 billion vaccine doses to reach the manufacturing phase by the end of 2021 [39]. This prediction was further confirmed by Airfinity in September when it predicted that vaccine manufacturers were producing 1.5 billion doses per month and with the expected scaling, this would reach 11.3 billion vaccine doses required to vaccinate the world's population [19]**.** Airfinity also predicted that even after providing booster shots to adults, over 1.2 billion doses would be available for donation by the G7 alone in 2021. It suggested that 258,765,005 vaccine doses could be distributed per month given currently pledged donations and available stocks. It also predicted that the G7 countries would waste 241 million doses by the end of 2021. Therefore, these doses are distributed immediately [40]. This G7 available stock could allow LIC/LMIC to vaccinate 70% of their populations [19, 41]**.** Over 1.2 billion doses were pledged to be donated by COVAX and bilateral supply donations from G7 by mid-2022, of which till September 2021, only 12% were delivered.

Vaccine Wastage

A study conducted by Airfinity showed that vaccines were not being utilized properly. Monopolized vaccine delivery contracts resulted in the wastage of 100 million unused vaccine doses lying with western countries. Allowing for the wastage of 100 million plus doses is equivalent to putting hundreds of thousands of unvaccinated people in LICs to unnecessary suffering and death [13].

Vaccine Inequity

Global vaccine equity, widespread acceptance, and efficient deployment are moral imperatives for pandemic control. No country is safe unless all countries are safe. Thus, redistribution of vaccines, funding international platforms, and increasing availability and manufacturing capacity of vaccines is crucial for bringing the pandemic under control and preventing future epidemics from escalating into global emergencies. Inequitable access not only prevents mortality and suffering, but also hampers critical control efforts globally. Such geographies serve as breeding grounds for the emergence of viral mutants which could lead to 'immune escape variants' resistant to current vaccines and antibody based therapeutics. There is a continuing need for non-pharmaceutical interventions to prevent outbreaks until sufficiently high immunization levels are reached globally and it becomes clear how effective vaccines are in preventing viral transmission. The future of the pandemic will also depend on how effectively and rapidly countries can control small outbreaks [32].

Role of International Bodies

The role of international organizations working globally is important for controlling the COVID-19 pandemic as they galvanize action, maintain global mitigation efforts, build resources, prevent continual resurgence, and combat future global health crises.

Global Alliance for Vaccines and Immunizations (GAVI)

Established in 2000, the Global Alliance for Vaccines and Immunizations (GAVI) is a public–private partnership that has helped to vaccinate half the world's children against some of the world's deadliest diseases. GAVI has helped to immunize over 888 million children and has prevented 15 million deaths. And over the years, GAVI has helped to halve child mortality in 73 low-income countries. GAVI played a role in strengthening global health systems as well as in providing funds for Ebola, cholera,

meningitis, and yellow fever vaccines. Employing innovative financing and the latest technology, GAVI has saved many lives and has prevented several outbreaks. GAVI is funded by governments, corporations, foundations, and private individuals. As a co-founder of COVAX, GAVI is focused on procurement and delivery for COVAX with its Alliance partners United Nations Children's Emergency Fund (UNICEF) and WHO along with national governments [42].

COVID-19 Vaccine Global Access Facility (COVAX)

COVID-19 Vaccine Global Access Facility (COVAX), an initiative of 178 countries, is one of the three pillars under the Access to COVID-19 Tools (ACT) Accelerator. It pools economic resources of its member countries to enable equitable access to vaccines. The two main objectives of this initiative are: (1) to enable vaccine developers to make high-risk investments for the development of vaccines; and (2) to subsidize vaccine costs for middle- and low-income countries.

COVAX coordinated by GAVI, the Vaccine Alliance, the Coalition for Epidemic Preparedness Innovations (CEPI), and the WHO acts as a platform for a wide range of research, development, manufacturing, and price negotiations of COVID-19 vaccine candidates. With the initial aim of making available two billion doses by the end of 2021 for high-risk, vulnerable frontline workers, COVAX created the most diverse portfolio of vaccines with nine candidates already in development and a further nine under evaluation. COVAX promises to provide to 170 countries, with sufficient guaranteed doses irrespective of funding or self-financing [43]. In addition, 78 high-income economies have confirmed their interest in supporting the COVAX Facility.

COVAX has established a COVAX Manufacturing Task Force that coordinates with the Coalition for Epidemic Preparedness Innovations (CEPI), GAVI, WHO, and UNICEF and partners with the Bill & Melinda Gates Foundation, International Federation of Pharmaceutical Manufacturers & Associations (IFPMA), Developing Countries Vaccine Manufacturing Network (DCVMN), and Biology Investigative Opportunities (BIO). The COVAX Task Force aims to advance the work and partnerships of COVAX with the longer-term aim to help strengthen regional health capacities to respond to such crises in the future. The COVAX Manufacturing Task Force has specific objectives categorized as short-, medium-, and long-term [44]. Its short-term objective is to establish global trade, promoting cross-border trade, promote voluntary partnerships, and support vaccine development. Its mid- to long-term objective is to upgrade vaccine manufacturing and raise funds for LMICs.

Vaccines need to be allocated simultaneously to all participating countries proportional to their total population size with a five percent buffer kept aside to build a stockpile. No country will receive more than 20% of the vaccine for its population until all countries receive the same amount of vaccine [43]. By October 2021, COVAX shipped over 406 million COVID-19 vaccine doses to 144 participant countries [45].

GAVI-COVAX-AMC

To arrange funds for 92 middle-and lower-income countries that cannot fully afford to pay for COVID-19 vaccines, a separate arm of the COVAX facility called the GAVI-COVAX-AMC arm, focuses primarily on providing equal access of COVID-19 vaccines to middle- and low-income countries at the same time as to high-income countries. GAVI-COVAX-AMC receives its funds from the private sector, philanthropies, and Official Development Assistance (ODA) [43].

Funding is now coming from various sources like the recent deal with six Gulf countries to support COVAX and GAVI-COVAX-AMC. Over 9.8 billion USD in funding were pledged by donors to GAVI-COVAX-AMC and almost 600 million doses have been received to date reserving five percent of the funds to be used as the 'humanitarian buffer'—a key component of the COVAX buffer—for high-risk populations in humanitarian settings [42]. The UN Security Council also passed a resolution in 2021 making it the obligation of countries to ensure access to COVID-19 vaccines for populations in humanitarian settings [46]. Hoping to receive continuous support, COVAX has started delivering COVID vaccine stocks to countries.

Coalition for Epidemic Preparedness Innovations (CEPI)

The Coalition for Epidemic Preparedness Innovations (CEPI) was launched in 2017 as part of a 3.5 billion dollars action plan that forged partnerships with over 30 vaccine developers, academic institutions, and manufacturers. Member countries include European nations and 30 other countries and philanthropic organizations—the Bill and Melinda Gates Foundation and the Wellcome Trust. In addition, CEPI, alongside GAVI and the WHO launched COVAX to enable equitable access of COVID-19 vaccines across nations.

Scientists believe that the coronavirus family is a significant recurrent pandemic threat. Two classes of coronavirus, SARS and MERS are deadly with fatality rates of 10%-35% [47]. To reduce the threat of future outbreaks, CEPI has set the following objectives:

1. **Compress vaccine development time-lines to 100 days**: Scientists developed COVID-19 vaccines in a record time of 300 days. CEPI aims to reduce this time-line of vaccine development further to 100 days
2. **CEPI aims to develop a universal vaccine against coronavirus**: **A** broadly protective vaccine to eliminate the risk of the existing coronavirus and future risk of other possible coronaviruses.
3. **Develop a library against other threats**: Previous work on MERS enabled us to spring on to COVID-19 vaccine development. A library will be helpful in addressing newly emerging threats [47].

World Health Organization (WHO)

The World Health Organization (WHO) is working with partners to develop, manufacture, and deploy safe and effective vaccines. WHO has evaluated six vaccines against COVID-19 that met the criteria for safety and efficacy WHO is assisting COVAX, the Country Readiness and Delivery (CRD) workstream, the Pan American Health Organization (PAHO), and the United Nations Children's Fund (UNICEF) to provide safe and effective vaccines worldwide, especially in low-middle-income countries [48]. However, the goal to vaccinate at least 10% of the population of every low-income country remains unrealized. This is mainly due to the monopolized delivery contracts of western countries [13].

To ensure transparency, WHO developed regional level dashboards—the PAHO COVID-19 vaccines delivery dashboard and the AFRO COVID-19 vaccine dashboard. These dashboards helped to enhance the transparency and efficacy of vaccines delivered to Africa and the Latin American regions. In addition, in creating regional dashboards, WHO is collecting and collating data from various platforms and is publishing reports related to vaccine deployment. These reports are published weekly on issues like the disease profile of post-vaccination infection, surveillance of adverse events, vaccine usage, and falsified vaccine stocks. As an international body, WHO has a significant role to play in ensuring transparency and building vaccine confidence by sharing vaccine-related information. In addition, it can put pressure on developed economies to support middle- and low-middle-income countries to ensure equitable distribution of vaccines. Despite committing to donate vaccines, high-income countries have shared only a fraction of the doses needed by developing countries [31].

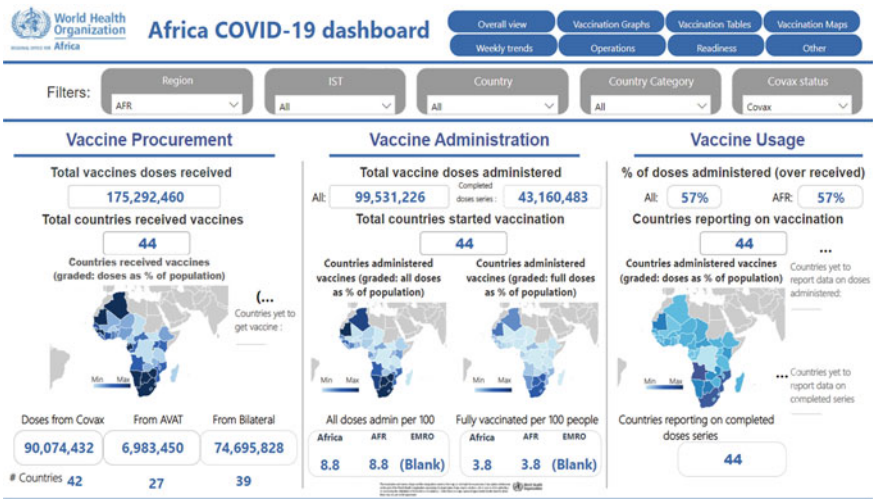

Fig. 5 Africa COVID-19 dashboard by WHO with COVAX vaccine supply status in 44 countries
Source Africa COVID-19 dashboard

Pan American Health Organization (PAHO)

The Pan American Health Organization (PAHO) is a specialized international health agency for the Americas [49]. Along with its 51 member countries, PAHO engages in technical cooperation to fight communicable and non-communicable diseases. It is committed to strengthening the healthcare system and ensuring that all people can access healthcare during emergencies and disasters. PAHO aligned with WHO and its partners (The Revolving Fund and others) to pave the way for implementation of the COVAX Facility. PAHO is currently monitoring international logistics for 36 countries in the Americas region and, as part of the preparations, has reviewed the countries' national vaccination and deployment strategies offering feedback and technical assistance. PAHO works with local health authorities to ensure that people receive the required doses of the vaccine. The first COVAX doses arrived in Latin America in the first week of March 2021 [50]. Figure 6 shows the data of the COVAX Facility, doses delivered, doses in transit, and total doses administered. The PAHO platform demonstrates how PAHO and COVAX work to achieve equitable distribution of COVID-19 vaccines to middle-and low-income countries.

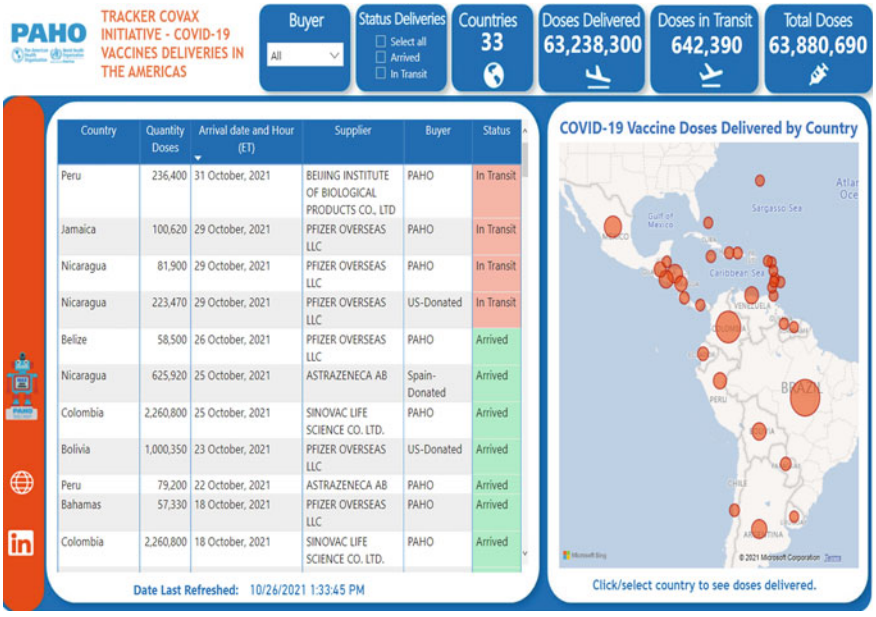

Fig. 6 PAHO Platform
Source Tracker COVAX initiative—COVID-19 vaccines deliveries in the Americas

G7 Countries

G7, an inter-governmental political forum that includes Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States, is the world's largest and wealthiest liberal democracy [51]. In March 2021, G7 published a statement to enhance its efforts to strengthen health systems within countries and globally. It mentioned supporting WHO in its global mandate to lead on disease outbreaks and emergencies [52]. The G7 countries achieved a vaccination rate of 60% and above of fully vaccinated people against COVID-19 in 11 months. But efforts to help the rest of the world fell far behind [25]. It was not until June 2021, after the G7 leader's summit, that it came forward to support the rest of the world with a billion vaccine doses having shared 200 million doses by the end of 2021. The G7 countries are providing vaccine doses. But the need is much higher in real-time to save 60,000 lives as analyzed by the analytics company Airfinity [53, 54].

United Nations Children's Fund (UNICEF)

The United Nations Children's Fund (UNICEF) works in over 190 countries and territories for child protection, survival, education, social policies, gender issues, emergencies, and supplies and logistics. As the most significant single vaccine buyer globally, UNICEF harnessed its decades of expertise to deliver COVID-19 vaccines. In collaboration with PAHO, it procured and supplied authorized vaccines to 92 low and lower-middle-income countries [55]. UNICEF aims to deliver two billion doses of COVID-19 vaccines globally by the end of 2021 [56].

UNICEF and GAVI have been installing solar refrigerators across countries since 2018. During the COVID-19 pandemic, an early mapping was carried out of the necessary equipment that was missing at various locations while COVID-19 vaccines were being developed. When the impact of COVID-19 became evident in 2020, UNICEF, along with regional governments and partners, began to take stock of the number of vaccine doses required to impact the pandemic. As countries introduced travel restrictions, UNICEF was on the ground and was working round the clock with governments, COVAX Facility, and partners to transport COVID-19 vaccines to West and Central Africa and other difficult to reach locations [55].

Developing Countries Vaccine Manufacturing Network (DCVMN)

The Developing Countries Vaccine Manufacturing Network (DCVMN), a network of 19 countries, provides a platform for organizations to come together regularly to share technical information, best practices, and prospects related to COVID-19. Its member

countries are engaged in deploying platforms for research, development, manufacturing, and scaling up the COVID-19 vaccine as gene sequencing is becoming available. DCVMN members scaled up production from zero to millions of doses in a record span of 10–12 months. They also licensed pharmaceutical companies like AstraZeneca and Johnson & Johnson to ensure the availability and affordability of vaccines to millions of people in LICs and LMICs.

The Serum Institute of India (SII) was the first organization that supported COVAX to supply vaccines to Africa. It's most remarkable achievement, as a member of the DCVMN, was that it produced and supplied around 200 million doses globally to cater to the needs of various countries worldwide [34]. When the second wave hit India, there was a pushback in the delivery of vaccines in the national interest. Nevertheless, the delivery of vaccines was resumed and will hopefully continue until the pandemic ends. There is a need to enhance global collaboration to ensure equitable vaccine access. Hence, a more robust and effective global preparedness and response architecture is required. This means that a global research and manufacturing network needs to be in place.

The Bill and Melinda Gates Foundation (BMG)

The Bill & Melinda Gates Foundation's (BMG's) footprint is all over the COVID-19 response. The Foundation provided 1.8 billion USD in funding. It was an early investor in messenger RNA vaccines and other technologies instrumental in the fight against COVID-19. It emphasized three core priorities:

1. Containing the global COVID-19 crisis
2. Rebuilding and accelerating economic recovery
3. Better preparing the global system for future pandemics

The BMG supported lower-income countries by strengthening their capacities, coordination, and funding for the development of new tests, treatments, and vaccines by supporting countries at regional and global levels [57]. The BMG is a significant partner of COVAX, GAVI, CEPI and WHO to pool donations from wealthy countries. However, COVAX could not deliver its promises until July 2021. This resulted in the low-income nations being short of vaccines. COVAX was set up as the primary avenue for low and middle-income countries with a promise to deliver vaccines which it could not in the initial months due to the complexity of global governance and the market. Therefore, international bodies, scientists, and NGOs had to come forward to demand equitable access to vaccines. In 2021, The BMG joined others in calling for high-income countries to share one billion doses of COVID-19 vaccines with low- and middle-income countries [58].

Key Factors to Strengthen Vaccine Programs

Vaccine Acceptance

Vaccination acceptance rates vary from region to region in high-income countries where the reason for sub-optimal vaccination rates is a lack of acceptance of the vaccines. In low-income countries, however, low vaccine rates are due to access issues.

A study was conducted in 2019 by project AViD (Anthropological Exploration of Facilitators and Barriers to Vaccine Deployment and Administration During Disease Outbreaks) to explore the reasons for vaccine acceptance. The study examined various social, cultural, political, and religious factors affecting vaccine acceptance. It showcased six case studies from low and low-middle-income countries that categorized the factors identified under the ecosystem of anthropological studies policy and systemic levels, as well as local knowledge and perceptions of vaccines. The study helped in the identification of political and economic factors that influence vaccine deployment. It also highlighted how the healthcare system itself could generate vaccine controversy. For example, the impact of the Zika outbreak on public trust through the period of uncertainty of what was causing the microcephaly outbreak in Brazil in 2015 was spreading rumours that an expired batch of vaccines administered by the government was responsible for microcephaly. This pointed to a lingering suspicion of a link between vaccines and microcephaly and resulted in vaccine hesitancy. Also, local perspectives on experimental vaccine deployment during the Ebola epidemic and local knowledge regarding vaccines were responsible for vaccine hesitancy. It is important to understand local cultures and the realities on the ground on how vaccine trials are perceived by people at the local level. Contributions from the social sciences alongside the medical sciences are important for developing and rolling out safe and effective vaccines [59].

During the COVID-19 pandemic, the challenge of vaccine hesitancy in countries was explored— how to rethink health service delivery and how to develop ways to reach out to women, children, and families with quality support and care, thereby, building trust. An analysis was undertaken by the OECD. Its policy paper specified the role of the government in communicating the benefits of the vaccine to the people, ensuring the safe and effective delivery of vaccines, and ensuring efficient and equitable vaccine distribution. Although mass vaccination campaigns are essential, the transparency of the government is also necessary [60]. It is also important to ensure extensive and well managed public engagement. In a study conducted in Jordan, information received from healthcare workers was quoted as the most trusted source of information [61]. To build confidence in vaccines, the US enlisted family doctors and other emissaries in its official plan as these doctors are trusted voices in their communities. The US also announced a new federal website and a phone number to help people find vaccination sites closest to them [62].

Figure 7 shows data collected by the Kaiser Family Foundation (KFF) from the COVID-19 Vaccine Monitor of the US. Potential reasons for getting vaccinated were

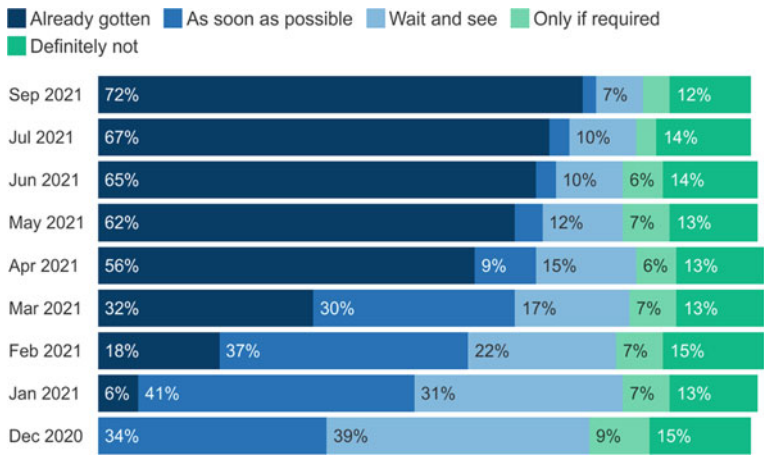

Fig. 7 COVID-19 vaccination in the US
Source Kaiser Family Foundation COVID-19 Vaccine Monitor

examined. It was found that transparency can build trust and change the behavior of people towards the acceptance of the vaccine. Increase in COVID-19 cases due to the Delta variant, mandates of various sorts like traveling and attending events, FDA granted full approval for the Pfizer vaccine, social pressure from family and friends, and financial incentives from the employer were among the many motivational reasons for vaccine acceptance [63]. Various other reasons for vaccine acceptance were building confidence, enhancing transparency and undertaking coherent public communications to address misinformation.

Drivers of Vaccine Confidence

A report published by the World Economic Forum analyzed publicly available content from the news media and the social media to capture drivers that correlate with vaccine confidence. The reports discussed how messages on 'protection offered by the vaccine' and 'guarantee of protection by the vaccine' were the main drivers for positive communications. Moral messages, low trust in the vaccine, and its impact on personal health were the drivers for negative communications. The survey highlighted how simple, positive messages were well received by society. The report showed that the role of the general public was highly effective in building vaccine confidence among friends and family [64, 64]. The all of society approach is needed to protect oneself and the community [64, 64]. The report also found that people

rarely distinguished between different vaccines. Other drivers included group identity,[5] involvement of public figures, and trust in government and other institutions, whether or not people's concerns were valued, and how vaccine confidence, labels, empathy, and risks and benefits.

"It is important to come together and engage in a dialogue to understand public health concerns. Vaccines represent one of the greatest public health advances in modern times. Their role in ending the COVID-19 pandemic depends in large part on understanding how to meet people where they are and listen to and respond to their questions" said Genya Dana, Head of Health and Healthcare at the World Economic Forum.

New Technologies

There are no short-cuts to building vaccine development capacities. Low-income countries are in dire need of adopting advanced technologies. Recent advances in technology have encouraged low-income countries to prepare for such future crises. For example, 'single use technologies' and process intensification (lowering the costs of production and improving efficiencies) and 'fill-finishing' technology which focuses on manufacturing (the process of putting vaccine ingredients in individual or multi-dose vials in a controlled manner), are important [26]. Apart from investing in vaccine development technologies, data management applications and disease response dashboards are among other systems that countries need to invest in to strengthen and support their healthcare systems.

Vaccine Equity

After years of manufacturing vaccines, we have learned that expanding the geographic distribution of vaccine manufacturing capacity is critical for achieving vaccine equity. It is not a coincidence that countries with domestic capacity to manufacture vaccines have received most of the COVID-19 vaccine doses while those without capacity have been forced to wait. Vaccine manufacturers located in developing countries (or 'DCVMs') are also more receptive than large multinational corporations to focus on neglected diseases, especially those diseases that are endemic in those countries and regions like MenAfriVac, an affordable Meningitis A vaccine that came out of a multi-year partnership with PATH and the Serum Institute of India (SII). While bacterial meningitis became rare in much of the world thanks to the vaccine, it still kills tens of thousands of people a year in Sub-Saharan Africa. But since its introduction in 2010, MenAfriVac, the first internationally qualified

[5] Group identity here refers to the groups with which an individual self-identifies. This includes where the group sits politically, societally, and what defines its values and beliefs.

vaccine developed outside the major multinational pharmaceutical companies and the first vaccine developed specifically for Africa, has effectively ended meningitis as a public health problem there [26].

Learnings from Selected Countries

United States of America

The US faced a major change in addressing the COVID-19 problem from President Donald Trump's tenure to when President Biden took over office in early 2021 which is when the US COVID response strategy had shifted to vaccination. On January 21, 2021, President Biden released the National Strategy for the COVID-19 Response and Pandemic Preparedness that included seven goals. Goal two promised to mount a safe, effective, comprehensive vaccination campaign sparing no effort to ensure that Americans get vaccinated quickly, effectively, and equitably. President Biden's efforts focused on making the vaccine widely available by reaching out to those who needed the vaccine shot the most by strengthening the allocation and distribution process. To have a strategy in place meant gaining people's trust, focusing on hard-to-reach and high-risk populations, compensating states and local governments for the cost of administering vaccinations, creating public education campaigns, maintaining transparency, and monitoring vaccine safety by taking the help of the FDA to make available timely vaccine safety and efficacy data to the public [66]. The US followed this strategy to control the spread of the infection.

In the early months of 2021, the US vigorously defended intellectual property rights on vaccines that it had developed. However, in early May, when 50% of its population had received at least one shot, the US announced at the World Trade Organization (WTO) its support for waiving intellectual property protection for COVID-19 vaccines [30]. This delay in waiting for the intellectual property protection is possibly the primary reason why low and lower-middle-income countries are now facing the problem of inequitable access to COVID vaccines.

In June 2021, President Biden, as the leader of the G7 + Plan to Defeat the COVID-19 Pandemic by 2022 welcomed the commitment of G7 and guest countries to provide one billion additional COVID-19 vaccine doses to the world. The US was committed to providing 500 million doses by August 2021 through COVAX, the largest single donation of the vaccine in 12 months. This half a million was in addition to the $2 billion funding that the US provided to COVAX through GAVI and its previous promise of delivering 80 million vaccine doses. The Biden-Harris Administration also promised to provide support for programs worldwide, including in Latin America, Asia, and Africa. Also, through the Quad Vaccine partnership of the US, India, Japan, and Australia, it promised to support vaccine manufacturing in Africa-for Africa and to help in developing regional networks. As part of its transformational disease surveillance and early warning strategy, the US invested

500 million USD to modernize public health data, infrastructure, and established a new Center for Epidemic Forecasting and Outbreak Analytics at the US Centers for Disease Control [67].

"America will be the arsenal of vaccines in our global fight against COVID-19, just as America was the arsenal of democracy in World War II" said Joseph R. Biden, President of the United States [68].

In June 2021, the pace of vaccination fell short of the set target. So, a new phase was launched, shifting vaccination sites to more local settings (doctor's offices, pharmacies, mobile clinics, and pop-ups in rural areas). The goal in this phase was to vaccinate 70% of adults and those who were resistant to getting vaccinated [62]. Figure 10 shows the progress made by the US to vaccinate its population.

After the CDC declared in August 2021 that 98.8% of infections in the US were due to the Delta variant, the Biden administration started working on new strategies to offer COVID-19 vaccine booster shots to nursing staff. This decision was driven by the data indicating a decline overtime in the vaccines' ability to protect against new variants [69]. This decision was followed by vaccine mandates when the Bidden administration declared a 75 days period for federal workers to be vaccinated or face termination unless they fell into limited exemption categories [70]. This order also applied to big businesses with more than 100 employees with paid leave by providing an option to either get vaccinated or take weekly tests [71]. Before this mandate, a vaccine communication strategy, with an outreach plan through social media campaigns and advertisements, had been implemented. The campaign was conducted to educate citizens about the efficacy and safety of the vaccine. As part of the strategy, other campaigns, like lotteries for COVID-19 vaccinated residents, sports tickets, tuition fees, cars, beer and even a $1 million cash prize, were undertaken. However, these campaigns were short-lived and yielded no long-term results [71].

In September 2021, when the US was battling the 'third wave' of the COVID-19 pandemic, a study conducted by Kiser Family Foundation (KFF) showed that 72% (seven in ten) US adults were at least partially vaccinated. Vaccination in 18–29-year-olds increased by 11 percentage points from July to September 2021. This shift in vaccine acceptance was due to a surge in cases, hospitalizations and deaths due to the Delta variant. The most significant increase in vaccine acceptance and uptake seen from July to September 2021, was mainly due to factors like full FDA approval of the Pfizer vaccine and adoption of other vaccine strategies like vaccine mandates [63, 70]. However, there were differences in the uptake of vaccines related to partisanship, education level, age, and health insurance. Most unvaccinated adults saw the booster dose as a sign that the vaccines were not effective. Among the vaccinated, there was an inclination to take a booster because the FDA and CDC had recommended it. There was much debate about vaccine mandates and boosters in the USA. Different states adopted different vaccination strategies to avoid future crises. People favored the mandate for healthcare workers, school teachers, college students, and federal employees. But there was a perfunctory response among employers to COVID-19 vaccine mandates.

India

India implemented the lockdown too abruptly when the pandemic was declared and was too quick to reopen. Through lockdowns, India could control the initial outbreak better than most countries. India also supported the COVAX Facility and led the DCVMN network of vaccine manufacturers and distributors. However, because it opened too quickly, the second wave took over the country, hitting the nation disastrously. Failing to track how the new variants behaved, the government made quick decisions and changed its vaccination strategy. Earlier, following the WHO recommendation of phase-wise vaccination, India had decided to provide vaccination to all (if you can find a shot). However, because of the over-burdened healthcare systems, the central government made a new condition for individual states to bear the cost of the vaccine. This spontaneous and unplanned change created unrest and an environment where people were on their own until the government later reassured the country. India also had to stop exporting vaccines to low-income countries that it had promised to supply vaccines to.

India started receiving support for vaccines only after the daily caseload exceeded 300,000 during the second wave induced by the Delta variant [72]. This situation was completely different to what it was six months earlier. The Serum Institute and Bharat Biotech, makers of the two effective vaccines distributed in India, pushed up vaccine output to 200 million doses. These two vaccines were in addition to those that were in the pipeline earlier—Biological E, Sputnik, Novavax, and Zydus Cadila. By October 2021, India had successfully administered one billion vaccine doses to the adult population (55% had received one dose and 24% had received two doses) [12].

India, with its international vaccine strategy, sent 66 million doses to 47 countries prior to March 2021. It had to discontinue this supply due to a shortage of vaccines at home and the surge of cases in the summer months [73]. The stepping back of India disrupted vaccination plans around the world—such is the dependence on India of developing countries in Asia. However, later India resumed vaccine supplies to the world kitty with about 5% of its production capacity.

In addition to vaccine production, India played a significant role internationally. For example, along with South Africa, India gave a proposal in 2020 at the WTO ministerial conference about the IP waiver on all COVID interventions. This proposal was crucial in achieving stability in vaccine manufacture and distribution. The US supported the proposal in May 2021 when the call to action was raised against the inequitable distribution of vaccines and vaccine patents. This proposal resulted in the waiver of COVID-19 vaccine technology transfer and manufacture to low-middle-income countries [30].

"Countries including Canada, South Korea, and Bangladesh have shown interest in making COVID vaccines if they can get a patent waiver" said Prof K Srinath Reddy, President, Public Health Foundation of India.

Bhutan

One of the most remarkable and inspirational vaccine strategy stories comes from the least developed country, Bhutan, which has a population of 0.7 million. This tiny Himalayan nation had, by the end of July 2021, vaccinated 90% of its adult population. In just three weeks, it delivered a second vaccine dose to nearly every adult. Bhutan is a good example of science-based policy-making and is a role model for countries facing the challenge of vaccine confidence. Bhutan received support from India during the deployment of the first dose of the vaccine and then received vaccine doses from other countries like the US, Bulgaria, Croatia, China, and Denmark. It received its second dose through COVAX.

Schools, monasteries, and other public buildings were mapped as vaccination sites and digital platforms. And the Bhutan Vaccination System helped to rollout the second vaccine doses. In addition, the Health Ministry itself conducted online conferences in districts and villages to address vaccine-related concerns. The challenge in the healthcare system of the shortage of doctors was met by recalling 50 registered doctors from overseas. The demand for nurses and healthcare workers to manage vaccination sites were met by an ongoing program called 'Guardians of the Peace.' A combined effort of solidarity to identify and reach out to the remotest populations and good leadership were the hallmarks of Bhutan's vaccine rollout. As a role model for low and middle-income countries, Bhutan showed us how to achieve equitable vaccine rollout [74].

Kenya

Vaccinating people for COVID-19 has been a challenge when vaccinating hard-to-reach communities. Several strategies were adopted worldwide to enhance vaccine acceptance among these communities and to check if there were enough vaccine supplies. Kenya adopted one such vaccination strategy to reach nomadic herders which was the most challenging community to reach. The authorities planned to reach out to 250,000 people of these cross-border communities and encourage them to get a jab to boost the uptake of the COVID vaccine. They offered the COVID-19 vaccine and livestock vaccination at the same time [75].

Israel

Israel was one of the first few countries that initiated a national campaign to vaccinate its population against COVID-19 in December 2020. With a population size of 9.1 million and a population density of 400 per square kilometer, Israel rapidly rolled out its vaccination campaign.

During the time-line of one year (December 2020 to December 2021), Israel had successfully administered 10 million vaccine doses in a quarter with 54% of its entire population being fully vaccinated. A well-developed health system that includes advanced information technology and logistical capacity of community-based healthcare providers, well trained and salaried nurses, cooperation between central and state governments, health plans, hospitals, and emergency care providers along with an effective existing system for implementing prompt services to address large-scale national emergencies, was in place in Israel. The existing system was able to prioritize, allocate, and document its vaccine eligible population and to vaccinate them [76, 77]. It already had a robust system in place. There were other factors specific to the COVID-19 vaccination effort that included: government funding for vaccine purchase and distribution, timely contracting for vaccines required for Israel's population, determined priority, distribution process, creative cold storage, demands for the Pfizer-BioNTeach COVID-19 vaccines, and well-tailored outreach efforts to increase vaccine acceptance.

From a 7-day moving average of new COVID-19 cases of 149 per day in April 2021, there is an increase to a 7,320 per day 7- day moving average in August 2021, Israel saw a dramatic change in the COVID-19 vaccination response rate. The number of COVID-19 cases peaked in September 2021 despite 60% of the population being fully vaccinated. This was the result of a third wave fueled by the Delta variant. The share of Delta-positive sequences in Israel increased from 13% in the first week of June to 87% in mid-August indicating that the new cases were driven by the Delta variant [78]. The rise in cases among the fully vaccinated showed that the efficacy of the vaccine in preventing infections against the Delta variant had reduced but the share of severely ill patients and fatalities was recorded to be lower among the fully vaccinated. This data also indicated that the vaccine continued to protect people against critical infection, sever illness, and death. Considering the existing data, Israel adopted the strategy of administering a third dose to people over 60 years of age who had received their second shot at least five months earlier. Israel's Ministry of Health used aggregated data from the national SARS-CoV-2 surveillance, vaccination program dataset, and other sources such as research studies that compared disease incidence in vaccinated and unvaccinated people. This data helped to develop efficacy estimates of the Pfizer vaccine [76]. The 7-day moving average reduced to 457 per day in the month of November 2021 with over 64% of the population being fully vaccinated and 42% having received COVID-19 booster doses.

In a successful vaccination campaign, continuous sharing of data through a full bodied platform to examine vaccine effectiveness and the impact of high vaccine coverage, in real-world conditions helped the scientific community to undertake parallel studies. This continuous data sharing helped to develop an understanding of how demographic and socioeconomic characteristics are significant predictors of vaccination behavior and how this changed when the new Variant of Concern was detected in the country in August 2021. These studies also revealed that a lack of confidence in COVID-19 vaccines is a major factor in vaccine hesitancy [79].

United Kingdom

The United Kingdom (UK) with a population of 40 million and 54 per square kilometer population density, was the first country in the world to undertake a COVID-19 vaccination program by approving the use of Pfizer/BioNTech vaccine and starting inoculations on December 8, 2020, and then of AstraZeneca by December 30, 2020. During that time the 7-day moving average was around 30,000 new COVID-19 cases per day, which soon decreased to 5,000 [7] new cases per day by March 2021 when phase 1 of vaccination was completed. The vaccine was offered to people based on advice from the Joint Committee on Vaccination and Immunization (JCVI). The administration of the vaccine was divided into phase 1 and phase 2 with group numbers from 1 to 12 categorized based on descending age orders and priorities. Vaccination for 12–15 years old children was rolled out on September 20, 2021 [81, 82].

Based on the JCVI recommendations, in August 2021, the UK government started a 'third primary dose' of vaccination for individuals aged 12 and over who were severely immune suppressed when or shortly after they received their first or second doses. This primary third dose was different from the booster dose that was started in September 2021 for the phase 1 group and in November 2021 onwards for phase 2 and other groups.

Two doses of the Pfizer/BioNTech and AstraZeneca vaccine were estimated to be 96% and 92% effective, respectively against hospitalization with the Delta variant. Even after providing four vaccines for use: Pfizer-BioNTech, Oxford-AstraZeneca, Moderna, and Janssen and the high rate of COVID vaccination, the UK showed an unusual trend of new COVID cases recorded on a daily basis since July 2021. Until November 2021, the UK had vaccinated more than 8 in 10 individuals aged 18 and over with both doses of the vaccine and around 6 in 10 individuals aged 50 and over with a booster or third dose. But the 7-day moving average of new COVID cases reached as high as 40,000 per day with the Omicron strain which spreads faster. It was also found that people who had already received two doses of the COVID vaccine were being hospitalized [80–82]. This raised concerns. It looked like a race between 'the virus and the vaccine'[83].

UK, with an average rate of 400,000 vaccine doses administered per day, placed a spotlight on the risks and benefits of expanding the vaccination program in an effort to help other nations and make vaccines available in poorer countries or to focus on the UK epidemic. Other options like providing resources and funding to COVAX, the global vaccine sharing initiative, supporting technology transfer agreements to domestic manufactures, and scaling up vaccine production helped to ensure that at least 10% of the world was vaccinated and also prevented the emergence of new strains as recommended by WHO [84].

Japan

A country with a population of 126 million and a population density of 347 per square kilometer, organized one of the most effective COVID-19 vaccination programs. But Japan delayed its COVID-19 vaccination campaign by two months compared to several other developed countries that started their COVID-19 vaccination campaign in December 2020 as soon as COVID-19 vaccines became available.

The lag in the rollout can be attributed to: (1) the delay in the COVID-19 vaccines regulatory approval process that required domestic clinical trials. Japan required more clinical tests than other countries for the vaccine to be deemed safe [85, 86]. It was also due to the smaller number of patients with COVID-19 recorded initially in the country, which were less than the number required to register into international clinical trials to prove vaccine efficacy. The delay in the country's own review process was due to changes in the regulations for vaccine approval that were considered only after Japan's program was criticized. (2) Japan also experienced a delay in vaccine importation. (3) In Japan the vaccine rollout system was insufficient for achieving mass vaccination and ensuring other legal bindings [87].

Japan rolled out its vaccination program in the middle of February 2021 when the 7-day moving average of new COVID cases was recorded to be 1,500 per day. After the slow rollout of COVID vaccines with only 3% of its population being fully vaccinated at the start of June 2021, the country was under pressure to reduce the infection case load before the Summer Olympics when the number of new COVID cases was recorded to be as high as 3,553 cases per day [7] by July 2021. However, Japanese doctors administered more than one million doses a day throughout the summer and the country fully vaccinated 45% of the population by the end of August 2021 with three vaccines AstraZeneca, Pfizer, and Moderna [88]. This vaccination rate was achieved while the Summer Olympics 2021 were ongoing. By November 2021, Japan fully vaccinated 77% of its population and reported 90 new COVID cases per day [7].

South Africa

South Africa experienced the maximum number of COVID waves with the fourth wave of the Omicron variant reported in December 2021. This African country, with a population density of 47 per square kilometer, has 20% of its 60 million population with waning immunity due to HIV. It is one of the most vulnerable countries [89]. So, to meet the demand, the government being the sole responsible body for sourcing, distributing, and overseeing the rollout of the vaccine, adopted various strategies to vaccinate its population. The international body COVAX played a major role in arranging for the vaccine.

Drug and vaccine manufacturers have always preferred bigger markets as testing hubs to avoid the expense and uncertainties of testing products, which is why less

than 3% of clinical trials were implemented in Africa. The constant mutation of the COVID virus made it evident to the world that manufacturers cannot afford to wait years to test the efficiency of vaccines in poor countries. It was due to the efforts of Shabir Madhi, who approached the Oxford team and Novavax to conduct clinical trials in South Africa to highlight how different socioeconomic and health conditions can change the vaccine's performance. But he faced many challenges even after getting funding from the Bill and Melinda Gates Foundation to run the vaccine trials. This was due to lack of resources like cold freezers and backup generators and a shortage of a trained workforce. Despite these challenges, along with his team, he somehow managed to conduct clinical trials with limited resources. This promoted South Africa as the epicenter of clinical trials and as an important local vaccine producer [89]. The goal of conducting clinical trials in South Africa was to later leverage deals with vaccine manufacturers to provide vaccines to South Africa. However, this really did not happen.

The daily confirmed COVID-19 new deaths that had peaked at 292 during the first wave, rose to 577 deaths in the second wave and then declined to 420 deaths during the third wave. The fourth wave again picked up exactly when the third reached its tail. In a span of two weeks, South Africa experienced a significant rise in new COVID cases from 1,200 in the last week of November 2021 to 16,000 new COVID cases per day as per [7] in the last week of December 2021. This was because of the low vaccination rate in South Africa with only 42 doses per 100 people. This rate was even lower in other African countries [90]. Due to its reliance on a combination of bilateral deals, donations, and the COVAX vaccine sharing scheme, the country struggled to get supplies until August 2021. It was not just the uneven supply of the vaccine, but the country also faced the issues of misinformation or a lack of good information about the safety of the vaccine [90]. Initial issues were related to vaccine deployment through the central management approach using an electronic data system that was later abandoned as it made vaccines less accessible.

Comirnaty and Johnson & Johnson's JNJ-78436735 are two authorized COVID-19 vaccines in use in South Africa with enough supply. But the challenge was to deploy them. Adopting a new approach of walk-in vaccinations, South Africa did fairly well but challenges remain because most of its population is living with HIV infection.

The country has a long-term agenda which is to increase its own vaccine production capacity from the current 1% rate of production to 60% that Africa needs. COVID-19 vaccine trials will definitely serve as an important starting point to generate future opportunities [91].

Concluding Comments

The vaccine for COVID-19 has been the fastest vaccine ever developed and deployed. Continuous efforts by the scientific community, international organizations, and governments made this possible. Studying the vaccination rates of densely populated

countries and analyzing COVID-19 vaccination strategies of these countries provides a clear picture of progress made so far. By using international frameworks and vaccination strategies for COVID-19, this chapter underscores that there are substantial challenges in the development, procurement, and supply of COVID vaccines and their impact on vaccination in low- and middle-income countries. Patents for COVID-19 vaccines, waning immunity, the need for booster doses, and surplus vaccine stocks in Western countries are the factors responsible for vaccine inequity. Despite the efforts of international organizations and coalitions like CEPI, WHO, PAHO, GAVI, COVAX, and G7, manufacturing vaccines and making them available equitably has been a difficult goal to achieve. The lack of equity has resulted in high vaccination rates in high-income countries and uncertainty of vaccine access in the rest of the world. Unequal vaccine distribution is one of the main reasons for the relapse in COVID-19 infection even in countries which have 75% fully vaccinated populations.

A review of data on COVID-19 infections and vaccination rates draws attention to factors that strengthen COVID-19 vaccination strategies. This review provides an understanding of interlinkages among various factors. For example, technology is important for keeping records, reaching out and vaccinating larger populations, and ensuring transparency. Data transparency, in turn, is necessary for building vaccine confidence among the people and, thereby, increasing vaccine acceptance.

While fully vaccinating everyone against COVID-19 is necessary for controlling the pandemic, equal distribution of the COVID-19 vaccine globally is still a challenge that needs to be addressed. Equity can be achieved by developing stronger international frameworks and actively engaging high-income countries in donating vaccines to the developing world.

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The Impact of COVID-19 on Adolescents, Nodal Teachers, and Frontline Workers

Aparajita Gogoi, Mercy Manoranjini, and Rohini Banerjee

Abstract Adolescence is a critical developmental period that has the power to shape an individual's dreams and future. Young people have been severely impacted by the COVID-19 pandemic. Closure of schools and non-formal education deprived them of learning opportunities and also of social engagement with their peers and educators. Prolonged lockdowns/closures and movement restrictions led to additional emotional and mental unrest and anxiety. Adolescents and youth, especially adolescent girls and young women, experienced higher levels of violence due to quarantine and isolation. The authors discuss the effects of these ground realities on access to health services and education during the COVID-19 lockdowns. They highlight important issues and make recommendations for policy dialogue and advocacy around critical areas like vulnerability to COVID-19 infection, physical abuse, limited access to mobile phones, disruption of supply chains, adolescent-friendly counseling, dealing with violence, early marriage, school drop-outs, and trafficking. Recommendations are made to decision-makers and program implementers for addressing barriers to access timely and appropriate care.

Introduction

Nineteen-year old Meera (name changed), who hails from a village in the interiors of Jharkhand, was on the cusp of entering the first semester of her B.Com Degree when the COVID-19 pandemic first hit. She was the first in her family to attend college and the first in her family to receive a scholarship to aid her studies. But

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the pandemic dealt an unrelenting blow thrusting the promise of a brighter future into complete darkness. Her father lost his job during lockdown plunging the entire family into financial insecurity. Meera's scholarship too, fell through. When she did eventually secure the funds to pay her fees through the support of a local women's self-help group (SHG) and a few generous neighbors, there were more hurdles to overcome—the specter of digital education. Her family barely had the funds for a mobile recharge, much less a stable internet connection. Meera's access to her online classes became more and more tenuous. She either had to forgo classes completely or rely on her peers for help. This process continued to get complicated. What had started out as her being a scholarship student poised for success with the possibility of being able to pull her family out of poverty, had turned into a nightmare.

Over the months of living with the global pandemic, Meera's story is not an uncommon one. Countless adolescents and young people like her across the country—especially in vulnerable communities and marginalized social contexts—grappled with myriad financial, social, gendered, and emotional burdens due to the pandemic [1]. While isolation from peers took a severe toll on young people's mental health, other struggles were also encountered, like that of the vast digital divide, the added responsibilities of house work and care work for young girls, increased domestic violence and increased likelihood of girls dropping out of school and being forced into unwanted marriages.

India has the world's largest young population—253 million. Every fifth person in the country is between the ages of 10 to 19 years [2]. This period of adolescence is a critical formative period in the life of an individual. Habits formed at this young age become the foundation for adulthood. At the same time, adolescents experience a unique set of struggles. While education plays a key role in their lives, they are also more susceptible to a wide spectrum of communicable and chronic health conditions including nutritional deficiencies, substance abuse, mental health and reproductive and sexual health problems. At the same time, they have limited access to quality health services and health-related information— particularly around sexual and reproductive health. Digital challenges and gender-based violence continues to put adolescents at grave risk. COVID-19 has further exacerbated these risks and heightened inequalities.

Witnessing these realities, the Centre for Catalyzing Change (C3), an organization working for more than 30 years of experience with adolescents, decided that it was important to assess the impact of the pandemic on adolescents' lives and their lived realities during the pandemic. With multiple telephonic surveys and dialogues in states like Jharkhand, Chhattisgarh, Bihar, Odisha and more, covering thousands of adolescents as well as stakeholders who interact closely with them, C3 made an effort to understand the risk factors affecting school dropouts including early marriage, health (including physical, reproductive, menstrual, and mental health), nutrition, and digital access.

Here's what these surveys told us:

Access to Food and Essential Commodities

> Earlier we used to have two side dishes for a meal but now we manage with only one dish. My younger brother used to have milk twice a day but now he has it only once a day. We have minimized our food consumption to manage within our available resources.
>
> —Adolescent girl, Uttar Pradesh.

Perhaps the most immediate and significant impact of the COVID-19 pandemic was the resulting financial crisis which resulted in widespread loss of livelihoods among vulnerable and marginalized families and the lack of resources to purchase food and essential commodities. Difficulties were widely reported in procuring milk, vegetables and other essential groceries, not only in C3's initial survey with adolescents in Bihar, Chhattisgarh, Jharkhand and Odisha (between April and August, 2020), but also in the Lived Realities Survey that was conducted across nine states. Respondents in the former survey reported that only 20% of adolescents could easily access these essential supplies [3, 4].

There were distinct gendered differences in how these gaps in access were experienced. Marginally a higher percentage of young girls (39%) faced difficulties in accessing essential commodities in comparison to young boys (34%). The gendered effects were more pronounced in the gap in access. The responsibility of going out even during the strict lockdown restrictions and procuring essential supplies (like groceries and other household products) fell significantly on adolescent boys (74%). The mobility of young girls was severely curbed. Girls were only allowed to go outside when they had to perform household chores like fetching water, bathing, and washing clothes (since the sources of water were in most cases located largely outside their houses). Only 39% of the girls were allowed to venture out within their villages on their own compared to 62% of boys of the same age who were allowed to go out.

School Closures, Disruptions in Education, and the Gendered Digital Divide

> I wanted to nrol for school. But it is closed and there are no admissions right now
>
> —Adolescent girl, Maharashtra.

The COVID-19 pandemic shed a cruel and incisive light on the tenuous access adolescent girls in India had to formal education. It also highlighted the vast gendered divide in digital access and digital literacy.

For adolescents, especially adolescent girls from marginalized, economically impoverished rural backgrounds, schools are often safe spaces. For them, schools often go beyond simply being a source of knowledge to becoming a larger medium of exposure to opportunities, ideas, and modes of expression that they otherwise

cannot access in their social and familial settings. In fact, for countless adolescent girls, schools become an essential means to circumvent the burden of early marriage and for securing their future rather than being coerced into patriarchal social norms and practices.

And so, with the closing of schools as the COVID-19 pandemic began, adolescents were completely left in the lurch. Among the school going adolescents surveyed initially in Bihar, Odisha, Jharkhand, and Chhattisgarh, 96% were grappling with school closure and nearly half of these adolescents had not been provided with any guidance/support for studying during the first COVID-19 lockdown. Here too there was a gendered divide. More boys (54%) than girls (49%) reported that their teachers had provided them with guidance. During the pandemic, adolescents also faced other shortages that hindered their ability to study. Between April and August, 2020, 48% could not access essential textbooks and notebooks. The other daunting, almost insurmountable, challenge was that of digital access.

Even before the pandemic, India alone accounted for nearly half of the world's gendered digital divide [5]. The pandemic further highlighted how gender biases, financial constraints, lack of infrastructural support, and absence of digital skills puts young girls at a distinct disadvantage when it comes to digital access. In a survey conducted in association with the Digital Empowerment Foundation (DEF) across 29 districts in 10 states, C3 found that 71% of the adolescent girl respondents did not own a mobile phone because they could not afford it and 79% did not have a computer at home [6]. At the same time, access to digital modes in community facilities like schools, community centres, and internet cafés was severely limited with 83% of the girls getting less than even an hour of internet access in a week. But this is not where the struggle ended; 65% of the teachers and 60% of the community organizations said that parents often considered mobile phones 'unsafe' and an 'unhealthy distraction' for their adolescent daughters. Even when families and adolescents could afford smartphones, computers, and other digital devices, male family members were given priority and precedence over the female family members.

Given that online learning was, and continues to be, the most significant transformation within the educational system in the aftermath of the pandemic, this lack of digital access and digital literacy for young girls alienated them from education even further. Stories like that of Meera, who despite getting admission into a reputed college experienced significant hurdles in her education due to inadequate digital access, are widespread. There were anecdotal reports of young girls getting forced into early marriage because they did not have the digital resources to continue their online education. And even more disturbing, there were cases of young girls succumbing to suicide due to the frustration and angst of not having digital access for attending online classes.

Barriers in Health Service Delivery

> Managing menstrual hygiene without access to sanitary napkins was a huge challenge faced by us. Shops were closed and government supplies were not available during this period
>
> —Adolescent girl, Odisha.

With the public health system, especially in rural areas, being overburdened with COVID-19, other essential health services were severely disrupted during the two waves of the pandemic. The supply of essential nutritional supplements like iron and folic acid (IFA) tablets important for tackling anemia and the supply of sanitary napkins at community centres and medical shops and access to other reproductive health services was hampered due to lockdown restrictions and the diversion of resources and public health manpower to battle COVID-19. In Bihar, 87% of the elected women representatives surveyed reported that women and girls did not receive IFA tablets. In Jharkhand and Chhattisgarh, only 1% of the girls surveyed reported receiving sanitary napkins during the initial lockdown.

This paints a dire picture indeed. Girls from marginalized, rural communities often rely on local a*nganwadi* centres (AWCs) and community leaders for their essential health needs a*nganwadi* workers (AWWs) were overworked and overburdened with the pandemic response, and so sidelined adolescent girls' health needs which could have devastating long-term implications. With the already exacerbated food insecurity during the pandemic, long-term nutritional health outcomes among young girls are likely to worsen. Because of the inadequate supply of sanitary napkins and other menstrual hygiene products, girls resorted to unsafe and incredibly damaging forms of menstrual management such as using used, unsterilized cloth, scraps and so on which can not only cause reproductive tract infections but can also have other long-term health impacts.

The Crushing Toll on Adolescent Mental Health

> The pandemic has led me to worry about what will happen to my studies in the future. Because of this, I am unable to eat or sleep properly and I am emotionally distressed.
>
> —Adolescent boy, Chhattisgarh.

In the aftermath of the pandemic, the prevalence of anxiety and depression among young people increased monumentally. Disruption of mental health services during lockdowns, the widespread impact of school closures, the looming labor market crisis that disproportionately affected young people, the loss of peer interactions, and the loss of physical spaces of support and expression plunged countless adolescents into despair, uncertainty, and a state of hopelessness. Vulnerable young people, especially young girls, those struggling with substance abuse, and those who identify on the LGBTQ spectrum, were at an increased risk. Severe shortage of psychosocial support and affordable and accessible mental health services, alongside stigma around mental

health issues (which makes it difficult for adolescents to access information on mental health) and the hesitation and discomfort adolescents experience in terms of opening up to adults about their mental health concerns, made it all the more difficult for them to seek help.

In C3's initial survey in Bihar, Jharkhand, Odisha, and Chhattisgarh conducted between April and August, 2020, about a third of the young respondents stated that as a result of the pandemic they were anxious about the financial status of their families; 19% said that their family environment was stressful because of verbal and physical fights at home. Another assessment in late 2020 in two states revealed that about a fourth (23%) of the young respondents felt low, depressed, or hopeless during the COVID-19 pandemic. Four percent had contemplated suicide in the past one year.

In 2021, C3 convened a series of interactions with adolescents to understand their mental health concerns during the pandemic through 'Mental Health Conclaves' where both adolescents and other key stakeholders who interact closely with adolescents (teachers, frontline workers, and health service providers) across 12 states of India shared their experiences. A diverse group of adolescents including LGBTQ youth participated in this conversation. It was emphasized that mental health struggles of adolescents are not monolithic and so cannot have monolithic solutions. During these conclaves, the major stressors and triggers for poor mental health that came up were the struggle of coping with online education, isolation from peers during lockdowns, dealing with family pressures, barriers to practicing proper menstrual hygiene, and heightened exposure to social media.

Loss of Agency and Increased Vulnerability to Violence and Discrimination

> At home also sometimes, there are fights between mother and father. They fight over things like what will we do when we have shortage of supplies? How will we manage? Mother is also constantly in tension. If coronavirus wasn't there, I would have earned some money by taking tuition classes.
>
> —Adolescent girl, Maharashtra.

In a cultural context like that of India where women already have limited agency and where their safety and dignity is tenuous, the pandemic further eroded their agency and sense of personhood making them all the more vulnerable to violence and discrimination. Adolescent girls' choices around their mobility, their future academic or professional prospects, or even marriage, were in jeopardy. It was the family's financial situation that determined whether an adolescent girl could continue her education, whether she could go out and work, and whether she could spend more time on leisure activities or participate in house work and care work. For example, as per C3's initial lockdown survey that was conducted in four states between April and August, 2020 showed that deeply entrenched gender roles led to more adolescent girls being thrust into activities like household cleaning (61%), cooking (59%),

washing clothes (44%), washing utensils (41%) and taking care of siblings (23%) than adolescent boys (19%, 12%, 17%, 8%, and 17%, respectively). At the same time, due to their family's dire financial situation, 27% of adolescent girls felt compelled to undertake more income-generating activities during the lockdown rather than to focus on their studies. A higher proportion of boys than girls felt their economic contribution to the household was essential.

At the same time, gender-based violence also increased. It was triggered by both prolonged confinement at home and extreme financial insecurity brought on by the pandemic. In C3's Lived Realities Survey, women and young girls across nine states unanimously reported an increase in verbal and physical abuse. Anger and frustration of the men in the households were due to job losses, uncertainty around the future, debt, and spending limitations. Lockdowns also made it difficult for victims of such violence to seek help. Not only did they have a mounting burden of household chores to grapple with, they also lost privacy and personal space as all the family members now lived under one roof. Their awareness of crisis helplines was abysmal. Only 36% of the adolescents surveyed between April and August, 2020 knew the correct helpline numbers. Awareness around the use of these helplines was even lower. Only 18% knew that they could be used for reporting domestic violence. Only 22–23% knew that they could also be used for reporting child labor and child trafficking cases.

Adolescent girls' vulnerability to child marriage was at its peak during the pandemic. While 8% of the adolescents surveyed between April and August, 2020 said that they had heard about instances of child marriage in their neighborhood; 2–3% said that their family members were already planning their marriages. Their chances of getting married early increased. The prevalence of early marriage was higher among young girls compared to young boys.

Support from Government Schemes

> These schemes have helped women during the lockdown as women received money in their Jan Dhan account or Ujjwala Yojana and girls who are enrolled in school also received money. So, at this time of crisis, when men have lost their income, women have become the support system for their family. However, it is still the husband or the father who decides how to spend this money.
>
> —Woman respondent, Bihar.

A slew of government schemes was launched during COVID-19 to mitigate its social and economic impact. Hearteningly, awareness around these schemes among adolescents was good. More than half of the adolescents (66%) surveyed between April and August, 2020 said that they were aware of government schemes. Of the adolescents who were aware of these schemes, 69% knew of the *Ujjwala* Scheme (under which the government provided free gas cylinders), 64% knew about the government's distribution of subsidized rations scheme, and around 64% knew about the *Jan Dhan* Scheme which facilitated cash transfers for struggling families.

However, despite this, only 43% of the adolescents' families actually availed the Subsidized Ration Schemes. The proportion availing the *Jan Dhan* Scheme (35%) and *Ujjwala* Scheme were even lower. This discrepancy between knowledge and actual access to the schemes was definitely a cause of concern, leaving room for other program and policy-level interventions to bridge this gap.

A similar gap was demonstrated when it came to government-sponsored scholarships and exemption of school fees. While 20% of adolescents knew of these scholarships and 13% knew about fee exemptions, a mere 9% and 4%, respectively could actually avail these schemes.

However, all was not bleak. While, in the first round of this survey only 2% of adolescent girls reported receiving sanitary pads that were initially provided free of cost by government schools, the percentage rose to 28% in the second round of the survey in August 2020. Despite a significant number of adolescent girls continued to access sanitary napkins. There was a two-fold rise in numbers from the first round to the second signalling positive improvement— even if by baby steps.

Responses of Frontline Workers and Teachers

Adults who engage most closely with adolescents beyond adolescents' immediate families, are local frontline workers and their teachers. Local AWWs, ASHA workers, and ANMs regularly address adolescents' health needs and are uniquely positioned to support them both physically and emotionally thereby ensuring their overall well-being. Teachers too are constantly exposed to the intellectual, cognitive and emotional growth of adolescents. These authority figures and role models can genuinely influence their thinking. Hence, a conversation around the impact of COVID-19 on adolescents is incomplete without hearing from frontline workers and teachers.

Frontline Workers

The true heroes of the pandemic response were the frontline workers (ASHAs, ANMs and AWWs) who work tirelessly, at the risk of their own wellbeing to support communities to battle the virus. In the absence of schools, AWWs took on the mantle of distributing dry rations and food to deprived children and adolescents and also engaged regularly with adolescents to coney information on menstrual hygiene, reproductive health, the importance of IFA tablets and more [7].

Frontline workers were instrumental in ensuring that the regular immunization of children was not hindered during the pandemic. While 96% of frontline workers C3 surveyed in Jharkhand and 78% in Chhattisgarh helped children in receiving vaccinations from their local AWCs, 43% from Chhattisgarh and 36% from Jharkhand did so through a public health centre or a sub-centre in their locality, 12% of the frontline

workers reported that children received vaccinations through home visits by ANMs and ASHA workers.

At the same time, their work was fraught with several challenges. Reaching out to the community became difficult due both to lockdown restrictions and a reigning fear of the virus. While 77% reported that the community expressed fear and distrust as they were apprehensive of the frontline workers, being potential carriers of the virus, 40% said that it was difficult for them to directly reach communities as Village Health and Sanitation Days (VHSNDs) were not organized during the initial lockdown period. At the same time, social distancing norms mandated that frontline workers engage with officials, other fellow frontline workers, and the community through online mediums. While 84% were able to use WhatsApp, 30% Zoom and 10% Google Meet, digital literacy around these platforms was still low. Only 24% of frontline workers were comfortable engaging with communities through audio-visual content, 48% were only somewhat comfortable, and 15% were not at all comfortable with conveying health-related information through audio-visual content [7].

Teachers

While the closure of schools significantly affected adolescents, teachers too had to grapple with this tectonic shift in the medium of imparting education. There are lakhs of teachers working in educational institutions all across India. During the pandemic, they had to adjust to a completely new format of teaching— online classes— for which many lacked the resources, access, and some even the skills. Adapting to this new normal coupled with the uncertainty of the pandemic, was something that not only added to the burden of stress that teachers faced, but also anxiety about how they and their students would cope in the future [8].

For better understanding, the impact of the pandemic on formal education from the teachers' perspective and to gauge their apprehensions and difficulties during this time, C3 reached out to over 1,000 nodal teachers who were assigned to conduct e-learning across three high-burden Indian states—Jharkhand, Chhattisgarh, and Bihar—through a structured survey conducted between April and September, 2020.

During school closure, teachers had to find various alternative ways to connect with students in the absence of physical classes. One such method was mobile messages which were unanimously reported as the most adopted platform for connecting with students during the lockdown across all three states. While 88% of teachers in Chhattisgarh and 87% in Jharkhand took to mobile messaging, the number was a tad lower in Bihar with 73%. Mobile apps like *Unnayan* and Digi *SATH*, which enabled an accessible and user-friendly interface for teachers to impart their lessons was widely preferred. Teachers also adopted other virtual platforms such as pre-recorded video/audio classes (46%), *Doordarshan* /NCERT *Swayam Prabha Diksha* (57%), and E-*pathshala* (22%) [8].

However, when it came to formal, structured online classes, the numbers were far from encouraging. Despite being able to connect with their students via mobile

messaging, a mere 66% of the teachers in Jharkhand, 53% in Chhattisgarh, and 46% in Bihar were able to fully adopt online classes during the lockdown. Inadequate access to resources such as a reliable internet connection, a personal computer or smartphone of their own were major contributors to such low numbers. A whopping 82% teachers in Bihar and 74% teachers in Jharkhand said that they "did not have access to resources to provide online classes". The number was slightly lower in Chhattisgarh (32%). Female teachers stated they had to often use their male family members' phones to conduct online lessons and to engage with students. Others reported that they had to somehow manage with the inadequate resources available to them.

The other major barrier to online classes which was echoed across the board was the lack of skills for remote teaching. More than half (53%) teachers from Bihar, 35% teachers from Jharkhand, and 23% from Chhattisgarh stated that they lacked the adequate skills required for distance teaching and faced difficulties in adapting to this new teaching model which hindered the pace and structure of their classes.

Teachers were also deeply concerned about the long-term effects of school closures with 72% of them fearing school drop-outs of children from poor households, and 57% fearing drop-outs from children who did not have parents. Around 3/4ths of the teachers surveyed said that children were likely to drop-out of school due to financial problems.

At the same time, almost 54% of the teachers (31% in Chhattisgarh; 67% in Bihar; and 55% in Jharkhand) feared that the challenges in adapting to online learning might ultimately lead to lower learning outcomes among students i.e. that they would no longer receive the quality of education that is necessary for their continued growth.

Recommendations

As we near the completion of two whole years of living with the pandemic, the questions that bear repeating are: How do we rebuild? How do we ensure that the damage done by the pandemic does not leave permanent stress? How do we ensure that adolescents' lives and futures are not completely jeopardized? How do we offer support at policy, programmatic, community, and personal levels? How do we envision recovery?

Ensuring Access to Education

In the absence of schools and opportunities for one-on-one learning, we need to develop alternate strategies for young people to engage with their peers and with the larger community and have access to informal opportunities for learning and psychosocial development. Mobilizing existing resources to develop remedial courses that can be delivered through peer learning, blended solutions that provide

education specific to the learner's context while at the same time, leveraging both hi-tech (digital mediums), low-tech (simple SMS and phone calls), and no-tech (governance structures like school management committees, teachers' groups, parents' groups and *gram sabhas*) modes for continued learning, is the need of the hour. At the same time, designing these learning methods without taking into account the diverse and unique challenges children, parents, and teachers face would be counterproductive.

Once schools begin to reopen, priorities must shift to reintegrating students and teachers into the school setting and ensuring that students actually return to schools and do not drop-out indefinitely. This could be a challenge, given the time and effort both teachers and students will require to readjust to school settings given that a significant number of students might have already dropped out either due to early marriage or familial pressure. However, re-enrolment campaigns for students, professional development workshops for teachers, participatory community action, financial and non-financial incentives (through mid-day meals programs, direct cash transfers, and conditional cash transfers etc.) could go a long way in achieving this. School management committees, elected representatives of *Panchayati Raj* Institutions, *Bal Sansads*, and Self-help Groups can play an important role in monitoring and facilitating community-level efforts for preventing drop-outs and ensuring school attendance. At risk youth—those in financially vulnerable situations and those who fell prey to substance abuse or patriarchal policing need to be given extra care and support through tailored interventions such as part-time school, night school, etc.

At the same time, gaps in gendered inclusion in education due to the massive digital divide cannot be ignored. Girls cannot be left out simply because they cannot access a smartphone or the internet. An inclusive model for classes must be adopted. And alternate mediums like pre-recorded lessons through television broadcasts need to be leveraged. Additionally, digital access itself needs to be bolstered. Providing better and accessible digital facilities in educational institutions, building infrastructure, increasing machine-to-student rations, and digital upskilling programs for girls along with uninterrupted internet connectivity are the bare minimum amenities that must be made available to young girls. However, efforts to bridge the gendered digital education gap do not end at just providing connectivity. Digital educational content support, meaningful training on digital literacy and safety and digital-based curricula in schools and colleges can not only enhance girls' knowledge, but can also provide them pathways to build their future careers based on this knowledge. Digital libraries can be helpful for those who do not attend school. This should include young girls' exposure to digital spaces at the community level.

Addressing Safety and Violence

First and foremost, there needs to be greater community-level awareness on gender-based violence, including physical abuse, emotional abuse, and sexual abuse as well as awareness of legal provisions and rights of victims of abuse and resources for

seeking help. In all this, the contribution of ASHAs, womens' self-help groups, as well as local women *panchayat* leaders, can be helpful. Under government-run programs like the *Rashtriya Kishor Swasthya Karyakram* (RKSK), these stakeholders can play a key role in keeping a vigilant eye on issues of violence, early marriage, school drop-outs, and trafficking. Since their daily responsibilities already involve going door-to-door in their communities, they can monitor vulnerable households for warning signs and engage directly with the community to challenge stigma and misinformation about domestic violence. They can also engage with District Child Protection Units (DCPU) to identify and support adolescents at risk of early marriage. Most importantly, they need to be equipped with adequate training not only in legal procedures, but also in interpersonal counseling. At the same time, young girls need to be aware of and have access to crisis helplines and information and counseling support. Local ASHA workers, teachers, or *Kishori Samooh* can organize at least one internet-enabled mobile phone in each village which girls can use to contact crisis helplines in a safe and private manner.

Access to Health Services

Despite closures and lockdowns, both in-school and out-of-school girls and college-going adolescent girls should continue receiving essential health products like sanitary napkins, iron and folic acid (IFA) tablets, and supplementary nutrition through the Rajiv Gandhi Scheme for Empowerment of Adolescent Girls (RGSEAG) and RKSK. Sanitary napkins and IFA supplements should qualify as essential services with a provision for home delivery of these products.

Making adolescent-friendly counseling available over the phone where adolescents can voice their physical, reproductive, and menstrual health concerns to medical professionals is equally necessary. Even when adolescents are confined to their homes, they should not lose their safe spaces. Nor should they lose access to essential health services. In C3's intervention areas in Jharkhand, this form of telephone counseling is being facilitated at the community-level and an overwhelming majority of adolescents are availing this service, highlighting just how essential it is.

Health and Wellness Centres (HWCs) within communities can also be positioned as overall 'Wellness Centres' that address both the physical and mental wellbeing of adolescents. It is critical to sensitize primary health care teams at these centres so that they understand the specific needs of adolescents and are equipped to work with them.

Access to Peer Interactions

One of the most significant adverse consequences of the pandemic on adolescents was the gaping lack of physical peer interaction. Adolescence is a foundational period

when the social environment is important for crucial brain development, self-concept construction as well as mental health. Adolescents' use of digital technologies and social media mitigates some of the negative effects of physical distancing. It is important to offer virtual forums to adolescents by creating opportunities for them to connect with their peers and share their mental struggles during difficult times. Small-scale use of issue-based online discussions in C3's project areas in Chhattisgarh demonstrated that adolescents are keen to interact and to connect. Isolation devastated adolescents during a time when they are craving human connection even if virtual or telephonic. There is a need to envision such virtual interactions on a larger scale and to simultaneously keep in mind the safety and privacy concerns that arise with internet communications.

Support for Mental Health Needs

Given that a large number of vulnerable adolescents lack access to formal mechanisms for mental health support, there is a need to recognize and promote community-based psychosocial support to address their mental health needs. Adequate resources (financial and human) must be allocated to ensure proper and equitable provision of psychosocial support and services including helplines, social media, apps, and other digital platforms that offer support and telemedicine guidance and support to victims of violence.

Most importantly, there is a need to sensitize not just adolescents, but also families and communities to recognize when someone is experiencing mental distress and understand the importance of seeking help for such distress. Until we break the larger stigma around mental health and make formal channels of mental healthcare affordable and easily available, we cannot adequately address the mental health needs of adolescents.

Conclusion

Young people are the future of the country. They are the ones who will determine social and economic development in the coming years. Therefore, ensuring their health and wellbeing is not just a key individual need, but is fundamental for the nation's progress. With the pandemic causing massive disruptions in the lives of adolescents, it is crucial now more than ever before to come together to understand their specific needs and experiences and counter the barriers that are threatening their future.

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Impact of COVID on Our Digital Lives

Sharon Khushroo Pithawalla and Anshul Chhabra

Abstract The COVID-19 global pandemic has ripped through our society like a tornado, displacing and destroying everything in its wake. This is not different from the many other pandemics that have hit throughout the history of humanity… except for one new dimension that did not exist earlier, the digital dimension. According to a Pew Research Center survey, only 7% of adults in the US say they do not use the internet, which means 93% use the internet in some manner. COVID-19 has irrevocably shifted the direction of human attitudes and technology/cybersecurity on our planet. Whether it is our wide acceptance of technologies like Zoom as a natural way to interact with each other in a variety of social, educational, and work settings, or the mindshift around the acceptance of remote work and Zoom parties, or even the boost to the upcoming virtual, augmented, and hybrid reality of a metaverse, COVID-19 marks the beginning of another epoch in the modern history of humankind. In a seemingly contradictory way, COVID-19 has further exacerbated the digital divide, while also providing a fresh new boost to further innovation and the inevitable merging of our physical and digital lives. It is at once a deeply anxious and deeply exciting time that we are all living through. Those of us who live through this pandemic will clearly remember the answer to the question— where were you during the pandemic….

Introduction

The COVID-19 global pandemic has ripped through our society like a tornado, displacing and destroying everything in its wake. This pandemic is no different from others that have hit throughout the history of humanity, except for one new dimension

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that did not exist earlier, the digital dimension. According to a Pew Research Center survey, only 7% of adults in the US say they do not use the internet, which means that 93% use the internet in some manner. COVID-19 has irrevocably shifted human attitudes and the direction of technology/cybersecurity on our planet. Whether it is our wide acceptance of technologies like Zoom as a natural way to interact with each other in a variety of social, educational, and work settings, or the mind shift around the acceptance of remote work or Zoom parties, or even the boost to the upcoming virtual, augmented, and hybrid reality of a metaverse, COVID-19 marks the beginning of another epoch in the modern history of humankind. In a seemingly contradictory way, COVID-19 has further exacerbated the digital divide while providing a fresh new boost to further innovation. It has led to the inevitable merging our physical and digital lives.

This shift in technology and how we use it has had even more implications on society as it has resulted in inequality, and dichotomy in the success of the technology-enabled industry versus serious challenges faced by core human interaction-based services. There is also the second order impact of the penetration of technology on the threat surface and exposure to cybercrime, and consequently, the need for better cybersecurity for the future. In this chapter, we dive deep into the impact of COVID-19 on technology and cybersecurity, human attitudes around technology, and the post-COVID technology and cybersecurity landscape through the lens of (1) the elderly population, (2) women and children, (3) the workforce, (4) the healthcare industry, and (5) the service industry. We conclude by taking a deeper dive to understand the progress brought about by the pandemic in the acceleration of various technologies in order to draw lessons for the future.

Elderly Population

The elderly population of the US (or even in the world) was a double victim of the COVID-19 pandemic. First, the daily routines of old people were sent for a toss due to social distancing, wearing masks, business and public place closures and countrywide stay-at-home orders. To make survival even more challenging, the elderly were forced to learn and adopt technology as their only means of accessing routine medical services, their personal finances, talking to their families or even just getting their day-to-day groceries delivered.

Cybercriminals, with their ever-expanding radars, quickly discovered this as a lucrative target. Taking advantage of the lack of technological knowledge and cyber-street smartness, they swindled the elderly using all the tools available in their arsenal, right from emails claiming to have the latest COVID-19 updates, to hijacking their Zoom sessions, to holding their data and devices at ransom. One story that gained popularity through the New York Times and later through many media channels was about how the mother of one journalist, Alina Simone, got her computer and data held at ransom and the challenges she faced to get her data back, besides paying the criminals the demanded ransom [1].

Alina's mother got a ransom note on her computer screen on the Tuesday before Thanksgiving. At this point all her 5,726 files were locked. The hackers called CryptoWall demanded USD 500 in a week or USD 1,000 after that. They threatened that a week after that all her files would be lost forever. This particular type of virus infiltrates your device when you click on an attachment in the email. Once activated, it encrypts all your files and leaves one single file unencrypted for you to know that the data is still there.

After several attempts at trying to decrypt the files with professional assistance, she failed and decided to pay the ransom. However, the payment was not as straightforward as one might think. The hackers only accepted payment in Bitcoin. At the time, Bitcoin was not as accessible to the common public as it is today, and it was even harder for an elderly person to wrap her head around it. As we know, criminals are always a step ahead and anticipate that their "clients" do not know the process. As such, the hackers provided step by step instructions on how to procure the required amount of Bitcoin and transfer it to them.

Keep in mind that it was Thanksgiving time, and many banking institutions were on a break by the time Alina's mother figured out how to make the transfer. She was already on day six, and the clock was ticking… She was finally able make a cash deposit via her bank to the unique Bitcoin "wallet" provided by the CryptoWall hackers. But due to the extreme volatility in the price of Bitcoin, her payment fell short by USD 25 by the time it was converted and deposited. The fastest way to make up for the shortfall was to make a direct deposit at a Bitcoin ATM. As you can imagine, this ATM was not like a bank ATM and was not easy to find. It was located in a hidden location that was a long drive away in the snowy conditions of winter. The ATM was housed in a hallway on the second floor of a cooperative workspace, tucked inside an old Nynex phone booth. Inside was a little white box with just a screen, no buttons, a camera eye, and a money slot. Upon presenting the provided QR code to the machine, it kept whirring for more than 20 min on the "Balance query in progress," screen. After several hours of call attempts and voicemails to "Coin Café", the owners of the ATM, someone answered and said that the "technical issue" was resolved.

Coin Cafe did not support criminals but was in the unfortunate position of brokering these kinds of ransom transactions. They were often faced with elderly parents crying on the phone at the threat of losing all their photographic memories stored on their computers or with small business owners who stood to lose their entire family income. Coin Cafe hated profiting from these desolate victims.

Unfortunately, after all the excitement and getting the final deposit at the last minute, the timer for the seven-day window had just run out and now the ransom had shot up to USD 1,000. Alina's mother was desolate. At that time, someone advised her to use the message interface provided by CryptoWall and tell the criminals exactly what had happened—to be honest, in other words.

Taking their advice, she explained that the virus came in the same week that a major snowstorm had hit the state of Massachusetts and because it was a Thanksgiving holiday in the US, most banks were shut down. She laid out the entire story, her unexpected Bitcoin shortfall due to conversion rates, sending her daughter at the last

minute to make the deposit at the Coin Cafe ATM, and the technical issues she faced at the ATM. She vowed that she had tried her best not to miss the deadline. Suddenly, a weird thing happened: She received her decryption key from the perpetrators!

One might think that the hackers took pity on the poor old woman and let her have her files back, but they had an ulterior motive of maintaining their reputation so that more people would resort to paying the ransom rather than deal with the authorities.

This is just one of the hundreds of thousands of stories about how hackers took advantage of the naivety of the aging population. There are several other stories out there about fake messages from grandchildren asking for money due to illness or being stuck overseas or malicious actors posing as individuals asking for money to help during quarantine. The American Association of Retired Persons (AARP) has also tracked the increasing scams with the group reporting that as of November 12, 2020, it had logged more than 250,000 complaints related to COVID-19 and stimulus payments, with more than two-thirds of the complaints being related to fraud or identity theft. AARP noted that nearly USD 183 million had been lost by consumers as a result of these scams with the average victim losing around USD 320 [2].

On July 8, 2020, the City of London Police reported that since January 2020 more than GBP* 11 million had been lost due to COVID-19 scams [3]. In Switzerland, one in seven respondents to a survey experienced a cyberattack during the pandemic period [4]. Between February 2020 and May 2020, more than half a million people were affected by breaches in which personal data of video conferencing services users (e.g., name, passwords, email addresses) was stolen and sold on the dark web. To execute this attack, some hackers used a tool called 'OpenBullet' [5]. Prior to the pandemic, about 20% of cyberattacks had used previously unseen malware or methods. During the pandemic, the proportion rose to 35% [6].

The only way to start eliminating these types of cyberattacks on the senior population is to prevent them before they reach the intended recipient. There are several resources available to seniors, such as public libraries that offer education about such vulnerabilities. Some of the easiest things to do would be to explain the importance of backing up personal information to external hard drives or by using a cloud backup service like Carbonite, perform timely software updates and take "patch" alerts seriously. Most of all, be cautious of all attachments and links. Legitimate businesses, especially banks, never send attachments or ask the recipient to click on links that ask for personal information. They never ask for a call to be placed to a call center where a mysterious "tech support" person asks for credentials or even asks to log into accounts. When in doubt, always find the number for the institution which issued the credit or debit card or do an independent internet search for the phone number and call the company directly. Even though some of these measures seem foundational, they are of paramount importance for protecting the average citizen. Our collective awareness and adherence to these basic principles can help make the cyberspace safer and more friendly for all.

Women and Children

The COVID-19 pandemic created a complete sea change in the way education is delivered. From day care and elementary school through high school and even all the way to college, there is no aspect of education that was untouched or unchanged by the pandemic. However, the impact is quite varied across the spectrum. The biggest impact was on the youngest of children and their caregivers. The usual mode of replacing in-person childcare and classes with a digital teleconference technology like Zoom is not very effective. Younger children are still learning verbal and social skills and much of their "education" is really just learning how to be in social settings. With the absence of reliable visual and non-verbal cues, it is extremely difficult for young children to keep their attention in the class (which is difficult even without the hindrance of technology). This had a big impact on their caregivers. A parent or care-giver would previously be able to drop the child off at school and proceed to their daily tasks, but now the parent or caregiver is forced to dedicate much of their attention to the child who is now at home instead. They must also find ways to support the child's peer to peer interactions that were also curbed during the pandemic and were, therefore, spend even more quality time with their children. This led to many young families having to sacrifice the time of one of the earning adults for this purpose. This tended to fall disproportionately on women who are traditionally considered as the primary caregiver in our society. In addition to the economic, financial, health, and social impacts, this increased screen time and made children and caregivers more susceptible to cyberattacks.

As we move up the age bracket, the impact of digitized or online education on middle or high school aged children is arguably more manageable as they are much savvier with technology in general. By the time they reach middle or high school, they are better able to focus in the virtual classroom. There are techniques used by teachers which sometimes help increase productivity and participation. For example, turning the camera on, making sure that the teacher still has a very classroom like feel, and keeping the class more engaging to make up for the loss of in-person learning. These teleconference/Zoom like technologies can help children stay more connected with a more geographically dispersed set of friends (though there is of course the sacrifice of in-person interactions).

Since the students are spending so much time online, it opens them up to more social media interactions online which makes them more susceptible to cyber bullying and other nefarious behaviors like phishing attacks, cat fishing, identity theft, etc. "Zoom Bombing" attacks that have gained notoriety are example of nefarious behaviors that are a direct product of this enhanced digital interaction. With increased time spent online, these cybercrime activities can get exacerbated and cause children to be impacted in very real and tangible ways.

There are real losses in terms of team sports or even team activities like robotics (e.g., the annual robot competition and games organized globally by FIRST Robotics). In 2021, the competition was practically scrapped and replaced by an "innovation" challenge in which the participants could take part remotely. However,

this took away the whole experience of understanding technology and its impacts to the real world— not to mention the camaraderie and social benefits of a team activity.

To summarize, there are three main takeaways for digital impacts on children due to the pandemic. First, technology has not had a chance to evolve to truly replace or even partially replace the loss of in-person interactions thus limiting the necessary social and team skills development. Second, the pandemic has forced all of us, especially children, to ramp up their consumption and use of digital and online technology which greatly increases susceptibility to cybercrime. Finally, the socioeconomic impacts on our world because of this, whereby the inequalities and devices that occur in our society, have been further accentuated. Thus, families with younger children who are usually financially more vulnerable are impacted more. And women, who still tend to take on more than their share of child care, are forced to take breaks from their careers.

Some of these trends are here to stay and will even develop further when the pandemic "ends". The technology for better quality of interactions online will continue to develop, which also means that an increased threat surface created due to the pandemic is here to stay.

What is it that all of society can do? Ultimately, this is the question to which all seek the answer. First, awareness and education of technology and online behaviors is of paramount importance for both the children (as appropriate for their age) and definitely for their parents or caregivers. They must keep themselves well-informed about cybercrimes and other nefarious behaviors like cyberbullying of children. Reading and following such stories is one way. The other way is to enroll in, or subscribe to, a reputable cyber protection suite. At the very least, this combination would provide some level of protection against such reprehensible behavior. There are also socioeconomic impacts and so policies to protect privacy, especially for children, need to be implemented. Finally, good old-fashioned techniques like listening and parents staying close to their young children are more necessary in this brave new world than ever before…

We all need to remain aware and alert to global trends, local trends, and to specific clues of what is going on with our children. Dealing with them individually is key. There is one silver lining in all this. In some jobs, where working remotely is equally (if not more) productive, it is possible for parents to have a little more flexibility in their work schedules while still being able to take care of their children.

Workforce

Overnight, thousands of companies were forced to allow their workers to work from home. This was an easy transition for some, especially for those in the technology sector, where working from home or working "remote" was the norm even before the pandemic. However, for a large number of companies, remote-work was beyond their current technological capabilities. The only way they would continue to have a productive workforce was to very quickly shore up their digital capabilities including

devices, networks, and tools that would allow their employees to continue operating from home as they did from the confines of their offices.

The biggest component that these companies needed to focus on, as they allowed their workforce to work from home, was cybersecurity and protection of the company's intellectual assets. A study by the United Nations showed that cybercrime was up 600% due to the COVID-19 pandemic [7]. Since the start of the pandemic, ransomware attacks increased by nearly 500% [8]. Cybercrime is predicted to cost companies worldwide an estimated USD 10.5 trillion annually by 2025, up from USD 3 trillion in 2015 [9]. In 2020 alone, malware increased by 358% overall and ransomware increased by 435% as compared to 2019 [10]. This was just at the beginning of the pandemic…

Overnight, demands were placed on digital infrastructure skyrocketed. The lack of research and rudimentary use of technology also became a larger and more lucrative target for cybercriminals. Officials depend on digital channels to reassure the public and maintain order. With the increased demand on healthcare systems around the world, service providers are turning to remote technologies like virtual chat, email, phones, and telemedicine portals for remote counseling and diagnoses. Companies are allowing less secure forms of communication such as accessing enterprise applications through personal digital devices, with no mechanisms to enforce security or prevent loss of data.

This has opened new doors for cybercriminals. They are taking advantage of the increased dependency on digital vulnerabilities to capture confidential data, siphon money, and hold companies' assets at ransom. By exploiting the psychological vulnerabilities of people, they are launching COVID-19-themed attacks in the form of phishing emails with malicious attachments or websites and apps that show patient count. These emails and apps enable malware to disrupt systems and steal data and credentials. Remote working tools such as Zoom and other videoconferencing systems have been hacked for vulnerabilities allowing "Zoom bombers" to hijack teleconferencing sessions/meetings and insert lewd, obscene, racist, or antisemitic material, typically resulting in the shutdown of the session and loss of reputation for the company.

The only way that companies can face this new digital future is to develop a leadership mind shift to the importance of security measures and allocate appropriate budgets to security as a "must have" not a "nice to have". Some of the measures companies can take involve looking at cloud based security and platform services that markedly reduce deployment time. Additionally, companies that use secure remote access technology can give remote employees private access without a virtual private network (VPN) to enterprise applications and systems. Firms can also use privileged access management (PAM) services to allow special remote access to their information technology (IT) and application administrators [11]. Multi-factor authentication services, including biometric and text-based methods, enable stringent risk-based access to internal applications that are opened for remote access [12]. The following are some points organizations must consider for becoming more resilient:

- Some organizations will need to move to new business operating models.

- Companies will need to reset their security systems to ensure there are no outliers.
- New cyber risks that appeared during the pandemic must be understood.
- Corporate IT security architectures should be reassessed.
- Updates must be made to remote access and bring-your-own-device (BYOD) policies.
- Advanced technology must be deployed.
- Use the most cutting-edge threat detection and response capabilities.
- 'User and entity behavior analysis' or UEBA. This technology analyzes the normal behavioral patterns of users and detects instances where it finds anomalous deviations from the normal pattern.

Companies must ensure that employees who are working from home use either a company issued device or their own personal devices implement the necessary cyber hygiene practices. These include:

- Antivirus protection: Companies must provide their employees with the required licenses for antivirus and malware software, even for use on their own personal computers. This basic measure may not be 100% failsafe, but it eliminates a lot of low-level attacks.
- Phishing awareness: Regular phishing tests and campaigns must be conducted to ensure that employees know how to check authenticity of the sender's address and not fall prey to real looking emails.
- Cybersecurity awareness: Staff should be trained on best practices and procedures to ensure they are not sharing intellectual property or non-public information with non-company domains and cloud storage websites.
- Virtual private networks: VPN's provide an added layer of security to make sure the user logged in is an employee who can only get access to a company resource through the company's network. This provides organizations additional capability to monitor and control the user's access.
- Home network security: As a part of cyber hygiene training, employees must be taught how to create secure passwords or passphrases that are not easily decipherable.
- Identification of weak spots: All technology has weaknesses. Companies should routinely scan for vulnerabilities and patch the most critical vulnerabilities as soon as possible. Surprise penetration tests must be routinely conducted and infrastructure hardening should be performed.
- Frequently scheduled reviews: Existing controls should be routinely evaluated for robustness and cybersecurity risk exposure. They must plan for handling any new vulnerabilities and cyberattacks.
- Refresh business continuity, disaster recovery, and crisis plans: All lines of business need to keep their Business Continuity Planning (BCPs) updated and consider various cyberattack scenarios.

More advanced measures that can be taken include:

- Apply new tools and technology: Companies should use advanced tools such as host checkers that ensure that any device connecting to the company network is secure before allowing it to access corporate information.
- Intelligence techniques: Companies should use artificial intelligence (AI) based tools that identify relevant indicators of attacks (IOC) and address known attacks.
- Risk management: Companies must adopt governance risk and compliance (GRC) solutions for improving their risk management posture. GRC solutions provide an integrated view of the company's risk exposure linking various risk disciplines like cybersecurity, operational risks, and business continuity.
- Be prepared in case of an attack: Due to the frequency and magnitude of modern day cyberattacks, companies must engage in frequent attack simulations and cyber war games to ensure preparedness.
- Zero trust: Chief information security officers (CISOs), chief technology officers (CTOs), and chief information officers (CIOs) should consider implementing a zero-trust approach to cybersecurity. In this security model, only authenticated and authorized users and devices are allowed access to corporate applications and data. Users are not given access to anything unless they need it.

In conclusion, organizations must change their outlook from reactive to proactive and plan for scenarios from 'if' they get attacked to 'when' they get attacked. Preparation is key. Organizations need to increase security awareness among their workforce and quickly react to unforeseen events.

Healthcare

Did you know that Americans' private health data is estimated to be worth up to 20 times the value of financial data on the Dark Web and is sought after by criminals and nation states alike [13]? This makes the Health and Public Health (HPH) Sector a primary target. As with most other growing sectors, the healthcare sector has been rapidly growing and evolving its technical landscape. Internet connected medical devices have been developed and widely deployed, without proper privacy and security measures in place. Proliferation of unregulated mobile apps leverage protected health information and personally identifiable information (PHI/PII) but do not secure it. Many healthcare personnel are overworked and undertrained on cybersecurity.

The advent of COVID-19 has forced many traditional medical institutions and healthcare providers to open up their cyber doors and start seeing patients online through video conferencing as well as exchange private health data through digital portals and email. At the surface, this is a great convenience, even a necessity, but without deeper measures taken to protect this data, it leaves yet another door open for malicious actors.

Some key statistics uncovered during this pandemic prove the point that this shift in digital healthcare requires much more regulatory intervention and security planning [14]:

- Malicious URLs: 35,364 malicious COVID-19 websites were taken down in 2020 alone.
- Phishing: In April 2020, Google reported blocking 18 million daily malware and phishing emails.
- Malware: From January to April 2020, Interpol detected 907,000 spam messages, 737 malware related incidents, and 48,000 malicious URLs tied to COVID-19.
- Several malware groups have been weaponizing COVID-19 maps and dashboards to distribute malware:
- Trickbot is using COVID-19 financial aid schemes.
- AZORult is being spread via malicious COVID-19 case tracking websites.
  - Ransomware attacks: Maze Ransomware attacked mid-Atlantic pharmacy in July 2020.
- In May 2020, a European healthcare group was hit by Snake ransomware.
- In June 2020, an eldercare group based in Maryland was attacked by the "ransomware-as-a-service (RaaS)" group, Netwalker. Ransomware-as-a-Service (RaaS) is an illegal enterprise developed by organized crime syndicates.

Even prior to the pandemic, we were aware that cybersecurity risks existed across the digital health landscape. Medical implants, like pacemakers, were always susceptible to cyberattacks. In October 2020, the Federal Bureau of Investigation (FBI) warned about the increasing attempts of large-scale ransomware attacks on hospitals and medical facilities [15]. At the end of 2020, there was a massive cyberattack on the US healthcare system, which in all probability pointed to nation state involvement. An enterprise patch management tool called SolarWinds used widely in the public and private sector was used as the vehicle to carry out this attack. Initially thought of as a supply chain attack, it was very quickly deemed to be way more complex than just the one software. This attack ended up affecting multiple private and governments organizations including the United States Department of Health and Human Services (HHS), a critical agency in responding to the COVID-19 pandemic in the US [16].

While this incident gained national media spotlight due to the probability of espionage by nation states, there were many other smaller scale malicious criminal attacks and exploitations during the pandemic. Cold storage units that maintain appropriate temperatures for COVID-19 vaccines were plagued with ransomware. Due to the mass scale disruption in the supply chain, COVID-19 vaccines were sold on the dark web at exorbitant prices. In another similar cyberattack, commercial vaccine related regulatory documents were stolen from the European Medicines Agency (EMA). The entire vaccine clinical development industry and supply chain witnessed such sustained cyberattacks.

Vaccine, medicine, medical device manufacturers, and healthcare delivery organizations are responsible for securing product design, network security, and undertaking thorough user and employee training to protect the consumer against phishing and other malicious schemes. As the US moves closer to the Internet of Things (IoT) model, regulations laid out by HHS's cybersecurity guidance and safety communications must be heeded and followed even more closely [17].

A key factor to remember is that cybersecurity must be much more than an afterthought or a "good to have" add on, especially to respond to crises like COVID-19 and to develop digital health capabilities in the future. The role of the chief information security officer (CISO) should be elevated and made integral to digital health planning and implementation. Just like other healthcare licenses, cybersecurity training should be intensified and frequently refreshed for all healthcare employees and service providers. Cyber vulnerabilities in critical systems must be identified and proactively addressed.

Besides cybersecurity, the ability to provide a unified service to the patient is highly dependent upon coherent and accessible data structure, which proved to be a key aspect of the digital health revolution that the COVID-19 crisis exposed as a critical gap. Several critical health care data sources are very disjointed and do not facilitate continuous care despite the 2009 "Health Information Technology for Economic and Clinical Health" (HITECH) Act that pioneered the digitization of health information. This can have a crippling effect in critical situations because data is the backbone for digital technologies that support the global population. COVID-19 highlighted a unique group of lesser-known cases in the healthcare industry and health policy systems. These cases very quickly overburdened the capacity of the current technological landscape. To better understand the failure of the current system, it is important to conduct a national technology review and lookback. This is the key for developing solutions to address the gaps that prevent us from fully adopting technology to achieve healthcare that is equitable, efficient, effective, enhances patient experience, and saves lives.

The non-availability of data and digital interoperability was especially noticed when governments and research organizations were trying to understand the numbers and trends of COVID-19 contact tracing, the treatment capacity of the health system, patient encounters, and developments in the utilization of that capacity. New data modules were published by the US Centers for Disease Control and Prevention (CDC) to standardize the reporting of encounters, capacity, and utilization of data elements in an effort to provide more visibility. In March 2020, former Vice President Michael Pence ordered healthcare organizations in the US to present a daily report of case data. While this step was intended to help combat the pandemic, it became an even greater burden on the overstressed hospital and clinic staff to take on even more responsibility of manual data gathering, filling out a spreadsheet, and submitting it daily. No modern-day enterprise would tolerate such a method.

The key lesson to consider is that if no steps are taken to come to a common solution towards a comprehensive data architecture, similar to other non-healthcare industries, all of the digital tools and data assets of the decades are less useful and effective and will soon become antiquated. Looking forward into the future, the

US needs to be prepared for a similar coordinated mass scale response to health crises. The only way to quickly and efficiently achieve this is by understanding the importance of data architecture and finding effective ways to define and create such an infrastructure that can be mobilized on demand.

However, not everything was all doom and gloom. COVID-19, being the first global pandemic of the digital age, also brought a lot of promise and opportunity. There are several shining examples of how digital health solutions and innovations helped in very critical ways during this global pandemic. The most notable acceleration, both in the United States and other parts of the world, was in the rapid adoption of telemedicine. There have, however, been less visible digitally dependent advances that are just as important across all sectors of healthcare, public health, and medical research. In many ways, the response to COVID-19 sparked years of advances in mere months.

Service Industry

The service industry as a whole is defined as that part of the economy that creates services rather than tangible objects.[1] In the United States, the service industry has seen a steady growth over the past century or so forming about three-fifths of the gross domestic product (GDP).

The impact of COVID on the service industry can be thought of in two broad ways: (1) those services that require physical proximity or contact for their delivery (like airline, travel, household services or healthcare or even some parts of art and entertainment; and (2) those services that need very limited, if any, physical proximity or contact (like insurance, financial services, and information).

With regard to buying or paying for the services, the pandemic has very much accelerated the existing trend for moving into the virtual world with services like Zelle, Venmo, or PayPal which have been experiencing increased usage. The pandemic has also accelerated adoption of online shops and e-commerce presence like Amazon and Shopify etc.

However, when it comes to consumption, there was a temporary dip during the pandemic in services that need consumption in-person like airlines. Industries like insurance became more virtual except of course when one needs the actual services like body shops for auto insurance, etc. Services needed by homeowners like plumbing and air conditioning remodeling, took a different turn. The demand for these services, increased since more people were staying at home and therefore looking to complete renovations they had otherwise neglected. To some extent some of these are quite basic services which would have similar demand no matter what. However, on the service provider side, due to the other impacts of the pandemic on people's employment and what has been called "the great resignation", there were

[1] Please refer to https://www.britannica.com/topic/service-industry for a basic definition of the service industry.

fewer people providing services thereby significantly increasing the demand and the price of these services. It remains to be seen how permanent these impacts might be.

Then there is the restaurant industry where the pandemic pushed the industry almost exclusively towards delivery and take out based models many months before dine in. This greatly increased the demand for services like GrubHub, UberEats, DoorDash, and Postmates, or even Google's online ordering or plain old order by phone. This industry (waiters and cooking staff, etc.) had a huge shortage of employees which resulted in many restaurants doing more business but with less hours and yet still managing to do a brisk business as the overall demand for food remained at a high enough level.

There is also the component of time in many industries for travel or eating out. Initially there was a precipitous drop in the consumption of these services but this was followed by a transformation (like in the food and restaurant industry). There was a resurgence in some services i.e., people are traveling more since they have a pent-up desire to travel now.

If we look at the long-term impacts, there are three main areas:

1. For buying and selling services: It is almost a requirement now for everybody to support the e-commerce option. Hardly any service industry can remain untouched by this shift. The pandemic has greatly accelerated the e-commerce transformation that started more than two decades ago.
2. For consumption of services: There is an impact to the model in some cases and the opportunity for a new business model for consuming the services. The food delivery business and restaurants can survive almost solely as a kitchen and food to go/delivery [18]. The boost to online education can impact the education industry quite a bit. Another area impacted was entertainment with more people streaming at home. A perfect example of this is the simultaneous release of movies in theatres and on an exclusive streaming service of their choice. This further accelerated the blurring of lines between streaming services and content creators.
3. Finally, the strange twist from increased unemployment at the beginning of the pandemic to now, experiencing a labor shortage (due in part to The Great Resignation), we are looking at an increase in automation in various parts of the industry. The most basic of these is the robot that delivers food to people eating in a restaurant. Instead of a human carrying a tray of the ordered food, this robot effortlessly navigates the restaurant floor and parks itself at the table where people can help themselves. Then there is the ordering of food or paying the bill at the end of the meal which is done with a terminal at the table. Even the backend services of cooking the meals are getting automated with robots like Flippy that can essentially flip burgers [19].

With all the increase in automation, online buying/selling, and even consumption of services, where possible, the threat surface of security and privacy issues will only increase. Many banks and other financial institutions are stepping up and providing more services to small businesses and consumers to keep them safe from cybercrime but it is still important for everyone from small businesses to consumers to get better

education around cybercrime and take active precautions where necessary to keep themselves protected.

The Silver Lining

We instinctively think of things as good and bad but most things in life turn out to have two sides. Perhaps, the pandemic is no different. We have seen many impacts of the pandemic that can definitely be defined as "bad". There are a few that we may perhaps call "good" or at least "not bad". For example, connections with friends. One may be thinking what's so good about this? Well, in-person meetings definitely reduced during the pandemic. However, in many cases, in-person meetings were replaced by "Zoom" parties. The advantage there, was that no commuting was involved. Hence the connections could happen with less time investment. People in very different time zones could now also come together and still keep human connections alive, without having to travel. It is amazing how human beings can sometimes convert a disadvantage to be advantageous.

What about working from home? Working from home was a part of work culture even before the pandemic, however it was optional. Now it is no longer optional. Therefore, the inequality of a hybrid working environment was erased. Suddenly, there were no longer people who could whiteboard together and afford to ignore those secondhand meeting participants who were remote. Everybody was a secondhand participant, and therefore, everybody was equal. This type of equality resulted in more people being able to participate, more people to turn on their videos, and more people being sensitive to each other's "disadvantage" due to being remote.

Working from home brought another advantage. Reclaiming the time spent on commuting. This time was now spent reconnecting with family, or exercise, or other forms of self-care, even more productivity for the company. Many companies saw a resurgence in productivity during the pandemic. This time was also spent working on one's hobbies which were oftentimes neglected over the years because of professional priorities.

The pandemic also restricted many activities and choices. But in a strange twist, many of these so-called restrictions actually forced people to choose a healthier slower lifestyle. For instance, it forced people to spend more time outdoors or with nature. For example, the national parks saw an increase of 28% visitors in 2020 from the previous year [20]. People were also eating healthier because they were eating out less and, therefore, cooking at home more which tends to be healthier. Not to mention the drastic improvement in air quality in several crowded cities of the world due to reduced traffic on the streets!

The pandemic, like many other emergencies, forced human beings into unprecedented levels of innovation and collaboration. There are many examples in healthcare, education, and other essential services. For instance, the incredible speed with which the COVID-19 vaccines have been mass produced and made available in record time. This was made possible due to decades of research into mRNA-based vaccines [21].

It will open many doors for future vaccines to be made even more quickly. This has been possible due to collaboration technology that was scaled up to meet these new demands. People across the age spectrum adopted new technology and newer ways to collaborate and, therefore, contribute to innovation. But along with this deep adoption also comes cybersecurity risks.

Some of these practices are here to stay and, therefore, the need for education and awareness at all levels for cybersecurity will only increase. Ultimately, crises like the pandemic show the deep adaptability and capability within human beings to persevere and come through with the indomitable human spirit.

Metaverse: Future Digital Life

Ever since its advent, people have sought to use the personal computer as an escape from the reality of their mundane day to day life. It started with gaming personas followed by online chat forums and message boards to several channels of digital interaction that exist today. These channels not only offer anonymity, but also a chance to live a parallel life in which people can be whoever they want to be. In recent years, these channels have evolved into more sophisticated platforms that allow users to create their own virtual characters or *avatars* and make their interactions in this virtual universe even more life-like.

Today, this concept has evolved into what is known as the metaverse, which not only allows users to create their own virtual worlds, but also enables them to interact with others in this virtual universe. The term "metaverse" was first used in Neal Stephenson's seminal 1992 novel Snow Crash [22]. It was defined as a shared virtual space—a platform that would encompass all virtual worlds connected together much in the same way that the internet connects various sites and apps. It was the internet, but in three dimensions, and something you could interact with through a screen or inhabit by donning a pair of virtual reality (VR) goggles. The COVID-19 pandemic accelerated the need for virtual interaction to go beyond leisure. The metaverse provides a platform for businesses to host virtual store fronts, organizations to conduct virtual conferences, and host booths where your virtual persona can visit and interact with other virtual personas. The possibilities are endless.

Since the early days of the pandemic, there has been an accelerated rise of virtual communities such as interactive gaming worlds and mixed reality activations as important lifestyle spaces for locked down consumers. Current and new developments in digital social experiences will lay the groundwork for the next phase of post-COVID online life. The dawning of the metaverse, an always on, real-time virtual environment, offer huge opportunities for brand engagement. Key drivers of the metaverse include average persons being stripped of their day-to-day activities, leaving them wanting an easier, more tolerable world. In the metaverse, one could have any number of realities and replicate experiences from real life. Due to the ongoing threat of COVID-19 and other future large-scale pandemics, the metaverse is filling many of the social gaps, constantly creating new interest and engagement.

In this metaverse, people have the power to escape a pandemic burdened world. This is fast propelling us into a disease-free alternative reality—a metaverse that empowers us with the ability to do almost anything we can imagine, be it ordinary or extraordinary.

Several companies are opening digital headquarters in the metaverse where employees can 'return' to work. Businesses have been rethinking their workspaces ever since the lockdowns in the US during the spring of 2020. Several have decided on permanent remote work, while others are still debating on the value of physical presence. However, the pandemic has put the power in the hands of workers to make this decision for themselves, especially the ones who are able to fully engage and be productive remotely. Some people are still unsure about going back to shared spaces risking being among potential COVID-19 carriers.

On the other hand, the metaverse provides them a great long term consistent alternative that would remain unaffected by the COVID status of other co-workers. To illustrate the point, a company called eXp Realty that embraced the metaverse since 2016 conducts virtual meetings that are complete with meeting rooms, communal spaces for agents to take a leisurely stroll, and various multi-use areas for networking and mingling customers and team members as in real life. If the highly social realtor profession can find a way to bring real world, on-the-ground work into the virtual metaverse, surely anyone should be able to do it.

Education is another area that was severely impacted. Children missed several days of school during the COVID pandemic. They were constantly sent home to quarantine during 2021 due to risk of potential exposure to the virus from fellow students and teachers. This interrupted their education and made it difficult for them to keep up with their classroom goals. Many schools started their classes online but struggled to keep children engaged with their flat, unengaging discussion boards. An early experiment in the virtual world, a platform called Second Life, had a hard time attracting teachers and students in the 2000s but those were the early days of the internet and neither students nor teachers were as technologically adept as they are now. Roblox, a virtual experience platform, is trying to relaunch the effort. They recently announced a USD 10 million fund to help support online learning and development for students in the science, technology, engineering and mathematics (STEM) space. Their goal is to reach a 100 million Kindergarten to 12th grade students globally by the year 2030. They are already running a successful educational platform that has about seven million students enrolled to provide a proof of concept for metaverse schools.

Concerts and other entertainment venues suffered huge losses during the pandemic fearing that having thousands of people in a tight space could become a breeding ground for the virus. Performers are resorting to online concerts and other social events but those have a significant risk of last-minute cancellation. However, the statistics are different when it comes to the metaverse. The number of cancellations and no shows is significantly lower. Before the COVID-19 pandemic, only 45% of the population had attended virtual events like a concert. But in recent times, at least 87% have explored this avenue. Virtual events are a terrific bridge for people who miss the excitement and adrenaline rush of being in a high energy venue like an amphitheater

with other people who share their passion. They provide a win-win situation for both the audience and the event staff by protecting them from the risk of COVID exposure. They don't need to socialize since they aren't present physically, but they still get to experience all the excitement of attending an in-person concert or performance.

COVID has brought about major changes to many of our lives. With friends and family moving away and changing jobs, social media was the only way to stay connected. But it was unable to replace real world joint experiences. The metaverse will fill that gap where people are able to mirror their real lives. People everywhere are looking for ways to substitute their neglected social needs, whether they be at home, at work, or in school. This calls for momentous opportunities for the smart investor with the foresight to invest in these emerging disruptive technologies [23].

Conclusions, Lessons Learnt: Looking Forward

It is abundantly clear that this is not the first nor the last pandemic we and our children will face. If anything, we should take our collective human experiences from the past couple of years and use those to forge a much more resilient future for the generations to come. As we jet speed further into the digital age, we should prepare for a COVID like global cyber pandemic that will spread faster and further than a biological virus and will have equal or greater economic and psychological impacts. Our "new normal" isn't COVID-19 itself—it is COVID-like incidents. The first step to achieving this is to examine the lessons of the COVID-19 pandemic and use them to prepare for the future [24].

Lesson #1: Get educated, be informed, stay alert

New York state was doubling the number of cases every three days before the lockdown. A cyberattack with characteristics similar to the coronavirus would spread faster and further than any biological virus. The following interventions are important for preventing the problem:

a. Stay abreast with the latest technology news, keep your computers backed up, keep your software updated and patched.
b. Be aware of nefarious cyber behaviors like cyberbullying of children. Keep a check on the software they use. Make sure it is always obtained through secure channels and kept updated for security.
c. Healthcare companies and service providers should make cyber education mandatory for staff and ensure that they keep up with trainings similar to those for maintaining their healthcare licenses.

Lesson #2: The economic impact of a widespread digital shutdown would be of the same magnitude or greater than what we are currently seeing

A single day without the internet would cost the world more than USD 50 billion. A 21-day global cyber lockdown could cost over USD 1 trillion. Companies need to

change their perspective from 'if' they get attacked, to 'when'. Preparation is key, they need to increase security awareness among their workforce and quickly react to unforeseen events.

Lesson #3: Recovery from widespread destruction of digital systems would be extremely challenging

Finger pointing about the source and motive of the cyberattack as well as competition to be the first in line for supplies would inevitably lead to geopolitical tensions. The US healthcare industry needs to embrace the importance of data architecture and a unified backbone to provide seamless services across the country whether it is in-person or online care. The service industry must adopt a new business model for consuming services digitally. Whether it is the entertainment or the restaurant industry, new models of automation and requisite controls around that need to be standardized and widely adopted.

COVID-19 has revealed the importance of international, cross stakeholder coordination. Cooperation between public and private sector leaders is also critical, particularly when it comes to mitigation. But perhaps the most important lesson is that COVID-19 was a known and anticipated risk. So, too, is the digital equivalent.

However, we cannot discount the positives that have come out from this time of the global crisis. Humanity united to fight against one common invisible enemy. This showed us, once again, the resilience, creativity, and unity of the human spirit. There have been several glowing instances of the ways in which digital and online healthcare solutions and innovations assisted in extremely critical ways during this global pandemic. In so many ways, COVID-19 responses have sparked years of advances in just a few months. People became more sensitive to each other's "disadvantage" due to being remote. Many companies saw a resurgence in productivity during the pandemic. The national parks saw an increase of 28% in 2020 of people trying to reconnect with nature and spending time in open spaces. Last but not the least, adaptation to the metaverse was inevitable but the COVID-19 pandemic helped speed up the timeline by years spurring us into the next level of our digital future.

In conclusion, to quote David Koh, Commissioner of Cybersecurity and Chief Executive of the Cybersecurity Agency (CSA) of Singapore "like the coronavirus, cyber threats are borderless and asymmetric." We must unite on all fronts to face these together and to be better prepared for the inevitable threats of the future.

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Media and Communications

Unmasking Realities: Public Health Communication in India During the COVID-19 Pandemic

Sonalini Mirchandani and Sunitha Chitrapu

Abstract The authors take a critical look at India's public health communications during the COVID-19 pandemic. The case study method is used. Data include what was gleaned from interviews with key informants engaged in outreach communication, news reports, and artefacts from select COVID campaigns as they evolved through the first and second waves of the pandemic. Learnings are drawn from previous health communication campaigns that focused on behavior change including India's successful and well recognized communications interventions during its HIV and AIDS campaigns, as well as its remarkable Pulse Polio efforts.

Introduction

India has a rich history of health communication campaigns in response to varied public health challenges that include HIV/AIDS, polio, tuberculosis, and reproductive and sexual health among many others. In this chapter we review some of the lessons learnt from these campaigns and examine the extent to which COVID-19 communications have integrated valuable insights gleaned from campaigns of the past. While the differences between COVID-19 and other public health challenges such as HIV/AIDS and polio in terms of the disease, transmission routes, vulnerable communities, measures of protection, and the nature of risk behaviors involved are very distinct, there are significant learnings from a public health communication lens that India acquired through its national polio and AIDS control programs that lend themselves to application in the ongoing pandemic. These learnings draw on theories in behavioral science that have found wide application and acceptability, resting on

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an evidence base of experience of several countries that successfully grappled with polio and the AIDS pandemic over the years.

In order for public health communication to make a significant difference in efforts mounted to address COVID-19 and its ramifications, the behaviors sought to be influenced need to be internalized and sustained over time (unlike communication that calls for one-time action, such as an appeal to donate blood). Messaging around COVID-19 encompasses a spectrum of issues ranging from preventive behaviors to testing, care, treatment, vaccination, and others. While we cannot cover the complete spectrum of communication issues around each of these, we have attempted to focus on the underlying determinants that would make for recommended behaviors to be sustained over time. This assumes significance in light of the uncertainty that has marked the progress of the pandemic, with the medical fraternity and public health specialists learning along the way, as the body of empirical evidence grew with the passing of time.

We use the analytical framework of the Self-determination Theory to contextualize our observations and to help us identify the areas where our COVID-19 communication efforts can be augmented. According to the Self-determination Theory, the maintenance of behavior change over a period of time has been shown to be achievable if it is anchored in one's experience of (1) autonomy (as in providing choices), (2) competence (feeling effective and believing one can act upon the messages), and (3) relatedness (feeling cared for by others, trusted and understood) [1].

This chapter is divided into six sections. We begin with a short review of the main concepts of the Self-determination Theory in the first section. Section two evaluates COVID-19 communications in India from the point of view of relatedness. It is followed by sections three and four which present insights into the importance of community engagement and the importance of building trust. In section five we explore how COVID-19 communications can appeal to individuals' need for competence. Section six highlights the importance of credible information and the role of community leaders and community champions in contributing to it. In the final section we present some guidelines for action.

Self-Determination Theory

The Self-determination Theory focuses on the different types of motivation for human action [2]. Autonomous motivation that is intrinsic to and integrated with the self offers volition and self-endorsement and is more effective than controlled motivation which originates from external sources (even if it is partially internalized and involves approval and shame among other things) when it comes to predicting a range of outcomes in domains including health, problem-solving, parenting, sports, and learning [2, 3]. The three central concepts of this theory are the needs for autonomy, competence, and relatedness. Satisfaction of these needs is related to beneficial mental health and behavioral results, irrespective of whether the individuals are in individualistic or collectivist cultures [4]. Most importantly, social

conditions can aid or obstruct individuals depending on the extent to which they create situations for these needs to be met [4]. A meta-analysis of 184 empirical datasets from 166 publications in the fields of both physical and mental health as well as health promotion (over a wide range of issues including tobacco cessation, weight management, dental care, diabetes, fitness, and adhering to prescriptions) that applied the framework of the Self-determination Theory revealed strong support for its arguments [5].

Relatedness: The Importance of Feeling Connected to Others

The concept of 'relatedness' (feeling cared for by others, trusted, and understood) is important and justifies a closer examination to understand its centrality to the COVID-19 response in India, especially among marginalized and vulnerable communities, including slum dwellers and migrants. As the pandemic spread and countries began to put into place response measures, UNAIDS shared guidelines that encompassed key learnings from forty years of responding to the HIV epidemic [6]. An important lesson it highlighted was: "…the need to have a community-centered and informed response, one that embraces solidarity and kindness, that prioritizes the most vulnerable, and that empowers people to be able to take action to protect themselves and others from the virus. These are essential for creating trust between affected communities, the government, and public health officials, without which it is unlikely that the response will be either rapid or effective. Equally, swift action must not be rendered ineffective by existing inequalities, lack of information, and barriers related to cost, stigma, privacy, and concerns around employment and livelihoods".

In retrospect, India's success story in managing the HIV epidemic was grounded in the recognition of the simple fact that it was by placing communities at the center of the response that meaningful change could be brought about. In the context of public health communications, this translated into identifying community needs, priorities, and importantly barriers to behavior change that needed to be taken into account while designing both programmatic and communications interventions. Studies in India highlighted significant barriers that impeded the adoption of the behaviors recommended. For example, community members were hesitant to come forward for testing as they feared stigmatizing attitudes as well as discriminatory behavior would follow if the test report indicated positivity [7–9]. For many groups that were at higher risk of HIV such as MSM (men who have sex with men), PWID (people who inject drugs), and sex worker communities, societal attitudes were already characterized by disapproval and alienation. Their understandable reluctance to test and then to come forward for treatment if required presented a significant barrier to the program's efforts. It was only when proactive measures were taken to build trust, engage actively with the communities, and bring them to the center of the discourse, did the health communications efforts begin to show results. As S. Y. Quraishi, Former Director General of the National AIDS Control Organization, and currently Chairman of the Governing Board of the AIDS Alliance India, emphasized "It is important to engage

affected communities from the beginning in all response measures—building trust, ensuring suitability and effectiveness, as well as frequent sharing of information" [10].

The above learning, however, did not find expression in the manner in which public health messaging was rolled out in India as the pandemic broke. The imposition of what has come to be recognized as the world's most stringent lockdown by the national government, took place with a lead time of only four hours. The trauma and untold suffering that followed with migrant families being displaced overnight without any safety nets to fall back on has been well documented. Mander noted that "…it was not only the overnight annihilation of their livelihoods which drove millions of migrants home. It was the demolition of their faith and trust—in their employers, in their middle-class neighbors and, most of all, in their governments" [11]. Mander highlights the gaps between the health communication messages that urged people to maintain 'social distancing' when Census 2011 statistics indicate that 67% of urban dwellers live in houses with two or less rooms, with an average family size of 4.9; to 'wash hands regularly' when the National Sample Survey (NSS) 2018 shows that half of Indian households did not have an exclusive water source; and to 'stay at home' when India has 1.7 million homeless people as per the Census 2011. One of the central pillars underlying the Self-determination Theory—relatedness (feeling cared for by others, trusted and understood)—was thus completely absent in this approach.

Linked to the above was the issue of the sense of a lack of autonomy, of real choices which could generate a feeling of inadequacy at not being able to follow the guidance being recommended. The need for autonomy along with the lack of trust made for communications that were unlikely to affect behavior change as it was mere risk communication without the critical component of community engagement that is needed to make a difference. T Sundararaman, Global Coordinator of the People's Health Movement and a former Director of the National Health Systems Resource Centre, stated, "…the mainstream messaging has a terrible subtext. And that subtext does not help to follow COVID appropriate behaviors or support public health measures" [12]. Sundararaman notes that India's public health communication strategy emphasized victim blaming and stigmatized behavior. In his words, "The overall approach to public health behavior has been authoritarian, a law-and-order approach, enforcement, and fines. In some sense you are saying people are irresponsible and so they get the disease. So when a person gets COVID-19, they may feel ashamed, they may feel guilty" [12].

Community Engagement: Partnering for a Meaningful Response

The meta-analysis by Gilmore et al. of 37 campaigns across 32 publications examining five epidemics in the twenty-first century such as Ebola, Zika, Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS), and H1N1 identified the six main actors for community engagement as (1) local leaders, (2) community and faith-based organizations, (3) community groups, (4) health facility committees, (5) individuals, and (6) other key stakeholders whose inputs and coordination are required for six main functions that include (1) designing and planning, (2) community entry and trust building, (3) social and behavior change communication, (4) risk communications, (5) surveillance and tracing, and (6) logistics and administration [13].

In the entertainment and financial capital of India that is home to Asia's largest slum Dharavi, officials feared the worst when the first case of coronavirus was detected on April 1, 2020. The slum's population of about one million residents live in a tightly packed area of just over 520 acres, making this one of the most densely populated areas in the world. Response to the outbreak called for swift action on multiple fronts. Unlike the national response to the situation of other vulnerable communities such as migrant labor, the local municipality responded by understanding that strategic behavior change can only be sustained when it incorporates aspects of autonomy, competence, and relatedness and that without effective partnerships with civil society organizations on the ground, this was not going to happen. What is notable about Dharavi's success story, which went on to be hailed by the WHO as a model worth emulating across the world, was its recognition of the fact that the public health response to such a situation necessitated going beyond the measures of lockdown, testing, surveillance, and engagement of multiple sectors to include a focus on community engagement and communication, without which none of the other measures would have succeeded [14–16]. Dharavi's 'Chase the Virus' model was seen to be effective because it included (1) community participation and risk communication, (2) governance, multi-sectoral coordination, and a stringent lockdown, (3) public private partnerships, (4) ramping up of quarantine, isolation, and treatment facilities, and (5) robust surveillance, contact tracing, and screening [16].

Gaining the trust of the communities was recognized and prioritized as an important first step by the municipal authorities who realized that communities were hesitant to come forward with their health-related problems. The discovery of a COVID-19 positive case in Dharavi led to a heightened fear of stigmatization among its residents [17]. A baseline study carried out by *SNEHA*, an NGO working in the slums of Dharavi, Govandi, and Malvani, revealed that people were hesitant and believed that employment opportunities would further shrink if Dharavi came to be identified as a 'COVID hotspot' [18]. Understanding this, the Assistant Municipal Commissioner of the Brihanmumbai Municipal Corporation (BMC), Kiran Dighavkar, who led the Dharavi response, partnered with local groups and individuals who the community trusted such as NGOs and local doctors whom community members knew and

accessed [17]. Small but meaningful gestures went a long way in cementing the relationship and forging the bonds of trust. For instance, the municipal authorities, sensitive to the challenge patients in isolation wards in the slums faced during *Ramadan*, ensured that meals were provided at the appropriate times when the fast was broken [17]. The administration organized yoga, breathing exercises, and aerobics to address the stress that those in quarantine were experiencing [16]. The recognition of the reality that 70% of Dharavi's residents was daily wage earners, with little or no savings—the running of community kitchens and ensuring of regular supplies of groceries and food through lockdown, all went a long way in gaining trust, and consequently, compliance with recommended COVID appropriate behavior [17]. One of the lessons from HIV communications is that "…life circumstances bring different challenges…the most effective messaging reflects and responds to the real-life issues people face" [19].

Building Trust: Increasing Actionability

The concept of trust between the sender and receiver of communications being central to its acceptability appears to emerge as an important factor, especially in the context of risk communication during a pandemic. Trustworthiness has been defined as, "the source's intentions in the relationship between the message and the receiver of the message" [20]. Transparency plays an important role in building trust, as Abraham notes, "if the public knows that information and the reason behind decisions are going to be fully disclosed, it is more likely to trust advice coming from government agencies" [21]. In an environment of uncertainty, where knowledge of the virus and the disease evolved over time, this aspect became even more important. Yamini Aiyar, President and Chief Executive of the think-tank, Centre for Policy Research described how the distrust between the State and its citizens shaped bureaucratic communication, the relief response, and the health response during the first wave of the pandemic [22]. Bureaucratic 'orders' became the default mode of communications leading to heightened confusion and insecurity. The relief response was perceived to be grossly inadequate. It depended on paperwork and documents that impeded it. The public health response required governments and people to act together. As Aiyar put it, "…participation is critical to ensure symptoms are reported to enable early detection and speedy provision of medical care. It is also essential to ensure long-term behavior shifts." However, the stigma and fear (including the pinning of 'blame' on some communities for the spread of the virus in the first month of the outbreak) came in the way of responding to health communication messages such as the importance of testing, thereby undermining an essential ingredient (early detection) of an effective response to the pandemic [23]. When the second wave hit India, a variety of factors were seen to be responsible for the disastrous consequences. In addition to failures arising from governance and lack of preparedness, there was the letting down of the guard by the general public who believed the worst was over. There was also complacency arising from observing the administration's own example of seeming

indifference to the gathering of crowds at election rallies and religious gatherings such as the *Kumbh Mela* [24].

COVID-19's second wave impacted the residents of the slums very differently from those who live in the high-rise housing complexes of Mumbai. According to the Brihanmumbai Municipal Corporation (BMC), 90% of the infections in the second wave were recorded in high-rise buildings in the beginning of March 2021. It was clear that the main challenge was to contain the spread of COVID-19 in the high-rises and not in the slums [25]. Authorities observed that COVID-appropriate behavior appeared to be better followed among the slum-dwellers than among the more privileged sections of society, supporting the argument that the on-the-ground efforts of the administration, civil society organizations, and local influencers who sustained their outreach work among the slum communities, and building on the relationship of trust and partnership had paid off in terms of the community's continued adherence to the recommended behavior protocols [26].

The above is perhaps best illustrated by the work of NGO *SNEHA* in Mumbai. Before the second wave could hit, behavior change communication initiatives had shifted gear in December 2020 to focus on reminding the communities that COVID-19 had not 'gone away'. A survey undertaken revealed that many in Dharavi believed that COVID was no longer a problem in their community; the case load had decreased significantly [18]. The campaign '*Corona Gaya Nahi? Corona Gaya Nahi.*' ('Hasn't Corona gone? Corona hasn't gone') (Box 1) was designed and implemented by *SNEHA* to address this sense of complacency that had begun to set in. The integrated social and behavior change campaign that was conceptualized, pre-tested, and implemented in the months that followed worked because it was rooted in the reality of the residents of the slums. It addressed their needs and concerns and was designed using a 'bottom-up' approach that engaged communities in the campaign through dialogue. For example, a mirror image activity was conducted that encouraged people to validate the correct usage of a mask by selecting the appropriate image. Key considerations while designing the campaign were that the different components should [18]:

- Be technically sound, but also culturally appropriate
- Be relevant and feasible for communities to act upon
- Include online and offline channels of communication
- Include a feedback mechanism to understand what is working and what needs to change.

All the above reinforced the community's need for a sense of autonomy, competence, and relatedness. The latter also arose from the long period of trust already built among community members by *SNEHA* over two decades of its work on maternal and child health.

Competence: Supporting People to Feel Empowered

Sakan et al. in a survey of the psychological needs of individuals during the COVID-19 lockdown found that "when the sense of competence was thwarted within the environment, distress was more pronounced" [27]. Most COVID-19 communications placed restrictions on people's access to work and other activities which gave them a sense of self-efficacy. However, in marked contrast to this general pattern, communication outreach undertaken by *SNEHA* through the lockdown included the innovative '*Gharwalli Diwali*' (*Diwali* at home) campaign which encouraged the community to celebrate the festival of lights (*Diwali*, the New Year as per the *Hindu* calendar for some communities) by spending time with the family and celebrating indoors [18]. With a seemingly simple tagline, the underlying message that went out was that the outreach team cared for the sentiments of the community and their desire to celebrate an important festival. Most important, in an environment marked by constraints and 'don'ts', it shared with them what they can do.

Initiatives like the above validate the learning that reinforces that a sense of competence and agency is important in order to encourage adherence to behavior change. Porat et al. state that "…understanding what people can do in addition to what they cannot do is important. It is useful to advise people to be proactive and do things that are constructive and directly relate to the crisis they are facing. Taking action and being proactive during a crisis can help to develop a sense of control and overcome emotions of helplessness and hopelessness. Helping the public feel in control and empowered in some parts of their lives may also decrease fear" [28].

When it came to the broad-based communication that the authorities put out in India, however, this important aspect of communicating 'what people can do in addition to what they cannot do' was largely absent. Menon observed that "… we have (not) done enough to emphasize that open ventilated areas are probably ten times safer than any enclosed space. And perhaps this should have been done to give people an alternative earlier on." Adding that "the psychological impact of the pandemic has been such that people have been told there are many things they cannot do. But they have not been told about things that they can do. And allowing for low density public spaces, I think would have been a bit of positive messaging while preventing crowding in enclosed and badly ventilated, air-conditioned spaces" [12].

Box 1

The 'Corona *Gaya Nahin* (Corona has not gone) campaign' used a 360degree approach, using digital media, bulk short message service (SMS), mid- media such as displays and loudspeakers mounted on auto rickshaws, cable TV, and interpersonal communications, spearheaded by a large team of community volunteers (a part of the Community Action Groups that *SNEHA* had facilitated over the years, that served as a link between the community and the public health system) who were designated as COVID *Yoddhas* (COVID warriors).

Phase 1: created curiosity in the community with the question Corona Gaya Nahi? The outreach team triggered discussions at community-level around this teaser question *'Corona Gaya Nahi? Jald Hi Pata Chalega. Sathark Rahe'.* (Hasn't Corona gone? We will know soon. Stay Aware.)

Phase 2: emphatically announced that corona has in fact not gone away. A mascot was launched and was accompanied by multiple campaign products including films, road show events, and others.

Phase 3: reinforced key campaign messages including on modes of transmission, use of masks, distancing, hand wash, spitting, stigma and discrimination, and safety measures to be followed. In particular, boys and men were targeted as field insights indicated they were less particular about following COVID appropriate behavior. Communications also incorporated information on vaccination including the process of registration, details of centers, and such like.

Key findings from the study to evaluate the campaign (*SNEHA*'s End of Project Report):

Television (90–94%), friends/family (56–70%), and social media (34–53%) were the most commonly reported sources of information on COVID-19. However, community health workers (98–97%), *SNEHA's* community organizers (COs) (98–97%), doctors (94–97%), and COVID *Yoddhas* (98–98%) were the most trusted sources of information.

The baseline-endline comparison indicated a marked increase in awareness about fever (88–96%) and breathing difficulty (53–71%) as symptoms of COVID-19. There was an increase in awareness (41–64%) of at least one of the uncommon symptoms (loss of taste, diarrhea, conjunctivitis, fatigue, muscle ache, chest pain, and skin rash).

The proportion of respondents reporting the combined practice of three protective behaviors (hand-washing, use of masks, and social distancing) increased from 78 to 83%.

The proportion of respondents who perceived medium or high risk of contracting COVID-19 infection increased from 20 to 27%.

Among those who had not taken the vaccine, 63% reported willingness to take the vaccine when made available to them. However, 37% reported hesitance to take the vaccine. Vaccine hesitancy was more among women (46%) than men (27%). Vaccine safety (19%) and the side-effects after administration (20%) emerged as major concerns related to the vaccine.

One of the important elements to note is that through the period of the campaign, which is now moving into the phase of addressing vaccine hesitancy, the fundamental 'basic' messages around the three preventive behaviors remained a consistent thread throughout. This was an important learning that India had also derived from the campaigns on HIV and AIDS that moved from messaging around prevention to testing, treatment, stigma reduction, and other

issues. In India, as in many other countries, as reported by the Kaiser Family Foundation 'even after more than three decades into the HIV epidemic, we still see a need to cover fundamentals, like how HIV is—and is *not*—transmitted and that testing is the only way to know if you (or someone else) has it. As the COVID-19 conversation shifts to testing, treatment, and vaccines, there will still be a need for reinforcing messaging about frequent hand washing, not touching your face, and physical distancing'.

Enhancing Credibility: Engaging Community Leaders and Champions

The outbreak of a new disease and especially the havoc caused by a pandemic such as COVID-19 can lead to a situation of uncertainty and confusion among the public. A feeling of helplessness is more acutely felt by communities that are more vulnerable either in terms of their economic status, relative lack of access to healthcare and facilities, and inability to access credible sources of information, including digital and mass media. The void in information is often filled by rumors, misconceptions, and myths that take on a momentum of their own and sometimes outpace the sharing of evidence–based scientific knowledge. Communities such as migrants, refugees, and internally displaced persons are known to be at higher risk of being left out of shared credible information and messaging. Recognizing this special vulnerability, seven organizations including United Nations Children's Fund (UNICEF) and World Health Organization (WHO) came together during the COVID-19 pandemic to issue a set of joint guidelines that provided recommendations on how to address this challenge [29]. Two recommendations that emerged are noteworthy:

> When direct community engagement is not possible, communicate remotely with community leaders and/or other members to ensure continuous provision of information and mobilize people who have recovered from COVID-19 to act as community champions to build social trust and hope.

The first, the engagement of community leaders, was an important component of India's successful polio eradication communication strategy. The second, engaging with those with 'lived experience', was a strong element of India's HIV/AIDS communication strategy and action plan. In both cases, in-country experience proved the soundness of the approach.

In 2001, when the Social Mobilization Network (SM Net) was set up to address the polio communication challenge in the highly endemic regions of India, community members who were identified and trained as social mobilizers faced formidable barriers when it came to the acceptance of the oral polio vaccine in resistant pockets. These included fears and apprehensions about the side-effects, lack of faith in the efficacy of the vaccine, lack of conviction pertaining to the need to give children

the vaccine repeatedly, and several others [30]. One of the main barriers among minority populations in particular was fueled by strong rumors that the vaccine caused impotence. There was also resistance stemming from hostility towards so much emphasis on one issue when other more immediate problems being faced by disadvantaged communities were seen to be neglected. Wasan notes that "a lot of brainstorming ensued and the final conclusion was that it would be wise if religious leaders could be taken on board because enlisting the support of religious leaders meant gaining allies to influence families. By building bonds and partnerships with religious leaders, who are widely respected within the community, it was hoped that grassroots networks and support systems could be developed" [31].

India's polio communication strategy thus evolved to include a strategic mix of mass media, frontline communicators, and a strong group of identified local influencers including religious leaders. The latter worked closely with the program to address community fears and misgivings and also made relevant announcements at religious congregations such as mosques. Gitanjali Chaturvedi, who documented India's experience with polio communication, remarked on this 360 degree approach to communication by noting "…pasting banners, posters, and distributing leaflets would not work. People followed by example. If some influential members of their community appealed to them to immunize children against polio, they could be convinced. If their doubts were clarified by community volunteers recruited exclusively to change behavior towards immunization, a significant improvement could be registered. In other words, an intense combination of social mobilization and interpersonal communication was the answer" [30].

The engagement of a variety of stakeholders and local influencers, including teachers, traditional birth attendants, *anganwadi* (nutrition) workers, and others, led to an intensive on-the-ground effort that addressed concerns and information gaps on polio. When the COVID-19 outbreak took place, Chaturvedi highlighted lessons from the polio communication experience that could be harnessed for COVID-19 communication plans [30]. It was not just India that successfully engaged with religious leaders and community influencers, other countries such as Nigeria also achieved success through this approach. Ms. Chaturvedi highlights an important point "however, rather than as an afterthought, this engagement has to be done carefully and upfront. For instance, in several low-income settings, explaining lockdowns that impact people economically will have to be accompanied with a response plan involving communities and their leaders. Liberia shut down completely during the Ebola crisis. But this was done in consultation with community leaders and detailed micro-plans were prepared assessing rations and other essential requirements of communities" [32].

The lack of strategic planning of the kind detailed above when it came to announcing the lockdown in India led to the unfortunate events that followed, and these have been documented and analyzed extensively—the plight of the dispossessed migrants walking thousands of miles to reach home and the anxiety and fear generated by the evident lack of an on-the-ground response plan that could have been put in place with consultation with community leaders and civil society organizations. Reporting on the migrants, Yadav and Priya noted that "In haste to control

the situation created by pandemic, the State considered little about these people while implementing a nationwide lockdown. The employers and intermediaries who were the last hope had also turned their backs on these pitiable people. The migrant workers' class, which largely depends on their daily earning, had literally nothing to fall back on" [33]. In a study undertaken by the Stranded Workers Action Network (2020) of the 11,159 migrant workers interviewed, a high proportion (72%) had food supplies for only the next two days.

The experience gained from engaging local influencers in polio communications can be brought to bear on important components of COVID-19 communications as we go forward. One of the key areas that have similarities has to do with COVID vaccine hesitancy. Communication strategies to address this can build on the learnings of how to leverage influencers to address fears and misconceptions.

One of the recommendations pertaining to risk communications in the context of vulnerable populations and COVID-19 refers to the guidance to 'mobilize people who have recovered from COVID-19 to act as community champions to build social trust and hope' [29].

Engagement of people with 'lived experience' in the planning and implementation of programs is an approach that has been used in a variety of ways across sectors. Notable among these is the involvement of people who experienced mental health challenges in the design and roll-out of programs addressing such issues. Other sectors include TB prevention and treatment, for example in India, where 'TB Champions' were featured in campaigns to inspire others on the importance of non-stigmatizing behaviors, on the need to ensure adherence to medication, and other such issues [34]. India's experience with campaigns on HIV and AIDS include the involvement of PLHIV (People living with HIV) to 'normalize' the virus and reduce the fear and stigma surrounding it [35]. People living with HIV not only participated in campaigns on broadcast media but they also personally addressed large forums including the press, the corporate sector, educational institutions, and elected representatives through their training as 'Positive Speakers' [36].

The engagement of PLHIV in program and communication efforts provided valuable insights on how the use of terminology and language can fuel stigma and trigger discrimination. These are useful lessons that may be applied while designing public health communications around COVID-19. As advised by UNAIDS, "Words matter. The way governments, communities, and the media speak about an epidemic, its modes of transmission, and people who have the virus can all shape the way people and communities are perceived and treated. Avoiding phrases such as 'super-spreader' or choosing neutral phrases like 'acquired' rather than 'infected' can make a difference as to whether people feel empowered and willing to be tested and self-isolate and to provide help to others in need" [6].

In addition to those who have survived COVID-19 and can participate in public health campaigns, thereby allaying fears and reducing stigmatizing attitudes, the featuring of other stories and narratives is important too. There is a need to go beyond dry statistics and share stories of hope, adoption of COVID appropriate behaviors, and resilience as these relate to family caregivers, frontline workers, the medical staff, and others. Explaining the value of 'role modelling through narratives', the authors

state that "the use of role models to teach social behavior through narratives can be implemented during disease outbreaks or pandemics as well. During the COVID-19 pandemic, for instance, narratives using positive role models can demonstrate the advantages of following the guidelines, thus strengthening people's self-efficacy" [37].

A similar approach has been used by advocates of 'positive deviance' such as Arvind Singhal [38]. Positive deviance is based on the premise that communities have within them individuals who by the practices they adopt and the behaviors they choose, demonstrate the doability of such actions and the benefits of the same. Campaigns featuring such positive deviants have been designed based on audience research in India on subjects where triggering behavior change has proved to be particularly challenging. For example, in convincing rural women to adopt the intra-uterine device (IUD). Field studies showed that women were likely to be more favorably disposed towards a family planning method if someone who had personally used it shared her story with them.

In the ultimate analysis, it is a sense of solidarity, empathy, and inclusion that would need to permeate all public health communication in the context of COVID-19. India's former Union Health Secretary, K Sujatha Rao, who successfully spearheaded the country's response to the HIV pandemic, emphatically believes that "more than the infection, we need to battle the fear that we seem to have got into our psyche and ensure that in so doing we do not become complacent… We have a chance only if we live with a sense of social solidarity and social responsibility" [39].

Conclusions

The COVID-19 pandemic has brought to the fore the importance of harnessing public health communications in a strategic and focused manner, not only to support essential preventive behaviors such as hand washing, the use of masks and physical distancing, but going beyond these to address the larger inter-related concerns that influence such behavior, including experiences of fear, stigma, anxiety, and isolation. Beyond the need to reinforce essential preventive behaviors, there is also a growing need to address concerns as the pandemic evolves, such as living with uncertainty, accepting a new normal, addressing vaccine hesitancy, and many more.

This chapter illustrates how such communications can be designed and implemented based on the well accepted theory of Self-determination (that outlines the three building blocks of relatedness, autonomy, and competence being fundamental to sustained behavior change). It also elaborates on how such an approach was applied in addressing two major public health challenges that India grappled with, the HIV/AIDS pandemic and the polio eradication program.

The theoretical foundation of the country's experience points to the significance of the following five inter-related principles that can serve as useful guidance going forward. These are (1) the importance of fostering a feeling of relatedness and solidarity; (2) generating trust between the sender and receiver of communication; (3)

engaging with communities to design interventions and messages that are appropriate and relevant to their life circumstances; (4) reinforcing a sense of competence by highlighting the 'doables' in an atmosphere of constraints and restrictions and finally; (5) leveraging the influence of community leaders and narratives of champions/survivors to enhance the credibility of the communications. These five inter-related components, tried and tested in the design of India's campaigns in HIV and Polio, can serve to guide the development of COVID-19 communications going forward.

Going forward means dealing with myriad issues that are not possible to touch upon in this chapter. The canvas of what needs to be done in public health communications around COVID-19 in India, as indeed in many other countries, is large and complex. To give some examples, communications would need to address the important aspect of mental health and engage with this issue in a manner that is nuanced, appreciative of the inter-sectionality of mental health with other issues and take into account the special needs of diverse vulnerable populations such as women, people with disabilities, the elderly, the *adivasis* (indigenous tribal communities), and others. As rural India grapples with the virus, communicators would need to explore channels for reaching out that are accessible and believed to be trustworthy to rural and tribal communities and importantly, in synch with service delivery and accessibility. Simultaneously, the need to harness the power of social media (that fosters heightened interactivity and participation, but comes with its pitfalls of being easily harnessed to fuel misinformation and rumors) would require careful planning and implementation. Underlying all this is the need to continue to gather a body of evidence on what works well in public health communications by investing necessary effort and time on documentation of good practices.

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Social Media in the Time of a Pandemic

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Abstract Social media has evolved from being a set of rudimentary tools to a complex instrument that has had both positive and negative consequences, often leading to widespread circulation of misinformation impacting societies and institutions. The COVID-19 pandemic, significantly, is the first health crisis, witnessed globally in the age of social media and amidst unprecedented connectivity. Throughout the pandemic, the world has witnessed a widespread use of social media. The medium has not only enabled isolated people to remain connected with their friends and families but also to communicate with medical experts. At the same time, myths about COVID-19, its treatment, and effects have circulated on the same platforms leading governments to issue guidelines in several countries including India. While social media has enabled a regular flow of information, it has also led to unverified content circulating on platforms such as Twitter and Facebook, fueling panic in people about the virus and the vaccines. This chapter explores the role social media platforms (Facebook, Twitter, Instagram, and others) have played in enhancing and delivering evidence, connecting communities and also in circulating myths and unverified content during the COVID-19 pandemic. Through quantitative analysis, it encapsulates trends being witnessed in different geographies. It will conclude with learnings that we have gathered on leveraging this medium which can be used going forward in instances of future health crises.

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Introduction

Miriam-Webster describes social media as 'forms of electronic communication through which users create online communities to share information, ideas, personal messages, and other content'.[1] In a relatively short period of modern electronic history, social media has changed from a convenient means of communication to a virtual gathering space, retail platform, and a vital marketing tool [1]. The authors look at the ongoing social media evolution and the pros and cons of its use for public health, with a specific focus on the COVID-19 pandemic.

And so It Begins: From Phreaking to WhatsAppitis

The New York Times' obituary on Steve Jobs in 2011 credits the 'spark that ignited the partnership' between Jobs and Apple co-founder Steve Jobs, to an article by Esquire columnist Ron Rosenbaum in 1971 [2]. In the article titled 'Secrets of the Little Blue Box', Rosenbaum details the activities of a group of people who were into phone 'phreaking' (a combination of phone, free and freak)—an elaborate manipulation of phone lines that allowed phreaks to make free long-distance calls and even use it as a channel to conduct discussions between different users [3]. That article subsequently led Jobs and Wozniak to track down one of the phreaks.

'Mr. Wozniak, and Mr. Jobs later collaborated on building and selling blue boxes, devices that were widely used for making free- and illegal- phone calls' [2]. Possibly the first *avatar* of social media, phreaking became popular in 1950 among technologically savvy individuals who made home-made devices that allowed them access to telephone systems which, in turn, hosted online discussions among users [4].

Fast forward to April, 2014: A Spanish doctor writes to The Lancet about his patient, a 34-year-old physician who woke up one morning with unbearable wrist pain [5]. The patient, also a physician, had been working during the night of December 24th. The following morning, on Christmas, she had spent a reasonable amount of time—a total of six hours—responding to messages received through WhatsApp on her phone. The doctor, Inés M Fernandez-Guerrero, explains in his letter to The Lancet, 'The diagnosis for the bilateral wrist pain was WhatsAppitis.'

Clearly, we are witnessing a rapid and precipitous growth of a formidable sociological and commercial force. Social media platforms, networking sites, and messaging applications are an inseparable part of our lives today. So much so that it's difficult to remember what the world was like before information was available at the tap of a touchpad or the click of a button. However, that world did exist—not too long ago.

Some say social media began with the Morse Code—the electronic dots and dashes complete with OMG and LOL. "What God hath wrought", Samuel Morse's first message in 1844 was a harbinger of things to come [6]. However, most contemporary

[1] Hunt Allcot, Matthew Gentzkow, Chuan Yu. Trends in the diffusion of misinformation on social media. May 9, 2019.

accounts of today's social media origins point to the Advanced Research Projects Agency Network—the AFRANET, that was developed by the US Defense to help scientists of four interconnected universities to share software, hardware, and other data [6].

And then, of course, was the email. Its predecessor—an electronic message was first created at the Massachusetts Institute of Technology (MIT) as recently as in 1965 and was used to post messages and files by users at MIT that could be accessed from a common system—much like a social networking site. The email as we know it today was invented a few years later in 1971 by the American programmer, Ray Tomlinson [7]. From 1990, social media platforms started emerging with enormous speed and regularity. Very few of the initial pioneers such as Napster, ThirdVoice, Six Degrees, Lunarstorm, and Ryze still exist till from today.

Facebook, Twitter, YouTube, LinkedIn, and Instagram entered the social networking universe post-2000, touching billions of people and altering the way the world communicates. Recent data shows that Facebook has 2.853 billion monthly active users. WhatsApp has around 2 billion monthly active users. In terms of revenue, YouTube's potential advertising reach is 2.291 billion and Instagram's is 1.386 billion [8].

As of July 2021, there were 4.48 billion social media users globally—approximately 57% of the total global population [8]. Data Reportal's Global Social Media Stats report compiled in July 2021 states, "Social media user numbers have surged in the past 12 months too, with 520 million new users joining social media in the year upto July 2021.That equates to annualized growth of 13.1%, or an average 16 1/2 new users every single second". The report further explains, when online, people usually visit an average of 6.6 social media platforms every month and spend close to 2 1/2 h every single day on social media sites. 'Assuming that people sleep for 7–8 hours per day, these latest figures suggest that people spend roughly 15% of their waking lives using social media. Added together, the world spends more than 10 billion hours using social platforms each day, which amounts to nearly 1.2 million years of human existence.'

In India, according to numbers presented by the government at a press conference in February 2021, 530 million people use WhatsApp, and 448 million use YouTube. Facebook has 410 million users [9]. Twitter has 15 million users.

Modern social media outlets

Today's social media landscape is populated by a suite of services that jockey for the attention of more than 5 billion mobile device users worldwide. Here is an overview of the most prominent social media networks of 2020.

Overview of the most prominent social media networks of 2020
Facebook
Launched in 2004 by Mark Zuckerberg, who was studying at Harvard, Facebook has nearly 1.7 billion users—including almost 70% from the US, according to Pew Research
Reddit

(continued)

(continued)

Overview of the most prominent social media networks of 2020
Launched in 2005 by Steve Huffman and Alexis Ohanian as a news-sharing platform, Reddit with 300 million users is a combination of news and social commentary. Its popularity is based on the ability to 'up-vote' and 'down-vote' user posts
Twitter
Founded in 2006 by Jack Dorsey, Evan Williams, Biz Stone, and others as a microblogging site, its popularity soared immediately, leading by 22% of adults from the US logging on by 2020, according to Pew Research
Instagram
Founded in 2010 by Kevin Systrom as a photo-sharing site, it was bought by Facebook in 2012. Instagram today has more than 1 billion users worldwide
Pinterest
Founded in 2010 by Ben Silbermann who created apps for Apple, Pinterest was conceived as a visual 'pin board'. It has more than 335 million active monthly users
Snapchat
Founded in 2011 by Evan Spiegel, Reggie Brown, and Bobby Murphy, all from Stanford—this video-sharing platform started the concept of 'stories', or chronological short videos and 'filters', to enhance photos
TikTok
Founded in 2016 by ByteDance in China, the video-sharing platform became popular with young Americans when it was merged with the U.S.-based app Musical.ly in 2018. As of 2020, it had more than 800 million users worldwide

Source Reference [1]

Free Speech: Who Has the Freedom to Speak?

With billions of people finding a voice online, free speech has taken on an altogether different meaning. As trolling, anger, and abuse among users become commonplace, battle lines have been drawn between social networking sites and governments across the world.

The issue of privacy or the lack of it has been a constant tussle between governments, citizens, and social media platforms. In 2018, the Cambridge Analytica scandal opened a can of worms that led to global concerns about safety and privacy. The New York Times along with The Observer and The Guardian acquired documents from the data firm, Cambridge Analytica that showed that the company had used personal user data from millions of Facebook users, without their knowledge or permission, to create voter profiles and collect personal information—which in turn, helped undertake targeted political campaigning, based on a person's location, likes, posts, etc. The fallout of this scandal led to several high-profile celebrities deleting their Facebook accounts, and Facebook CEO Mark Zuckerberg being called to testify before Congress in the United States where he said, "It's clear now that we didn't

do enough to prevent these tools from being used for harm [10]. That goes for fake news, foreign interference in elections and hate speech, as well as developers and data privacy".

Last year, Australia passed a bill that required organizations like Google and Facebook to pay media houses for the news content that is posted on their platforms, including pieces that come up through search engines. The Financial Express explains, 'The Bill that has been passed by the Australian Parliament and has now effectively become a Code, is called the News Media and Digital Platforms Mandatory Bargaining Code [11]. The Code aims to help news providers earn by directing services like Google and Facebook to pay for using their content on their websites.'

With news organizations dependent on online resources including social media platforms and search engines, for readers to connect with their content, this move by Australia is meant to smoothen out the power and financial imbalance in news consumption, largely dominated by social media platforms and search engines. What's more, these platforms will now also have to inform news outlets, should they change the algorithms, or the methods of search—which would affect news pieces from showing up when users search for specific content.

Closer home in India, laws such as section 69A of India's Information Technology Act 2000, gives the government 'power to issue directions for blocking public access of any information through any computer resource where the Central Government or any of its officer specially authorized by it in this behalf is satisfied that it is necessary or expedient so to do, in the interest of sovereignty and integrity of India…' [12].

In February 2021, the Indian government announced a new set of regulations for social media platforms, messaging applications, online news sites and Over the Top (OTT) platforms or streaming sites, functioning in India. The Information Technology (Guidelines for Intermediaries and Digital Media Ethics Code) Rules, 2021 (Rules) sets down clear rules for tech companies to function—chief among them, companies must have a physical presence in India, identify the source of a message that is considered unlawful and remove such messages. The new guidelines also emphasize that social media platforms must always co-operate with the government, especially in investigations.

A Tool for Public Health

Brownson et al. have rightly commented that "the gap between discovery of public health knowledge and application in *practice* settings and policy development is due in part to ineffective dissemination" [13]. While COVID-19 has spotlighted the role of social media in public health communications and messaging, the public health community has recognized for several years now, the immense value of digital platforms for information sharing and awareness building. It was abundantly clear that presentations in consensus conferences and in prestigious journals were important but did not necessarily get the message across to the broader public or even critical

decision-makers. Traditional media (TV, print, and radio) platforms were effective in communicating in-depth information but were expensive.

Social media emerged as a much more cost-effective and accessible option for the public health community to disseminate information, increase the reach of communications during emergencies, and even respond to health queries in real-time. However, these platforms often came with their own set of unique challenges in the public health space. First, information shared by private medical practitioners was often in conflict with views shared by the larger public health fraternity—leading to contradiction and confusion among people. Unverified information posted on messaging apps ostensibly by doctors often led to inaccurate, unverified and even wrong facts being paraded as truth. Second, issues such as sexual and reproductive health and rights, mental health and stigma associated with various diseases have rarely been addressed by reputable public health institutions and personalities in the past. Third, the scientific and public health community has traditionally been media-shy which has spilled over into social media as well. They continue to be uncertain of how best to use social media channels to get their opinion or data or research out at the right time. As a result, their voices and opinions have largely remained soft on issues where they needed to be outspoken and quick, especially to counter myths, rumors, and misconceptions.

At the same time, it is important to note that increasingly social media is seen as critical and has been used by institutions and organizations to deliver public health messages rather effectively. Between 2009 and 2010, the Burnet Institute started the FaceSpace Project—a sexual health promotion intervention targeting young people and men who have sex with men (MSM). This pilot project, which aimed to find out whether social media could be used for health promotion, used fictional characters to interact with users and post content on sexual health across different social media channels. The findings of this project showed that the messages reached a significant number of youth and MSM [14]. Innovative methods were used often by different institutions to target the young demographic. For instance, to educate 12–24-year-olds on the harms of using tobacco, the New Zealand Health Sponsorship Council developed online anti-tobacco games that were played and shared virtually by young people [15].

Infodemic 2.0

As with so many issues, COVID-19 has brought focus on the role of social media in public health communications and messaging. Given the challenges in communicating to the public about a crisis that has been constantly evolving, international health organizations, medical practitioners, and governments have often struggled to allay the fears of people and counter the rush of misinformation propagated through social media platforms by various individuals and groups.

"We're not just fighting an epidemic; we're fighting an infodemic," Tedros Adhanom Ghebreyesus, Director-General of the World Health Organization

(WHO) famously said in February 2020, as false information about possible remedies and cures for COVID-19 began circulating online immediately, as cases started surfacing across the world. Authors of a scoping review on social media during COVID-19 analyzed over 2 million online queries between February and May 2020 and found that as interest in information around COVID-19 intensified, the infodemic grew side by side [16].

While the word 'infodemic' gained prominence post-2020, in the aftermath of an information overload during the COVID-19 pandemic, Merriam-Webster points out that the word existed well before SARS-COV-2 [17]. Coined by David Rothkopf for a Washington Post column in 2003, infodemic is defined as 'a blend of 'information' and 'epidemic' that typically refers to a rapid and far-reaching spread of both accurate and inaccurate information about something, such as a disease. As facts, rumors and fears mix and disperse, it becomes difficult to learn essential information about an issue.'

WHO further explains "an infodemic is termed as a situation when there is too much information including false or misleading information in digital and physical environments during a disease outbreak. It causes confusion and risk-taking behaviors that can harm health [18]. It also leads to mistrust of health authorities and undermines the public health response".

For instance, during the COVID-19 pandemic, false claims such as inhaling steam, cleaning nostrils with salt water and even drinking disinfectants as possible remedies to COVID-19 quickly garnered traction on social media, leading to several people falling ill after consuming massive quantities of disinfectants such as Dettol and Lysol [19, 20]. In India, similar claims for immunity-boosting tablets and potions were quick to find their way on social media platforms, online forums and messaging applications—with some of these being attributed falsely to the medical and scientific community.

That myths, misconceptions, and rumors via social media have damaged public health efforts is not new. In 2019, a teenager from Ohio who was repeatedly removed from classes because he was not vaccinated, got vaccinated despite strong opposition from his mother. The child blamed 'anti-vax' pages on Facebook for making his mother a staunch critic of vaccination [21]. The same year, The Atlantic conducted an analysis that found that between 2016 and February 2019, just seven pages that were against vaccines generated nearly 20% of the top 10,000 posts on vaccination during that time frame [22].

The Ebola crisis in the Democratic Republic of Congo was made worse by fake news, often on social media platforms—which originating as early as 2014 in the United States. A study published by the BioMed Central (BMC) Public Health in 2020 found that 10% of tweets on Ebola were partially or completely false, and that 28% tweets provoked readers to respond or promoted discord and 42% of such posts contained 'risk elevating' messages [23].

> We're adding a label on posts that discuss the safety of COVID-19 vaccines that notes COVID-19 vaccines go through tests for safety and effectiveness before they're approved—Mark Zuckerberg, Founder, Facebook.

In India, a small but vocal anti-vaccine group has for long demonstrated against vaccines, especially for children. As recently as in 2017, when the government launched the vaccination campaign against measles and rubella, several states struggled to get parents to bring their children for the vaccination, after rumors against the vaccine circulated through WhatsApp.

After the outbreak of the global COVID-19 pandemic, the United Nations recognized the importance of addressing and arresting the sudden and overwhelming onslaught of wrong information, hate and stigma around COVID-19. Following this, in April 2020, the UN Secretary-General launched the United Nations Communications Response Initiative to combat the spread of mis- and disinformation [24].

However, despite all efforts, the infodemic has only grown since the start of the pandemic. SARS-COV-2 was a novel pathogen and every new information and study was posted on social media almost in real time. While this helped many medical personnel and scientists, it also at times fueled panic, kick-starting debates on the harm of such platforms. The negative posts and tweets increased exponentially as vaccine development progressed and vaccines against COVID-19 entered the public health system. Vaccine hesitancy was prevalent even before COVID-19 vaccines were developed and as mentioned earlier, negative messages have a way of attracting higher engagement. More than two years into the pandemic, anti-COVID-19 messaging on online forums questioning its safety and efficacy continues to threaten parts of the world that remain unvaccinated.

In July 2021, US President Joe Biden blamed forums like Facebook (which he later toned down) for 'killing people' because of the misinformation on these platforms. Facebook, on its part strongly objected to the statement saying they would "not be distracted by accusations which aren't supported by the facts" [25]. Even though social networking platforms have been working since the start of the pandemic to remove users propagating false information on COVID-19, much more remains to be done. Despite rigorous monitoring and measures to block accounts which are spreading lies and rumors, it remains a challenging and daunting task for platforms like Facebook, Twitter, and YouTube. The algorithms built into their systems are aimed at boosting content to engage users no matter what these posts or tweets say. Therefore, it is almost impossible for these platforms to identify all accounts propagating misconceptions around the pandemic [26].

The silver lining

On April 30, 2021, India became the first country in the world to record over 0.4 million COVID-19 infections in 24 h. On the same day, close to 3,500 people died. The second wave of COVID-19 in India brought about a never before collapse of the public health system.

As the country saw steep shortages of oxygen cylinders, medicines, hospital beds, and basic medical infrastructure, scenes of absolute and complete helplessness became the norm rather than the exception. With the health infrastructure in India completely overburdened and overwhelmed, citizens struggled to keep their loved ones from dying. Social media platforms like Twitter and Facebook and messaging

applications like WhatsApp surfaced as forums to send out SOS cries. They were flooded with desperate pleas from people seeking everything from oxygen cylinders and medicines to hospital beds, ambulances, and even food. According to The Wire, between March, 1 and April 21, 2021, more than 519,000 individual accounts were in touch with users on Twitter to help provide information or medical-aid [27].

Ordinary citizens joined celebrities and influencers to become the messiahs that India needed in those months of unrelenting horror. Crowdsourced information and listservs on availability of beds, oxygen and critical medicines became the lifeline of thousands of online users who were seeking services and information that would ordinarily be offered by state infrastructures. These were extraordinary times. India was facing an unimaginable public health crisis that had completely spiraled out of control.

Online personal accounts of untold misery relayed the story of India's COVID-19 crisis with thousands of requests for help posted. Those at the frontline of organizing relief were quick to respond, others further re-tweeted every post and tweet they came across to get the attention of those who could help. An incredible public response emerged. Strangers turned up at homes with oxygen cylinders. They organized ambulances for those that had to be rushed to hospitals and procured medicines that were running in short supply. Across neighborhoods in India, WhatsApp groups run by resident welfare organizations kept track of people who needed help and ensured that essentials were delivered at the homes of people affected by the virus.

"The most beautiful part of social media is that you trust strangers," said Nikhil Jois, a technology executive in an interview to The New York Times on May 3, 2021 [28]. Nikhil was just one of the hundreds of people who came forward to assist people who flooded Twitter with a cry for help. According to the news article, along with his team of volunteers, Nikhil got in touch with organizations that supplied oxygen, food, and even sanitary napkins. Others like Abhishek Murarka from Mumbai say "they searched for words like 'verified' 'confirmed' and 'available' to find authentic information that could be useful to others". 'Hundreds of miles away, Praveen Mishra who is 20 years old and runs a start-up in the southern city of Bangalore, studied Murarkas video and applied his own filters to search for beds, oxygen, and medicine. He was able to get a particular medicine to a patient in Delhi after confirming that it was available in Hyderabad.'

Such was the state of emergency across the country that even diplomatic missions turned to Twitter to seek help. On May 2, a tweet by the New Zealand High Commission in New Delhi tagged a youth opposition leader, asking for an oxygen cylinder. This created a diplomatic flutter [29]. The tweet was subsequently deleted even after the oxygen cylinder was delivered but the tweet had been seen enough times to drive home the fact that everyone was vulnerable and in need of help. Twitter meanwhile also set up a COVID-19 resources page which provided real-time updates on the availability of medical resources.

These tweets were also a way of documenting what was happening across the country. However, on April 23, Twitter blocked over 50 tweets from politicians, film-makers, and others criticizing the mishandling of the pandemic. "These tweets mention rising cases and deaths, a shortage of medicines, accompanied by photos

of political events, even as the COVID-19 wave became uncontrollable, scores of funeral pyres, and patients struggling outside hospitals" reported Quartz [30].

> We'll continue to take enforcement action on content that violates to elevate credible, reliable health information,—Trenton Kennedy, Twitter spokesperson

However, even as appreciation and gratitude flowed in from different quarters, with many people pointing out what ordinary citizens had done, Quartz reported that several tweets and posts were blocked by the government. In an interview to Deutsche Welle, an un-named official from the Ministry of Electronics and Information Technology justified the action by saying, "This decision has been taken to prevent obstructions in the fight against the pandemic and a breakdown of public order due to these posts" [31].

However, few can deny that many more lives would have been lost in India's second wave had it not been for social media platforms like Facebook and Twitter. As Atish Padhy from Bangalore's *Takshashila* Institution summarized in an article, "In many ways, Indian social media's altruistic response to the COVID-19 crisis gives us adequate reason to be optimistic about human psychology, communication and, above all, social media" [32].

The Way Forward

Blessing or bane—the jury is still out on the role of social media in public health. As the India case study shows, the medium made information more accessible and saved countless lives, because of good Samaritans in the online community. It also gave rise to newer, more diverse voices. But the cons often stack up against all things good on social media platforms. The inherent unregulated nature of these sites has caused an equal amount of damage, and free speech—often misinformation and anti-science rhetoric—has set back efforts to combat public health emergencies, including the ongoing COVID-19 pandemic.

Further, the pandemic has taken a toll on mental health—often linked to doomsday scrolling on social media sites. An online survey conducted among 4,872 Chinese citizens above the age of 18 concluded that 'frequent social media exposure increased the odds ratio of anxiety, showing that frequent social media exposure is potentially contributing to mental health problems during the COVID-19 outbreak' [16].

To weigh the pros and cons of social media, the impact it has on public health and arrive at any conclusion is far too simplistic an exercise. While there are benefits and pitfalls, it is perhaps far more constructive to look at where we are today, learn from mistakes made and plan for the road ahead, so that if and when the next pandemic arrives, we as public health professionals, as communicators and as social media users are better informed and equipped to tackle a public health crisis. While COVID-19 is often referred to as the 'once in a lifetime pandemic,' public health experts have warned us time and again, that this may not be the last pandemic we live through.

Much like everything available online, it is important to remember that not every word we read, every photo and video we view on social media will be accurate. With news television's 'breaking news' syndrome stretching to social media as well, often the first tweet we see is not necessarily accurate. Similarly, when it comes to matters of public health one needs to question the information on undocumented, unverified remedies and cures—even from social media influencers or those with a large follower base. While credible sources like international health organizations or government bodies may take longer to pass on evidence-based, data-backed information, they remain more trustworthy.

The role and art of communications in public health has been slowly evolving over the past decade, and these mediums have now had to completely re-invent themselves. While public health officials and institutions have a greater role to play as information-bearers, storytelling and narratives have also changed drastically. With most people turning to online news sources, including social media for immediate answers to their queries, the time has come for institutions to invest in communications, especially online communications to be able to connect better with the public. Similarly, communications professionals attached to public health bodies must rise above jargon and the usual narratives and formats to pass on information faster and make the messages succinct but clear.

Social media platforms have moved beyond being places to connect with friends and families. Even sites like Facebook and Instagram which may seem like more private channels compared to Twitter—given that they remain platforms for people to share photos and personal content—have today become forums of debate, dissent, and marketing. Further, with social media having become a legitimate source of 'media' or a means to inform the public—it is time the medium is treated with the seriousness it deserves. Therefore, the ambit of communications needs to expand to include social media—whether it is in including how to use it effectively and responsibly in curriculums across journalism institutes or higher education, or to train spokespeople and those in positions of leadership on how to leverage these platforms.

Lastly, given the unregulated nature of social media sites, the onus falls on us to be responsible users and consumers of information. This means, being accountable for content one puts out and checking the veracity of that content on our timelines before further amplifying it. While this might be the hardest task of all, it is by far, the most critical. Even with countries, including India, today penalizing users for putting out false information on social media sites, much more remains to be done. An unverified or un-authenticated post or tweet by a user is often viewed by millions and duplicated or re-posted or re-tweeted. This often leads to myths and misconceptions being paraded as the truth. False information on these sites and on messaging apps have caused too much damage to people, including claiming innocent lives.

Kevin Systrom, the founder of Instagram is quoted to have said, "I like to say that the one thing that all people who succeed in changing the world have in common is that they at least tried". While the lessons learnt through the life of this pandemic will inform governments and leaders to prepare better for the next pandemic such as building stronger health infrastructures and committing to greater investments in

health, the role of communications and that of the media, especially social media—needs to be accounted for as well. As the world tries to build back better and stronger, so should social media.

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Communication Strategies to Build Vaccine Confidence in Vulnerable Populations in the United States

J. Carlos Velázquez and Amelia Burke-Garcia

Abstract The authors address the communication challenges of the disparate impact of COVID-19 on vulnerable populations in the USA including Latino, African American, American Indian populations, and older adults. They examine the barriers that mitigate vaccine confidence and testing efforts. They also highlight the successful communications strategies that were used to engage vulnerable populations at a grassroots level to own and organize vaccine promotion efforts in local communities and to shift the narratives about vaccine hesitancy. Three case studies are presented to provide tools and resources that can be implemented for ongoing communication interventions to promote COVID-19 vaccine uptake.

Introduction

The Chinese government first detected the novel coronavirus (SARS-CoV-2) or COVID-19 in late December 2019 [1]. COVID-19 quickly spread internationally. The first confirmed case in the United States was reported by the Centers for Disease Control (CDC) on January 21, 2020. The infection spread resulting in an epidemic in February 2020, and there was rapid transmission a month later resulting in a crisis [2]. COVID-19 is the most devastating public health crisis of modern times. From January 2020 to August 2021, the United States reported more than 36 million confirmed cases *and* more than 618,000 deaths [3]. The death toll of COVID-19 in the United States is higher than in any other country [3].

The trajectory for the spread of the virus, treatment options, and vaccine development rapidly evolved. There are, however, many challenges including the disparate impact of the pandemic, high levels of misinformation, and a politicization of policies related to public health safeguards and vaccine options.

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These factors have contributed to communication challenges that require a unified public health response. These challenges include lack of trust in science-based information, coverage gaps for routine vaccines, and the impact of COVID-19 on mental health. These challenges have an impact on how people seek up-to-date data, separate facts and science from disinformation and misinformation, and follow guidelines issued by the government.

Communication strategies, messaging and practices help to inform people about risk and access to vaccines and resources. In this chapter, we discuss the impact of COVID-19 on vulnerable populations in the United States, challenges of vaccine hesitancy, and vaccination disparities among minority populations. In addition, case studies on communications initiatives and strategies to promote vaccine uptake are presented.

Challenges of Disparate Impact

There are significant racial and ethnic disparities in the burden of morbidity and mortality associated with COVID-19. Recent data show that the age-adjusted hospitalization rates for African American, Alaska Native, and American Indian populations are five times higher than those for non-Hispanic white people [4]. Hospitalization for Latino/Hispanic persons is four times higher than that of non-Hispanic white people [5]. Disparities are, however, not limited to hospitalization. Rates of COVID-19-related deaths are significantly higher in African American/Black and Latino/Hispanic populations. According to the CDC, 18.3% of U.S. COVID-19 related deaths are among Latinos/Hispanics and 15.1% are among American Blacks [4]. As of August 4, 2021, total deaths by race/ethnicity are as follows:

- Latinos/Hispanic: 11,15,21 deaths—18% of total deaths
- African Americans/Blacks: 92,396 deaths—15% of total deaths
- Non-Hispanic Whites: 37,13,03 deaths—61% of total deaths
- Asians: 23,147 deaths—4% of total deaths
- American Indian/Alaska Native: 6,871 deaths—1% of total deaths
- Native Hawaiian/Pacific Islander: 1,153 deaths—0.2% of total deaths [6]
- Total: 60,23,87 deaths

Data from CDC and other health agencies suggest that there are disparities in the disease burden among different population groups. Health professionals, policymakers, and the media have reported that since March 2021, minority populations such as African Americans/Blacks and Latinos/Hispanics have less access to medical care, are more likely to be uninsured or underinsured, face language barriers, and are in poorer health with higher rates of medical conditions such as diabetes and high blood pressure. They also have less access to higher education and are more likely to have jobs deemed essential. These jobs, on farms, in factories, in grocery stores, and in public transportation do not allow people to work from home. Once they return home from work, they are more likely to live in crowded, multi-generational

households where they are more likely to expose their loved ones to the infection [7].

Because African Americans/Blacks and Latinos/Hispanics are younger on average than non-Hispanic Whites, it could be assumed that the rate of hospitalization and death amongst these populations would be lower. But that is not what is happening. Instead adjusting for age differences, CDC estimates that Native Americans, Latinos/Hispanics, and African Americans/Blacks are two to three times more likely to have complications and die from COVID-19 than non-Hispanic Whites [4].

Scientists and healthcare professionals point to the low vaccination uptake among African American/Black and Latino/Hispanic populations compared to non-Hispanic Whites.

Vaccination Disparities

Vaccination disparities are typically associated with health equity. Health equity refers to the human right to health and equality and is designated under international law [8]. According to the CDC, there is "health equity when everyone has the opportunity to be as healthy as possible" [9]. There is vaccine equity "when everyone has fair access to vaccinations" [10].

According to data released by the Kaiser Family Foundation in 2019, African American/Blacks, Hispanic/Latino, Asian/Pacific Islander, and American Indian/Alaskan Native populations have higher morbidity and lower life expectancy than non-Hispanic Whites [11]. Specific disparities are visible in teen birth rates, infant mortality rates, and HIV/AIDS diagnosis and death rates.

Low immunization coverage is most often associated with low access to care, language barriers, low socioeconomic status, urban residence, and minority cultural status [12]. Thus, the very communities that are often most vulnerable to infectious diseases are also least likely to access vaccines to prevent them. Vaccination is the best public health tool for preventing infection and mitigating community spread. It is important to achieve high vaccination rates and herd immunity (70% of population is fully vaccinated).

Distrust in Vaccines

Vaccination is the most cost-effective preventive health intervention. Data show that there is a high return on investment. For each birth cohort vaccinated with the routine immunization schedule, 33,000 lives are saved, 14 million infections are prevented, and direct healthcare costs are reduced by USD 9.9 billion [13]. But despite scientific progress, 42,000 adults and 300 children in the United States die each year from vaccine preventable diseases. The World Health Organization (WHO) has identified

anti-vaccine messages and vaccine hesitancy as the biggest threats to global health and ending the COVID-19 pandemic [14].

Vaccine hesitancy defined as individual level reluctance to take vaccines ranges from the cautious acceptor to the anti-vaxer who may also be anti-government [15]. Hesitancy is fueled by concerns about vaccine safety and efficacy due to widespread disinformation and misinformation [16]. Since January 2021, many scientific studies and polls list the most common concerns and questions that lead to hesitancy. Vaccine misinformation presents several challenges for healthcare professionals, especially those on the frontline. Falsehoods spread faster than facts and science and are difficult to counter once they made public [17]. Furthermore, vaccine hesitancy is rooted in the history of medical mistrust which is greater in racial and ethnic minority communities due to generations of systemic and institutional racism, health inequities, and misrepresentation in research [18].

Case Study: How Right Now/Que Hacer Ahora Campaign

Since early 2020, when the pandemic was first declared, Americans[1] followed recommended mitigation measures such as staying home, social distancing, wearing a mask, getting tested, and getting vaccinated and boosted, in order to protect themselves and their loved ones against COVID-19 infection.

During this time, many people suffered substantial loss—the loss of loved ones, the loss of connections, the loss of jobs, and the loss of economic security. As a result, there was an increase in mental health challenges.

In June 2020, the CDC released a report on mental health during the COVID-19 pandemic.

Overall, more than 40% of people surveyed reported experiencing some kind of mental or behavioral health challenge. Specifically:

- More than 30% of people reported symptoms of anxiety and depression
- More than a quarter of people (26.3%) reported trauma- and stress-related symptoms
- More than 13% of people reported using substances as a coping mechanism

Over the course of the pandemic, incidences of depression, suicidal ideation, and substance use continued [19, 20].

Research indicates that strategies that address emotional and behavioral issues—both at the individual and community levels—are needed.

In response to this need, on August 5, 2020, the public health campaign—*How Right Now/Que Hacer Ahora* (*HRN/QHA*)—was launched. It was supported by the CDC Foundation and the Centers for Disease Control and Prevention (CDC). The

[1] https://www.facebook.com/watch/?v=2753559964920007.

goal of *HRN/QHA*'s is to support increased coping and resilience. *HRN/QHA* focused on four groups:

- Adults over 65 years of age and their caregivers
- People with pre-existing mental and physical health conditions
- People experiencing violence
- People experiencing economic distress

HRN/QHA also aims to focus on at-risk racial/ethnic and gender-identity subgroups. Understanding the audiences' thoughts, feelings, and behaviors during the COVID-19 pandemic helped to develop the campaign's communication plan. A team of public health professionals conducted rapid mixed method formative research using culturally responsive and inclusive methods. Research objectives included understanding *HRN/QHA*'s audiences' mental health related challenges, information needs, available resources, perceptions of resilience, and trusted information sources.

Out of this formative research process emerged a set of evidence-based, audience-centric messages that reflect people's lifestyles and experiences. A user-friendly *website is available* where people can find resources that provide support for a wide range of emotions. *HRN/QHA* content is culturally relevant and available in both English and Spanish in both digital and printable formats. To reach its audiences, *HRN/QHA* has leveraged community organizations and trusted messengers to amplify messages. Other strategies include use of English and Spanish language digital and social media advertisements and Spanish language radio advertisements.

After the campaign was launched, the team adapted it to the pandemic. Employing an evaluation design that includes a variety of data collection methods that are culturally responsive and inclusive, campaign progress was assessed in an ongoing manner and adapted, as needed, to address shifting needs over the course of the pandemic. Outcome data revealed positive effects on coping and resilience as a result of exposure to *HRN/QHA* messages. As well the outcome evaluation revealed that the campaign was most effective for people who reported the greatest levels of stress and discord in the family which suggests that the campaign really helped those who were most in need. As we continue to move through the various phases of the pandemic—and hopefully beyond it—*HRN/QHA* has the potential to continue to provide tailored support to people as their needs evolve.

Case Study: Better for It Campaign

Despite the availability of safe and Food and Drug Administration Emergency Use Authorization (FDA EUA) approved COVID-19 vaccines, many Americans remain unvaccinated. A significant proportion of unvaccinated people are adamant and will never be vaccinated. There is vaccine hesitancy among racial and ethnic minorities and other vulnerable populations, especially among African American/Black

and Latino/Hispanic communities. COVID-19 has also disproportionately affected American Indian/Alaska Native, Chinese, and Korean populations.

Source American Lung Association, December 2021

The American Lung Association and Anthem addressed the lack of culturally resonant COVID-19 resources by developing a series of toolkits for Latino/Hispanic, African Americans/Black, Korean, Chinese, and American Indian/Alaska Native populations. This series, known as *Better For It,* was launched to provide culturally relevant, science based factual guides for COVID-19 vaccination.

The campaign developed culturally relevant toolkits, videos and resources that engage vaccine ambassadors who are trusted messengers to amplify conversations within local communities about the benefits of vaccines and other health and safety guidelines. The toolkits encourage people to seek out the best information for making personal, familial, and community health decisions and to:

- Become Vaccine Ambassadors
- Supplement user's own research on vaccines
- Start a dialogue with families, friends, physicians, traditional healers and community members
- Understand the contributions of scientists and public health advocates who are helping to bring this pandemic to an end.

Case Study: Protect the Ones You Love

In September 2020, the Virginia Department of Health (VDH) launched a comprehensive state-wide communications campaign to counter vaccine misinformation and increase awareness of vaccine benefits, safety, and efficacy. VDH's priorities were to keep communities and stakeholders informed, engaged, and motivated to promote immunization. The long-term goal was to increase vaccine uptake among high-risk populations and to mitigate the impact of COVID-19 and future outbreaks.

The campaign's three goals guided the development of strategic communication tools and tactics: (1) Counteract misinformation with facts, science, and trusted sources to discredit online misinformation; (2) Promote the safety, benefits, and guidance for childhood vaccination; (3) Promote the safety, benefits, and guidance for flu vaccination, especially in light of COVID-19.

The target audiences for the campaign included underserved communities such as Latinos/Hispanics, African Americans/Blacks, and Native Americans. A health communications team worked with VDH to design strategies by researching preferred communication platforms channels for each target audience and by facilitators to build vaccine trust and develop key messages that could motivate people to get vaccinated. Due to COVID-19 guidelines and restrictions, access to routine vaccines was limited. There is an elevated risk of a twindemic of flu and COVID-19 during the fall and winter seasons.

A health communications team implemented strategies based on the analysis and findings of the formative research. The team identified the most popular communication platforms to reach each target audience and to engage facilitators to build vaccine trust and develop messages that could motivate people to get vaccinated to protect the ones they love.

Strategies included:

Source Virginia Department of Health, October 2021

- Identify people who are pro-vaccine and multiply the effect through trusted messengers in rural and urban areas through an aggressive partner engagement plan.
- Draft and disseminate messages that are supported by facts and science.
- Implement a strategic timeline to promote flu vaccines followed by an initiative that focuses on pregnant women.

Fig. 1 Protect the ones you love campaign results. *Source* HMA Associates, Inc., June 2021

- Increase awareness through timely information on immunization as it was impacted by COVID-19 through ongoing strategic digital content dissemination.
- Develop video testimonials from people in diverse communities that encourage others to talk to a doctor.

Campaign results in the first year, highlighted in Fig. 1, show the campaign's success and reach through a state-wide media buy and multi-sector partnership with trusted messengers. The campaign also connected grassroots partners across Virginia with health departments, free community clinics, and pharmacy chains. Through these partnerships, community leaders organized vaccination clinics in underserved neighborhoods.

Conclusions

There is a critical need for designing communication interventions that are focused on and tailored to racial and ethnic groups. Case studies show that there is a need for developing culturally resonant communications to increase vaccine confidence and the uptake of vaccines by underserved populations. Engaging community leaders as trusted campaign messengers is key to promoting COVID-19 and routine vaccination. Tools that can be used by trusted messengers have the power to provide sources of science-based information and resonant messages and information about local access points for vaccines.

New challenges will emerge as the virus mutates into new variants that are more contagious and deadly. Government agencies like the CDC will respond by updating guidelines to enhance vaccine uptake to achieve herd immunity. Evidence-based communication strategies and grassroots efforts should be intensified and expanded to support these efforts and protect the most vulnerable and achieve vaccine equity.

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Exploring a Vaccine for the Misinformation Virus in a Global Pandemic: Media Literacy, COVID, and Science Communication

Sundeep R. Muppidi

Abstract I explore the questions raised at the end of my recent book on "COVID-19, Racism and Politicization: Media in the midst of a pandemic". For this chapter, I extend on that book to explore the socio-cultural, politico-economic, and digital context of media audiences' consumption of information, misinformation, and disinformation and their innate ability (or lack thereof) to distinguish factual information and/or fall prey to false and misleading information (or not). The impact of such media consumption, how it breeds irrational fears of the unknown and opposing views, and its impact on participation in civil society are explored. I conclude by suggesting possible strategies to counter this trend.

Introduction

> The COVID-19 pandemic has been the perfect storm in how international and domestic politics, misinformation, paranoia, and media bias contributed to an undermining of democratic and community values, and heightened fear and distrust among various sections of the population, around the world.
>
> At the time of writing, as new vaccines flood the world to combat the spread of the COVID-19 virus, and the virus itself seems to be mutating into newer strains, a number of other issues still remain especially about how to combat the viruses of misinformation and conspiracy thinking that have also exploded exponentially with the spread of the pandemic. In the near future, while we may finally have a vaccine for the COVID-19 virus, what we still need is a vaccine for the misinformation virus.
>
> Seneviratne and Muppidi [1]

The SARS-CoV-2 virus is responsible for COVID-19. The global COVID pandemic has highlighted many challenges that governments and first responders, around the world, face in communicating with the stakeholders in their societies.

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"On 31 December 2019, the WHO was informed of cases of pneumonia of unknown cause in Wuhan City, China. A novel coronavirus was identified as the cause by Chinese authorities on 7 January, 2020 and was temporarily named '2019-nCoV'. Coronaviruses (Co-V) are a large family of viruses that cause illnesses ranging from the common cold to more severe diseases. A novel coronavirus (nCoV) is a new strain that has not been previously identified in humans. The new virus was subsequently named the 'COVID-19 virus'. On 30 January, 2020, Dr. Tedros Adhanom Ghebreyesus, the WHO Director General, declared the novel coronavirus outbreak a public health emergency of international concern (PHEIC), the WHO's highest level of alarm. At that time there were 98 cases and no deaths in 18 countries outside China. On 11 March, 2020, the rapid increase in the number of cases outside China led Dr. Ghebreyesus to announce that the outbreak could be characterized as a pandemic. By then more than 118,000 cases had been reported in 114 countries and 4,291 deaths had been recorded" [1].

The first COVID-19 case was confirmed in the US in January 2020. Contrary to public belief, deaths related to COVID-19 doubled after the arrival of the vaccines. The US COVID-19 Vaccination Program began on December 14, 2020, and as per numbers of the Centers for Disease Control (CDC) as of mid-December 2021, at least 72.4% of the US population had received at least one dose of the COVID-19 vaccine with close to 61.2% being fully vaccinated. In addition, about 57.1 million additional/booster doses in fully vaccinated people were reported as per the Centers for Disease Control. Despite that, more people died from COVID-19 in 2021 compared to 2020. As of writing this chapter (in December 2021), the U.S. had registered over 50 million COVID-19 cases, the most in the world, including over 800,000 mostly preventable deaths. This number is twice the 400,000 deaths registered in mid-January 2021 as per the dashboard data of Johns Hopkins University.

Omicron

As is commonly understood, viruses constantly change through mutation and sometimes these mutations result in new variants of the virus. Some variants emerge and disappear while others persist. The CDC has been using genomic surveillance to track the variants of SARS-CoV-2. Since scientific labels are difficult to remember and report, the common recourse is to label them by the place of origin or spread thereby leading to discrimination and stigmatization. Hence, the World Health Organization (WHO), after consultations with experts around the world, decided to identify Variants of Interest or Variants of Concern of the Coronavirus (COVID-19) with easy to remember Greek letters of the alphabet and encouraged everyone especially scientists, world media, and governments to adopt this nomenclature. Of these past variants, Delta has been the most dominant one, followed by eight others (Epsilon, Zeta, Eta, Theta, Iota, Kappa, Lambda, and Mu) that have fizzled out.

A recent new variant (B.1.1.529) was detected in specimens collected in Botswana on November 11, 2021 and identified in South Africa on November 14, 2021. On

November 24, 2021, South Africa reported the identification of this variant to the WHO. On November 26, 2021, the WHO named the B.1.1.529 Omicron and classified it as a Variant of Concern (VOC). In doing so, it decided to skip two of the Greek letters that were next in the order, namely, Nu and Xi, and went to Omicron because it explained that 'Nu' was too easily confounded with 'New' and 'Xi' was a common surname. Since the best practice was to avoid causing any stigmatization or discrimination to any cultural, social, national, regional, professional, or ethnic group, it was deemed obvious [2]. As per the European Centre for Disease Prevention and Control (ECDC), the Omicron variant is the most divergent variant that has been detected in significant numbers during the pandemic so far, which raises concerns that it may be associated with increased transmissibility, significant reduction in vaccine effectiveness, and increased risk for reinfections. As of 26 November 2021, ECDC has classified this variant as a Variant of Concern (VOC) due to concerns regarding immune escape and potentially increased transmissibility compared to the Delta variant [3].

This variant (Omicron) has mutations that change the spike protein on the virus's surface allowing the virus to evade the human body's immune response making currently available vaccines and treatments less effective. So, there is an increased possibility of breakthrough infections too. On December 1, 2021, the first confirmed Omicron case was identified in the USA in a person who had returned from South Africa. A second case was reported on December 2, 2021 in a person who had no international travel history but had attended a convention in the days preceding. As per the CDC, while there were such reported cases in individuals without travel history to Southern Africa in the US, most of the cases detected in several European nations as well as Australia, Brazil, Canada, Hong Kong, Israel, Japan, Nigeria, Norway, Sweden, and the UK were travel-related cases. As of December 19, 2021, there were 4,691 confirmed cases in the European Union (EU) and European Economic Area (EEA) with an additional 30,220 confirmed cases outside of the EU/EEA [4].

According to the CDC, Omicron was detected in most US states and was causing concern among public health officials. But as of writing this chapter, it is the Delta variant that still dominates in the US, and *many hospitals are still overwhelmed*. As of December 15, 2020, while the Omicron variant accounted for less than 3% of US cases, the numbers *could double every two days*, as per Lori Tremmel Freeman, CEO of the National Association of County and City Health Officials [5]. That means Omicron could soon become the dominant US variant. Experts estimate the true toll of COVID-19 to be even higher and even with the availability of vaccines, predict a surge with more transmissible variants like Omicron. The CDC expects that anyone with Omicron infection can spread the virus to others even if they are vaccinated or don't have symptoms. However, reports from South Africa's National Institute for Communicable Diseases (NICD) and other preliminary studies indicate that while the Omicron variant appears to cause less severe disease than previous versions of the coronavirus, the Pfizer vaccine seems to offer less defense against infection from it but still provides good protection from hospitalization. The best solution for now, as advocated by public health officials, is for everyone to be vaccinated and get booster

shots as also to practice safe behaviors like social distancing, wearing of masks, and frequent testing as required.

According to the WHO, as of the first week of January 2022, a record 9.5 million cases of the coronavirus were tallied around the world, noting a 71% surge in the weekly count of infections as Omicron swept worldwide. The WHO also warned that it still needs to be taken seriously.

"While Omicron does appear to be less severe compared to Delta, especially in those vaccinated, it does not mean it should be categorized as mild. Just like previous variants, Omicron is hospitalizing people and killing people" said the Director General of WHO, Tedros Adhanom Ghebreyesus at a press briefing in Geneva recently.

Its impact on the elderly is still unsure as most of the cases studied have been in younger people. For now, the best way to address the spread of this virus is to control incidence, implement strong public health and social measures, and adopt preventive social behavioral practices like social distancing, sanitizing, mask wearing, vaccinations, etc. However, in many societies around the world characterized by poverty and other socially vulnerable demographics, a bigger challenge has been the inability of governments to counter the negative socioeconomic and mental consequences of rigorous lockdowns to prevent the spread of the virus, while also providing wages, food, and/or means of sustenance for vulnerable populations that have found it difficult to survive without access to daily wages or working conditions. The migrant labor crisis in India at the beginning of the pandemic is a tragic example. The situation is complicated in the USA by polarization of the political atmosphere, prevalence of misinformation, and misconception of social responsibility vis-à-vis individual freedom/rights.

While the best strategy available, getting everyone vaccinated, easier said than done because of the unequal distribution of vaccines globally and vaccine hesitancy among a sizeable percentage of the population. The WHO Director General has repeatedly called for greater global equity in the distribution and access to vaccines. As per the WHO, 109 countries will miss the WHO's target of 70% of the world's population to be fully vaccinated by July 2022. At least 36 nations have not vaccinated even 10% of their populations and about 80% of severe patients worldwide are unvaccinated. As per its weekly epidemiological report, the WHO said that:

> During the week of 27 December 2021 to 2 January 2022, following a gradual increase since October, the global number of new cases increased sharply by 71% as compared to the previous week, while the number of new deaths decreased by 10%. This corresponds to just under 9.5 million new cases and over 41,000 new deaths reported during the last week. As of 2 January, a total of nearly 289 million cases and just over 5.4 million deaths have been reported globally. All regions reported an increase in the incidence of weekly cases, with the Region of the Americas reporting the largest increase (100%), followed by the Southeast Asia Region (78%), and the European Region (65%). The African Region reported a weekly increase in the number of new deaths (22%) while all the other regions reported a decrease as compared to the previous week.

Major reasons for this vaccine hesitancy, especially in the USA are:

(1) A history of bad experiences (e.g. Tuskegee experiments) among minority and/or marginalized populations that created a trust deficit in government infrastructure
(2) Easy spread of misinformation in a world of social media
(3) A confirmation bias for conspiracies about the virus catalyzed by a proliferation of user-generated content (and a lack of fact-checking)
(4) Media irresponsibility and spread of deliberate disinformation
(5) Religious beliefs and sensibilities
(6) The historical culture of privileging individual freedom/choice as a personal right in the USA over the welfare of the larger community.

A Kaiser Family Foundation report estimated that the cost of preventable hospitalizations for unvaccinated adults went from USD 0.6 billion in June 2021 to USD 3.7 billion in August 2021, with a total USD 5 billion spent on it across these three months alone. During this time, the number of unvaccinated adults who were hospitalized primarily for COVID-19 treatment went up from 39,000 to 342,000, the report estimated. In this period of three months, it was also estimated that over 280,000 hospitalizations could have been prevented by vaccinations alone [6].

Public health experts predict that more, possibly powerful, variants will emerge in the future since a lot of people are still unable/unwilling to be vaccinated. This is a major concern because of the risk that some of the future variants might outrun the efficacy of the current vaccines, countermanding all the successful efforts so far in controlling the virus, and thereby, putting everyone again at risk.

COVID-19 Information and Misinformation

"Despite its ranking, the United States has reported the greatest number of COVID-19 cases and its response to the pandemic has generally been viewed as extremely poor. These results highlight that although the Global Health Security (GHS) Index can identify preparedness, resources, and capacities available in a country, it cannot predict whether or how well a country will use them in a crisis. The GHS Index cannot anticipate, for example, how a country's political leaders will respond to recommendations from science and health experts or whether they will make good use of available tools or effectively coordinate within their government. The Index does, however, provide evidence of the tools that countries have and the risks they need to address to protect their communities. Countries that fail to use those tools or address those risks to thereby enable an effective response should be held accountable" [7].

From an information standpoint, the impact of COVID-19 is even more evident across all sections of society. Irrespective of one's economic status, there has been a blatant disregard for safe and healthy practices—from believing misinformation, to not adopting safe/preventive practices, to denying scientific facts, to vaccine hesitancy, among others.

"To inform is to communicate with the intention to make aware, educate, and persuade. There are also other purposes of conveying some message content—the form and content is different depending on the channel/medium. Certain qualities that are unsaid and assumed that it is 'true', based on facts, is not intentionally falsified, or manipulated. In this day and age, a lot of that is communicated is also qualified by the credibility of the source. To not do that intentionally can be broadly construed as disinformation or misinformation" [1].

A comprehensive study on COVID-19 misinformation by researchers at Cornell University found that the biggest driver of such misinformation in the US was President Trump. This study sampled 38 million articles published in English language media around the world and identified the most prominent misinformation topics that appeared in traditional and online media in the early phase of the pandemic from January 1 to May 26, 2020. The top 11 conspiracy theories identified by this study include the following (Fig. 1) [8].

The spread of a number of these conspiracies was fuelled by partisan media stories that bordered on disinformation campaigns as also social media forwards among groups of believing audiences. The dynamics of such media consumption and subsequent social and political behavior/s was also worsened by how search engines and algorithms guided media audiences down a rabbit hole, by promoting related searches, irrespective of the factual content of the news items/stories, and thereby, contributed to enhancing the irrational and baseless fears of the unknown, fuelled by

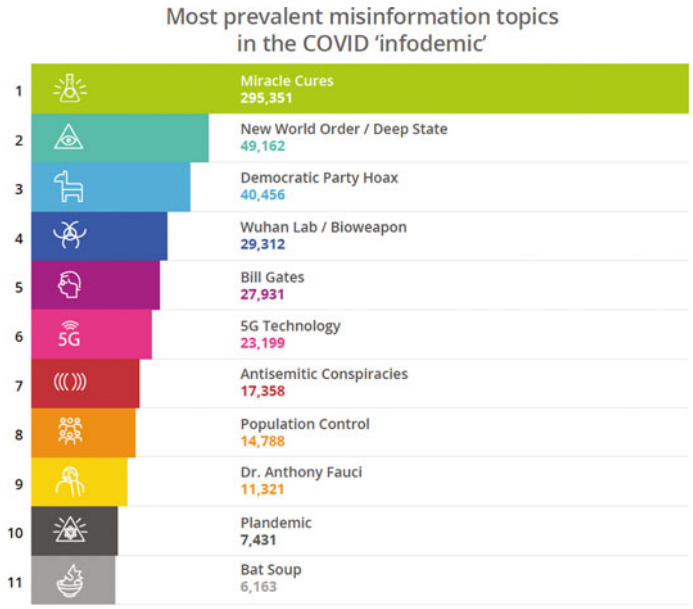

Fig. 1 Conspiracy theories and misinformation about COVID—themes. *Source* Table reproduced from Evanega et al. [8] Coronavirus misinformation: quantifying sources and themes in the COVID-19 'infodemic'

this conspiratorial thinking, without any fact-checking or cautionary messages. This increasingly got these audiences to populate and live in echo chambers without exposure to any contradicting views. Misinformed stories on mainstream media outlets like Fox aimed at appealing to a biased audience for ratings. This combined with Whatsapp and Telegram group forwards by members of groups like QAnon led to the infamous Capitol Hill riot on January 6, 2021. Later hearings are exposing how confirmation bias and lack of opposing views combined with a blind trust in politicians led to perceived trust/belief in disinformation and biased sources leading to false conclusions and belief in propaganda by vested interests. Media mentions of President Trump within the context of different misinformation topics made up 37% of the overall misinformation conversation, much more than any other single topic. Donald Trump was likely the largest driver of the COVID-19 misinformation 'infodemic'. In contrast, only 16% of media mentions of misinformation were explicitly 'fact-checking' in nature, suggesting that a substantial quantity of misinformation reached media consumers without being challenged or accompanied by factually accurate information. These findings are of significant concern because if people are misled by unscientific and unsubstantiated claims about the disease, they may attempt harmful cures or be less likely to observe official guidance and thus risk spreading the virus.

A recent study found that misinformation and political polarization have a strong influence on vaccination rates. As per a study by the National Public Radio (NPR), there was a direct correlation between COVID infections and people's political leaning. It found that unvaccinated persons were three times as likely to lean Republican as they were to lean Democrat. As per the study findings, people living in the U.S. counties that went heavily for Donald Trump in the recent presidential elections had much lower vaccination rates and were nearly three times more likely to die from COVID-19 than those who lived in counties that voted for President Biden. As per the report [9].

NPR looked at deaths per 100,000 people in roughly 3,000 counties across the U.S. from May 2021, the point at which vaccinations widely became available. People living in counties that went 60% or higher for Trump in November 2020 had 2.73 times the death rates of those that went for Biden. Counties with an even higher share of the vote for Trump saw higher COVID-19 mortality rates.

In October, the reddest tenth of the country saw death rates that were six times higher than the bluest tenth, according to Charles Gaba, an independent health care analyst who has been *tracking partisanship trends during the pandemic* and helped to review NPR's methodology. Those numbers have dropped slightly in recent weeks, Gaba says: "It's back down to around 5.5 times higher."

As the study by Evanega et al., 2020 also pointed out, "In previous pandemics, such as the HIV/AIDS outbreak, misinformation and its effect on policy was estimated to have led to an additional 300,000 deaths in South Africa alone. If similar or worse outcomes are to be avoided in the present COVID-19 pandemic, greater efforts will need to be made to combat the 'infodemic' that is already substantially polluting the wider media discourse."

The GHS 2021 report also indicated that, "some countries found that even a foundation for preparedness did not necessarily translate into successfully protecting against the consequences of the disease because they failed to also adequately address high levels of public distrust in government and other political risk factors that hindered their response. Further, some countries had the capacity to minimize the spread of disease, but political leaders opted not to use it, choosing short-term political expediency or populism over quickly and decisively moving to head off virus transmission" [7].

The Kaiser Family Foundation's COVID-19 Vaccine Monitor is an ongoing research project that measures and tracks attitudes and experiences with COVID-19 vaccinations [10]. "Using a combination of surveys and qualitative research, this project tracks the dynamic nature of public opinion as vaccine development and distribution unfold, including vaccine confidence and acceptance, information needs, trusted messengers and messages, as well as the public's experiences with vaccination." Some of the key findings include the following:

- "As 2021 comes to an end and the country faces another new variant and rising infection rates, a majority of the public now say they are frustrated about the status of COVID-19 vaccinations in the U.S., and the share who say they are optimistic has decreased eighteen percentage points since January. At the same time, the share of fully vaccinated adults who report receiving a booster dose has more than doubled in the last month, with one-fourth of fully vaccinated adults (16% of all adults) reporting receiving a COVID-19 booster dose.
- Older adults are most likely to report receiving a booster dose, with at least one-third of Black adults, Hispanic adults, and White adults over the age of 50 saying they have already received a booster dose and many more saying they plan to get a booster dose soon. This suggests that the initial concerns some Black and Hispanic adults had with the COVID-19 vaccine may have dissipated. Yet, among those who are fully vaccinated, younger Black adults seem slightly more hesitant to get a booster dose with three in ten younger Black adults saying they will not get an additional shot, compared to one in eight younger Hispanic adults and White adults.
- Partisanship continues to play an outsized role in initial vaccination uptake as well as intention to get a booster dose. Four in ten Republicans remain unvaccinated and smaller shares of vaccinated Republicans—especially older Republicans—report receiving a booster dose. Seven in ten unvaccinated adults say they aren't confident that the vaccines are safe for all adults.
- Roughly one-third (36%) of those who are pregnant or trying to become pregnant remain unvaccinated. One reason why this population may be less likely to get vaccinated is because nearly six in ten (57%) say they are not confident the COVID-19 vaccines are safe for pregnant women.
- Three in ten workers now report that their employer has required them to get the COVID-19 vaccine even as the share of the public that support the federal government requiring employers to mandate vaccines has dropped five percentage points since October. More than half of employees who work in workplaces with

100 employees or more (the size of companies covered in this federal requirement) either say their employer already requires vaccination (36%) or say they want their employer to require it (17%). Four in ten (41%) say they do not want their employer to require COVID-19 vaccination.

- Majorities of Black adults and Hispanic adults, two groups that have reported disproportionate impacts of the coronavirus throughout the pandemic, say the pandemic has had a negative impact on their ability to afford many household expenses. People in these groups are also more likely to report that they feel the government has not done enough to help either their communities or people like them."

Data from the same study also showed that "one in four adults remain unvaccinated with one in seven (14%) continuing to say they will 'definitely not' get vaccinated (a share that has held relatively steady since December 2020) and an additional 3% saying they will only do so if they are required for work, school, or other activities. Nearly three-quarters of adults say they have received at least one dose of the COVID-19 vaccine and another 2% say they will get vaccinated 'as soon as possible', similar to the shares who reported the same last month. Another 6% say they want to 'wait and see' before getting a COVID-19 vaccine."

The data also showed that disproportionate sections of certain groups—Republicans, Evangelicals, and uninsured adults remain unvaccinated. There were also disparities in vaccine uptake between those with (83%) and without college degrees (68%); between adults over 65 (89%) and those who were 18–29 years old (67%). Also, two-thirds of Hispanic, Black, and White adults reported receiving a vaccine [10]. In addition, the pandemic also negatively impacted the mental health of more than half of the adults in the US.

While several households were impacted by loss of household incomes, food and housing insecurity, and health care coverage, children, especially those from low-income households and communities of color were disproportionately affected. The unavailability and/or the unequal distribution of pandemic-related support resources has also disproportionately impacted the populations that most need them in these uncertain times.

Way Forward

In a healthy society, science communication plays a key role—from advocating prevention to helping nurture healthy lifestyles and habits, to disseminating credible information, and creating an awareness of facts. Science communication also has a major role to play in countering the virus of misinformation in any society by identifying the factors responsible and advocating strategies to reduce such barriers to the adoption of safe and healthy behaviors, especially during a global pandemic. It is also important to promote media literacy, especially in the general population, by creating an awareness about fact-checking and information dissemination while countering

the spread of misinformation, conspiracy theories, and enhancing sensitization to the politicization of the issues. This will help bring about awareness, attention to self-perception of risk, trust in scientific authority, belief in government measures, and adoption of advocated preventive and better behaviors for the common good.

Traditional models for science communication can generally be divided into two paradigms—the one-way, information transmission dissemination paradigm and the two-way, deliberative, dialogic public participation paradigm [11]. The approaches in both paradigms are important to address the spread of the virus as also to address knowledge, attitudes, and practice to bring about behavioral change in stakeholders. However, with the proliferation of social media, the one-way or dialogic models may not be sufficient to address communication that is facilitated by social media. A lot of the misinformation is disseminated through forwards via social media and group chats like WhatsApp, Telegram, and Signal without any fact checking.

From its initial discovery in Wuhan, China, the COVID-19 virus spread globally and mutated into various strains. While the Omicron strain is now the latest to emerge, most of the current infections and deaths in the USA are still attributed to the Delta variant. Across the country, there has been a spike in the number of infections and deaths.

"The 2021 Global Health Security (GHS) Index finds that despite significant steps taken by countries to respond to the COVID-19 pandemic, all countries remain dangerously unprepared to meet future epidemic and pandemic threats. Importantly, countries now have a more acute understanding of what this lack of preparedness means for their health and prosperity. This understanding presents an opportunity to convert high levels of political awareness about pandemics to long-term gains in preparedness by sustaining newly developed tools and building additional capacities to better protect lives and livelihoods against the next pandemic" (7).

These challenges highlight the need for developing effective strategies that can help stop the spread and transmission of the coronavirus. It is important to create an environment of trust and transparency that promotes an appetite for fact-checking to counter blatant misinformation and conspiratorial thinking.

During the HIV/AIDS pandemic, there were no vaccines to offer biomedical solutions and a lot of effort, therefore, went towards promoting prevention strategies including adopting healthy habits and practices. In a COVID-19 scenario, in a population that has a high vaccine hesitancy, promoting safe behaviors, enabling trust in authority, and belief in scientific facts, is very important. Hence, promoting social distancing, wearing of masks, and sanitization are an important aspect of prevention, especially in the unvaccinated.

Another lesson from past pandemics is audiences' self-perception of risk. Individual self-perception of risk is an important factor to address, as was found in HIV/AIDS-related studies was to dispel the myth that one is either immune or not likely to contract the virus even when one is aware of the risk factors and behaviors. The same is true when one considers knowledge, attitudes, and practices around other issues of concern like climate change, environmental pollution, etc. The natural progression from a pandemic to an endemic state depends on several complex factors. Few pandemics end up becoming endemic. As people become used to variants and learn

to live with the mutations of the COVID-19 virus, regular booster doses might just become the order of the day to protect against the disease. However, to be protected against the misinformation virus, there is still a long way to go.

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Vulnerable Populations

Preventable Losses: Threatening Rise in Suicides During the Pandemic

Komal Mittal, A. Philo Magdalene, and Drishya Pathak

Abstract From being a public health emergency to becoming one of the worst humanitarian crises of the twenty-first century, the COVID-19 pandemic has unraveled the very fabric of human lifestyles, with mental health at the core of its concerns. Now more than ever, suicide has become a serious public health problem worldwide. Studies published after the pandemic was declared in March 2020 estimate that suicide rates will rise globally as a result of the COVID-19 pandemic. The WHO estimates that for each adult suicide, more than 20 others attempt suicide and suicide risk is much higher in individuals who previously attempted suicide. Hence, suicide prevention in the times of the COVID-19 pandemic has become a global priority not only due to the increased rate of mortality, but also because of exacerbation of risk factors including economic instability, poor access to healthcare facilities, basic amenities, social disconnect, and many more. The aim of this chapter is to examine the relationship between the COVID-19 pandemic and the rise in suicide rates and mental health concerns. The authors undertake an analysis of existing systems and programs put in place by the government and civil society groups to critically examine suicide prevention strategies and approaches and comment on the way forward.

Background

The COVID-19 pandemic began in China around the end of 2019. Its prevalence increased dramatically all across the world. Hundreds and thousands of individuals died as a result of the millions of infections that were documented. Nothing in

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the twenty-first century can come close to the havoc wrought by the COVID-19 pandemic. The last pandemic crisis that unfolded in a similar manner was the Spanish Flu in 1918–19, which infected roughly one-third of the world's population. Millions of people became infected and hundreds of thousands died [1]. The Spanish Flu virus infected approximately 500 million people or one-third of the world's population. In addition to disease-related deaths, Spanish Flu was associated with suicidal deaths. This led to the conclusion that a decrease in social integration and communications during a pandemic and widespread fear can lead to an increase in suicidal cases [2]. The COVID-19 pandemic had an impact on mental health, escalating the risk of suicides globally. Despair and feelings of loneliness became pervasive [3]. There was misinformation about the virus spread. Global dispersion, number of infections, and mortality increased people's feelings of insecurity and anxiety [4].

Most of the world's population lives in low- and middle-income countries (LMICs) which have inadequate mental health resources in place [5]. COVID-19 spread rapidly in many of these countries. There is extensive literature on the health implications of COVID-19 in high-income countries. But low- and middle-income countries which have 83% of the global population have very little research [6]. There is evidence to show that the COVID-19 pandemic had profound psychological and social effects with psychological sequelae which persisted for months and years. Social isolation, anxiety, despair, chronic stress, and economic difficulties led to an exacerbation of depression, anxiety, stress, mass panic, substance and drug use, and other psychiatric disorders. These problems are contributing to a rise in suicides, a most concerning but preventable loss [7].

The COVID-19 pandemic disintegrated human lifestyles with mental health at the core of this concern. More than ever before, suicide became a serious public health problem worldwide. Suicide is the termination of a psychologically susceptible, vulnerable person's life. As the COVID-19 pandemic had profound mental health consequences, there was a concern that it could lead to an increase in suicide cases during and even after the pandemic. There is a pervasive sense of uncertainty about the future as we know that the pandemic is far from over. Most mental health consequences of the COVID-19 crisis, including suicidal behavior, are likely to remain for a long time and peak later than the actual pandemic [8]. The spread of the coronavirus disease may not have a direct effect on the increase in suicides. However, its implications on a broad range of socio-economic and psychological factors evidently perpetuate a chronic increase in risk Suicides are preventable. Therefore, there is an urgent need to design socio-culturally tailored interventions. Frontline workers, migrants, homeless, the unemployed and impoverished, and those with a pre-existing history of mental disorders are at a higher risk of suicide. According to research, fear of being infected, fear of becoming a burden to the family, generalized anxiety, social distancing and isolation, and mental distress were factors that increased suicidal risk during the pandemic.

Since COVID-19 disproportionately affected various countries, ethnicities, and groups, studies on suicides need to be sensitive to the socio-cultural context [9]. It is important to note that a dual vulnerability was created with the convergence of suicidal risk factors and the impact of the pandemic. Studies published after the

pandemic was declared in March 2020, estimate that the number of suicides will escalate globally [10]. The WHO estimates that for each adult suicide, there are more than 20 others attempting suicide and that suicide is much more frequent in individuals who previously attempted suicide. Suicide prevention in times of COVID-19 has become a global priority, not only due to increased mortality and morbidity, but also due to the exacerbation of risk factors including economic security, poor health facilities and basic amenities, and a social disconnect.

The United Nations has prioritized suicide prevention as an integral part of mental health interventions. To promote overall wellbeing, concerns of stress, fears, anxiety, and loneliness must be overcome in the general population. According to an advocacy statement released by the Indian Psychiatric Society (IPS), the pandemic crisis has increased the need for multi-disciplinary action to protect mental health. In this regard, an essential component of any public health intervention is suicide prevention, mental health management, and research [11]. Since COVID-19 is much more than a public health crisis and has serious socio-economic impacts, active outreach is necessary through traditional and tech-based media campaigns to promote mental health. To design effective interventions, there is a need for research to understand how mental health consequences can be mitigated during and after the COVID-19 pandemic. The pandemic has revealed the profoundly interconnected nature of global health and has generated knowledge to inform a mental health response. In this chapter, the authors examine the mental health implications of the COVID-19 pandemic especially in low- and middle-income countries (LMICs); assess changes in suicide trends during the pandemic; various triggers; prevention strategies and approaches taken by governments and institutions; and challenges encountered in designing and implementing mental health programs. The authors provide an overview of what is known about this topic, highlights gaps in the literature, and make recommendations for future research.

Impact of COVID-19 on Mental Health in Low- and Middle-Income Countries

A review of available secondary data shows that research on the impact of COVID-19 on mental health and suicides and on designing intervention strategies is largely limited to developed countries like Australia, North America, and Europe. There is a lack of research in LMICs.

The COVID-19 pandemic exposed a huge gap in the mental health infrastructure of LMICs and drew attention to the need to examine the intersection of mental healthcare with existing health systems. Given the challenges of scarce resources, low workforce capacity, inequitable access to interventions, and lack of verifiable information, it is speculated that the consequences of mental health are more severe in impoverished and vulnerable regions of the world [12–14]. As compared to high-income countries, there are higher rates of comorbidities among individuals with lower educational

attainment in LMICs. In general, about 75% of suicides occur in low- and middle-income countries where poverty rates are high. The relationship between economic variables and suicidal behavior highlights serious concerns [15]. The ripple effects of the pandemic affected the livelihood of the poor, especially those with inadequate safety nets and resources to support them during financially trying times. Following the COVID-19 crisis, global economic growth is expected to contract pushing millions into poverty [16]. This is expected to exacerbate suicidal behaviors. Furthermore, vulnerable groups such as people with disabilities, the elderly, patients in hospitals, and people experiencing violence and abuse are at greater risk of psychological distress due to the pandemic. Thus, there are a host of risk factors that need to be assessed in the context of COVID-19 to address the problem of suicidal behavior.

Assessing the socio-economic determinants of suicidal behavior is essential in aiding policy-makers to develop appropriate population-level interventions. Effective suicide prevention interventions among those with mental health concerns cannot be possible without a thorough understanding of the social and economic factors involved. In comparison to the psychiatrists per 100,000 population in high-income countries, LMICs have much lower numbers of psychiatrists per 100,000 population, which highlights the greater need to address suicidal behaviors from the angle of social determinants of health more than just a psychiatric diagnosis [15].

Variety of Risk Factors that Trigger Suicidal Attempts

Hawton and Van Heeringern note that suicide is the tenth leading cause of death globally and the fourth leading cause of death among 15 to 19 year old persons [15, 17]. It is estimated that every year more than 700,000 people die due to suicide. For every suicide, there are many more suicidal attempts. In 2001, Wasserman estimated that the rates of non-fatal suicidal behavior are 20 to 30 times more common than completed suicides which have increased since the start of the pandemic [18]. Over 77% of global suicides occur in LMICs which have less resources and high levels of poverty. It is, therefore, important to understand the relationship between poverty and suicide for suicide prevention in LMICs. The WHO Suicide Report in 2020 refers to the entire spectrum of suicidal phenomena: “suicidal behavior refers to a range of behaviors that include thinking about suicide (or ideation), planning for suicide, attempting suicide, and suicide itself”. Suicidal ideation, plan, and attempts are the stages involved before a suicide occurs [19, 20]. According to an estimate by WHO, for every successful completion of suicide, there are at least 20 suicide attempts [21]. The risk of suicidal ideation increased 13.810, 6.454, and 9.530 times for those who suffered from depression, anxiety, and stress, respectively during the COVID-19 pandemic [22, 23].

COVID-19 resulted in isolation, dread, depression, and vulnerability which along with biological (disposition, family background of self-destruction, prior mental issues, and substance abuse) and psychosocial factors (financial constraints, loss of

livelihood, old age, and others) has increased the risk of mental health problems and suicidal tendencies.

Table 1 shows some of the risk factors and contributors for suicide during the COVID-19 pandemic. It shows how the pandemic is increasing mental health risks because of social inequities, and economic and socio-cultural characteristics including age, religion, economic fall-out, abuse, violence, marginalization, fear, isolation, and other factors. In high-income countries, low educational levels and social disadvantages such as homelessness, unemployment, and social isolation are major risk factors for contracting severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [24, 25]. In low- and middle-income countries, poverty and socio-economic inequities are more prominent. They enhance vulnerability to mental health problems. A prevalence of 33% of depression and 5% of suicidal ideation was reported through an online study of more than 10,000 individuals in Bangladesh [26]. In Brazil, this pattern was apparent in the poorest communities in the country as they had a greater risk of disease transmission and mental health consequences [27]. The COVID-19 pandemic impacted the economic and social determinants of health worldwide. According to a study on the Global Burden of Diseases, mental health conditions had a negative influence on the social determinants of health, which in turn impacted overall wellbeing [28]. In the case of the COVID-19 pandemic, disruption destabilized the social determinants of health globally and as a consequence, impacted the mental health of populations as well as the nations' wellbeing.

McDaid and Kennelly noted that suicide was associated with economic inequalities and shocks [29]. In the wake of the global economic crises, the impact of unemployment in high-income countries were investigated extensively. Following the 2006–2008 economic crisis, higher suicide rates were reported [30]. A similar association between suicide and unemployment was observed during the Asian economic crisis with GDP contractions in Japan, South Korea, and Hong Kong but not in Taiwan and Singapore [31]. Higher risk was observed in the poorest sections of society. It was hypothesized that even after the economic recovery post-crisis, these countries will continue to suffer which will result in more suicides.

With increased exposure to known risk factors, the pandemic is laying the foundation for an increase in suicides worldwide. The risk factors are social isolation, unemployment, job insecurity, economic stress, inaccessible community support, difficulties in accessing mental treatment, and physical ailments especially among the elderly [32–34]. A model that combines data from multiple countries, including high-income and low- and middle-income countries, suggested that job losses from COVID-19 could result in upto 9,570 excess suicides annually across the globe [34]. Models assessing the pandemic regression trend in the US estimated that if the rate of unemployment is managed, economic recession would result in 3,235 additional suicides in the next two years (3.3% increase per year). They also estimated an excess of 8,164 suicides over two years (increase of 8.4% per year) if the rate of unemployment was not moderated [35]. It is important to note that pre-existing failures to prevent human rights violations is further complicating the mental health impact of the pandemic [36].

Table 1 Risk factors and contributors for suicide during the COVID-19 pandemic

Risk factors for suicide	Contributors
Loneliness, isolation, and boredom	Social isolation, travel restrictions, lack of access to technology, quarantine, and confinement
Fear and uncertainty	The unknown nature of the virus, misinformation, irresponsible media coverage, and inadequate healthcare facilities
Marginalization	Social stigma, xenophobia, and communal emotional responses
Psychological disorders	Anxiety, depression, grief, death of loved ones, acute stress, and substance abuse
Psychiatric disorder relapse	Limited access to healthcare, lack of prescribed drugs, supervision, and information
Economic ramifications	Financial crisis, unemployment or job loss, downfall and eventual destruction of small-scale industries for poor, daily wage workers
Domestic abuse and violence against intimate partner	Increased contact time with/between partners, drug and alcohol abuse, misogyny and bias against the opposite gender, and increased responsibility for children
Special vulnerabilities	Adolescents and elderly are more prone to isolation, loneliness, depression, and suicidal risk

Source 'The dual pandemic' of suicide and COVID-19: A biopsychosocial narrative of risks and prevention [11]

Studies on the COVID-19 pandemic forecasted an increase in the suicide rate based on rising unemployment rates [37]. In 2018, in the US, the suicide rate was 14.8 per 100,000. It was predicted to increase from 16.2 to 17.4 per 100,000 in 2021 [35]. Similarly, the rate of suicide mortality increased in developing countries. Based on a report by the Asian Development Bank, around nine million people will be unemployed due to the COVID-19 pandemic, which could result in an approximate loss of USD 3 billion in gross domestic product (GDP) [38]. As a result of these massive financial losses, large numbers of people would be pressurized and forced into mental breakdowns leading to suicidal behavior. Within the first three weeks of COVID-19 being declared a pandemic, nine COVID-19 associated suicides were reported in Bangladesh; a few of them were associated with sudden unemployment and financial breakdown [39]. Similar mental health consequences leading to suicides were reported in other countries.

Factors that trigger suicidal behaviors are: (1) socio-demographic factors such as gender, marital status, education, and employment; (2) behavioral and health-related factors such as abnormality in sleep, alcohol consumption, smoking, substance use, and lack of physical exercise; (3) COVID-19 pandemic-related factors such as lack of

knowledge and lack of preventive measures, economic losses, and deaths of acquaintances; and (4) psychopathological factors such as depression, anxiety, history of suicidal thoughts, and suicide attempts. People with low awareness and lack of knowledge about preventive behaviors and/or higher level of fear of the infection are at a higher risk of suicidal ideation [40]. Suicide risk was 1.347 times higher for people living in high COVID-19 exposure areas and 1.299 times higher for people with economic losses due to the pandemic. About 700,000 people take their own life every year and every suicide is counted as a tragedy that affects families, communities, and even entire countries. There is a long-lasting effect on people who are left behind. With the COVID-19 pandemic, suicide has become a serious public health problem that needs to be addressed with timely, evidence-based, low-cost interventions.

While suicide has wide-ranging and diverse socio-economic triggers that vary with each context, it is important to examine the experience of key population groups.

Impact of COVID-19 on Key Populations

1. **Students and working populations**: Extended closure of educational institutions is expected to have a deep impact on the mental health of young adults, adolescents, and children across the globe [41]. Schools not only benefit children academically, but also provide a well-defined and moderated space for socio-emotional development and social support, and offer protection from high-risk situations and behaviors like exploitative labor, drug abuse, early marriage and early pregnancy. In addition, public schools are often the main entry point for children's meals in many LMICs to ensure adequate nutrition through school feeding programs [42, 43]. Therefore, school closure in response to the pandemic could have the unintended consequence of increasing food insecurity among children, which negatively affects mental health [44]. In addition to school children, college going students and graduates also suffered from a sense of isolation and uncertainty due to the lack of social interaction and increased dependence on technology. Restriction in mobility and work-from-home lifestyles impacted the mental health of a large group of the working population who had to increasingly deal with 'burn-out' and mental exhaustion, not to mention the dual burden of working women in the household.
2. **Impact on frontline workers**: Frontline workers were the backbone of a country's fight against the spread of COVID-19 infection. Due to increased work pressure and responsibility, they were most vulnerable to the physical and psychological risks posed by the pandemic. With continuous exposure, they were in constant threat of infection and lived in fear of spreading the disease to their families and loved ones. Significant research has been undertaken on mental health care, especially on frontline workers. Their increased frustration, absenteeism, depression, and suicidality are attributed to growing work pressure, morbidity, chronic stress, and isolation [45]. In addition to disease exposure, health workers

also faced the additional burden of a lack of personal protective equipment (PPE) kits, lack of flexibility in work hours or increased hours of work, and inadequate health and insurance facilities, especially in LMICs [46].

3. **Impact on the elderly**: During the COVID-19 pandemic, age and ageism were special concerns. Age predisposes an individual to psychological vulnerability. Studies have found that quarantine and isolation causes profound loneliness, depression, and suicidality in the elderly [47]. Autonomy, decision-making, dignity, and mobility which are the vital signs of good health, may be compromised at some point during the pandemic [48]. In many cases, the elderly were stranded and pushed to self-neglect when lockdowns deterred their access to home help and essential resources. Suicidality is regularly under-recognized among seniors and their despair manifests in different forms, sometimes leading to suicide [49].
4. **Impact on the homeless and migrants**: The world shelters around 1.5 billion homeless people. They are mostly from South Asian and African countries [50]. They live in overcrowded and impoverished shelters with no possibility of social distancing and other preventive practices. Hence, they are at an increased risk of infection. They have poor access to testing facilities and inadequate knowledge about the infection. In addition to the vulnerability that accompanies infection, substance abuse and mental health issues that come with socio-economic stress contribute to suicidal risk. Post-lockdown, especially in countries like India, large numbers of migrants were stranded on the streets and at railway stations with no means of survival. They were tormented by starvation. They welcomed death as their living condition were harsher than the virus itself [51].
5. **Impact on victims of abuse and violence**: The pandemic witnessed a significant increase in intimate partner violence and domestic abuse, especially in families already dealing with marital conflict, interpersonal violence, and substance abuse. There was an increase in the number of registered complaints reported in the United Kingdom's domestic abuse helpline. Some expressed their death wish while registering their complaints [52]. This entrapment of families during the lockdown due to the unprecedented COVID-19 crisis had never been seen before. Tertiary mental healthcare helplines recorded continuous incoming calls for complaints. These calls were majorly of domestic violence associated with feelings of suicidality as the latter was considered an easy escape. This is preventable but due to underreporting, fear of legal hassles, acceptance, and untreated depression, suicides continue to occur.

Extent of Reporting

Currently, there are no standard models for reporting mental health issues in low- and middle-income countries. However, given that LMICs carried most of the world's suicide burden and were greatly hit by the economic consequences of the pandemic, it is possible for suicide rates to significantly increase in these countries [52]. A

review on COVID-19 and suicide by Indian media supports this speculation. In many LMICs, suicides are often under-reported or are reported as having different reasons for death due to stigma, cultural, and religious factors associated with them [53, 54]. These inconsistencies with reporting and the lack of an international database suggest that data on the socio-economic determinants of non-fatal suicidal behavior remains limited in LMICs. In the years between 2001 and 2007, as part of the WHO World Mental Health Surveys, data from 21 countries showed that low-income level and unemployment were major risk factors for non-fatal suicidal behaviors in both high-income and LMICs [55].

Therefore, to fully understand the impact of the pandemic, taking note of the regional difference in suicide rates and strategies implemented to address differing risk factors, it is vital to build transparent and rigorous suicide reporting and monitoring mechanisms. For instance, there is recorded evidence that substance use and disorders, which have led to an increase in suicidal rates in financially affected communities, were the major cause of mortality associated with previous global recessions [56]. Table 2 shows the preferred ways of reporting suicides and practices to be avoided by the media.

Due to increasing vulnerability in LMICs and rise in mental health concerns, resource-limited. LMICs were compelled to develop nation-wide policies to address the consequences. Using the guidance from psychosocial programs of the World

Table 2 Reporting of suicides by the media in a responsible manner

Preferred ways of reporting	Practices to be avoided
• Accuracy of information • Authentic and trustworthy sources for help-seeking and assistance • Suicide facts and risks Preventive methods for suicide • Vulnerable groups at risks of suicide • Expert opinions of qualified professionals/first person accounts of coping • Sensitive and humane bereavement interviews • Peer debriefing and support to media personnel dealing with trauma • Factual reporting of the suicide event (especially celebrity suicide)	• Personal assumptions, biases, 'tales' or stories of suicide • Conspiracy theories • Detailed and repetitive reporting • Sensationalizing, fantasizing, or normalizing suicides • Reporting and labelling self-harm as 'heroic' or 'constructive' • Generation of fear, stress, and panic • Extensive debate and discussion with multiple professionals about the same incident: which causes confusion and anxiety • Avoid 'catchy' or sympathetic headlines/phrases • Coercive questioning of the bereaved on camera • Avoid visual content (photographs, videos, social media links, etc.) whenever or wherever possible • Emphasize personal life and contextual information • Avoid judgmental comments

Source World Health Organization, 2017 [51]

Health Organization (WHO), some LMICs developed their own model programs to address the population's mental health needs and strengthen support systems [57]. Based on the demand for mental healthcare, systems need to be established in remote regions, WHO created the Ensuring Quality in Psychological Support (EQUIP) platform to provide supervision and counseling to people with mental health concerns and to support them [58]. This platform enables men and women in remote outlying areas to address issues related to their mental health and deal with suicidality [59].

Prevention Strategies and Approaches Taken by Government and Other Institutions

In a report by WHO, suicide was highlighted as a global public mental health concern. In 2014, to make suicide prevention a high priority in the global health agenda, WHO published the first World Suicide Report "Preventing a suicide: A global imperative". This report aimed to increase the awareness and the public health significance of suicide and suicide attempts. It also aimed to encourage and support countries to develop and strengthen prevention strategies through a multi-sectoral approach. Through the WHO Mental Health Action Plan 2013–2030, member states committed to work towards reducing their suicide rates by one-third by 2030. The suicide mortality rate is an indicator of target 3.4 of the Sustainable Development Goals (SDGs) to reduce mortality rate and promote mental health and wellbeing (WHO) [60].

In June 2020, a study in the U.S. suggested a notable increase in mental health concerns related to COVID-19. Groups like young adults, racial and ethnic minorities, frontline workers, and caregivers for the elderly experienced disproportionately worse mental health outcomes, increased substance use, and suicidal ideation. The study cited several reasons for the lack of evidence on the impact of mental health programs. While the pandemic was still advancing in many countries, most health programs were carried out with a sense of urgency with limited time and resources for comprehensive assessments. The study examined initiatives undertaken and capacity of governments in low- and middle-income countries to develop COVID-19 mental health plans. It highlighted the diversity and innovative capacity of these programs. It acknowledged that while a variety of programs sought to address population groups, cater to individual needs, and provide lessons on implementation, they were yet to be effectively carried out. This underscores the importance of assessing program implementation and outcomes for developing a comprehensive mental health response during emergencies.

Workers in the health system, ranging from community health workers to mental health experts, were trained in several countries to identify individuals suffering from mental health issues and distress (Fig. 1). Kerala, a state in India, organized phone based programs to identify and refer people in need of mental healthcare, while Pakistan and Uganda implemented face-to-face initiatives [61, 62]. In China,

mental health consequences were recognized by artificial intelligence programs and mental health materials were disseminated through online applications like WeChat, Weibo, and TikTok, Turkey built apps to allow access to mental health counselors [63]. In South Africa, films were developed for people and healthcare professionals highlighting signs of stress, anxiety, and depression and showcasing tools for those seeking assistance. In the Honduras, Médecins Sans Frontières (MSF) offered phone based psychological care to patients and survivors of violence. It also established a mental health phone helpline. Similarly, virtual online resources were offered for education and information in Nicaragua, Serbia, Liberia, Costa Rica, and other developed and developing countries.

Based on past humanitarian emergency experience and the specific needs of the COVID-19 pandemic, many LMICs quickly developed National Mental Health and Psychosocial Support (MHPSS) response plans for COVID-19. The National Health Commission of China developed guidelines for psychological crisis intervention in emergencies emphasizing the importance of mental health services and the need to organize at the city, community, and province levels including psychological counseling teams and hotlines [64]. Lebanon published a government action plan for a MHPSS response in March 2020 outlining the promotion of mental health and associated risk factors related to COVID-19, support for the quarantined and frontline workers, and ensuring continuity of services for patients with pre-existing psychiatric conditions [65]. Similar national action plans were released in South Africa, Kenya, Uganda, the Maldives, and India. Regional responses within countries preceded national plans in some cases [66–68]. For example, in February 2020, the Kerala state government formed a multi-disciplinary team that integrated the efforts of various sectors and established a state hotline [69].

Materials were evolved in many LMICs to promote mental health and wellbeing during the COVID-19 pandemic. The WHO published an illustrated manual to showcase evolving stress during the COVID-19 crisis [70]. In India, Firework, a short 30-s decentralized video platform was launched in 2019. It released #sparkthejoy, a social effect promotional marketing campaign to encourage individuals to conduct an 'act of good'[71]. During the lockdown in India from the start of March 2020 to the end of May 2020, the platform's usage increased to more than double [72]. The Mental Health Innovation Network and WHO provided stories from the field for the purpose of providing mental health and psychosocial help during the pandemic crisis [73]. Material for information, mentoring, and communication highlighting mental health and stigma globally. For example, a collection of videos on grief and mental health, as a part of the Regional Psychosocial Support Initiative, was developed for South African youngsters and teenagers.

The WHO and the U.S. Centers for Disease Control and Prevention (CDC) published a series of psychosocial and mental health recommendations in 2020 [74, 75].

Government actions: Encourage multi-disciplinary mental health teams to play an active role at the national, state, and municipal levels; provide training in stress management, trauma, depression, and relative risk protocols; standardize and make

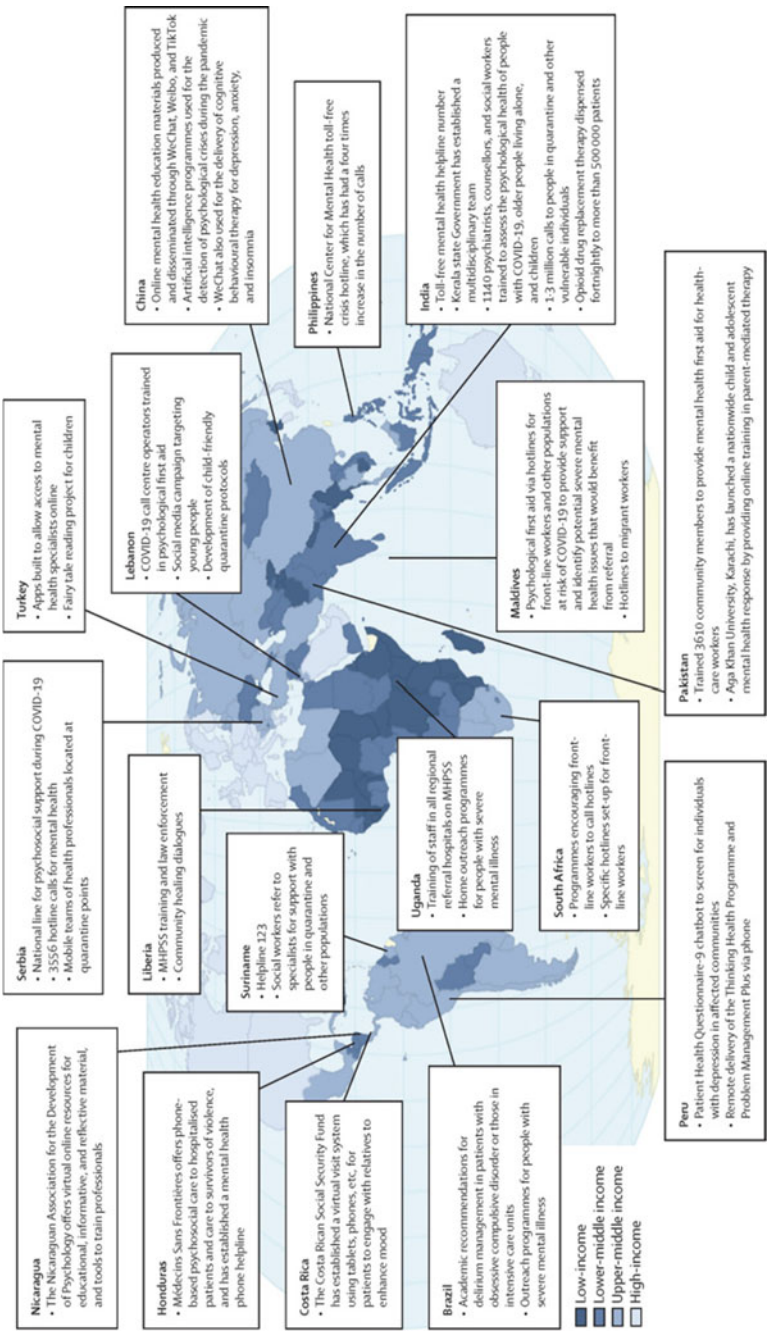

Fig. 1 Mental health responses to COVID-19 in low- and middle-income countries. *Source* Lancet

available psychotropic drugs; ensure adequate resources and infrastructure for mental health services; ensure that clinical and mental healthcare is accessible to the population; develop psychoeducational materials and make them widely available to the population; and provide official channels for the public to receive up-to-date information; provide alternative service channels (apps, websites, and phone calls); monitor and disprove fake news; promote scientific research; take into account and respect cultural diversity when developing public policies; and collect epidemiological data to support future prevention and mental health policies.

Individual recommendations: Take care of yourself and others by staying in touch with friends and family and making time for recreational activities; adhere to the WHO and government health agency recommendations and guidelines; pay attention to your own needs, feelings, and thoughts; limit physical contact with others while maintaining emotional proximity; limit exposure to pandemic-related news because too much information can trigger mental health problems and cause anxiety disorders; monitor dysphoric mental states such as irritability, mood swings, and aggression; share or tell your peers if you experience symptoms of sadness or anxiety; as much as is possible, assist people in high-risk groups and widely disseminate contamination prevention information and instructions [3].

This was in line with longitudinal data from the WHO demonstrating that psychological factors are directly associated with the causes of morbidity and mortality [74]. Thus, increased investment in research and strategic actions for mental health is urgently needed worldwide, especially during such outbreaks.

Challenges Encountered in Devising and Implementing Mental Health Programs

Governments, healthcare providers, and other establishments in many LMICs responded to demanding situations by not only imposing lockdowns, restricting mobility, and strengthening clinical response to the virus, but also by devising a range of suicide and mental health helplines and promoting the public's psychological wellbeing through billboards and other traditional and non-traditional media channels. Nevertheless, the prevention of suicide has not been adequately addressed due to the lack of awareness and stigma associated with discussing mental health in many conservative societies, especially in LMICs. Many people thinking of taking their own life and those attempting suicide do not seek help due to the major stigma surrounding mental health and suicide disorders. It is important for governments to break down this taboo and raise community awareness through a range of interventions in order to make progress in preventing suicides. There is also the question of prioritizing available resources to manage situations like this public health emergency. For national responses to be effective, a comprehensive multi-sectoral prevention strategy for suicides is needed. To date, only a few countries have included

suicide prevention among their health priorities and only 38 countries report having a national suicide prevention strategy [17].

Limitations

Most of the available evidence comes from high and upper-middle-income countries with very few studies from low-income countries. Most studies focus on poverty, joblessness, and the increasing economic crisis. Dimensions such as debt, interest on payments, poverty, and the support of systems have been neglected, especially during the COVID-19 pandemic. Most studies were carried out within a risk factor paradigm and used descriptive statistics, thus providing very little useful information. Stronger evidence is needed in this area with studies focusing on a broader range of dimensions and using better statistical methods. The chapter, therefore, presents a partial picture of the associated risks because it is based on the available literature.

Concluding Comments

The COVID-19 pandemic has disrupted almost every aspect of life in all countries simultaneously. This global phenomenon is unlike any other in human history. Emerging evidence indicates that mental health consequences will be significant and long-lasting. The impact is greatest in under-resourced or low-resourced settings and among disadvantaged populations. Because of the lockdown and constraints associated with public health measures, a growing number of individuals are struggling psychologically and economically which exacerbates mental health problems and eventually leads to suicide. Suicide itself is considered to be a pandemic. Suicide prevention by early detection of risk is an important strategy. It is a collective responsibility. Given its strong socio-economic determinants, an increase in suicide rate is not surprising. Niederkrotenthaler et al. in 2020, in their paper 'Suicide Research, Prevention, and COVID-19' note that there is a pressing need for impartial and authenticated information regarding the determinants of population-based suicidal behavior for designing viable strategies for suicide prevention [76].

Even though suicides are preventable, we are losing lives every day. To prevent suicides, a number of measures can be taken at the population, sub-population, and individual levels. In 2018, WHO recommended the following interventions based on its approach of 'Live Life' to prevent suicide: (1) limit access to the means of suicides such as pesticides, drugs and medications, and firearms; (2) report responsibly through appropriate media interaction; (3) foster socio-emotional life skills, especially in adolescents; and (4) identify early, manage, and follow-up people with suicidal behaviors [17]. Prevention of suicide requires collaborative and coordinated efforts among multiple sectors of society such as health, education, agriculture,

media, law and justice, politics, and other sectors. These efforts need to go hand-in-hand with the foundational pillars of multi-sectoral collaboration, raising awareness, building capacity, regular surveillance, and monitoring and evaluation. All these efforts must be integrated for maximum impact on this most complex problem.

The world stands at a difficult juncture. High quality registration data is vital especially in low- and middle-income countries, as the majority of suicides are predicted to occur in these countries. Enhancing surveillance mechanisms to monitor suicides is crucial to aid the planning and evaluation of intervention strategies in LMICs and to precisely evaluate progress towards global suicide mortality targets.

The International COVID-19 Suicide Prevention Research Collaboration (ICSPRC) requested for a worldwide representation, risk assessment and for employing preventive and control measures. This collaborative community focuses on the moral aspect while systematically studying the duration during the early stages of the pandemic, emphasizing the need for sharing high quality suicide studies, designing and developing appropriate evaluation tools and platforms, and harmonizing information from diverse settings [77].

Every country dealing with suicide has a distinct public health infrastructure, socio-cultural environment, and demographic framework. Therefore, in addition to global collaboration through public health organizations like the WHO and CDC, there is a need for providing additional insights from these countries to advance strategies for suicide prevention during pandemics [78].

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We Are Not All in the Same Boat: Refugees and Asylum Seekers in the Context of COVID-19

A. Philo Magdalene, Michelle Whiting, Felicia Rangel-Samponaro, and Amali Tower

Abstract The COVID-19 pandemic has exacerbated the existential risks and uncertainties experienced by refugees and asylum seekers on a day-to-day basis. Although the pandemic presents some level of risk to everyone, the world's refugees and asylum seekers bear a disproportionate burden of risk in the context of COVID-19. Overcrowding in camps, lack of access to medical services, changes to the asylum-seeking process, movement restrictions, and other factors converge to marginalize refugees and asylum seekers. This chapter presents a case study that looks at the experiences of asylum seekers at the US-Mexico border through the lens of a non-governmental organization (NGO) volunteer who has been working in the region throughout the pandemic. By using this case study and secondary level research, the authors seek to provide an understanding of the ways the pandemic has aggravated the challenges refugees and asylum seekers are facing globally, with an emphasis on the US-Mexico region.

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Introduction

Refugees and asylum seekers were vulnerable populations long before the World Health Organization declared COVID-19 a pandemic on March 11, 2020 [1]. COVID-19 has only exacerbated the challenges they face on a daily basis. With asylum hearings moving online, overcrowding in encampments, and increased stigmatization of migrants in the context of disease spread, refugees have been shouldering unequal impacts throughout the COVID-19 pandemic. As of December 2020, there were 82.4 million people who were forcibly displaced worldwide as a result of persecution, conflict, violence, human rights violations, or events seriously disturbing public order (UNHCR). This number is projected to be on the rise.

This chapter provides a global overview of some of those impacts and firsthand accounts from a volunteer in the encampments at the US–Mexico border. The first section of the chapter brings into perspective the conditions of the world's asylum seekers in the context of COVID-19 and an understanding of the ways the pandemic has aggravated their challenges. The second section features a narrative from an NGO worker at the US–Mexico border who brings a much needed experience-based insight into the lived realities of asylum seekers, especially during the pandemic. By using this case study and secondary level research, in the final section, the authors attempt to draw an inceptive understanding of the long-term implications and lessons that the pandemic offers with regard to the refugee crisis.

Terminologies

The United Nations High Commissioner for Refugees (UNHCR) updated its Master Glossary of Terms in June 2021, fifteen years after producing the first version of the document [2]. The update came, in part, as a response to an increase in displacement and a need to provide stakeholders with consistency and clarity around displacement terminology [2]. One of the important clarifying points in the document was that "Not every asylum seeker will ultimately be recognized as a refugee, but every refugee is initially an asylum seeker" [2]. Article 14 of the Universal Declaration of Human Rights states that "Everyone has the right to seek and to enjoy in other countries asylum from persecution" [3]. Asylum seekers are people who are either seeking, or have a need for, international protection [2]. People seeking asylum may be awaiting a decision on an application for refugee status or intending to submit an application for refugee status [2].

According to international law, refugees are people who have fled 'their countries of origin', and "are in need of international protection because of feared persecution, or a serious threat to their lives, physical integrity, or freedom in their country of origin as a result of persecution, armed conflict, violence, or serious public disorder" [2]. Internally displaced persons face similar circumstances to refugees but have not crossed an international border [2].

Migrant is a term that defies an all-encompassing definition and has no definition under international law [2]. The term is typically associated with more agency in relation to movement, particularly 'across international borders' [2]. This agency differentiates migrants from refugees in that migrants "continue in principle to enjoy the protection of their own government, even when they are abroad" [2]. It is for this reason that UNHCR advises against using the term migrant 'as a catchall' word for refugees and asylum seekers since refugees are entitled to international protection and it is best to acknowledge this clearly [2].

COVID-19 and the Increased Vulnerability of Refugees and Asylum Seekers

> COVID-19 has been likened to an x-ray, revealing fractures in the fragile skeleton of the societies we have built.
>
> It is exposing fallacies and falsehoods everywhere:
>
> The lie that free markets can deliver healthcare for all;
>
> The fiction that unpaid care work is not work;
>
> The delusion that we live in a post-racist world;
>
> The myth that we are all in the same boat.
>
> Because while we are all floating on the same sea, it's clear that some are in superyachts while others are clinging to drifting debris.
>
> - António Guterres, Secretary General of the United Nations [4]

As the UN Secretary-General rightly pointed out in July 2020, the COVID-19 pandemic exposed the truth that not everybody is in the same boat. For asylum seekers across the world, the pandemic not only aggravated their existing vulnerabilities, but also shed light on the deep fault lines and inequalities that normally make up their reality. According to a UNHCR report from 2020, 86% of the world's refugees and asylum seekers were hosted in developing countries. There were 3.7 million refugees in Turkey, 1.7 million in Colombia, 1.4 million in Pakistan, 1.4 million in Uganda, and 1.2 million in Germany. Between 2018 and 2020, an average of 290,000 and 340,000 children were born into a refugee life per year [5].

This section of the chapter looks at the varied ways in which the pandemic has aggravated the challenges faced by asylum seekers, including the imposition of movement restrictions, asylum hearings moving online, changes to policies that impact their daily lives, lack of access to health services, xenophobia, and violence. This section also presents a case study that looks at the experiences of asylum seekers at the US-Mexico border through the lens of a non-governmental organization (NGO) volunteer who works in the region.

Movement Restrictions

At the start of the pandemic, governance systems across the globe were faced with difficult decisions regarding how to continue operations in the short- and long term. The lockdowns and border closures that followed in the days, weeks, and months after March 11, 2020, were challenging for many people, but disproportionately so for asylum seekers. Globally, there were 109,956 restrictions on movement put into effect between the first day of the pandemic and July 12, 2021 [6]. Of these 109,956 restrictions, 980 exceptions were made [6]. Had there not been a pandemic, we could have expected far more asylum seekers and refugees to arrive in host countries in 2020. According to UNHCR, that number is about 1.5 million [5]. When UNHCR compared actual numbers with those that were forecast, they found that there were roughly "1.5 million fewer people than would have been expected [to arrive] in non-COVID circumstances" [5].

Online Asylum Hearings

Even in cases where people were able to travel to host countries to seek asylum, the circumstances often looked very different than they did prior to COVID-19. In the United Kingdom, for example, as in many other countries, asylum hearings took place online in response to the pandemic lockdowns [7]. The United Kingdom's Immigration and Asylum Chamber accelerated its shift to online services once the pandemic began [7]. The move to online hearings was not without its complications for those seeking asylum, even though it did allow for asylum applications to continue being processed in spite of the pandemic.

Developing a sense of trust between asylum seekers and the barristers representing them is more precarious in a virtual format [7]. Establishing a good rapport is more likely to occur face-to-face than it is online [7]. Additionally, asylum seekers may not be able to consistently connect with their representatives digitally prior to their hearings if they are inexperienced with the necessary technology or cannot afford it [7]. Virtual asylum hearings are prone to the same technical difficulties as other online events, but the stakes are much higher [7].

On top of this, asylum seekers may also have additional characteristics that exacerbate their vulnerability in the context of their asylum hearings [7]. The language of their host country, and therefore, the language used for their asylum hearing, may not be their native language. They could be experiencing mental health challenges, including fear or anxiety, or they may have a dependency on drugs or alcohol. Young adults and children asylum seekers are also more likely to be vulnerable litigants [7].

If asylum seekers experienced trauma prior to arriving in their host country, some of the characteristics of 'lockdowns' such as confinement and a sense of captivity, paired with the anticipation leading up to their asylum hearing could be particularly difficult. Asylum seekers may also inherently distrust the government officials

involved in their asylum hearing, due to the negative experiences from which they fled in their home country [7]. Feelings of mistrust could be amplified in an online environment due to a lack of ability to make direct eye contact, see full body language, and the dampening of other non-verbal communication factors. These same qualities may also disadvantage asylum seekers as they communicate with judges. For example, asylum seekers may appear to be averting eye contact and thus seem evasive, when in reality they are simply looking down at the people on their screen [7].

An element of legal proceedings that is meant to bolster trust in the system—making hearings open to the public—may pose a perceived and/or real risk to asylum seekers in an online setting [7]. If third parties are able to watch recordings of asylum hearings after the fact, then asylum seekers may worry about disclosing their full case. Asylum seekers' trust in the process could be damaged if they do not feel assured that bad actors in their home countries will be prevented from viewing their asylum hearings. The benefit of in-person hearings is that asylum seekers can see the people who enter the room for the hearing. If a recording is made available, there is no way for the asylum seeker to know exactly who has seen it or will see it [7].

Policy: Title 42 in the United States

Asylum seekers have had to manage additional perturbations beyond and prior to hearings moving online. During the first three months of lockdowns due to COVID-19, the United States Citizenship and Immigration Services halted services that normally take place in-person, including interviews for asylum applications [8]. Adding to the disruptions in the typical process for seeking asylum is a clause of the United States Code called Title 42 [9].

The pandemic opened up the possibility for government agencies to use certain emergency powers. Section 265 of Title 42 gives the Surgeon General the authority "to prohibit, in whole or in part, the introduction of persons and property from such countries or places as he shall designate in order to avert such danger, and for such period of time as he may deem necessary" in the context of communicable diseases being introduced into the US from foreign countries [9]. Nine days after COVID-19 was declared a pandemic, the US Department of Health and Human Services (HHS) issued an emergency regulation, which implemented Sect. 265 of Title 42 and set in motion a chain of events impacting asylum seekers at the US–Mexico border.

The Director of the Centers for Disease Control and Prevention (CDC) subsequently issued an order which suspended the introduction of certain 'covered aliens' into the United States, focusing specifically on people trying to enter from Canada and Mexico [10]. This order allowed agents working for US Customs and Border Protection (CBP) to expel individuals 'without valid documents' including asylum seekers, back to their home countries or Mexico without screening for fear of persecution [11]. As of May 2022, more than 1.8 million people have been expelled under Title 42 [12].

According to CBP, "Expulsions under Title 42 are not based on immigration status and are tracked separately from immigration enforcement actions" [12]. Although the CDC and CBP have stated that Title 42 expulsions are a public health policy, rather than an immigration policy, public health experts in the United States have contested the validity of this [13]. In a letter addressed to the secretary of HHS and the director of the CDC, 57 leaders of public health schools, medical schools, hospitals, and other US institutions implored that HHS and the CDC end the policy of expelling individuals and families seeking protection from the US, saying that "public health laws should not be used as a pretext for overriding humanitarian laws and treaties that provide life-saving protections to refugees seeking asylum and unaccompanied children" [13]. The CDC has since exempted unaccompanied children from being expelled under Title 42, although other individuals and families continue to be expelled [14].

The policy is directed at non-citizens arriving at US entry points by land [13]. The public health experts who signed the letter pointed out that the US is still allowing citizens, permanent residents, as well as tourists who travel to the country in airplanes and ships, to enter the country regardless of the fact that this type of transportation is categorized by HHS as having a 'higher risk of disease transmission than land travel' [13]. They viewed the policy as a way 'to target certain classes of non-citizens' and not as one that is explicitly in the interest of public health [13].

Accessing Medical Services

Asylum seekers have always faced administrative, financial, and legal hurdles as well as language barriers when trying to access medical services they need [15]. In 2020, WHO's Global Health and Migration Programme surveyed over 30,000 refugees and migrants living in 170 countries to learn about how the pandemic has affected these vulnerable groups. Common reasons cited by participants—who lived on the street or in insecure accommodation—for not seeking medical assistance for a suspected COVID-19 infection included lack of money, fear of deportation, non-availability of healthcare providers, and in some cases uncertainty about their entitlement to healthcare. Refugees and migrants living in encampments had less access to COVID-related information than others. The study also found that civil society actors played a key role in disseminating COVID-related information to refugees and migrants [16]. In terms of the impact of COVID-19 on mental health, there were greater feelings of depression, anxiety, loneliness, and worry. Some primary reasons for anxiety included uncertainty about the future, fear of falling sick or fear of suffering from serious financial consequences [16].

In addition to access to medical services, it is important to note how the pandemic has impacted the social determinants of the health of asylum seekers. In the *Matamoros* encampments in Mexico, the pandemic reportedly reduced access to nutrition, employment, asylum processing, and health facilities due to financial, transport, and

discrimination challenges [17]. These barriers were observed to impact the mental and physical health of asylum seekers, relatively more than COVID-19 [17].

Xenophobia and Violence

Estimates from the WHO European region show that asylum seekers commonly have a low risk of transmitting communicable diseases to host populations [15]. Despite the evidence, this vulnerable population group is often the first to be stigmatized and unjustly blamed for the spread of viruses. In February 2020, when the African continent had just one case of COVID-19, Italy's far right politician Matteo Salvini blamed the rescue ship that docked in Sicily with 276 African refugees onboard for bringing the virus from Africa [18]. In March 2020, when no confirmed case of the coronavirus was yet recorded in Hungary, the country suspended the access of asylum seekers to border transit areas noting that a 'certain link' was observed between COVID-19 and asylum seekers [19]. Xenophobia against asylum seekers during the pandemic has been largely perpetuated by nation states not merely in their vocabulary, but at many systemic levels disrupting the rights of asylum seekers. Xenophobic and hostile measures including detentions, pushbacks, migrant deterrence policies, and so on have led to human rights violations of asylum seekers who still continue to face the impact in the form of torture, drownings at sea, trafficking, and sexual violence [20].

According to the Global Monitor of COVID's Impact on Democracy and Human Rights, almost 12,000 people trying to leave Libya in 2020 were captured by the coast guard, and the majority of them were held in crowded detention facilities [21]. Likewise, officials in Ghana, Kenya, Morocco, and Tunisia have unlawfully imprisoned asylum seekers, detaining them in immigration centers, police custody, and prisons [21]. This routine of violence heightened during the pandemic as asylum seekers faced assault, forced quarantine, poor legal assistance, overcrowding, and more.

Narrative of an NGO Volunteer at the US–Mexico Border

Civil society has always been known to take the lead and steer possible responses in spaces ignored or abandoned by state actors. At the US–Mexico border, the *Reynosa* and *Matamoros* encampments are examples of such spaces where asylum seekers have been supported by non-governmental organizations (NGOs) and aid workers. This was especially true during the COVID-19 pandemic which forced asylum seekers to confront new vulnerabilities. What follows is the narrative of an NGO volunteer at the US–Mexico border, who has been serving asylum seekers as they grappled with the impacts of COVID-19. We will call her Mia. Amidst the media coverage and secondhand accounts of the plight of refugees and asylum seekers in

encampments, Mia's narrative offers much needed experience-based insights into their lived realities during the pandemic.

> These encampments are not fit for people to live in, first. That's just without COVID involved at all.

Mia has worked in both the *Reynosa* and *Matamoros* encampments and is aware of how asylum seekers in these camps live with a shortage of resources, abysmal sanitation, and little to no safety. The *Matamoros* encampment closed down in March 2021, one year after the pandemic began. Shortly after its closure, the *Reynosa* encampment was created. The *Reynosa* encampment has significantly fewer resources than the *Matamoros* encampment with only 20 portable latrines for over 2,000 people living inside the camp. If such impoverished living conditions were not difficult enough to deal with, the asylum seekers also live in constant vulnerability to threats of kidnapping and assault. This is put into perspective when Mia describes an incident that unfolded just 30 min prior to the interview; four women asylum seekers were beaten, forced into a truck, and kidnapped. '*This is at 1:30 on a Wednesday afternoon,*' she says, highlighting how unsafe it is for anyone living or volunteering in the *Reynosa* encampment. The outbreak of COVID-19 has amplified the multitude of challenges faced by those living in the encampment and added new layers of complexity.

Denial of Medical Help for COVID Recovery

> COVID has hit the Reynosa encampment so hard we're lucky no one has died from it up to this point.

When the virus outbreak first happened inside the *Reynosa* encampment, it spread to such a high extent that for each family tested, one family member tested positive for COVID-19. During this period, the bigger issue was the lack of any legitimate means to avail medical support including medications and ventilators. The denial of medical support to asylum seekers was a well-known reality even prior to the pandemic. From morning to night, men, women, and children in the camps are all prone to fainting from heat exhaustion, illnesses, and many other reasons. Describing this, Mia says, "*In Reynosa, right now people pass out all the time; that's not an uncommon thing.*" She also observes how at night time, when it gets quiet, one can hear coughing throughout the encampment.

Mia has received phone calls almost every night during this period if an asylum seeker was very sick, needed medical attention, and the ambulance did not arrive. "*Ambulances have been called on multiple occasions, but just like in most border cities, an ambulance won't put an asylum seeker inside of their truck. They won't,*" she says. If an asylum seeker is lucky and a paramedic is compassionate enough to take him/her to the hospital, the hospital won't accept this person specifically because s/he is an asylum seeker. She recalls a recent incident when a boy who had

been sick passed out in the camp around midnight. Once she was alerted to this, Mia called the delegate of *Reynosa* and demanded that the child be taken to the hospital immediately and warned that if he were to die in the camp from COVID, the officials would be accused of inaction. Only after receiving a photograph of the ambulance on the *Reynosa* Plaza did Mia go to bed. Later the next day, she learnt that the ambulance had arrived and provided medical assistance to the boy but left him there. She then conducted a COVID test. Looking back on this incident, she says, "*Sad to say, officials don't care that much about asylum seekers, they just want them out of their city; but what they do care about is how they appear to others.*" A social worker, Mia's typical day consists of putting out such fires for the asylum seekers with whom she works closely. Her undeterred sense of commitment and dedication comes through when she says, in passing, "*Oftentimes, when there are problems and issues, I get phone calls, which is fine because my role is to solve them.*"

The Migrant Protection Protocols

The Migrant Protection Protocols (MPP), otherwise known as the "Remain in Mexico" program, was implemented in January 2019. According to the Department of Homeland Security, under MPP, "certain foreign individuals entering or seeking admission to the US from Mexico—illegally or without proper documentation—may be returned to Mexico and wait outside of the US for the duration of their immigration proceedings, where Mexico will provide them with all appropriate humanitarian protections for the duration of their stay" [22].

NGOs such as Mia's have stepped in to provide asylum seekers with food, education, and medical care while they wait in Mexico. MPP is, in part, meant to deter people from trying to enter the United States, but people have continued to seek asylum even with MPP in place. Asylum seekers are still living in tent cities at the US–Mexico border for months, and sometimes years, as they await their asylum hearings. MPP was implemented prior to the pandemic. Therefore, people were already living in encampments once the pandemic began. Mia points out, "*COVID shut down the court systems, COVID shut down interviews…That's how MPP and COVID collided; it shut down the system for minority asylum seekers…*".

The Secretary of Homeland Security decided to terminate MPP in June 2021, which received pushback from the US District Court for the Northern District of Texas. The Department of Homeland Security will terminate MPP "as soon as practicable after issuance of a final judicial decision to vacate the *Texas* injunction" [23].

Civil Society Leading the Public Health Fight

Mia's group was among the first respondents to assist the asylum seekers in *Reynosa* when COVID-19 hit. They procured several thousand face masks and with the support of two other NGOs, transported and distributed them to every asylum seeker in the *Reynosa* encampment. In addition, during the early months of the pandemic, her team transported hundreds of COVID-19 testing kits to Mexico and distributed them to asylum shelters in *Reynosa* as there was a rising need to test asylum seekers who were sick. "*For a while, we were spending between 6,000 to 8,000 dollars a week for buying COVID tests alone,*" she says, highlighting how they spent the little grant money they had very quickly and cleaned out retail stores until other NGOs began to provide support through procuring test kits. If an asylum seeker believes s/he has COVID, multiple questions are asked to note any visible symptoms before a COVID-19 test is administered. Mia says that this is because COVID-19 testing kits are treated like gold in *Reynosa.* They are not only expensive to acquire, but it is also a laborious process to cross them into Mexico with the permission of the Mexican government, which fines every testing kit if the protocol is not strictly followed.

Given the denial of medical services at the hospital, the NGO has set up three medical teams who rotate shifts at the plaza. Mia and her team have also become certified to give a valid COVID test that is approved and acknowledged by the United States Customs and Border Protection (CBP). If individuals test positive the NGO pays for their medication advised by the doctor.

Heightened Risks and Exacerbated Realities

> "COVID has made the situation for the asylum seekers worse," she notes, "and that's a really hard thing to do if you live inside of the Reynosa encampment or the Tijuana encampment."

COVID-19 testing kits, protective masks, and access to medical support may be some key issues for asylum seekers from a public health standpoint during the pandemic. However, what often goes unrecognized are the complexities that compound them. For instance, availability and accessibility are not the only concerns when it comes to face masks for asylum seekers. Given the extreme heat and humidity in the region, it is impossible for them to live outdoors and breathe with the N95 face masks on 24/7. As Mia states, "*It's hot. It's like 101 and 105 degrees out there everyday. So, you can imagine how it would be living outside 24 hours a day with a face mask on your face.*" Except for the times when volunteers or visitors visit the plaza, very few asylum seekers wear face masks inside the encampment because breathlessness is a more visible concern than the spread of disease.

When an asylum seeker gets infected with COVID-19 and needs medical assistance, the hospitals refuse to treat them unless they are escorted by an NGO worker and pay cash up front for COVID tests and overnight stay. This was the case even prior to COVID. Mia says, "*We've walked them into many doctors' offices. We've also*

taken asylum seekers to get cancer treatment, but we always have to be the ones there with them for them to be accepted to get medical care, which is awful. If you're an asylum seeker and you have COVID and you're not walking in with some American, then you're not going to get treated." The risk here is not merely the denial of medical help but the precarious situations they are pushed into as a result. For instance, the threat of kidnapping has increased since the pandemic began. As Mia points out, "*Anyone who says, I'm willing to help you, and if you're in Reynosa, you should not accept any help from any stranger because the odds of you getting kidnapped or assaulted are really, really high. They happen on a daily basis.*" However, if a child or a spouse is suffering from COVID-19 and there is no known NGO volunteer present, the asylum seekers are forced to take a risk and trust any strangers who claim they can help, despite the evident threat of kidnapping and assault. Mia describes this predicament, "*If we're not there, who is left for you to depend on and how long are you willing to watch your child or spouse be sick, before it's just too much for you, before you say yes to that stranger and get in that van or that truck?*" The COVID-19 pandemic in the encampments has worsened the already aggravated realities of asylum seekers and the deliberate lack of a state-led public health response has ensured that there is nothing for them to depend on, except the NGOs.

Furthermore, basic necessities are lacking when asylum seekers try to recover from COVID. In addition to an obvious lack of medical care and an appropriate quarantine space, there is no access to clean drinking water and also a high chance of missing meals when asylum seekers are too unwell to receive food assistance deliveries.

It is with exasperation that Mia declares, "*Because of COVID and because you're an asylum seeker, you are like beneath the totem pole. It's like you're not even at the bottom, you're beneath it, where you have no other options if you, your child, or your spouse is sick. We put asylum seekers in impossible situations and then we blame them for wanting to come to our country.*"

Stigma, Denied by the State

Social stigma is another aspect over which asylum seekers have no control. Asylum seekers who wait in the encampments and cross the border to the United States are often blamed and stigmatized for carrying the coronavirus into the country. "*The narrative that the media has put out that asylum seekers are just bringing COVID into the US is false,*" Mia counters.

She elaborates on the system put in place by the United States government at the US–Mexico border to prevent disease spread. For the asylum seekers who are crossing the border to be able to enter the United States, they need to test negative for COVID-19. If they test positive, they are held in Mexico for two weeks until they test negative. It is only with a negative test that they are allowed to go to the port of entry to the US and present themselves to the CBP. They are tested again for COVID once they enter the US, before being released. Pointing to this two-step verification

put in place by the administration, Mia says, "*Whenever I see these reports about asylum seekers bringing in COVID, it often surprises me how our administration sits back and says nothing when they're the ones who put the policy in place. They don't really try to correct that false narrative out there.*"

Denial of Vaccination

The only place asylum seekers can rightfully gain access to vaccines is when they are allowed to enter the United States. Mia notes that, unlike American citizens, asylum seekers don't have the luxury of turning down a vaccine because vaccination is not made available for those awaiting hearings in the *Reynosa* encampment. "*There's no reason they should go unvaccinated as us Americans get booster shots,*" she says. When Mia attempted to address this with the local authorities at the US–Mexico border, she was told by the US government that ensuring vaccine availability for asylum seekers is the responsibility of the Mexican government, even when the individuals in question are US asylum seekers and future US citizens.

Fault Lines Exposed by COVID-19

When asked if the COVID-19 pandemic offers any lessons for how the US refugee crisis needs to be handled, Mia says, "*Our whole asylum system needs an overhaul. Everything about it works against asylum seekers and when I say, 'everything about this', I mean US laws and policies against the asylum seeker.*" In this regard, one can observe that the pandemic has not only exacerbated the vulnerabilities of asylum seekers, but has evidently uncovered and further exposed the systemic hurdles that surround their day-to-day realities as non-citizens. State intervention is deliberately absent when it comes to meeting the bare minimum necessities of asylum seekers. Mia reflects on the disparities that have been made clear by the pandemic. "*We are not giving asylum seekers access to vaccines. And we are not giving the asylum seekers access to medical care if they become sick with COVID. We leave them out on the Reynosa Plaza gasping for air, as Americans go to sleep.*"

From procuring masks and COVID-19 testing kits to arranging for comfortable quarantine shelters and appropriate medical and nutritional support, different NGOs in *Reynosa* have taken on vital tasks and work with mutual exchange of resources to ensure the wellbeing of the asylum seekers during this period. Pointing to this collaborative effort, Mia adds, "*We've all done our part to help out asylum seekers during the pandemic.*"

The role played by NGOs and aid workers in 'stateless' settings like the asylum encampments is exceptional. It exemplifies the true pursuit of ensuring human rights. However, as long as the state and its institutions deny and evade their basic

responsibility to protect the wellbeing of asylum seekers, no amount of civil society intervention can adequately fill this fundamental gap.

Policy: Global Perspective

The world over, refugees, asylum seekers', and migrants' rights and protections are impeded on a daily basis, many of which are heightened by lack of status in countries of asylum, surveillance, curfews, and other means of marginalization that enhanced risk protections during the COVID-19 pandemic [24].

The global lockdown unduly affected these populations precisely because of the lack of rights afforded to them. As the COVID-19 pandemic began, human rights organizations reported on immigration raids and arrests in Malaysia in response to public anger, fears, and concern over the spread of the coronavirus [25].

In the crowded Cox's Bazar refugee complex in Bangladesh, *Rohingya* refugees feared family separation. Isolation in treatment facilities hampered testing efforts. That fear was clearly connected to Bangladesh's restrictions on movement as well as internet and mobile communications which infringe on refugee rights to health and freedom of movement [26].

When the pandemic struck, East Africa simultaneously dealt with a triple crisis of COVID-19, floods sweeping across the region, and a second round of crop destroying locusts in a 'decade of back-to-back-crises' linked to climate change. In Somalia alone, one million people were impacted and 400,000 were displaced. In Kenya, at least 40,000 people were displaced by floods. The pandemic struck Somalia while it had struggled with years of drought, war, food insecurity, and rising internal and cross-border displacement. Kenya, which already hosts a record number of refugees, continued to receive new Somali arrivals. As part of a containment strategy for the coronavirus, Kenya restricted movement in and out of its refugee camps at Dadaab and Kakuma camps [27].

Pakistan also faced the effects of the same locust battle, which deeply impacted its food security as it dealt with surging COVID-19 cases and continued to host 1.4 million Afghan refugees within its borders [28].

In the US, deportations of migrants and asylum seekers from its borders continued even with the virus status unknown. For instance, on May 11, 2020, a deportation flight from Texas to Haiti departed with 50 passengers who were sent to hotels for quarantine upon arrival in Port-au-Prince at the Haitian government's expense. However, Immigration and Customs Enforcement (ICE) did not deport five Haitians who tested positive for COVID-19 on that flight after media reports revealed the US government's plans were to deport them as well. Deporting individuals who are known to be infected with the virus violates both the US and international public health guidelines to prevent the spread of the virus [29].

In Guatemala, 15% of its caseload in May 2020 comprised US deportees, where at least 117 Guatemalans deported from the US tested positive as of May 4, 2020 [29].

The drivers of forced displacement persisted despite the global pandemic and its commensurate lockdown. But how can you flee persecution amidst closed borders? How can you live in situations of forced displacement among your persecutors and abusers?

And once again, when a new global challenge tested our resolve, it was the resilience of refugees that shined through as an example for us all.

Refugees and Asylum Seekers as Stakeholders for Their Own Solutions

Amidst this global lockdown, refugees showed time and time again why forcibly displaced populations face particular threats. They also showed how the particular contributions and support they provide are an asset in situations of crises. All over the world, refugees stepped up in their own communities to respond to the needs of fellow refugees, migrants, and asylum seekers.

In Lebanon, pandemic restrictions limited refugee rights even further. But refugees stepped up to meet their community's needs by translating COVID-19 health information into Arabic, raising awareness on social media, collecting donations, and distributing relief, even as public sentiments turned against them [30].

In Uganda, refugee-led organizations responded in both camps and cities. In the *Nakivale* Settlement, the *Wakati* Foundation employed refugees to sew and distribute masks, while also raising community awareness about the virus. In *Arua*, the Global Society Initiative for Peace and Democracy conducted hygiene and sanitation information campaigns to slow the spread of the virus [31].

Time and again, throughout the initial months of the pandemic, *Rohingya* refugees in Bangladesh and refugees from Uganda, Lebanon, France, Germany, and more filled critical gaps where the international community had failed. The 2016 World Humanitarian Summit 'Grand Bargain' recognized people affected by crises as first responders. But they still remain on the periphery. We did not need the COVID-19 pandemic to demonstrate this, but surely it has served as an apt reminder that it is high time we stop sidelining refugees who can provide solutions within their own communities [32].

In March 2020, the Medical Council in Ireland announced that refugees and asylum seekers with medical training can provide essential medical support during the pandemic [33]. This form of inclusion should apply at all times, rather than only in emergency situations such as a pandemic. A true testament to the importance and value—of this type of inclusion are NGOs like Mia's that work in refugee encampments with the active support and engagement of asylum seekers. As we advocate for states to take responsibility to ensure human rights, asylum seekers and refugees need to be recognized as vital stakeholders for their own solutions. This is one among the four basic tenets propagated by the UN in advancing 'safe and inclusive human mobility' during and beyond the pandemic [34].

Moving Forward: Climate Change as an Analogy to the Pandemic

Our next 'global virus challenge' is climate change. And with that too it is refugees and migrants who will be challenged to the extreme but will also rise to that challenge. We are already seeing that resolve tested in the asylum seekers held in the US detention centers at the US-southern border who are fleeing violence in their Central American countries as well as climate change. Naysayers may call it poverty and they would not be wrong. It is poverty, but it is poverty fueled by food insecurity, fueled by drought, fueled by climate change, and climate variability [35]. Just as some are in denial about COVID-19 and robust COVID-19 response, the same holds true for climate change, which we already know is deeply impacting some of the poorest and most marginalized populations in the world who have had little to do with contributing to global warming in the first place.

Closing Comments

The refugee crisis has grown into a wide ranging and nuanced problem that has only increased in complexity since the COVID-19 pandemic began. Aside from offering lessons in terms of the global public health response, the pandemic has also shed light on the immense authority wielded by nation states in influencing the rights of asylum seekers, through their actions and inactions. Nations' oppressive refugee policies defended as public health response have had a detrimental impact on asylum seekers, just as the absence of state led interventions and support systems continue to have on their fundamental human rights.

States need to uphold the commitments they made when they became signatories to the Universal Declaration of Human Rights which guarantees the right to seek asylum. It was ratified at the 1951 Refugee Convention. It bears mentioning that both these instruments are customary international law binding on states, regardless of ratification. Problems of resource management, often cited by host countries can be resolved through strategic planning and proactive policy-making. In the absence of sufficient state support, civil society continues to respond to events that force people to seek refuge in other countries. The Migrant Protection Protocols in the US and other similar policies around the globe are not deterrents to asylum seekers as they were intended to be. The number of asylum seekers in the future is projected to increase, not decrease. Political instability, climate change, economic insecurity, resource scarcity, conflict, violence, and persecution are some of the factors, often interrelated, that continue to drive the upward trend of the world's refugees. Recent events in Afghanistan and Ukraine have highlighted the need for the international community to implement better policies to support asylum seekers.

Within this context, it is critical to ensure that the deeply embedded racial disparities and related forms of discrimination in policies addressing the refugee crisis

are dealt with seriously. Just as the COVID-19 pandemic has exposed fault lines and inequalities, so have the varying responses in how asylum seekers are treated based on race. A recent testament to the prevalence and extremity of racism and xenophobia is the proactive and unprecedented response wielded by western countries, particularly Europe and North America, in providing aid to Ukranian asylum seekers; a response which minority asylum seekers have not experienced in equal measure.

We are not all in the same boat. Lest we blame all this on the virus, it is a good reminder that the virus has laid bare pre-existing structures of gross inequality, failed policies, neglect, and forgotten crises all over the world that have now become even worse. There is no doubt that refugees will answer the call yet again, but let's hope that when all is said and done, we give refugees their due and no longer sideline them as passive beneficiaries in a system of dependency.

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Stigma Mechanisms in a Globalized Pandemic in India: A Theoretical Framework for Stigma

Anirban Chatterjee and Balaji Ramraj

Abstract Stigma has been documented to act as a significant barrier to healthcare access and healthcare-seeking behavior. Traditional frameworks of stigma and discrimination have been used in the past to explain the stigma associated with diseases such as tuberculosis, leprosy, and HIV. However, increasing globalization and unprecedented access to information via social media and the internet have altered infectious disease dynamics and have forced a rethink on mechanisms which propagate stigma. SARS, MERS, Ebola, and more recently COVID-19 have been

The members in the GRID COVID-19 Study Group are the co-authors of this chapter. Dr Anirban and Dr Balaji are representing the GRID COVID-19 Study Group in the author byline as the corresponding author.

Generating Research Insights for Development (GRID) COVID-19 Study Group has members located across institutions in 21 of 28 states and 3 of 8 union territories (UTs) in India. These include teaching faculty, residents in medical schools, and public health experts in academic research organizations. The members were identified based on their engagement in COVID-19 pandemic containment in various capacities (as program advisors, implementers, members of rapid response teams, treating physicians, and researchers) in respective states/UTs and at the national level. The group keeps track of developments in the COVID-19 in India.

The original version of this chapter has been revised. The text "The members in the GRID COVID-19 Study Group are the co-author of this chapter. Dr Anirban and Dr Balaji are representing the GRID COVID-19 Study Group in the author byline as the corresponding authors" has been included. The correction to this chapter can be available at https://doi.org/10.1007/978-981-99-1106-6_26

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associated with fear in communities across the globe due to the inherent uncertainties associated with emerging infectious diseases and a concurrent spread of misinformation—an infodemic. The authors present a theoretical framework to explain the evolution of COVID-19 associated stigma by exploring the complex interplay of various international and national mechanisms. It is anticipated that a conceptual framework which explains the evolution of stigma in fast-spreading global pandemics such as COVID-19 may also prove to be useful as a starting point for furthering the discussion on the progenitors, pathways, and manifestations of COVID-19-related stigma. This should be of practical use to researchers who are interested in exploring, validating, and identifying interventions for informing other frameworks for similar diseases.

Background

Stigma influences population health outcomes by worsening, undermining, and impeding social processes. It impacts social relationships, resource availability, and access (including care-seeking behavior), and triggers psychological and behavioral responses [1, 2]. The coronavirus disease 2019 (COVID-19) incited stigma as a prominent individual and societal reaction. Still, amidst the more tangible and observable dimensions of the pandemic (e.g., health and economic outcomes), the role stigma plays in influencing health outcomes is likely to remain under-assessed.

Stigma related to COVID-19 was maximally reported in India during the first wave of the pandemic (2020). Even though the fatality rate was 3–5%, people were afraid of adverse outcomes if they tested positive. Dead bodies were left unclaimed, pregnant women who had tested positive for SARS-CoV-2 found it difficult to get a hospital bed, patients' families refused to help them, and people were refused entry into their homes by family members and relatives even after they had recovered from COVID-19. Incidents were reported where family members of COVID-19 patients were discriminated against though they had tested negative. Cured persons and their families also suffered discrimination. Even healthcare workers faced stigma and discrimination.

Documented real-life experiences of patients admitted in COVID-19 wards underscored how internalized stigma, feelings of guilt of infecting near and dear ones, the shame of infecting others, and anger directed towards self, led to a vicious cycle of stigma and psychological distress among patients during and after their hospital stay [3].

It was also reported that stigma impeded care-seeking for COVID-19 which led to adverse outcomes. Many people avoided getting tested for SARS-CoV-2 even if they had symptoms of COVID-19. Incidents are reported of people quarantining inside a car instead of going home to their families. Stigma related to COVID-19, on occasion, resulted in arguments, conflicts, and feuds among individuals. Suicides were also reported due to COVID-related anxiety [3].

In the initial days of the pandemic in India, there seems to have been a lack of effective stigma mitigation and behavior change management strategy based on evidence that could translate into public education and community engagement and instill trust in the healthcare system and government initiatives.

Unlike stigma associated with other health conditions (e.g., HIV/AIDS, tuberculosis, and mental health), the stigma associated with COVID-19 is unique in several aspects. Its evolution was speedy despite (and sometimes partially due to) the society having better access to information that was regulated, accultured, and more cohesive than before. This was the case because even though a hitherto unprecedented number of people could access and potentially consume information from a multitude of legitimate sources, there was a concurrent mushrooming of sources of misinformation on various platforms at a rate that rivaled the rate of the spread of COVID-19. This epidemic of misinformation, aptly named infodemic, was responsible for fostering stigma directed at those purported to be afflicted with COVID-19 and their caregivers [4]. Secondly, medical stigma is usually preceded by labelling followed by stereotyping. Another unique trait of COVID-19-related stigma is that although initially there were indications of the generation of stereotypes, the rapid progression and spread of the disease left little space for any enduring stereotype. Stigmatization seemed to be happening directly based on labelling [5–7]. Although unique, it seems that similar patterns of stigma can be theorized for earlier infectious disease pandemics in recent history [8, 9].

In this chapter, we review the existing definitions for stigma and the literature from India on stigma related to COVID-19 to propose a theoretical framework for the characterization of COVID-19-related stigma in India.

Existing Frameworks of Stigma

In the sociological context, stigma has been studied from as long back as the nineteenth century and is generally understood to be the process by which persons having a particular attribute are first labelled and then stereotyped. This stereotyping subsequently gives rise to stigma. Many theories have been proposed to define stigma and its operators in society (Table 1). Traditional stigma frameworks developed for medical conditions (HIV, obesity, or mental illnesses) have relied on the conventional progression from labelling to stereotyping and from stereotyping to stigmatizing. Unique socio-cultural backgrounds that foster stigma directed at various health conditions have necessitated the development of multiple stigma frameworks. Of late, there have been efforts to condense them into a broader more encompassing framework [2, 10]. For example, in the context of HIV/AIDS, stigma was seen to evolve through three phases. Firstly, those infected with HIV were labelled. This led to the evolution of group-based beliefs which were applied to all individuals with HIV. This was followed by their being stigmatized [11]. Such stigmatization usually followed the cycle of social stigma, internalized stigma, and anticipated stigma [11, 12]. Similarly, mental health stigma frameworks also envisage the process of labelling

followed by stereotyping which ultimately culminates into stigma which again cycles through social stigma, internalized stigma, and anticipated stigma [13–15]. Stigma frameworks have also been developed for obesity, tuberculosis, leprosy, and more recently, Ebola and severe acute respiratory syndrome (SARS) [9, 16–21].

Most stigma frameworks have focused on individualistic approaches to the development of stigma with either perspective from the victims or the perpetrators and the victims [9, 11, 15–18, 20, 22]. Very few stigma frameworks focus on the social

Table 1 Some of the popular theories of social stigma

Durkheim [23]	Rules of sociological methods	Explored the idea of stigma to be associated with crime or 'deviance'; postulated that such acts of 'deviance' shall be treated as criminal acts in society
Goffman [24]	Stigma: Notes on the management of spoiled identity	Described stigma to be arising from a behavior, attribute or reputation which leads to the labelling of people (or groups of people) displaying it as an undesirable stereotype
Farina and Hastorf [25]	Social stigma: The psychology of marked relationships	Described stigma as one where a deviant 'mark' links the identified person to undesirable characteristics that discredit him or her in the eyes of others
Stafford and Scott [26]	Stigma, deviance, and social control—in the dilemma of difference	It was proposed that social stigma 'is a characteristic of persons that is contrary to a norm of a social unit' where a 'norm' is defined as a "shared belief that a person ought to behave in a certain way at a certain time"
Mehta and Farina [22]	Associative stigma: Perceptions of the difficulties of college-aged children of stigmatized fathers	Speak of stigma by association. Define it as the process by which a person is stigmatized simply based on association with another person who is stigmatized
Link and Felan [27]	Conceptualizing stigma	Postulate that stigma is the co-occurrence of labelling, stereotyping, separation, status loss, and discrimination coupled with the exercise of power
Falk [28]	Stigma: How we treat outsiders	Elaborated that stigma is necessary to maintain group solidarity by separating 'insiders' from 'outsiders'; described stigma to be of two types: existential—wherein it is derived from a condition or conditions over which the stigmatized have little to no control, or achieved—wherein the stigmatized have either achieved stigma due to their actions or their contributions towards the evolution of the condition which eventually led to stigma
Deacon [29]	Towards a sustainable theory of health-related stigma: lessons from the HIV/AIDS literature	Defined stigma as a social process of 'othering, blaming, and shaming' that leads to status loss and discrimination

Source Compiled by authors

and/or systemic and structural pathways engendering, emboldening, and perpetuating stigma [2]. Although most frameworks distinguish between the stigmatized and stigmatizer, frameworks such as the Health Stigma and Discrimination Framework proposed in 2019 do away with the differentiation between the victim and the perpetrator(s) of stigma, to discourage the process of 'othering', but also retain the baseline process of labelling, stereotyping, and stigmatization [2].

Literature Review

We conducted a scoping literature search to summarize published primary research on stigma and COVID-19 in India. Two searches of peer-reviewed manuscripts till August 2021 were conducted in July and in August 2021 using the PubMed and Scopus databases. Searches included terms related to [1] 'stigma' or other associated terms such as 'social stigma'; [2] 'COVID-19' and [3] 'India'. An initial title and abstract review were performed, followed by a full-text review of articles included during the first phase. For charting, data were extracted according to authors and year of publication, study design, sample size, objectives, and type of stigma measured (i.e., perceived, anticipated, internalized, experienced/enacted). The studies included in the chapter are listed below (Table 2).

Proposed Framework of COVID-19 Stigma

Our COVID-19 stigma framework is based on previously developed frameworks for other medical and health conditions. It is informed by prevalent theories of stigma and contemporary literature (Fig. 1) [9, 14, 16–29]. We observed that the stigma associated with COVID-19 had its inception in 'labelling' as soon as the person tested positive for SARS-CoV-2. Stereotyping was not universally obvious, though, at times, it was associated with health workers and other frontline personnel engaged in combating COVID-19.

There is considerable overlap between the various terminologies used in the context of stigma. As noted elsewhere, the term internalized stigma has been used to have the same contextual meaning as experienced stigma or perceived stigma. The terms internalized stigma and self-stigma have been used interchangeably. Anticipated stigma has been conflated with stigma concerns, stigma apprehension, and stigma consciousness. In the framework proposed by us, we have used the following definitions:

Table 2 Literature review summary

S. No	Authors	Title	Design	Population	Sample size	Objectives	**Stigma studied**
1	Gopichandran et al. [30]	A qualitative inquiry into stigma among patients with COVID-19 in Chennai, India	Cross-sectional and qualitative	People recovered from COVID-19	12	To inquire into the lived experiences of stigma among persons diagnosed with COVID-19 at various stages of their disease from the point of onset of illness, through diagnosis, care-seeking, hospitalization, isolation, recovery, and discharge to returning home after recovery	Social stigma
2	George et al. [31]	Challenges, experience and coping of health professionals in delivering healthcare in an urban slum in India during the first 40 days of COVID-19 crisis: A mixed-method study	Cross-sectional and mixed methods	Healthcare professionals	Qual-42 Quant-64	To describe the experience of running health services in one of the biggest slums of Bangalore during the first 40 days of the COVID-19 pandemic	Social stigma; Associated stigma

(continued)

Table 2 (continued)

S. No	Authors	Title	Design	Population	Sample size	Objectives	**Stigma studied**
3	Sumesh et al. [32]	Collecting the 'thick descriptions': A pandemic ethnography of the lived experiences of COVID-19-induced stigma and social discrimination in India	Cross-sectional and quantitative	General population		To investigate the lived experiences of stigma and social discriminations in the context of the COVID-19 pandemic in India	Social stigma
4	Moideen et al. [33]	COVID-19-related stigma among inpatients with COVID-19 infection: A cross-sectional study from India	Cross-sectional and quantitative	COVID-19 patients in the hospital	56	To explore stigma among COVID-19 patients	Anticipated stigma
5	Uvais et al. [34]	COVID-19-related stigma and perceived stress among dialysis staff	Cross-sectional and quantitative	Dialysis staff	335	To measure the perceived stigma of dialysis staff regarding COVID-19	Anticipated stigma
6	Sahoo et al. [35]	Lived experiences of the Corona survivors (patients admitted in COVID wards): A narrative real-life documented summaries of internalized guilt, shame, stigma, anger	Case Narrative	Persons diagnosed with COVID-19 infection and admitted to the COVID ward	3	To document the experience of 3 persons diagnosed with COVID-19 infection and admitted to the COVID ward	Self-stigma and anticipated stigma

(continued)

Table 2 (continued)

S. No	Authors	Title	Design	Population	Sample size	Objectives	**Stigma studied**
7	Singh et al. [36]	Patients' experiences and perceptions of chronic disease care during the COVID-19 pandemic in India: A qualitative study	Cross-sectional and qualitative	Participants with chronic conditions (hypertension, diabetes, stroke, and cardiovascular diseases)	42	To describe patients' lived experiences, challenges faced by people with chronic conditions, their coping strategies, and the social and economic impacts of the COVID-19 pandemic	Social stigma
8	Uvais [34]	Perceived stress and stigma among doctors working in COVID-19-designated hospitals in India	Cross-sectional and quantitative	Physicians	58	To measure the perceived stigma of doctors regarding COVID-19	Anticipated stigma
9	Sahoo et al. [37]	Psychological experience of patients admitted with SARS-CoV-2 infection	Cross-sectional and quantitative	Persons diagnosed with COVID-19 infection and admitted to the COVID ward	50	To evaluate the experiences of patients with COVID-19 infection during their inpatient stay in COVID isolation wards and intensive care units (ICUs)	Anticipated stigma

(continued)

Table 2 (continued)

S. No	Authors	Title	Design	Population	Sample size	Objectives	**Stigma studied**
10	Banerjee et al. [38]	Psychosocial framework of resilience: Navigating needs and adversities during the pandemic, a qualitative exploration in Indian frontline physicians	Cross-sectional and qualitative	Physicians	172	To explore the 'lived experiences' of frontline physicians in terms of their challenges, unmet needs, and psychological resilience during the crisis	Social stigma
11	Dar et al. [39]	Stigma in coronavirus disease-19 survivors in Kashmir, India: A cross-sectional exploratory study	Cross-sectional and quantitative	COVID-19 survivors	91	To measure stigma among COVID-19 survivors	Social stigma and self-stigma
12	Radhakrishnan et al. [40]	The perceived social stigma, self-esteem and its determinants among the health care professionals working in India during COVID-19 pandemic	Cross-sectional and quantitative	The frontline health workers	600	To understand health workers perceived stigmatizing experiences and self-esteem during the COVID-19 pandemic	Social stigma
13	Kumar et al. [41]	The experiential impact of isolation and quarantine on patients during the initial phase of the COVID-19 pandemic in India	Cross-sectional and qualitative	Patients in isolation and quarantine due to COVID-19	10	To assess the experiences of patients in isolation and quarantine in the initial stage of the COVID-19 pandemic	Social stigma and self-stigma: Associated stigma

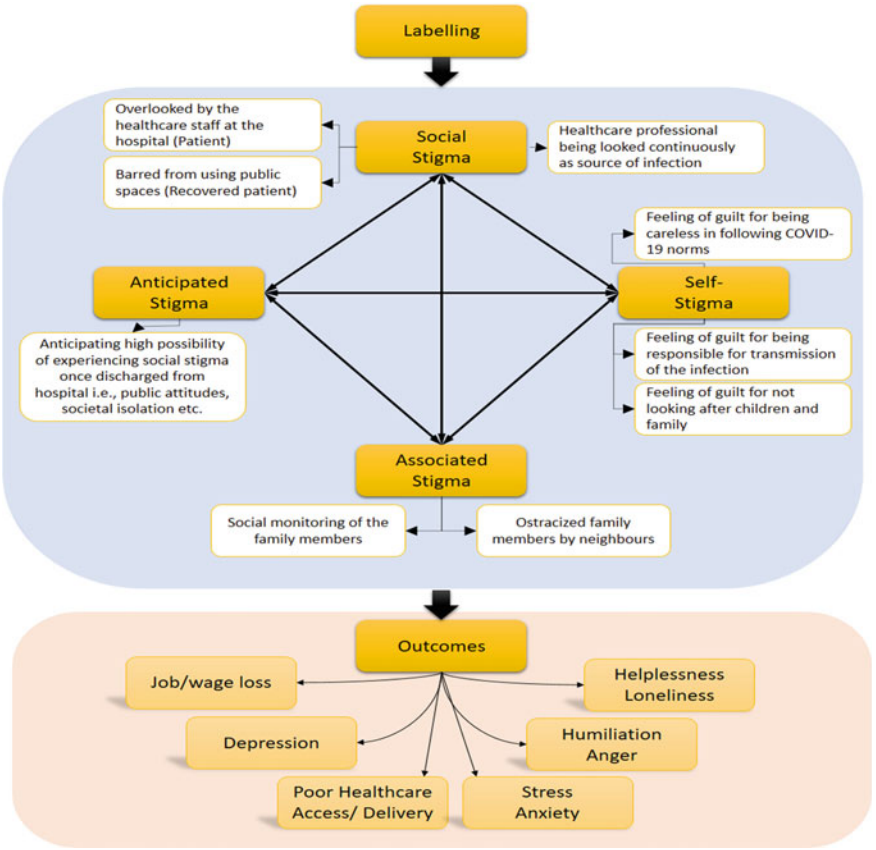

Fig. 1 Conceptual framework of engenderment of the stigma associated with COVID-19. *Source* Compiled by authors

Social Stigma

The term social stigma is used to define people's reaction to someone who is assumed/confirmed to be having the stigmatized condition. It was first described by Goffman and later by Farina et al. [24, 25, 29]. Recent insights into stigma acknowledge the role that structural factors play in the persistence of stigma in the community, provisionally defined as "societal-level conditions, cultural norms, and institutional policies that constrain the opportunities, resources, and wellbeing of the stigmatized" [27, 42]. Structural factors range from governmental and systemic policies which discriminate against the stigmatized (such as against 'undocumented' immigrants and gender and sexual minorities) to prevalent cultural norms which stigmatize certain identities and conditions (such as mental illness or sexual identities) [43–46]. In addition, it is postulated that power differentials may play a formative role in the production

of stigma. For example, studies on schizophrenia patients report that greater social power was associated with less internalized stigma and negative symptoms as well as more stigma resistance. Studies define social power as "the perception of one's ability to influence another person or other people" [12, 47].

Policies based on the premise of social stigma in existing literature define social stigma "as the process by which the victim is labelled and subsequently discriminated against by society based on the suspicion/confirmation of harboring SARS-CoV-2". Early evidence from India showed that patients who recovered from COVID-19 experienced social stigma and prohibition from essential services due to social stigma [30, 36, 39]. They were restricted from dining in public spaces, using public bathrooms in hostels, grocery shopping, and procuring water from public tap facilities. One study reported stigmatization at the health facilities; patients reported that they were almost abandoned and overlooked by health providers in the hospitals. Few patients reported that after being admitted to the hospital, the doctors asked them to measure their blood pressure and oxygen saturation level [30]. Health professionals, who are on the frontline in the COVID-19 pandemic also experienced social stigma. Health professionals reported that the people in their locality considered them to be carriers of infection and avoided them [31, 38, 40]. We hypothesize that this stigma is fueled by the fear of contracting COVID-19 from the victim.

Self-stigma

The term self-stigma has been used to describe the process by which victims internalize the labels applied to them and eventually end up believing those ascribed labels to be true [48]. Furthermore, self-stigma may be enacted alongside anticipated stigma, especially in cases where the stigmatized identity is not visible. The fear of being discovered, along with the negative connotations of the stigmatizing label, collectively act as a source of psychological distress [49].

We base our definition of self-stigma on previous definitions provided in the Encyclopedia of Critical Psychology by Corrigan, Pattyn et al., and Mak and Cheung [50–53]. We define self-stigma "as the process by which victims become aware of social stigma, agree with and internalize the label applied to them". Similar evidence emerged from a study conducted on lived experiences of individuals. In addition to the anticipated stigma, because of being traced as the source of infection within the household and community, individuals started blaming themselves for their carelessness and felt ashamed and guilty [35]. Self or internalized stigma was reported to be high in a study conducted on COVID-19 survivors in Kashmir, India [39].

Anticipated Stigma

Anticipated stigma is an essential component of our framework because, in the case of COVID-19, the stigmatized label may not be visible. We hypothesize that anticipated stigma would influence the healthcare-seeking behavior of the victims as they would try and avoid enactment of the anticipated stigma into social stigma [46]. We base our definition of anticipated stigma on definitions provided by Scambler and Hopkins, Quinn and Chaudoir, and Earnshaw and define anticipated stigma "as the degree to which individuals expect that others will stigmatize them if they know about their concealed stigmatized identity" [54–56]. In one study participants on being discharged from the isolation ward, were concerned about the likelihood of facing stigma from the community and the neighborhood after going back home [30]. Similar findings were reported by another study, wherein on being discharged from the hospital, the participants reported a high level of anticipated societal stigma as compared to self-stigma and apprehension of being stigmatized by their family members [37]. Additionally, patients who were still in the hospital and undergoing treatment for COVID-19 reported their concerns about being stigmatized on their return to the community. Another study on stigma in COVID-19 inpatients reported that 7.1% of the respondents had significantly higher stigma scores, especially in the domain of concern about public attitudes [33]. In a study from Kerala, a southern state of India, the investigators discovered high anticipated stigma scores among doctors on COVID duty [34].

Associated Stigma

It is observed that in the case of medical stigma, conditions as disparate as mental illness, leprosy, and HIV have the potential to affect, not only the patients, but also the family, friends, and caretakers by association [57–59]. Such stigma has been called 'courtesy' stigma by Goffman and was first described by Mehta and Farina as a stigma by association [22, 24]. Further work on stigma by association or associative stigma has been done by Lefley, Phelan et al., and Byrne, Struening and Kjellin [60–64]. There is also evidence of associative stigma affecting medical professionals associated with caring for the stigmatized such as among mental health professionals [65, 66]. We define associative stigma as "stigma felt by family members and caregivers of the stigmatized victim who is, in this case, a person suspected/confirmed of harboring SARS-CoV-2, simply due to their association with the stigmatized". We hypothesize that in the case of COVID-19, associative stigma may arise due to suspicion of the care-giver(s) acting as 'vectors' of the disease. Other studies report that there is ostracized behavioral and social monitoring of the infected and their family members by the neighborhood [31, 41].

Currently, evidence related to stigma and its manifestation has been reported widely, however, limited studies have also reported the intervention to deal with the

stigma and its outcome. Video-based interventions reported reductions in COVID-19-related fear and stigma [67].

Conclusion

It must be understood that the realization and perception of stigmas are contextual and are influenced by the victims' understanding and perspective of how they conceptualize and realize the stigma directed towards them. This is more so for stigma directed towards identities not visible in the victim. Therefore, while constructing the stigma framework for COVID-19, we recognize that stigma would have differential impacts depending, not only on how victims are stigmatized, but also on how they perceive they are being stigmatized. Stigma related to COVID-19 has a temporal trend and is subject to individual awareness, population behavior change management interventions, and public information. The framework proposed by us is generic. We suggest that by using available evidence, the conceptual framework that we have proposed be used as an initial model for future improvisation and validation— a starting point to study and develop interventions to address stigma during similar pandemics in future.

Appendix I

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The Social, Education, Health, and Economic Effects of the COVID-19 Pandemic on Kenya's Adolescents

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Abstract The first case of COVID-19 was detected in Kenya in March 2020. Initial government responses included several containment measures such as school closures, movement limitations, and bans on public gatherings. These measures had many follow-on effects, in particular for the country's vulnerable adolescents. Between June 2020 and February 2021 two round of quantitative data was collected in four counties in Kenya (Kilifi, Kisumu, Nairobi, and Wajir) via phone surveys (n = 3,921). In addition, qualitative in-depth interviews were conducted in person in November 2020 with adolescents, parents, and other key stakeholders (n = 234). Results showed that the pandemic's effects on adolescents were wide-reaching and often differed by gender. While 85% of students reported doing some form of remote learning during school closures, 98% of them reported considerable challenges with less than one-third using technology (i.e., computers, phones, television, and radio) to support their learning. Over half of the adolescents reported depressive symptoms and over three-quarters reported skipping meals in the past week due to COVID-19. Twelve percent of girls and 9% of boys reported skipping healthcare services in the past one month, with the most common reason being lack of money to access the needed service. Once school had fully re-opened, 16% of girls and 8% of boys who were enrolled at the start of the pandemic had not re-enrolled. Given the wide, multi-sectoral nature of the impacts of the pandemic, a coordinated response involving education, health, and gender actors, as well as government and non-government partners, will be needed to mitigate the long-term negative impacts for Kenya's adolescents, in particular girls and other marginalized groups.

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Introduction

The current generation of adolescents is the largest ever, with 1.2 billion people aged 10–19 years worldwide. They are at risk of inheriting a world blighted by climate change and scarred by COVID-19. Although they have been spared the most severe direct effects of the virus, the indirect effects on their wellbeing are devastating [1]. Many adolescents experienced, and are continuing to experience disruptions in their access to health, education, and preventive services. And the pandemic has further exacerbated inequalities. The pandemic is changing everything for adolescents, as they experience the transitions that will define their future wellbeing: completing education, moving into the workforce, and forming life partnerships.

Even before COVID-19, adolescents and young adults faced multiple and intersecting challenges to their wellbeing. These challenges include social injustice and inequalities (such as those related to gender and inclusion), insufficient social protection, inadequate mental healthcare, poor sexual and reproductive health, and an inability to exercise their rights resulting in unintended pregnancies, HIV, and all forms of harmful practices including female genital mutilation (FGM). Adolescents are also experiencing a crisis of connection to family, community, and society, with increasing numbers dropping out of school [2]. Between 2003 and 2015, development assistance for adolescent health accounted for only 1.6% of total development assistance for health [3], despite a third of the total global burden of disease estimated to have roots in adolescence [4]. Mental health problems affect 10–20% of adolescents, and many more experience symptoms that diminish wellbeing [5]. Furthermore, this is the age at which the gender inequalities that underlie and pose major barriers to wellbeing emerge clearly and when programs can transform these inequalities.

In Kenya, adolescents, who are aged 10–19 years, comprise about 24% of the country's population. Marginalized adolescent girls face considerable risks and vulnerabilities that affect their educational status, health, and general wellbeing. They are at high risk for early marriage, unintended pregnancy, early and unprotected sex, sexual assault, HIV, and other sexually transmitted infections. They have limited income earning opportunities and high rates of illiteracy. They often experience violence and social isolation. In addition to all these challenges, they are frequently living in the context of acute poverty at the household and community level.

These examples show that as a global community, emphasis needs to be put on the multidimensional and intersectional nature of adolescent wellbeing and the importance of the transition to young adulthood. Efforts to support adolescent wellbeing have tended to be piecemeal, with different sectors focusing exclusively on their own areas of expertise and sometimes losing sight of the overall objective of promoting adolescents' rights and wellbeing.

As the world continues to recover from the COVID-19 pandemic, decades of economic and social investments continue to be erased, with unprecedented negative effects on communities around the world. There is evidence to suggest that the

disruptions to education by the pandemic have had negative consequences on already vulnerable students, such as those living within poor households, and girls.

In September 2016, Kenya's Government launched its national implementation plan for the Sustainable Development Goals and expressed commitment that 'no one will be left behind' in the economic and social prosperity of the country. The Government of Kenya is committed to providing an enabling legislative and policy environment for addressing adolescent issues. Some of the key policies targeting this demographic include: (i) the 100% Transition from Primary to Secondary School Policy; (ii) Free Sanitary Distribution Policy; (iii) Return to School Policy; (iv) School Health Guidelines; (iv) National School Meals Strategy; and (v) Anti-FGM Policy.

The Presidential Policy and Strategic Unit (PASU) in the Executive Office of the President, recognized the need for a more concerted and collaborative approach to adolescents' wellbeing and prioritized the adolescent and youth agenda as an integral part of the government's work. Various streams of work have been identified to reflect a wholistic approach toward enabling this critical demographic to thrive. This includes Generation Unlimited, the Global Partnership for Education, Human Capital Development, and Universal Health Coverage to name a few.

In June 2020, PASU in collaboration with Population Council Kenya (PC Kenya), undertook a study to rigorously document the experiences of adolescents in Kenya during COVID-19. This chapter describes the social, economic, health, and educational effects of the pandemic on Kenyan adolescents.

Methods

The data for this study draws on two rounds of phone-based surveys collected in four counties in Kenya and qualitative data collected in seven counties. The four quantitative cohorts were established by sampling from ongoing cohorts of adolescents that PC Kenya had established prior to the pandemic. This allowed the study team to leverage existing contact information, as well as access pre-COVID-19 data on these adolescents. Across all sites, adult and adolescent COVID-19 cohorts were sampled to be two-thirds female and one-third male. This would simultaneously allow for comparison between women and men, as well as girls and boys, while allowing for a sufficient sample to look at outcomes related to fertility and sexual and gender-based violence. All quantitative data were collected over the phone with interviewers conducting the interview in local language and entering the responses into a tablet (Table 1).

To establish the COVID-19 cohort in Nairobi, PC Kenya drew on two existing longitudinal cohort studies of adolescent girls in informal settlements: The Adolescent Girls Initiative-Kenya (AGI-K) [6] and NISITU (Nisikilize Tujengane) [7]. The AGI-K cohort in Kibera and Huruma (n = 2,565) is part of a four-arm randomized controlled trial (RCT) testing the impact of programs for adolescent girls. The NISITU cohort in Kariobangi, Dandora, and Mathare (n = 4,519) was part of a

Table 1 Quantitative sample

Country	Location	Adult sample	Adolescent sample	Date	Underlying Cohort
Nairobi	Kibera Huruma Dandora Kariobangi Mathare	n = 2009 1260 women 759 men	n = 1022 859 girls 163 boys	March 2020 April 2020 May 2020 June 2020 February 2021	AGI-K NISITU
Wajir	Rural; Wajir East, Wajir West, and Wajir South	n = 1322 898 women 424 men	n = 1234 754 girls 480 boys	July 2020 February 2021	AGI-K
Kilifi	Ganze, Kaloleni and Magarini Sub-Counties	n = 1288 782 women 506 men	n = 602 428 girls 174 boys	August 2020 February 2021	Nia
Kisumu	Nyalenda Kolwa East	n = 858 721 women 137 men	n = 1063 774 girls 289 boys	August 2020 February 2021	DREAMS

quasi-experimental study evaluating the effects of a gender transformative program for girls, boys, and young men. For both cohorts, the last round of data collection was recent (completed in September 2019 for AGI-K and in January 2020 for NISITU), therefore phone numbers were up to date. In March 2020, we randomly sampled from these households to establish a COVID-19 cohort and completed four rounds of adult surveys (n = 2,009) and one round of adolescent surveys with 10–19-year-old girls and boys in the same households by June 2020 (n = 1,022).

In Wajir County, we used the second cohort of the AGI-K trial, which conducted its RCT to test the impact of programs designed for adolescent girls in this region, sampling from households across 79 rural villages in Wajir County with 2,150 households. The last data collection for this cohort of AGI-K was in October 2019, so contact information was up to date. We randomly sampled households from the AGI-K cohort, stratified by sub-county and study arm, to form a COVID-19 cohort. Data were collected in July 2020 from adults (n = 1,322) and adolescents (n = 1,234) in the same households.

In Kilifi County, we leveraged the cohort from the Nia Project [8], a longitudinal, cluster randomized evaluation of school-based interventions. The study involved 140 public primary schools in three rural sub-counties within Kilifi County: Ganze, Magarini, and Kaloleni. The Nia study included 3,489 households, of which 3,276 were interviewed at the last round of data collection in March 2019. For the COVID-19 Kilifi cohort, we randomly sampled households stratified by sub-county, study arm, and gender of the head of household. Data was collected in August 2020 among adults (n = 1,288) and adolescents (n = 1,603) in the same households.

In Kisumu County, we leveraged a cohort from the Determined, Resilient, Empowered, AIDS-free, Mentored and Safe (DREAMS) Initiative [9], which delivered a comprehensive package of evidence-based strategies to reduce girls' HIV risk and also addressed structural drivers of adolescent girls and young women's HIV risk.

To establish a COVID-19 cohort we re-contacted the initial DREAMS cohort and conducted a brief phone-based household roster to establish the gender and age of all households. We also obtained updated phone contacts for those 18 years and above. From the roster data, we created a sampling frame from which we randomly sampled households stratified by age and gender of the head of the household. Data was collected in August 2020 for adults (n = 858) and adolescents (n = 603) in the same households.

A second round of quantitative data was collected by phone in February and March 2021 from the cohorts in Kilifi, Kisumu, Nairobi, and Wajir to assess school re-enrollment, teenage pregnancy and marriage, as well as a range of other time use and health outcomes. As most adolescents in the sample had returned to school, response rates were at 70% on average (although with significant variation by site: Nairobi (49%), Wajir (90%), Kilifi (67%), and Kisumu (67%), with the least likely reach being for those who had returned to school. While this was lower than the target, it was understood as it was difficult to reach adolescents on the phone given that most do not own their own phones and the parents were busy most of the time, and many at boarding school did not have access to phones for the interview. For a proportion of the adolescents who could not be reached, key questions on school enrollment, pregnancy, and marriage were asked of the parents.

In addition, in each of the four cohorts described above, qualitative data was collected in November 2020 from adolescent girls, boys, parents, and key stakeholders to understand more in-depth the perceived impacts of COVID-19 on education, time use, mental health, teenage pregnancy, and early marriage. To obtain a more representative sample of the various regions in Kenya, we also collected qualitative data in Kajiado, Makueni, and Muranga Counties (Table 2). A semi-structured interview guide was developed and used for each segment. In-depth interviews were conducted face-to-face.

Analysis Methods

We used inverse probability weighting to predict the probability of being in the full sample, then used that to generate a weight to overrepresent those who were at the highest risk of being lost to follow up. In the adult samples, there was no measured difference between those who were and were not re-interviewed in Round 2. In the adolescent samples, there were differences in three out of the four sites (Nairobi, Kilifi, and Kisumu), and therefore the weighting process was applied to those three datasets.

We tabulated qualitative data segmented by county, age (10–14 vs 15–19), and sex (female vs male). Qualitative data were transcribed and translated into English, coded for key themes, and then analyzed.

Table 2 Qualitative sample

	Nairobi (Kariobangi)	Nairobi (Kibera)	Nairobi (Kiambiu)	Wajir	Kisumu	Kilifi	Makueni	Kajiado	Muranga	Total
Adolescent girls 10–14	4	4	4	5	5	5	3	3	3	36
Adolescent girls 15–19 (all)	–	–	–	8	8	8	5	5	5	39
Adolescent girls 15–19 (not pregnant/mothers)	6	6	5	–	–	–	–	–	–	17
Adolescent girls 15–22 (pregnant)	4	4	5	–	–	–	–	–	–	13
Adolescent girls 15–22 (mothers)	4	4	5	–	–	–	–	–	–	13
Adolescent boys 15–18	4	4		4	4	4	3	3	3	29
Mothers of girls	3	3	3	3	3	3	2	2	2	24
Fathers of girls	2	2	2	2	2	2	2	2	2	18
Key informants	3	3	9	5	5	5	5	5	5	45
Total	30	30	33	27	27	27	20	20	20	234

Ethics

Study protocols were approved by the Population Council IRB, the African Medical and Research Foundation (AMREF), the Economic and Social Research Council (ESRC), and the National Commission for Science, Technology and Innovation (NACOSTI). Informed consent was collected for all respondents aged 18 and above. For minors, informed consent was obtained first from a parent/guardian, and then assent was obtained for the adolescent themselves.

Limitations

Since the study was conducted at a time when the pandemic response measures such as movement restrictions were in place; telephone interviews were used in place of in-person interviews. Therefore, a majority of adolescents had to use a mobile phone owned by a parent/guardian or friend. The presence of adults during the interview had the potential of making the adolescents somewhat guarded with information on some questions. Additionally, we recognize that respondents may respond with what they think is the 'right' answer or what the interviewer wants to hear.

Results

Economic Effects

While the vast majority of the adolescents in our sample were not household breadwinners, their households experienced extreme economic shock due to the pandemic. In June–August 2020, over 80% of households had experienced a complete or partial loss of income and almost three-quarters of adolescents were skipping meals due to the pandemic. In February 2021, while over 80% of households still had a loss of income, the proportion reporting partial loss as compared to complete loss had improved, perhaps giving a sign of a slow return to economic activity for adults. Likewise, at the second round of data collection, there was also an improvement in the proportion of both adults and adolescents skipping meals.

The economic loss translated into effects in other domains. For example, in February 2021, 18% of girls and 11% of boys reported having skipped a needed healthcare service in the past one year. The main reason given was the inability to afford the cost of the service.

> Up to now, my parents cannot get money at all so unlike before we cannot eat what we used to eat before corona virus. Sometimes we end up eating little food since there is no money to have a balanced diet. We just eat whatever is there. – *Adolescent Girl, Kisumu*

Mental Health

Using the PHQ-2 and the GAD-2, symptoms of depression and anxiety in the past fourteen days were measured. Over one-third (37%) of adolescents experienced depressive symptoms and 30% experienced symptoms of anxiety. For both measures, 15–19-year-old adolescents experienced higher levels of depressive symptoms and anxiety as compared to 10–14 years old adolescents. However, compared to the first round of data collection, during the school closures, there was an improvement as at that time point close to half of adolescents in urban areas (Kisumu 47%, Nairobi 46%) and one-third of those in rural areas (Kilifi 34%) experienced depressive symptoms.

In the qualitative data, mental health issues affecting adolescents were described as manifesting themselves through stress, anxiety, worry, shame, embarrassment, isolation, desperation, frustration, sadness, low self-esteem, and stigma. Those associated with money, health, or school re-enrollment were common for both genders in urban and rural areas, as well as the fear of COVID-19 infection. Many parents were of the opinion that adolescents were more likely to experience mental health issues related to the economic difficulties faced at home due to COVID-19. They highlighted inadequate food as a major contributing factor. Although some adolescents mentioned the same issue, a large number of adolescents also identified other specific issues related to money that caused them to worry such as, how to cater for basic needs, whether parents would be able to pay fees when school re-opened, and health care needs.

School closure in 2020 created an abrupt and unanticipated interruption of adolescents' education plans. Adolescents were also worried about school fees, anxiety over repeating classes, concern about COVID-19 infection at school, and uncertainty over completing school. The long period of school closure also isolated adolescents from their peers and they reported feeling 'lonely' and 'stressed'.

> I personally keep on being stressed because I do not know if schools will be opened first, I don't know if I will go back to school or I will continue staying here if my parents do not have school fees. *Adolescent girl 15 years, Makueni*

> Like depression, you will stay at home stressed with no friend to turn to. *Adolescent girl 18 years, Kilifi*

> …students are better off in schools because they have their peers, they are going to laugh, at least they forget the money problems at home. *Female Stakeholder, Muranga*

Gender-Based Violence

Across all sites, adolescents reported an increase in tension and violence in the household since the start of the pandemic. However, it remained largely the same between the first and second rounds of data collection and did not differ between girls and boys (Table 3).

Table 3 Percent adolescents reporting increased household tension and violence since the start of the COVID-19 pandemic

County	Tension—Jun–Aug 2020	Tension—Feb 2021	Violence—Jun–Aug 2020	Violence—Feb 2021
Nairobi	24	20	6	7
Kilifi	11	12	5	5
Kisumu	21	20	7	4

In the qualitative interviews, most respondents described the loss of employment and reduced income due to COVID-19 as fueling the increase in violence and crime within communities. With increased financial 'stress', 'tension', and 'pressure', some in the community engaged in stealing, mugging, and breaking into houses in order to get money.

Other respondents cited incidences of physical violence between spouses due to differences arising as a result of reduced income and the financial inability to provide basic needs to household members such as food and clothing. In many cases, domestic violence was preceded by emotional violence in the form of verbal abuse and insults between partners.

> Since the outbreak of Corona things changed in our country, very many people lost employment, very many people were forced to stay at home. And you see, mostly men they are bread winners, they need to provide and you see here they are at home and don't have money, so automatically this situation will fuel some dispute, which will amount to maybe fighting or something of the sort. *Male Stakeholder, Kajiado.*

Personal experience of violence also increased, with girls experiencing more sexual violence, boys experiencing more physical violence and both girls and boys experiencing an increase in emotional violence in equal levels (Table 4).

Many respondents mentioned the rampant use of drugs and alcohol by idle adolescent boys as a catalyst in the development of aggressive behavior which led to physical violence on most occasions. In addition, a number of respondents noted that adolescents who were exposed to domestic violence at home experienced undue stress and anxiety contributing to further aggressive behavior towards others. Sexual violence was also experienced by adolescents during the COVID-19 period. A number of respondents mentioned that idle adolescent boys raped girls especially when under the influence of drugs or alcohol.

> During this time of Corona, a certain girl was walking at night. She met with boys and they raped her…it was not reported…the family did nothing about it. -*Adolescent Mother 20 years, Nairobi*

School Re-enrollment

Among all those adolescents aged 10–19 who were enrolled in school in March 2020 (i.e., at the time of the COVID-19 school closure), 84% of girls and 92% of

Table 4 Percent adolescent reporting physical, emotional, and sexual violence since the start of the COVID-19 pandemic

	Emotional violence Jun–Aug 2020	Emotional violence—Feb 2021	Physical violence—Jun–Aug 2020	Physical violence—Feb 2020	Sexual violence—Jun–Aug 2020	Sexual Violence—Feb 2021
Nairobi	7	8	5	6	2	1
Kilifi	9	9	4	5	2	1
Kisumu	12	16	8	9	2	2

Table 5 Percent adolescents in school in March 2020 who were enrolled in school in February 2021

	Girls	Boys
Kilifi	91	87
Kisumu	81	91
Nairobi	91	87
Wajir	94	94

boys in Nairobi, Kilifi, and Kisumu re-enrolled when schools were fully re-opened in January 2021. There were no gender gaps in Nairobi or Wajir, but large gender gaps that favored boys in Kilifi and Kisumu (Table 5).

The main reason given by both boys and girls for not re-enrolling was the inability to pay school fees (47% for girls, 21% for boys), followed by pregnancy in girls (10%), and having gotten a job for boys (14%).

There was very little reporting of increased pregnancy or marriage among adolescent girls in the sample. This is likely due to the relatively short time that had passed since the start of the pandemic. As all the risk factors that lead to those outcomes were present, it is possible that as more time elapses and the reality that some adolescents will not return to school at all, there will be a spike in these cases due to the pandemic as well.

Recommendations

Underpinning the findings of this study is a set of recommendations for adolescent wellbeing to inform policies and programming. The recommendations emphasize the importance of integrating five interconnected domains in adolescent programming: good health and optimum nutrition; connectedness, positive values, and contribution to society; safety and a supportive environment; learning, competence, and education; and agency and resilience. A road map is required to enable the country to plan for the immediate and long-term COVID-19 crisis mitigation and recovery actions for adolescents. In the long-term, a focus on early adolescence will be required to create an environment that protects them and enhances their future potential, based on the lessons that have been learned from the pandemic crisis in Kenya and other regions. The initial recommendations made by PASU in light of these findings were:

1. **Entrench, tangible, and valid representation** of adolescents and strengthen their role in leadership and meaningful participation in all decision-making processes to ensure their perspectives are heard and needs are met.
2. **Develop strong multi-sectoral, whole-of-government policy approaches** that truly address adolescent health, education, and wellbeing.
3. **Prioritize learning continuity in the period of school closures** and ensure that adolescent needs and life realities are considered. This includes accessible

and inclusive distance learning that will reach the most marginalized and limit inequalities in the education system.

4. **Diminish the gender digital divide and address gender disparities in access to digital learning**. This includes working to provide free or low-cost mobile internet access. Where digital solutions to distance learning and internet are accessible, ensure that adolescents are trained with the necessary digital skills, including ways to stay safe online.
5. **Remove financial barriers and address basic needs in education**, including ensuring better targeting of those most in need of school meals and other support.
6. **Strengthen the supply chain for menstrual hygiene products** and establish accountability measures.
7. **Invest in the mental health of adolescents** and implement the Kenya Mental Health Action Plan 2021–2025 recommendations to address stress and depression; prevent emotional, physical, and sexual violence, prevent substance abuse, and strengthen positive parenting. It also provides for the provision of psychiatric counseling services in schools and colleges.
8. **Strengthen partnerships at all levels** to ensure linkages between the adolescent wellbeing agenda and broader efforts to address young people's livelihoods, education, and skills, as well as productivity. This includes community accountability structures, a rite of passage programs, and the establishment of safe hubs.
9. **Invest in preventing teenage pregnancies and early marriages** through family, cultural, school, community, faith-based, and other spheres of influence to ensure a return to school for all adolescents; protecting girls and boys from risky behavior and focusing on the adolescent boys' needs. This includes enhancing sexual and reproductive health information, addressing stigma, gender norms, boys' challenges, and providing life skills.
10. **Address ongoing data gaps** by making data related to the outbreak available and the implementation of the response disaggregated by sex, age, geography, and disability, and include other gender equality indicators.
11. **Ensure that responses to the outbreak are context-specific**. Considering the diverse settings in which adolescents in Kenya live, any mitigation steps to enhance their success will have to be tailored to these unique settings.

Conclusions

Kenya has made great advances in improving the welfare of children and remains committed to expanding opportunities for all young people. Although adolescents have and continue to face many challenges during the pandemic, there are existing platforms that can form a good foundation for a cohesive response to the issues that have been raised in this study. There is a need for context-specific innovative responses and a readiness to enter uncomfortable spaces, especially on matters that affect sexual and reproductive health.

A country-specific roadmap is required to enable the country to plan for the immediate and long-term COVID-19 crisis mitigation and recovery actions for adolescents. In the long-term, a focus on early adolescence will be required to create an environment that protects them and enhances their future potential, based on the lessons that have been learned from the pandemic crisis in Kenya and other regions.

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Country Experiences

The Public Health Response to COVID-19 in the UK: A View from the Frontline

Tania Nayar Misra

Abstract The author charts the experience of working on the frontline public health response during the pandemic. The UK's initial public health response to the pandemic comprised a delayed lockdown, shortages of personal protective equipment (PPE), insufficient testing capacity, and ambivalence about mask wearing. The pandemic's first wave ravaged the health and care sectors. Subsequently, with experience and tight testing regimes, management of COVID-19 in the care sector was improved enormously. Hospitals reduced their workload to a bare minimum initially, followed by designing separate pathways to facilitate elective work, underpinned by testing and infection control. In addition to the elderly and frail, those on the fringes of society—for example, homeless, refugees, asylum seekers, and prison populations experienced high rates of infection and mortality. Nation-wide restrictions on movement were propped by an economic support program. The new school year in 2020 began amid rising cases, as people struggled to interpret confusing policies. Workplaces did not emerge from remote working till mid-2021 and remain a hub of infection transmission. The tussle between maintaining economic activity and education versus preventing the spread of cases continues, while the focus of the public health response moves to high vaccination coverage, rapid testing, and responding robustly to emerging variants of concern.

Disclaimer: The views expressed in this chapter are entirely her own, based on her professional experiences, and not indicative of her organization's in any way.

The original version of this chapter has been revised. The disclaimer text "The views expressed in this chapter are entirely her own, based on her professional experiences, and not indicative of her organization's in any way.", has been included. The correction to this chapter can be available at https://doi.org/10.1007/978-981-99-1106-6_26

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Introduction

The UK's public health response infrastructure consists of public health teams based in local authorities (LAs) and Health Protection Teams that are part of a national body called UK Health Security Agency (UKHSA, previously known as Public Health England – PHE).

The local authority (LA) public health (PH) teams work on health improvement activities and on tackling health inequalities through a range of programs. They also commission sexual health services and have an oversight of immunization and health protection issues. The local health protection teams (HPTs) respond to communicable diseases, chemical and radiological hazards, and any threats to the health of the population of UK. They work closely with the local authority public health teams.

I am a senior medical consultant. I work in a health protection team that covers North and East London. There are two other health protection teams in London—for North West London and South London, respectively. For the coronavirus aspect of health protection work, all three health protection teams have merged into one team which is called the London Coronavirus Response Cell (LCRC). The LCRC recruited additional administrative and operational staff, and subsequently, staff from Test & Trace who covered London also became part of this team.

I have been working as one of 3 or 4 clinical leads at the London Coronavirus Response Cell, at least one day a week since early February 2020. I have tried to capture the experience of providing the frontline public health response in London, amidst rapidly changing scenarios and deficient policy making. In this chapter, I describe the pandemic's impact in different settings, then cover the key aspects of control e.g., the role of Test & Trace, vaccination, and non-pharmaceutical interventions undertaken at borough level by the public health teams.

To date, the UK has had over 14 million people testing positive and over 150,000 deaths (Figs. 1 and 2).

Broadly speaking, the UK's COVID-19 planning and response fell short both in tackling the spread of infections and in protecting its most vulnerable population groups.

The initial public health response was based on a flu pandemic planning model. Unfortunately, this model was not entirely applicable to SARS-CoV-2. More importantly, public health policy failed to implement the known lessons from the SARS, MERS, and the Ebola epidemics [1]. Thus, it always felt like we were catching up rather than managing the spread of cases proactively.

Each nation within the UK—Scotland, Wales, Northern Ireland, and England—developed its own COVID-19 control measures based on advice from specialists who their political leaders accepted. Overall, control measures like the use of face masks, movement control, and social mixing rules in the other three nations were usually stricter than those imposed in England throughout the pandemic period.

The pandemic affected people living in areas of social and economic deprivation and those from ethnic minority backgrounds most adversely [2]. Health inequalities in England have been widening since 2011 and life expectancy growth had stalled

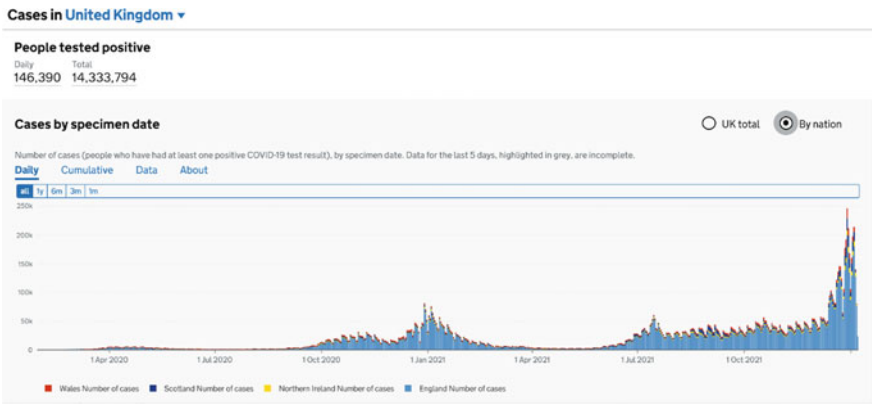

Fig. 1 Cases of COVID-19 in the UK from April 2020 to January 2022. *Source* Gov.UK coronavirus (COVID-19) in the UK

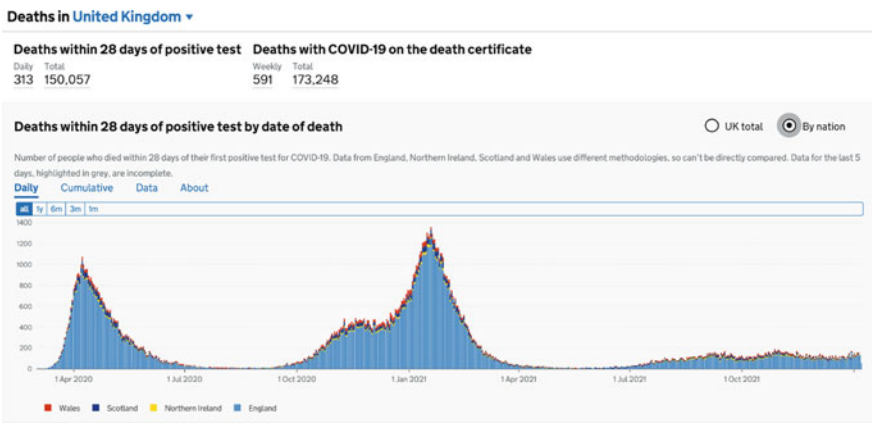

Fig. 2 Deaths due to COVID-19 in the UK from April 2020 to January 2022. *Source* Gov.UK coronavirus (COVID-19) in the UK

[3]. During the pandemic the stark differences in mortality and number of cases by deprivation indices (the higher the levels of deprivation, the higher the case and death rates) further widened the health divide [4].

Care Homes

The care sector in the UK was easily the worst affected by the pandemic as it holds the most vulnerable population—the elderly, frail, or highly dependent—all at high risk of COVID-19 complications [5].

As the cases began to rise in late February 2020, the situation was fueled by a series of unfortunate events.

Although the UK first developed a reliable polymerase chain reaction (PCR) test for COVID-19, it had not up-scaled the availability of the test to cope with the rising demand. As cases rose, a decision was taken to take away testing capability from the community and prioritize patients who were hospitalized [6]. This was a very poorly thought-out decision, as it meant that there was no way to case-find reliably, or to pick up the third of cases that were asymptomatic, or even to identify and rapidly isolate cases. This impacted the pandemic and really hampered safe working in care homes, which rely entirely on their workforce for all aspects of service delivery and serve those who are likely to have poorer outcomes.

Through March and April 2020, the ongoing plea from care home managers was to have on-site testing available. As their staff watched cases rise and their residents die before them, they became terrified of coming to work. Sadly, the mortality rates in staff increased multi-fold. Most staff who work in care homes belong to black and minority ethnic (BAME) populations who did not have higher case rates than average but had the highest mortality rates of all. We now know that there are both genetic and environmental (e.g., houses with multiple occupancy, multi-generational families, and deprivation) explanations for the higher mortality seen in these groups [7].

HPTs and LA public health teams hurriedly set up webinars for refresher training sessions for care home staff on PPE use, cleaning, donning and doffing of PPE, and appropriate IPC practices. These training sessions were well attended, but the main questions at the end of them were, "How can we get testing for our residents, and where can we get PPE"?

In the absence of adequate testing provisions and lack of PPE, managing and containing outbreaks was an uphill task. Given that 'confirmation of diagnosis' is step 1 in outbreak investigation, the frustration from this—both among care home frontline staff and the public health specialists giving advice on outbreak management—was beyond extreme. For two or three weeks, all existing testing capacity was diverted to those in acute care. Hence patients and staff in care homes could not get tested at all [6].

Two weeks into the first lockdown in 2020, possibly driven by research imperatives, provision of testing for care homes began slowly. Initially this was for a few care homes that were part of a study. It was then expanded and was provided from Pillar 1 (PHE laboratories). Soon, testing provision was expanded and was available directly through the Department of Health and Social Care (DHSC) [6].

Figure 3 shows the seven-day rolling rate of infections across age groups in London (with darker shades indicating higher rates). In the first wave, those over 80 were worst affected. Around the January–February 2021 wave, all age groups had high rates. Then in July 2021, it was mainly the younger age groups that had more mixing. In October to December 2021, it was younger age groups of 10–19-year-olds. Driven through transmission in school-age children, younger students starting university and the 40–49-year-olds (possibly parents of school aged children and those who stepped

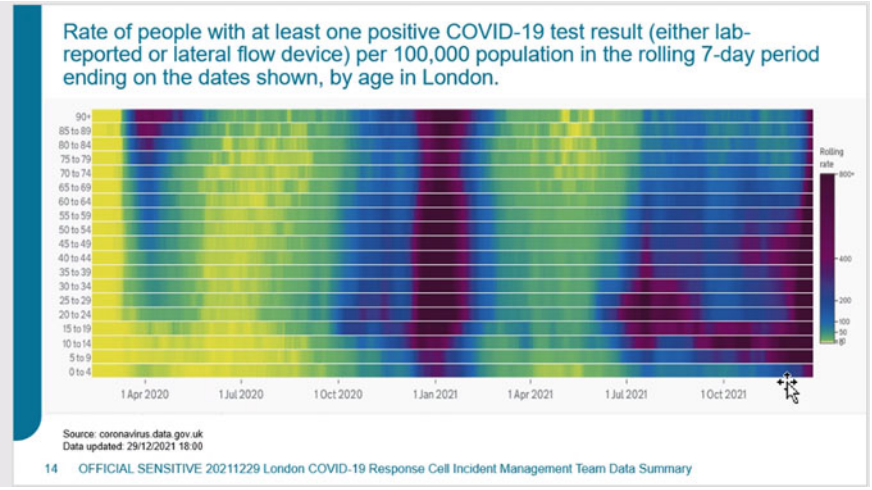

Fig. 3 Seven-day rolling rate of COVID-19 by age group in London. *Source* London coronavirus response cell, weekly epidemiological summary

out to work) showed the highest number of cases. As we progressed into January 2022, older age groups—over 60—began to appear amongst those affected.

As the country was not prepared for the first wave of the pandemic, the stocks of personal protective equipment (PPE) rapidly ran out. Clearly, hospitals had to be prioritized. But this was at the cost of inadequate provision for care homes. For a few weeks in the beginning, provision of PPE for care homes was limited and there were similar constraints in hospitals and other healthcare settings [8]. That period was probably the worst few days of work at the frontline. PPE had to be hastily procured and several gaps were identified in the procurement process subsequently [9, 10].

Then PPE provision steadily improved but in the absence of proper infection prevention and control (IPC) training, even with PPE provision there were many cases and deaths. Efforts were made at the local level to provide IPC training to care home staff. But this was patchy and variable. A few webinars were organized to train care home staff from PHE and from the LA. This seemed like a drop in the ocean while a fire raged on, till finally clear guidance for working safely in care homes was published in April 2020 [11].

The LCRC gave outbreak management advice to care homes that contacted us. Each care home received a detailed risk assessment, a systematic discussion on the infection prevention and control measures adopted by them, and then testing was arranged for them or advised where there were local arrangements for tests. The process took about 90 min. There were 40–50 new outbreaks reported to the LCRC from care homes every day and staff worked 11-h shifts (from 9 am to 8 pm daily, including weekends) from February to December 2020.

COVID-19 underscored the neglect of social care. This sector did not receive the same priority as the national health system (NHS) in the initial response to the

pandemic and over 15,000 care home residents died as a result [12]. The challenges facing social care have a long history and reflect the failure of politicians of all parties to agree on how care should be sustainably funded. Reforms have been proposed but have not been acted on [13].

Another contributory factor for this sorry situation was inadequate beds in hospitals which led to patients being discharged early to care homes. These patients were not tested and deemed 'well'. Many of these patients had acquired COVID-19 in the hospital and would take it back to their care settings and spread it there [1]. Cases spread rapidly among the frail, non-immune residents and there were an enormous number of fatalities. This showed the 'longstanding failure' to give social care sufficient priority and the same attention as the NHS [1].

By May 2020, the Directors of Public Health were being encouraged to take a more proactive role in the management of COVID-19 outbreaks in the community. They published multi-faceted outbreak management plans that were scrutinized by peers to ensure their robustness and potential for implementation [14].

By June 2020, the national Test & Trace service was set up. There was also an expansion of testing for care from the Department of Health and Social Care (DHSC) to order via Pillar 2 testing routes that went to a network of private laboratories [6].

Care home outbreak management was strengthened once the guidance for their testing regimes was published (15). Most care homes had tight management regimes with daily lateral flow tests (LFTs), weekly PCR testing for staff, and monthly PCR testing for residents [11]. In an outbreak, there would be whole home testing on day 0 and on days 4 to 7 [15, 16]. As disease dynamics and asymptomatic carriage were understood, the role of appropriate PPE became clearly vital for prevention.

By November–December 2020, there was sufficient understanding of the work to be done and the IPC teams in the community had also begun providing a lot of support to care homes for their outbreaks, alongside LA public health teams. By this time, testing drills, PPE, and IPC practices were well known and so were well implemented and it seemed that there was some control on the spread of cases. However, the pandemic effort suffered another blow with the emergence of variants of the virus.

First the Kent or Alpha variant led to a very large increase in cases as the vaccine roll-out was just beginning when it emerged in November 2020. It began to spread quickly by mid-December, around the same time as infections surged [17]. But the real setback was from the Delta variant which was so highly infectious and against which the standard PPE measures were not effective [18]. Well controlled care homes saw their work fly out of the window in the face of the Delta variant. There were a large number of cases and deaths due to this variant in January and February 2021 [18].

In March 2021, lateral flow testing (LFT) was introduced into care homes—for their staff to do daily in case of an outbreak, but otherwise twice weekly [19]. This was another robust control measure, even though the occasional non-concurrence of the LFT with a PCR result was a cause for confusion. Thankfully these instances were few and far between.

As the pandemic rolled on, a degree of control evolved in care homes that was enhanced with the vaccination roll-out that had begun from end November 2020

and is now being supplemented with a 3rd (booster) dose. Control of spread in care homes has now been effectively achieved with high vaccination coverage of residents, mandatory vaccination for care workers, regular testing regimes, IPC, PPE use, and visitor restrictions to main caregivers with on-site LFTs [20]. Care homes have occasional outbreaks where a few staff and one or two residents are picked up on routine screening. We hope that outbreaks of the past with large numbers of cases and deaths will not recur.

From December 2021 to January 2022, Omicron variant cases began appearing in care homes. The reason for this was some laxity in controls in care homes, with the opening of care homes to visitors, allowing residents to leave the care home setting, and some partially vaccinated care workers. Even though there were strict rules around visiting and vaccinations, the highly infectious nature of the Omicron variant contributed to a surge in care homes. It was observed that most cases among residents and staff were asymptomatic and were picked up due to the ongoing regimes of regular asymptomatic testing. Fortunately, the surge in cases was not accompanied by a surge in hospital admissions due to the high rates of vaccination among care home residents and staff, with the latter being mandatory from November 2021.

Hospitals and Healthcare Settings

The lack of preparedness for the pandemic hit hospitals very badly. The management of COVID-19 cases was initially led by the NHS111 response and emergency department services. All cases were asked to call 111 and were triaged by the helpline operators. Some hospitals had a mobile unit that went out to assess and swab patients, while others had testing units set up in their parking or outside accident and emergency (A&E), to avoid cases entering the Emergency Department.

As the pressure on health services mounted from rapidly increasing COVID-19 cases, general practices collaborated by designating some surgeries for the assessment of patients with COVID-19. As the cases began to rise in March 2020 and hospitals began getting filled with patients, it was impossible to control patient flows. There was inadequate Intensive Treatment Unit (ITU) space and a shortage of ventilators. Figure 4 shows the number of cases who received care in UK hospitals throughout the pandemic period.

Due to inadequate testing provision, it was not known which COVID-19 patients were positive and which were not. The situation was even worse in relation to doctors and healthcare workers. Although the guidance initially said that contacts of a case need to isolate for 14 days, it soon became clear that if this was applied to hospitals, there would be a dire shortage of healthcare workers and running hospitals would be untenable. Hence, any healthcare workers who were not symptomatic were asked to continue working.

Hospitals had reduced their workload to a bare minimum initially. Nearly all the elective work was stopped. Only cancer care, emergency care, and maternity care continued during the first wave. Private hospitals secured large amounts of funding

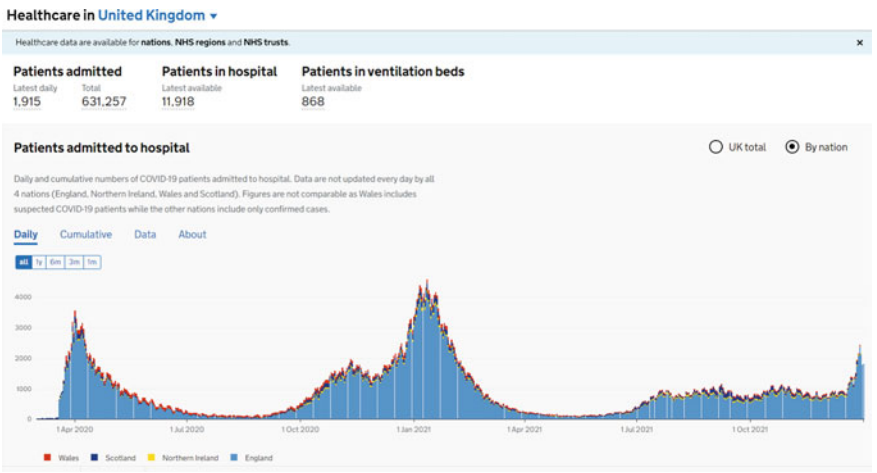

Fig. 4 Impact of COVID-19 on healthcare in the UK from April 2020 to January 2022. *Source* Gov.UK coronavirus (COVID-19) in the UK

to help the NHS during the pandemic, but treated very few patients with COVID-19 and delivered fewer NHS-funded operations than usual [21].

There was a dire shortage of PPE and many clinical areas of hospitals had no PPE availability [8, 22]. In the beginning of the pandemic, there was insufficient evidence regarding the type of masks appropriate for a particular setting or procedure and there were inadequate supplies as well [9, 10]. Inadequate pandemic plans and equipment stockpile left frontline workers risking their own and their families' lives to provide treatment and care [9, 10]. There were many cases among healthcare workers, particularly in the initial few months of the pandemic.

As evidence emerged on the proportion of asymptomatic carriage and the possibility of the virus having airborne transmission, PPE usage could be honed based on the type of clinical work being done [11]. Only at the end May 2020 did guidance for PPE use mandate the use of masks in both clinical and non-clinical areas. Initially, it had been available only for clinical areas [23].

In the summer of 2020, with the wider availability of testing, there was a bid to facilitate elective work and get patient waiting lists moving again [24]. There had been a considerable backlog over the months and separate pathways (green = low risk, amber = medium risk, and red = high risk) for patient flows evolved to facilitate elective work, underpinned by robust testing, pre-and post-procedure isolation rules, and effective infection prevention and control measures [24].

Among healthcare providers, certain groups were most affected. Mental health hospitals were among these. There were both patient and staff factors for this. The patients moved between the community and the hospitals but found it difficult to adhere to testing, use of PPE, and particularly isolation measures. This led to several prolonged outbreaks.

Staff factors that contributed to protracted outbreaks in these and other settings were a chronic shortage of staff, inadequate infection control expertise, lack of time to train staff in infection prevention and control (IPC), and an overall lack of understanding of IPC issues in relation to COVID-19. Mental health settings do not see very physically unwell patients. Hence, they had not previously focused on IPC or the prevention of outbreaks. Years of funding cuts had reduced IPC expertise in these settings to a bare minimum.

Once testing provision expanded, rules were put in place for testing of staff. All staff in healthcare settings were expected to do twice weekly LFTs and weekly PCR tests to work safely. The frequency of testing increased during outbreaks and exposure situations (where an infected patient or healthcare worker had exposed others) to daily LFTs and at least twice a week PCRs, and there was some flexibility in testing regimes with more frequent testing being done as needed.

Yet, humans are social animals, and there were a lot of incidents of staff exposures from each other in handovers, huddles, meetings, and training sessions in the early days of the pandemic. Occupational health teams in hospitals had not been trained in contact tracing, especially early on, and they struggled with identifying workplace contacts to test and isolate them quickly.

As cases began to decline, the NHS moved to the operationalization of elective work, with infection prevention and control risk assessments and extensive testing to address the backlog of 5.5 million referrals, alongside high vaccination coverage of healthcare staff, which too was made mandatory.

There was hope that the backlog of elective work would start being addressed. When the Omicron variant first emerged its potential impact on hospitalization was unclear. From mid-December 2021 hospital admissions began rising, but the demand for mechanical ventilation, which is a proxy indicator for severe illness, did not go up concurrently (Fig. 5). There were several weeks of crisis in the NHS due to lack of staff, due to very high rates of sickness absence amongst staff alongside high rates of hospital admissions for COVID-19 and other reasons. There were further constraints as patients found to have the infection and their contacts had to be isolated for a full 14 days, and bays and wards with cases had to be closed, thus adding further pressure on an already stretched system.

Unforeseen Health Consequences

There were unforeseen health consequences of the pandemic too, few of which need to be highlighted.

An unfortunate consequence of the pandemic was its enormous impact on mental health. The mental health effects of the pandemic were not the same for everyone. Those whose mental health was impacted by the pandemic included unemployed people, those with existing long-term physical or mental health conditions, women, people from minority ethnic communities, LGBTQ people, and older people who are isolated or digitally excluded [25].

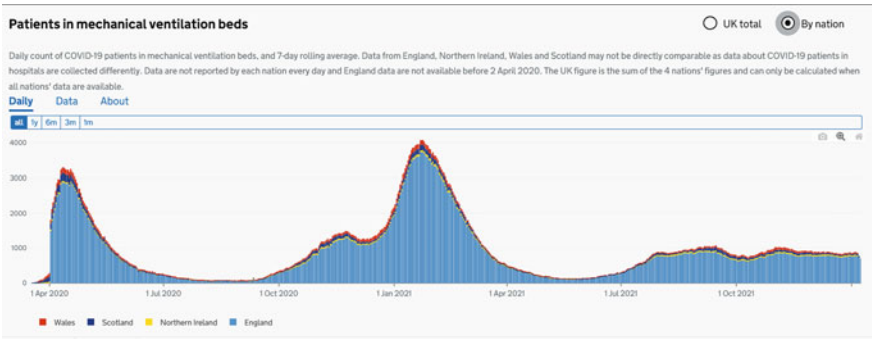

Fig. 5 Impact of COVID-19 on healthcare—Patients in mechanical ventilation beds from April 2020 to January 2022. *Source* Gov.UK coronavirus (COVID-19) in the UK

Young people were disproportionately affected by the pandemic. They faced challenges attaining education and future opportunities, work and unemployment, emotional wellbeing, housing, and relationships—with implications for the whole generation's future health and wellbeing [26].

Another impact of the pandemic was on immunization coverage. With prolonged periods of face-to-face care suspended, immunization clinics were disrupted. Messaging about staying at home possibly overwhelmed the message that the routine immunization program was to continue [27].

Long COVID is an increasingly widespread, multi-system condition which can be highly debilitating. Anyone of any age, including children, can experience long COVID, regardless of the severity of their initial illness [28]. The term 'Long COVID' includes both ongoing symptomatic COVID-19 (5–12 weeks after onset) and the post-COVID-19 syndrome (12 weeks or more) [28]. It is associated with a wide range of different symptoms that affect physical, psychological, and cognitive health. A recent systematic review revealed that an estimated 80% of patients infected with SARS-CoV-2 developed one or more long-term symptoms. The five most common symptoms identified were fatigue (58%), headache (44%), attention disorder (27%), hair loss (25%), and dyspnoea (24%) [29]. It can also influence the quality of life and ability to work or attend education [28]. £100 million of government funding have been allocated for managing Long COVID in hospitals, primary care facilities, and NHS England has published a plan to ensure that a systematic approach is implemented [28].

Schools

Keeping schools open and continuation of lessons was always a priority. There is robust evidence that extended time without face-to-face teaching is detrimental for cognitive, social, emotional, and academic development, learning, and long-term

prospects [30]. The government policy objective for children and young people during the COVID-19 pandemic was to maximize school attendance and minimize disruption of lessons [31].

Earlier in the pandemic, before the first lockdown, the schools' guidance involved basic contact tracing around a case. There was hardly any community testing available. Following a case linked with a school, all school contacts were identified and asked to isolate for 14 days. In December 2020, the isolation period was shortened to 10 days [31].

It is important to note here that in all table-top exercises where pandemic flu plans were tested, significant consideration was given to schools and their closure. It had always been acknowledged that the shutting of schools would impact not only the economy, but also key workers' ability to work, and so it was considered a last resort step.

However, schools were suddenly closed on 18th March before the first lockdown. And this closure was then kept in place for the rest of the academic year in 2020. To address the key worker issue, children of key workers were allocated school places at a local authority school. This was a pragmatic step that helped NHS and other key workers stay at work.

While key workers' children could be kept in school, most other families did not have this access and worked on a remote learning program. For homes where parents were not literate or IT savvy and homes where access to technology and computers was limited, remote learning for children was not straightforward at all.

Over the last several decades, the lives of families with children have been accustomed to run along the school year. Parents drop children to school, then go to work. Children where both parents work often attend breakfast clubs and after-school clubs. Furthermore, some families depend on the meals provided for their children at school. None of these were now available and the children were at home all day with parents struggling to balance their study needs alongside their own workday which too was now at home. For families with limited resources or space or both, this was very hard to implement.

By the summer of 2020, with lockdown taking effect, the number of cases began falling and the number of deaths also dropped. Through the summer there was a drop in cases, and then the government started its 'eat out to help out' scheme in August 2020 [32]. It encouraged people to eat out and they were given discounts for doing this. This was very popular, especially with young people and families fighting ennui, but all this social mixing led to a surge in cases.

The Test & Trace Program had been put in place on May 28, 2020. But the number of contacts from some of these social events and the snow-balling effect of cases was often beyond any control offered by the contact tracing and isolation done by Test & Trace.

When the schools reopened in September 2020, there were very tight operational plans with 'bubbles' to prevent inter-mixing of pupils, on-site cleaning, limited movements between pupil groups, cancellation of school fixtures, one-way systems at school drop off and pick up points, and strict isolation rules for cases and contacts [33]. Certain lessons like drama and singing were suspended. Mask wearing in

common areas, seating plans in class rooms, and social distancing were in place, alongside schools being responsible for intense contact tracing [33]. The schools followed the guidance well and had a robust process for contact tracing and isolation which helped prevent the spread of cases.

The implementation of social distancing and bubbles in boarding schools where pupils share bathrooms, common rooms, and dining halls was really difficult. A key constraint was the actual numbers of bathrooms and toilets available and the difficulty of isolating young people who were already living away from their families and homes.

Often the bubble sizes were a whole class rather than a sub-group of it, or a whole year group, and that was difficult because it entailed large numbers of pupils being isolated for a single case. Due to there being larger bubbles, often a much wider cohort needed to isolate than was strictly necessary.

The imperative was for schools to carry on with their plans till the Christmas holidays. As Christmas 2020 approached, the number of cases were on the rise, and school staff were exhausted from the endless contact tracing and isolation protocols that they had to implement. Often irate parents threatened legal action if their ward was found to be the contact of a case on more than one occasion or was asked to isolate soon after s/he had just finished one isolation period.

Remote learning was hard as explained earlier and even the 'blended learning' approach of a bit of onsite teaching and some remote teaching was getting exhausting. From the Coronavirus Response Cell, we had a checklist that we would go through to do a risk assessment with the school to ensure that all control measures were in place. This took about 30 min to complete and covered minute details like the size of bubbles, class sizes, number of cases and contacts as well as cleaning regimes and ventilation provision.

As Christmas 2020 approached and cases were on a relentless rise, some schools that had rising numbers of cases closed a few days earlier than scheduled. There was some polarity on this issue that led to a war of words between politicians and the teachers' unions. The London mayor called for schools to close early [34].

Schools did not then re-open after Christmas. They remained shut for over eight weeks of the new year. On March 8, 2021, schools re-opened, with remote learning in place, and all restrictions as previously, but with larger bubbles and twice weekly lateral flow tests (LFTs) for secondary school pupils. The systems of controls remained in place. Each time there was a case, contact tracing and the isolation involved a smaller, clearly defined group of pupils based on social groups and seating plans, rather than the whole class [33]. This was far more practicable and evidence-based than the previous approach of taking out the whole bubble.

Then the new variants emerged. First the Alpha variant that had led to the inexplicable surge in cases in November and December, then the Delta variant which defied nearly all measures of infection prevention and led to relentlessly rising cases. There were other variants too that emerged.

Schools that had cases of the variant were offered 'surge' or enhanced testing at or near their school site through mobile testing units (MTUs). Boroughs had to do enhanced testing when there were cases of variants in a certain geographic area.

This was an intensive, door-to-door activity, publicizing, on-site testing with mobile testing units, testing of sewage, and it went on for two weeks each time.

With enormous grit, head teachers managed to run schools till the summer holidays started. There were plans for summer school to make up for the loss of learning but there did not seem to be much appetite for this.

For the first time since the Second World War, examinations for General Certificate of Secondary Education (GCSE) and A level students were cancelled in 2020. The same step was taken the following year [35]. Examinations for GCSE and A levels were cancelled for two consecutive years and two cohorts of pupils going to university in the UK (in 2020 and 2021, respectively) did not take school-leaving examinations at all.

Another summer went by in 2021 with no travel permitted and many restrictions on activities. It was now 18 months since restrictions had been in place and most children had got no exposure to normal respiratory bugs. Hence, severe winter pressures were predicted in end-2021 with a surge of admissions due to respiratory infections.

The Department for Education's (DfE's) imperative was to keep pupils in school for their attainment and wellbeing, while the public health objective was to keep schools and communities safe [36]. While it is possible to have a shared agenda on this, education policy-makers decided that there would be no social distancing, no bubbles, no extra cleaning, and no mask wearing when schools re-opened in September 2021. Moreover, contact tracing would be by T&T and would no longer be the school's responsibility. There were extensive discussions about the need for normalcy versus the need for stopping the spread of cases.

The LCRC schools resource pack was revised innumerable times—made first for September 2020, then for spring 2021, and then for Autumn 2021, based on guidance updates. The need to keep kids in education was the overriding priority. We struggled to keep the number of cases in control as the new school year began in 2021 amid rising cases and no controls. Vaccination coverage was expanded to include 12–15-year-old too, and self-isolation rules were lifted for fully vaccinated people and for those under the age of 18 years.

A contingency framework was part of the guidance for operational management of schools—with a step-wise increase in control measures when there was a rising tide of cases [33]. These ranged from steps like extra cleaning, checking ventilation, and communicating with parents (green measures) to creating bubbles and wearing masks and stopping of assemblies and fixtures (amber measures). And finally, to actual exclusion of a very small group of pupils as a last resort and daily on-site testing (red measures) [33].

By the third week of October 2021 the number of cases in young people aged 10–19 was at a historic high, and remained so till mid-December [37]. Healthcare professionals questioned whether the current rates of COVID-19 infection in school children were acceptable when we have emerging evidence of the virus's lingering health effects [38]. The laxity of approach to controls in the school setting was criticized as a form of 'childism' and was deemed unfair [38].

Due to the surge in cases in December 2022 due to the Omicron variant, there were concerns that children could take the infection to their homes. Secondary schools

will now return after the Christmas 2021 break with provision for onsite testing and twice a week lateral flow testing for staff and students. Pupils in secondary schools will wear face coverings during lessons from January 2022. Staff in all schools will also wear face coverings in communal areas as previously, and there will be emphasis on increased ventilation and good hygiene [39].

Workplaces

Workplaces—particularly factories and smaller offices, were a hot hub of transmission due to lack of ventilation, space, and understanding. Several initial cases of COVID-19 could be traced back to conferences attended by employees at a large multi-national sports company and another was related to transport companies.

Businesses have a legal duty to manage risks to those affected by their business. The way to do this was to carry out a health and safety risk assessment, including the risk of COVID-19, and to take reasonable steps to mitigate the risks identified. Businesses were expected to use the published guidance to consider the risk within their premises and decide which mitigations were appropriate to adopt [40].

There was a lot of guidance, yet we found that workplaces lacked basic understanding of the steps entailed in a risk assessment, on how to identify contacts, and what information to give to cases and contacts where there was a case or an outbreak. There was an ongoing tussle between their need for business continuity and the necessity of following rules to stop the spread of cases.

The gov.uk website guidance was difficult to trawl through as well so the LCRC created a workplace resource pack that contained a framework for workplace risk assessments and suggested mitigations. It also had resources for communications with both cases and contacts. This was very well received. It ensured that quality advice was given consistently to all businesses that had outbreaks.

In the long term, it was expected that businesses will need to take fewer precautions to manage the risk of COVID-19 and high vaccination rates will mitigate the spread and severity of cases [41]. However, with the emergence of the Omicron variant in end-November 2022, England moved to Plan B. Those who could work at home were asked to do so. Mask wearing when indoors was re-instated and checks for COVID vaccination status were instituted in certain settings e.g. theatres, sports fixtures, and health and care settings [41].

Prisons

Prisons reflected the number and pattern of cases occurring in the community. They were severely affected during the first wave of the pandemic in March 2020. Prison outbreaks that occurred from end-March had large numbers of cases and high mortality—both in residents and in staff. The outbreaks were difficult to contain due

to a lack of testing capacity and PPE, and a lack of understanding of infection control principles, compounded by an inadequate infrastructure (in 100+ year old prisons) for contact tracing and isolation.

The lessons from the first wave were learnt and clear pathways and processes were defined for the management of cases of COVID-19 in prisons after the first wave. Yet, it was apparent that COVID-19 exacerbated existing health and social inequalities that usually affect people who are in contact with the criminal justice system.

There was Royal College of General Practitioners (RCGP) guidance which was aimed at ensuring equivalence of healthcare provided in this setting [42]. PHE (now UKHSA) guidance for management of outbreaks, yet outbreak control measures, when necessary, were far tougher to implement in this setting [43].

The main challenges faced were the mobility of detainees and staff and the inability to isolate prisoners effectively due to lack of space and shortage of staff. The ageing buildings were less amenable to adaptation and the already stretched staff were further deployed to unfamiliar areas of work (such as testing large numbers of prisoners quickly) in an outbreak. Despite deployment of a rapid testing team when there was a case or cluster detected and, repetition of the outbreak scenarios in these settings, it was difficult to embed key controls and processes.

There were also issues of delayed reporting and a considerable struggle in obtaining data on cases and their movements. When an area needed to be 'locked down' within the prison following two or more cases, it was difficult to implement this fully due to non-adherence to lockdown rules by prisoners and a chronic lack of sufficient staff to implement controls. Other ongoing issues were non-adherence to social distancing and vaccination for both staff and prisoners. There was always a struggle between regime continuation for the prisoners versus further isolation and imposing restrictions on this group of people whose freedom had already been taken away.

Asylum Seekers

Asylum seekers are among the most vulnerable groups in the UK with no money and huge uncertainty about their future [44]. There are language barriers and underlying physical and mental health concerns in this particularly vulnerable group [44, 45]. Their numbers fluctuate weekly and seasonally as larger numbers of asylum seekers crossed the English Channel during good weather [45].

Initial accommodation or contingency hotels are specifically identified for housing destitute asylum seekers in the first phase of the asylum process [45]. The accommodation provider for London is a private company that is commissioned by the Home Office [45].

Accommodation can be in single or multiple occupancy rooms (either family rooms or less usually single person dormitory style sharing rooms) depending on the setting; some may have communal kitchens, bathrooms, and living areas. Some

have en-suite bathrooms and food delivered to the rooms. The accommodations are intended to be short-term (usually around 21 days), rapid turnover settings. However due to the pandemic and shortage of onward accommodation, service users can stay on at these accommodations for many months.

A specialist team was commissioned to provide COVID-19 testing in asylum seeker accommodations and a separate contingency hotel was identified for those who tested positive to be moved to. Asylum seeker cases and outbreaks were a challenge due to lack of expertise in staff on the frontline and the complication of explaining isolation and movement restrictions (that often rapidly change as well) to affected cases and contacts with language and cultural barriers alongside existing constraints in the movement options and type of accommodation available for this group.

Testing

Rapid and reliable testing underpins the management of any infectious disease outbreak. Public Health England (now UKHSA) worked with key international partners to design and deliver the first UK COVID-19 diagnostic test, rolling it out faster than any other novel test in recent history [6].

There were challenges as the UK started from a lower base because it did not have a major diagnostics manufacturing industry to call on. With cases rising worldwide, there was also huge concurrent international demand for crucial testing materials like kits, swabs, and chemical reagents [46].

Given this finite capacity it was felt that priorities needed to be defined. Therefore, nearly all the testing capacity was concentrated in hospitals so that seriously ill patients could be diagnosed quickly. Community testing ceased on March 12, 2020 [46]. Any tests used had to be quality assured. This process was arduous and time-consuming in the early stages of the pandemic.

Aiming for testing provision to be universal, a phased approach was adopted—starting with hospitalized patients who needed the test, expanding to NHS workers and their families, then other critical key workers, and then expanding to the wider community over time. A five-pillar testing strategy evolved [6]. Figure 6 gives an overview of the testing provisions in the UK.

Figure 7 describes the breakdown of testing provision by each of the pillars. The first pillar was boosting swab testing—testing to find out if you have the virus—by PHE and NHS laboratories for patients and frontline workers in the NHS [6]. The second pillar was the creation of brand-new swab testing capacity delivered by commercial partners to build a network of new laboratories and testing sites across the country [6]. The third pillar was antibody tests designed to detect if people have had the virus and are now immune [6]. This was found to be less useful in the longer term. The fourth pillar was surveillance, using a high accuracy antibody test operated by Public Health England at their Porton Down science campus. These tests were aimed at strengthening scientific understanding on measures that need to be

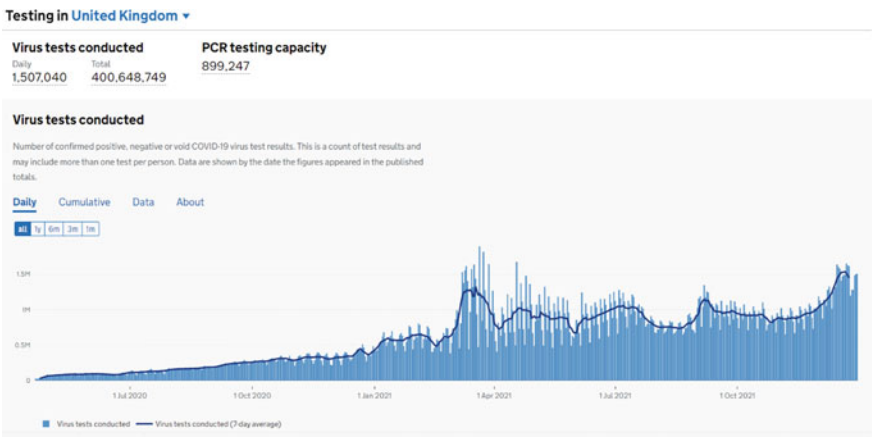

Fig. 6 Testing in UK from May 2020 to January 2022. *Source* Gov.UK coronavirus (COVID-19) in the UK

implemented to tackle the pandemic [6]. Later, it came to light that the 3.5 million antibody tests that had been invested in were not particularly useful. The fifth pillar was to build a large diagnostics industry in a short space of time [6].

There were many criticisms of the testing program [46, 47]. It was poorly coordinated due to the central controls. Up-scaling was delayed. The ceasing of community testing gave mixed messages to the public [46]. During the initial two months of the pandemic, testing capacity was very limited and this was gradually expanded [48].

The NHS testing capacity through its Test & Trace network now includes more than 1,000 sites, including 90 drive-through sites, 514 walk-through sites, 7 lighthouse laboratories, home testing and satellite kits, and a large number of mobile units [49].

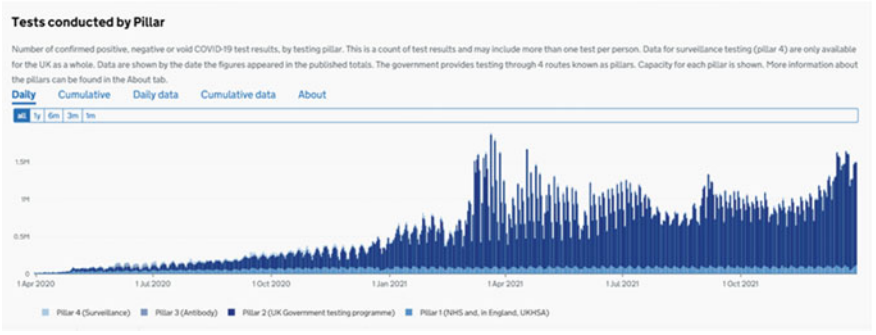

Fig. 7 Testing provision by pillar from April 2020 to January 2022. *Source* Gov.UK coronavirus (COVID-19) in the UK

Local Authority Public Health Response

Directors of Public Health (DsPH) and their teams are a fundamental part of a wider public health system in the UK. Public Health (PH) teams are based in local authorities. They also play a significant role at regional level, as a part of the local resilience and health protection functions. They are supported in these roles by national bodies (particularly Public Health England – now UKHSA) and they work with key partners including the NHS and the voluntary sector. They are considered appropriately placed to effectively protect and improve the health of their local populations [14]. However, the public health system particularly, and local government overall, had been under persistent financial pressure for several years prior to the pandemic. And trends in population health and inequalities were unfavorable [3].

Local PH teams were well aware that a pandemic could arise and what their response would entail, but there had not been any precedent for the scale at which cases and fatalities rose from COVID-19. This happened due to three main factors: the novelty of the virus, the absence of a vaccine, and insufficient knowledge of appropriate medical management of cases in the early stages [14].

These factors were compounded by the absence of reliable testing, as community testing provision was taken away to prioritize hospitalized cases in the initial stages [6]. Furthermore, the organization of the NHS in England was not fit for the purpose. The separation of commissioner and provider roles, the fragmentation of provision between NHS hospitals, and the legacy of over 30 years of market-oriented reforms made it difficult to plan for the needs of whole populations [16].

Critical factors that explain differences in the worldwide experience of COVID-19 are about how the response was managed—such as adequate testing provision, appropriate timing of lockdown measures, and effective contact tracing [50]. Additionally in the UK, due to the quality of the housing stock and houses of multiple occupation, working conditions, and social and economic factors with pre-existing inequalities, financially disadvantaged groups were far more vulnerable to the pandemic [3, 51].

The local authority PH teams provided support for outbreak management in care homes, schools, prisons, homeless hostels, and asylum seekers accommodation etc. based on their patch. In addition, they provided financial support for those who needed to isolate and supported local testing sites, and targeted testing initiatives when needed. The PH team devised and delivered local communications to promote preventive messages and employed a range of approaches for community engagement. All of this was underpinned by close collaborative working at a local level to ensure that strong COVID-19 controls were in place [14].

When the national COVID-19 vaccination program began, it relied heavily on the local PH teams and their community networks [14]. Quite early on it was clear that not everyone was enthusiastic about getting vaccinated. Several community groups were unsure about the vaccine's usefulness and some people found it complicated to access vaccinations [52]. Directors of Public Health did a lot of work with local champions and community representatives alongside formal organizations such as the NHS, to familiarize themselves with the concerns raised and the barriers people

faced to obtaining vaccines. They worked hard to address the barriers and formulated appropriate messages to promote high vaccine uptake [14].

Test & Trace

The Test & Trace system began on May 28, 2020. It identified contacts of a confirmed case and advised them to be isolated. Any situation where there was a case in a defined setting e.g. in a care home, work place, homeless hostel or school etc., was escalated for follow-up by the LCRC, as these would need more expert public health advice. The LCRC had many new 'Tier-1 Test & Trace staff' who only did COVID-19 contact tracing in these settings.

The system was not deemed fit for the purpose from the get-go [53]. It was felt that rather than a centralized system, there should be local Test & Trace teams led by the local authority- based public health teams who should be given additional resources to operate an area-specific Test and Trace system.

As per a critical report from the House of Commons Public Accounts Committee, the "NHS Test & Trace was one of the most expensive health programs delivered during the pandemic with an allocation of an eye watering £37 billion over two years, although it underspent by £8.7 billion in its first year. It focused on delivering programs but its outcomes were muddled and a number of its professed aims were overstated or not achieved" [54].

The report from the Commons Public Accounts Committee said that after the service was set up, there were still two national lockdowns and significant case numbers [54]. Hence, its input was questionable. Although named NHS Test & Trace, the system was largely run by two private companies—Serco and Sitele [55]. It was widely criticized for its use of expensive consultancy companies, its poor performance in reaching people who tested positive and their contacts in a timely fashion, and for its centralized rather than localized approach [55].

In 2020–21, NHS paid £3.1 billion to secure the laboratory capacity to process PCR tests and £911 m for contact tracing, mainly in call centers. However, it only used a minority of the laboratory and contact tracing call center capacity it paid for. Even at times when the demand for testing was high, few people were getting test results back within 24 h [55].

The T&T system is now part of the UKHSA. It was asked to detail how it will reduce its dependency on consultants and to explain the role of the local government in the future operating mode [54]. Local authorities played a vital and crucial role in public health, including in the response to COVID-19. NHST&T was earlier criticized for not engaging properly with important stakeholders, including local bodies [54]. NHST&T has made progress in its relationship with local authorities and the UKHSA has committed to co-designing its new operating model with local stakeholders [54].

Variants

The emergence of variants was a nasty surprise. First the Alpha variant that had led to the inexplicable surge in cases in November and December 2020. And then the Delta variant which defied nearly all measures of infection prevention and led to many cases. There were other variants too that emerged that were graded as Variants Of Concern (VOC) or Variant Under Investigation (VUI) [56].

Each variant case was followed up with a detailed questionnaire to ascertain both how it may have been acquired and how it may have spread further, through taking a history that entailed activities from 14 days before and after the onset of symptoms or the case's test date if asymptomatic. This was a time consuming and resource-intensive task. There was a stage when the cluster sizes were 50 to 90 cases and the HPT had to follow-up on all the linked cases and contacts.

Boroughs that had a cluster of variant cases in a geographic area had to do the enhanced testing in and around a defined perimeter of those cases. This was a rigorous door-to-door activity, publicizing, on-site testing with mobile testing units, including testing of sewage. Each surge testing initiative ran for at least two weeks.

Then the Omicron variant emerged which was identified by scientists in South Africa. On November 26, 2021, WHO designated the variant B.1.1.529 a Variant of Concern and was named Omicron [57]. The latest variant technical briefing suggests that Omicron continues to grow rapidly in all regions of England as measured by confirmed cases and S gene target failure (SGTF). Initial information suggested that Omicron cases had lower hospitalization and mortality than the Delta variant [58].

However, HPTs followed up the first few hundred cases and their contacts with detailed questionnaires that covered the fortnight before and after the onset of the case, to build a picture of its spread and transmissibility. All household contacts of confirmed cases were initially asked to isolate and have a PCR test done. Initially, even fully vaccinated household contacts of confirmed Omicron cases were asked to remain in isolation which was predicted to have a wider impact on essential services [59].

Studies of contacts showed that Omicron transmitted far more effectively than Delta. The UK Health Security Agency (UKHSA) had estimated that if Omicron continues to grow at the present rate, the variant will become the dominant strain by mid-December [58]. Omicron is the dominant strain in the UK now.

Further studies confirmed the lower risk of hospitalization from Omicron relative to the Delta variant. There was also a substantial reduction in risk of hospitalization in Omicron cases for those who had received three doses of the vaccine compared to those who were unvaccinated [60].

Vaccination

The UK was one of the first countries in the world to roll out a vaccination program—on December 8, 2020, when the first doses of the Pfizer vaccine began to be given. In the UK, the Joint Committee on Vaccinations and Immunizations (JCVI) advises UK health departments on immunization [61].

The vaccination roll-out was the most successful component of the COVID-19 response in the UK. A specially appointed vaccines minister led the delivery of the vaccination program, thus demonstrating that political will is a key factor in successful public health initiatives. The vaccine delivery infrastructure entailed a range of sites from pop-up clinics in pharmacies to large stadiums and mobile vaccination buses. There was enormous investment in freezers for the storage of the vaccines and rapid training sessions were organized for having fully trained staff to deliver one of the larges vaccination campaigns in history.

At the time of writing, over 133 million doses of the vaccine have been given with a coverage of 90.3% of the eligible population for the first dose, 82.8% for the second dose, and 61.3% for the third (booster) dose (Fig. 8) [62].

The vaccination program is increasingly the main component of UK's COVID-19 control strategy, particularly as emphasis shifts from non-pharmaceutical interventions (NPIs – e.g., physical distancing measures, ensuring adequate ventilation in closed spaces, the maintenance of hand and respiratory hygiene measures, the appropriate use of face masks, and staying home when ill) which are deemed by many as restrictive and infringements on individual freedoms.

The program began with two doses of the vaccine given three weeks apart, and very early on the JCVI recommended increasing the interval between the two doses to 12 weeks. Although this approach was heavily criticized at the time, it turned out to be a wise decision that enabled larger number of people to get initial protection quickly.

The target groups for vaccination are reviewed all the time and are expanding. From October 2021 onwards, 12–15-year-olds were also given a single dose of the

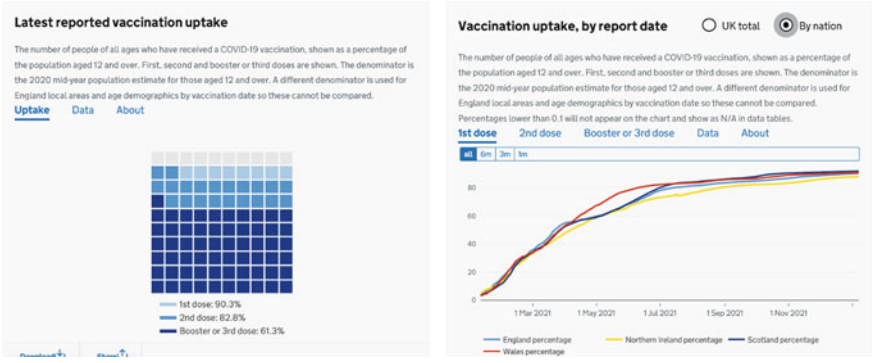

Fig. 8 Vaccination in UK. *Source* Gov.UK coronavirus (COVID-19) in the UK

vaccine. Currently, everyone over 18 years of age is recommended to have a third (booster) dose of the vaccine. Estimates of the efficacy of the vaccine against the Omicron variant are still emerging. Early evidence suggests that the booster dose is likely to prevent a significant proportion (about 80%) of serious illness [63].

Epilogue

By end-November 2021, more than 160,000 people died in England with COVID-19 being stated on their death certificate [64]. The way a COVID-related death is defined in England is different from the definitions used in other parts of the world. Hence data may not be entirely comparable.

When I look back at what it felt like to be in the pandemic, some things come to mind immediately. A lack of basic civic sense and humanity showed up in behaviors that surfaced very early on. Fights over loo rolls, shelves emptied of hand gel and soap, and food-hoarding beyond belief. This continued till supermarkets began imposing restrictions on the number of key items that people could buy.

Following an impassioned plea on social media of an NHS worker who couldn't get any fresh vegetables or fruit at the local supermarket after a long day at work, supermarkets created special times when NHS and frontline workers could shop [65]. They put in place one-way systems, limited on-site access, and a huge range of home delivery slots. Those who were on the list of 'shielded' (clinically extremely vulnerable) patients were prioritized for deliveries.

The pandemic has had an unequal impact on society in terms of mortality, loss of income, mental health, and other issues [14]. In many places, the pandemic worsened challenges and inequalities that people had already been experiencing [3]. The substantial 'backlog' in health and care services will entail major investment and work for the next 3–5 years at least [14].

Another serious consequence was rising unemployment and ensuing or intensified financial insecurity. The social impact of the pandemic was also seen in the large increase in people claiming Universal Credit since the beginning of the pandemic and a markedly higher dependence on foodbanks [66].

The disruption to children and young people's education for extended periods during 2020 and 2021 will inescapably impact on their future learning and employment prospects [14]. There was also a rise in reported cases of domestic abuse during lockdowns, sometimes resulting in children being taken into care [67]. There is a cohort of babies born in late 2019 who have barely been out of their houses and have not had any human interaction outside their families for nearly 18 months of their lives—till July 2021. It would be interesting to chart their development.

Every Thursday at 6 PM for many months, people stood outside their houses and clapped for healthcare workers. This was poignant and appropriate at the time. And then it was heart-breaking when ministers did not approve higher salaries for frontline healthcare workers and other key workers. Those who work in the health

and care sectors despite their fears and the enormous difficulties, felt undermined and unappreciated.

In a global infectious disease crisis, some change is inevitable. Many countries used emergency legislation to extend the power and responsibilities of specialist public health organizations and boosted resource allocation to existing structures to upscale their ability to respond (68). England did not adopt this approach. Instead, it abolished its national public health body (Public Health England) in August 2020 [68].

England's approach also included choosing commercial sector companies to design, manage, and provide critical public health functions during the pandemic [8, 53]. Despite repeated requests, there were refusals to provide adequate resources to the Directors of Public Health and their teams based in local government across England [68].

Finally, key ministers and government advisors set poor examples of behavior. It began with the Chief Adviser to the Prime Minister, who broke lockdown rules when he travelled out of London with his family in April 2020 [69]. The next year in June 2021, the Health Secretary resigned after it was shown that he had breached COVID-19 social distancing restrictions with an aide in his Whitehall office [70, 71]. And in December 2021, news leaked of Christmas parties held at the Prime Minister's office in December 2020 when there were strict restrictions on social mixing [72]. The mismatch between ministers' words and behavior was probably one of the most difficult aspects for people living through the pandemic.

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Social and Behavior Change Preparedness for COVID-19 Prevention: Evidence and Experience from Ethiopia

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Abstract The chapter focuses on three crucial elements of social and behavior change (SBC) preparedness within the realm of risk communication. The first section of the chapter describes how to implement a systematic first response to a new epidemic or outbreak. The World Health Organization (WHO)/The Global Outbreak Alert and Response Network (GOARN) framework provides a comprehensive structure to operationalize the immediate national level response for SBC. Ethiopia's first response was well coordinated and planned, and importantly, started before the detection of the first COVID-19 case in the country. The second section of the chapter provides pooled estimates of COVID-19 prevention behaviors in the country which show a pattern of uneven adoption. The need to develop strategic SBC approaches for both behavior change and behavior maintenance is highlighted. Finally, the third section of the chapter deals with the mental health context during the pandemic in Ethiopia. We propose an integration of community-based mental health support with SBC preparedness activities.

The chapter conducts a meta-analysis of peer reviewed literature on three COVID-19 preventive behaviors and on the huge mental burden borne by Ethiopians during

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the COVID-19 pandemic. The guidelines for practice provided in the chapter are globally applicable. We hope that Ethiopia's collective experience results in better success in the global fight against COVID-19.

Introduction

Ethiopia is Africa's second most populous country, with an estimated population of 115 million [1]. Yet the country had recorded only 470,760 COVID-19 infections and 7,510 deaths as of May 11, 2022 [2]. Several theories exist to explain the lower rates of infection and fatality in African countries including younger age of the population, cross immunity from other infectious diseases, and limited testing and surveillance [3]. The Ethiopian government's early response to the pandemic may be another contributor. Ethiopia ranks third in terms of COVID-19 preparedness among 9 African countries that had testing and Ready Score data available [4].

The first section of this chapter provides a case study of how the Ethiopia government acted quickly to mitigate the impact of the COVID-19 pandemic through mobilization of the local and international emergency response community and implementation of a coordinated risk communication and community engagement (RCCE) strategy. We describe the nation's application of the RCCE prevention framework to enable the adoption of a systematic response during March 2020–October 2020. We also assess how COVID-19 prevention activities were monitored and used for adaptive management during this time period.

The second section provides an analysis of behavioral and mental health trends in Ethiopia from March 2020 to April 2022 and identifies lessons learned for the nation's ongoing COVID-19 risk communication strategy. Using published peer-reviewed literature, we assess the pooled prevalence estimates of COVID-19 preventive behaviors and of mental health disorders in healthcare workers and the general population. Pooled estimates provide more stable estimates which take into consideration regional and within region variations. This analysis, as well as lessons learned from the Johns Hopkins University Center for Communication Programs (CCP), highlights the need to develop both short-term and long-term objectives to mitigate not only the immediate health impacts of the COVID-19 pandemic, but also mental health indicators.

The objectives of the chapter are as follows:

1. To share Ethiopia's early SBC emergency response process during the COVID-19 pandemic that can inform risk communication preparedness guidelines for future epidemics.
2. To identify gaps in COVID-19 prevention efforts by examining peer-reviewed literature from 2020 to 2022 on adoption of COVID-19 prevention behaviors.
3. To understand the context of mental distress in healthcare workers and the general population by assessing the magnitude of the problem and factors associated with mental disorders, and to offer insights on how to address mental health challenges

through the risk communication and community engagement (RCCE) prevention framework.

The COVID-19 Pandemic in Ethiopia

Ethiopia's first COVID-19 case occurred on March 13, 2020. The country experienced four subsequent waves of COVID-19 [2]. The four waves are shown in Fig. 1. The second wave saw the highest share of COVID cases. However, a sharp uptick of confirmed cases was also observed in the fourth wave. The highest death rate was observed in the third wave, and the lowest death rate was recorded in the fourth wave.

Understanding how the pandemic is unfolding, with periods of less transmission punctuated by severe outbreaks, is central to SBC communication planning, as described later in this chapter.

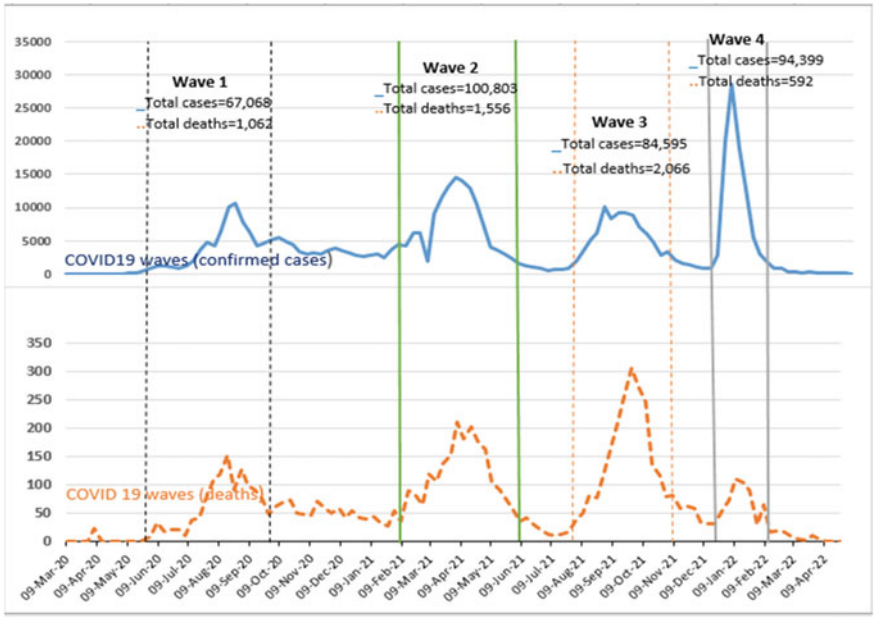

Fig. 1 Timeline of severe COVID-19 outbreaks and total number of confirmed cases and deaths. *Source* WHO Coronavirus Disease (COVID-19) dashboard with vaccination data

Emergency Preparedness in Ethiopia

Under the revised International Health Regulations (IHR–2005), countries are required to develop core capacities for responding to public health emergencies that may have international implications [5]. Emergency preparedness spans a number of core capacities including risk communication. States are assessed on emergency preparedness through the WHO Joint External Evaluation (JEE) [6]. Data from the JEE is used to create an aggregated ReadyScore for each country that is published on the Resolve to Save Lives: Prevent Epidemics website. Of 31 countries in Africa with a ReadyScore, Ethiopia ranks fifth highest with a score of 52 based on the JEE conducted in the country in 2016 [4, 7]. There are indications that the nation's emergency preparedness improved based on the self-assessed "all capacities average" of 72% as of May 2022, which compares favorably with the regional average of 48% and a global average of 64% [4].

Using the self-assessment tool, the country has consistently scored 80% for core capacity of risk communication since 2018 and above average regional scores of less than 64% annually [4]. A well-developed SBC preparedness structure is an important component of the health system's readiness to mount an effective and early emergency response [8]. The Ethiopian government was therefore prepared to commit to a prevention framework that prioritized risk communication in the very early days of the pandemic, prior to cases being recorded in the nation. CCP, which has a long-standing presence in the country, collaborated with the government along with the WHO, the United Nations International Children's Emergency Fund (UNICEF), the Centers for Disease Control and Prevention (CDC), and the United States Agency for International Development (USAID) implementing partners, and other major stakeholders to support RCCE activities for the prevention and management of early cases. These efforts were supported by USAID through Breakthrough ACTION, the agency's flagship global SBC project.

As a technical SBCC partner to governments in the management of disease outbreaks, CCP identified key elements of SBC preparedness during the Ebola outbreak in Guinea in February 2021, noting that it is both "….a short- and long-term process where preparedness is focused on public communication, counseling, stigma reduction, immediate prevention response that includes promoting prevention behaviors, transmission of accurate information, and transmission of epidemic related information that builds trust within communities and which reduces fear" [9]. As we continue to expand our understanding of SBCC preparedness, there was a need to develop both short- and long-term communication objectives for the prolonged COVID-19 pandemic.

COVID-19 Risk Communication in Ethiopia

The WHO JEE focuses on five indicators to assess risk communication preparedness among members states. These five indicators provided the structure for the Emergency Operations Center (EOC)'s risk communication efforts in Ethiopia [6].

- **Risk communication systems**: Formal and clearly recognized systems that will guide the development and implementation of a risk communication strategy "during times of emergency", determine who will make decisions; and how decisions will be made.
- **Partner and internal coordination**: Ensure that all key partners (external partners and government agencies) participate in the risk communication system and coordinate activities and messaging to ensure optimal timing, reach, and consistency of important information.
- **Public communication**: Use of media and public channels to communicate information about COVID-19 quickly and effectively.
- **Community engagement**: Focuses on reaching out to vulnerable communities to engage them in identifying and addressing communication needs and creating channels of engagement that acknowledge contextual factors and preferences.
- **Addressing uncertainty and perceptions and managing misinformation**: This is a priority for all risk communication and includes efforts to track rumors and misinformation and provide a rapid and clear response.

With USAID support, Breakthrough ACTION worked alongside the Ethiopian government and non-governmental partners to improve core competencies across all five areas and ensure a comprehensive, coordinated response to COVID-19. A key aspect of risk communication was reaching out to a large number of people through public communication to accurately describe risk and motivate behavior change without creating fear and panic among the population. SBCC campaigns can be defined as purposive attempts to inform or influence behaviors in large audiences within a specified time period using an organized set of communication activities and featuring an array of mediated messages in multiple channels generally to produce non-commercial benefits to individuals and society [8, 9, 10]. SBCC approaches in Ethiopia during the first months of the pandemic included mass media; social mobilization campaigns using audio mounted vans; and community engagement activities including facilitating community discussions and COVID-19 education in public places such as marketplaces, religious institutions, and community meetings. The Ethiopia government launched a highly effective text messaging campaign via mobile phones and inserted prevention messages into telephone answering systems. All of these interventions formed the cornerstone of an effective COVID-19 prevention strategy during that time period.

The next section of this chapter describes the RCCE's activities from March 2020 to October 2020. We present data from Breakthrough ACTION's continuous monitoring that captured major achievements across the five pillars of the WHO/Global Outbreak Alert and Response Network (GOARN) framework. Figure 2 presents

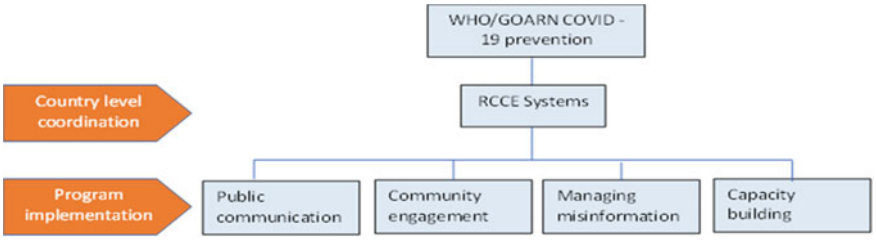

Fig. 2 Five pillars of the WHO/GOARN COVID-19 prevention framework.*Source* Diagram prepared by authors based on the WHO/GOARN pillars of risk communication

the WHO/GOARN indicators that form the framework for the risk communication approach.

Risk Communication Systems

The Ethiopian Public Health Institute (EPHI), which is responsible for responding to public health emergencies in the country, activated its EOC after the first COVID-19 case was reported in China on December 31, 2019, well before COVID-19 was declared a pandemic. The EOC was overseen by a national technical advisory team created by the Minister of Health, with the EPHI Director serving as Secretary. The EPHI Deputy Director served as the Chairperson of the EOC. The RCCE unit was established under the national EOC. Breakthrough ACTION project, as an active member of the communication technical working group in Ethiopia, provided technical support to EPHI to create the RCCE committee and its terms of reference based on WHO guidelines. The unit is composed of relevant departments from the Ministry of Health (MOH) including the Directorates of Public Relations and Communication, Health Promotion, and the Health Extension as well as multilateral and implementing partners. Overall, there were about 15 full-time experts from various implementing partner institutions that served on the RCCE committee. All implementing partners, including CCP, provided at least one dedicated full-time expert to the national RCCE team. The team held weekly virtual meetings and reviewed progress of the response activities. This level of effort across the government directorates and implementing partners enabled a highly coordinated RCCE response in the country.

The national EOC addressed several key functions of the emergency response: case management, logistics and supply, public risk communication and community engagement, and laboratory and diagnostic services. Public health institutes at the regional level established EOCs in 11 regions including in various city administrations, in a similar manner.

Breakthrough ACTION supported the national and regional RCCEs to regularly review and update the risk communication plan. The project participated in daily reviews of new developments regarding the status of the outbreak in Ethiopia

and subsequent preparations/revisions of the response plan with RCCEs at both the national and regional level.

Partner and Internal Coordination

As an active member of the RCCE, Breakthrough ACTION helped develop the first strategic communication plan to respond to COVID-19 at both national and regional levels. The project adapted its global synthesized guidance for COVID-19 message development to the Ethiopia context. The guide served as a reference for partners and national and regional RCCEs to design risk communication materials on COVID-19.

In the early stages of the pandemic when countries were trying to prevent COVID-19 from entering their borders, Ethiopia focused on the transportation corridors, especially the Bole International Airport, Ethiopian Airlines, and Addis Ababa international hotels. Breakthrough ACTION supported the RCCE to provide orientation for 3,000 Ethiopian Airlines flight crew members and airport personnel that included the COVID-19 case definition guidelines for managing and reporting and development of a universal precaution kit.

In collaboration with other partners, Breakthrough ACTION developed multisectoral engagement guidelines for interventions involving religious leaders, hotels, and media professionals. The project supported the national RCCE committee to develop and provide orientation to hotel managers in Addis Ababa and other tourist destination towns. Managers were equipped with quick guidelines on how to orient the rest of the hotel staff. The project supported the RCCE committee in developing training programs for all regional and zonal focal persons on harmonized action plans and helped to identify and reach out to vulnerable groups (e.g., nursing home residents, senior citizens, and people with chronic diseases).

The project provided technical support to regional RCCEs in conducting supportive supervision (SS) in collaboration with other departments in the regional health bureaus (RHBs) to woredas (districts), primary health care units, and health posts at the ground level. The SS aimed to enhance performance of the COVID-19 response activities and to mitigate the effect of COVID-19 on routine health services uptake behavior of the community. The SS team provided on-the-spot technical assistance to the visited woredas (districts) and health facilities based on identified gaps.

To facilitate learnings and knowledge sharing among partners, Breakthrough ACTION designed an online COVID-19 knowledge management platform. The platform helped partners to easily access resources related to COVID 19 prevention. It was launched in July 2020 with more than 90 risk communication tools uploaded and disseminated to the partners (Fig. 3).

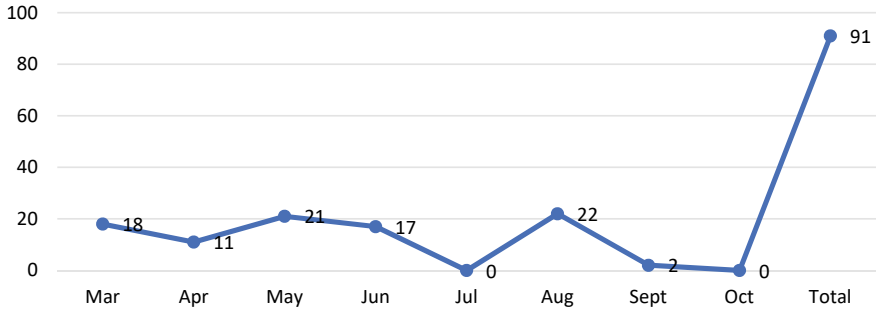

Fig. 3 Total of 91 risk communication materials designed, uploaded, and shared with partners by Breakthrough Action Ethiopia, October 2020. *Source* Breakthrough Action's monthly monitoring system for COVID-19 prevention program March-Oct, 2020

Public Communications

After the first COVID-19 case was reported in Ethiopia, the RCCE committee's strategy shifted from preparedness to response mode. A mechanism for daily press releases was established with a fixed time and place that was communicated to all media in advance. The RCCE team was responsible for compiling all new COVID cases, deaths, and recovery data coming through case management teams from all the regions and city administrations. The Minister of Health was identified as the official spokesperson who communicated with the press each day, after which the press release was also posted on social media.

In collaboration with national and regional RCCEs, Breakthrough ACTION designed and disseminated 39 radio spots and six television (TV) spots for dissemination through national and regional media (both public and private), and 53 unique print materials including banners, posters, leaflets, and stickers for distribution to the regions. These materials contained key messages on routes of transmission and prevention methods including handwashing, masking, and distancing. The radio and TV spots were disseminated through national and regional radio and TV channels, both public and private. The messages across all media reached an estimated 25 million people, excluding repeated counts (Fig. 4). In addition, the project created social media content to communicate accurate information to the public and tapped into existing and new platforms such as websites, Facebook, and Twitter pages of the MOH, EPHI, and Regional Health Bureaus to post daily COVID-19 updates.

Breakthrough ACTION supported the staff of the existing 952 call centers with orientation and training on how to respond to calls and questions about COVID-19. In addition, the project helped to establish a new national 8,335 call center and regional call centers in 11 regions. Breakthrough action provided basic counseling training for the counselors, developed a Q and A that served as a reference for counselors, and oriented all the call center staff to respond to queries from the public.

A guide to engaging the Ministry of Transportation included messages that could be transmitted at transport stations through long distance buses and city buses.

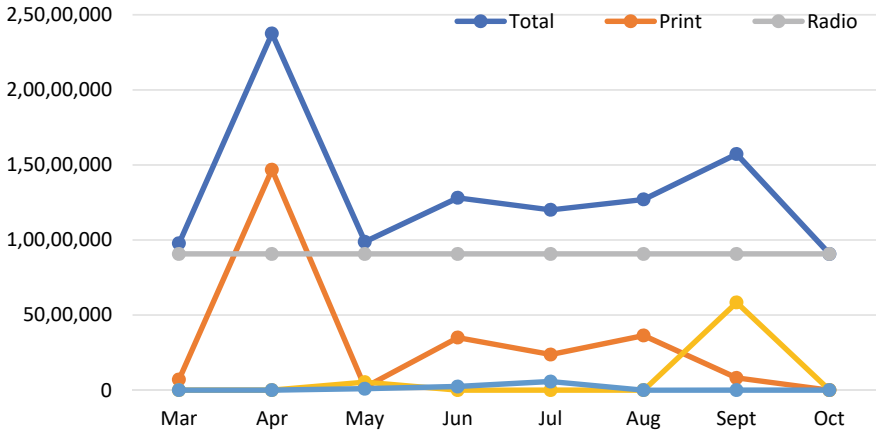

Fig. 4 Estimated mass media reach of COVID 19 messages in Ethiopia, March to October 2020. *Source* Breakthrough ACTION's monthly monitoring system for COVID-19 prevention program March-October, 2020

Posters, banners, and stickers were developed to create awareness for travelers and the public transportation team. A directive to reduce the number of people who travel in each bus was released.

To assess message reach to the audiences and level of recall, Breakthrough ACTION Ethiopia conducted a phone-based assessment of a randomly sampled group of 1,000 individuals. Findings of the assessment were used by the project and partners to identify focus areas for COVID-19 SBC.

Community Engagement

In order to engage various communities and influential groups, Breakthrough ACTION provided technical and financial support for the development of engagement guides for religious leaders, IDIRs (informal community support groups in Ethiopia), volunteers, nursing homes, schools, and industrial parks. The project supported the national and regional RCCE team to organize advocacy and orientation workshops for these different groups.

Local community groups played a significant role in raising public awareness on COVID-19 and promoting preventive behaviors. The project provided orientation to health extension workers (HEWs) and religious leaders focusing on social mobilization for COVID-19. The orientation was given to a total of 424 HEWs and 58 religious leaders (Fig. 5).

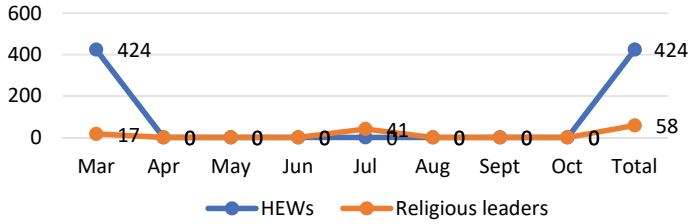

Fig. 5 Orientation training for health extension workers and religious leaders, October 2020. *Source* Breakthrough ACTION's monthly monitoring system for COVID-19 prevention program March-October, 2020

Addressing Uncertainties and Managing Misperceptions

In the early phase of the pandemic, the project messaging focused on raising public awareness of transmission and prevention methods. As the pandemic quickly progressed, misconceptions relating COVID 19 with that of "666 bad spirit" were identified as a barrier for preventive practices. The project designed messages addressing this misconception and focused on identifying and responding to rumors and misconceptions. The project supported the national and regional RCCEs to develop tools to help identify, evaluate, and respond to rumors. This effort included development of a misinformation management guide; establishment of a rumor and misinformation management team at national level; online and community level platforms to collect, analyze, and prioritize rumors and misinformation; and a system to quickly respond to them. All the above critical steps facilitated the creation of timely knowledge on COVID-19 among the public and helped to address misinformation and misconceptions.

In collaboration with the national and regional RCCEs, the project provided risk communication training to 186 regional media professionals. The training covered topics including facts about COVID 19 and the role of media in promoting COVID-19 preventive behaviors (Fig. 6). An information sheet for media outlets and a pocket guide for government spokespersons were also designed and distributed to media professionals to frame their role on risk communication about COVID-19.

Timeline for RCCE Activities and Pivotal Events

The following timeline describes the major steps taken during the first phase of the pandemic in Ethiopia to support the five core competencies of risk communication systems, coordination, public communication, community engagement, and management of misperceptions, along with important external events that changed the direction or nature of the outbreak. As described under previous sections, the strategy initially focused on the transportation sector to prevent the virus from entering

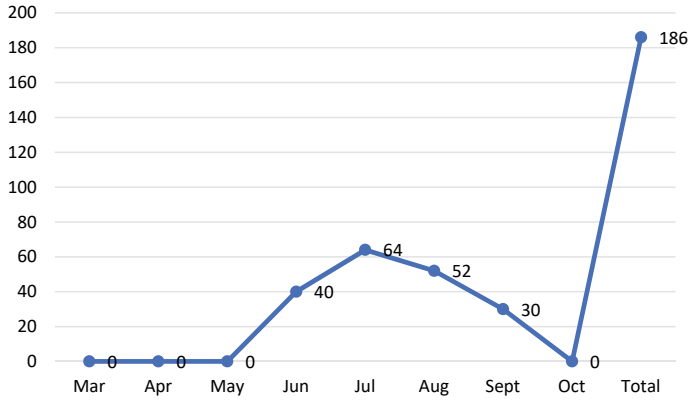

Fig. 6 Training for media professionals, October 2020. *Source* Breakthrough Action's for COVID-19 prevention program March-October, 2020

the country. Once the first case was documented, the strategy quickly shifted to emphasizing prevention.

Factors that Contributed to the Success of the RCCE

High-level political and administrative leadership and commitment to coordinate the COVID-19 pandemic response in the country, capacity strengthening efforts of various stakeholders, and a unified communication campaign were all key factors in the success of the RCCE's efforts in Ethiopia. Strong partnerships with WHO, UNICEF, USAID, and CDC, who were all willing and committed to bring financial and technical resources to Ethiopia; an active EOC; and active engagement of leadership at the highest level, especially the Minister of Health and the EPHI all contributed to an effective and well-coordinated RCCE platform. This heightened level of coordination and collaboration was necessary to implement response activities and interventions.

When the COVID pandemic challenged the world, there was an enormous strain on the existing health systems and structures of many developing countries. Countries needed full-time engagement of the RCCE to manage the situation. Experts from various organizations, who served full-time on the RCCE, played a critical role in multi-stakeholder coordination. Harmonizing messages, daily press releases, branded communication materials development, and active engagement of different stakeholders were made possible with systems strengthening and coordination efforts.

Breakthrough ACTION provided capacity building training to national and local media professionals, regional and zonal RCCE, health promotion focal persons, and hotline counselors. To accelerate the response mechanism at the community level, a

mobile-based training module was developed. This resulted in training of all HEWs in larger regions.

Breakthrough ACTION designed and used a monitoring system to assess the performance of the risk communication activities and used the results for adaptive management. The project provided technical support to regional RCCEs in conducting SS in collaboration with other departments in the regional health bureaus to woredas (districts), primary healthcare units, and health posts at the ground. The SS aimed to enhance performance of the COVID-19 response activities and to mitigate the effect of COVID-19 on routine health services uptake behavior of the community. The SS team provided on-the-spot technical assistance to the visited woredas and health facilities based on identified gaps.

Adoption of COVID-19 Prevention Behaviors and Adverse Mental Health Outcomes in Ethiopia

In this section of the chapter, we present evidence of the adoption of three COVID-19 prevention behaviors in Ethiopia: (a) wearing a face mask, (b) handwashing with soap, and (c) social distancing of two meters. In addition, the evidence on enormous mental distress experienced by almost every segment of the population is presented, as mitigating stress is a crucial aspect for reducing the negative impacts of the COVID-19 pandemic. We opted for a literature review and meta-analysis of COVID-19 behaviors and mental health outcomes to provide more stable estimates of prevalence ratios calculated through pooled estimates.

A systematic search was performed using the PubMed and Google Scholar databases. The peer-reviewed literature search included papers published from March 9, 2020 to April 25, 2022. The search was done using the following search terms: "COVID-19" and "Ethiopia" or "social distancing" or "wearing a mask" or "hand washing" or "mental disorder." The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guided the literature review. We identified a total of 8,674 articles (8,509 from PubMed and 165 from Google Scholar databases, of which 16 studies measured COVID 19 preventive measures and 20 studies measured mental disorders. The analysis consisted of overall and subgroup pooled analysis by regional states and different population segments. The results are presented through forest plots. The diamond in the forest plot indicates the summary measure, the square boxes provide the prevalence ratio, and the size of the box determines how significant the prevalence ratio of a single study is in comparison to the pooled estimate. The horizontal line running through the box is indicative of the 95% confidence interval around the prevalence, with the length of the line representing the width of the confidence interval. The vertical line represents the pooled prevalence estimate. Weights are assigned to each study based on sample size.

Heterogeneity implies the extent to which individual prevalence estimates are different from each other. Heterogeneity across individual studies was assessed by

I-squared statistic with percentage values ranging from 0 to 100%. A value of 0% indicated no observed heterogeneity, and larger values showed increasing heterogeneity. Heterogeneity among the included studies was tested using the chi-square (χ^2) test statistic (Cochran's Q statistic). The P values were obtained by comparing the statistic with a chi-square test distribution with $k - 1$ degrees of freedom where k is the number of studies.

Table 1 presents a list of all the peer-reviewed papers in the literature by the three COVID-19 preventive behaviors and by mental disorders. It also provides the regions where the studies were conducted, the population group that was surveyed, and the sample size for each study. Additionally, the prevalence of the preventive behaviors or mental disorders appears along with 95% confidence intervals.

Table 1 Prevalence of COVID 19 preventive behaviors and mental disorders in Ethiopia

Focus area	Authors (Year)	Regions	Population group	Sample	Prevalence/ proportion	Lower 95% CI	Upper 95% CI
COVID 19 preventive behaviors (facemask, handwashing and social distancing)	Abeya [15]	Oromia	Household heads	2724	83.1	82.4	83.9
	Aemro [16]	Amhara	Healthcare workers	418	71.3	66.81	75.48
	Asemahagn [17]	Amhara	Healthcare workers	398	80	75.75	83.62
	Azene [18]	Amhara	Household heads	623	32.4	28.85	36.21
	Belete [19]	Amhara	Health facility visitors	404	83.7	79.82	87.03
	Defar [20]	Addis Ababa	Employees other than health	6007	60.5	59.22	61.69
	Deressa [21]	Addis Ababa	Employees other than health	1573	96	94.94	96.88
	Desalegn [22]	Addis Ababa	Healthcare workers	1334	91	89.38	92.45
	Feleke [23]	Amhara	Health facility visitors	398	49	44.22	54.03
	Hailemarim [24]	Addis Ababa	Health facility visitors	12,056	77.3	76.54	78.04
	Hassen [25]	Amhara	Employees other than health	413	50.4	45.3	55.2

(continued)

Table 1 (continued)

Focus area	Authors (Year)	Regions	Population group	Sample	Prevalence/ proportion	Lower 95% CI	Upper 95% CI
	Kaso [26]	SNNP	Household heads	364	72.5	67.77	76.93
	Yoseph [27]	SNNP	Household heads	1214	67.1	64.37	69.65
	Zewude [28]	SNNP	Employees other than health	384	35.4	30.75	40.3
	Desalegn [29]	Addis Ababa	Healthcare workers	1259	96.4	95.43	97.35
	Dessu [30]	SNNP	Household heads	634	39.9	36.14	43.76
Mental disorder (Depression, Distress, Anxiety, and Insomnia)	Akalu [31]	Amhara	Community	660	32.01	28.4	35.5
	Asnakew[32]	Amhara	Healthcare workers	419	63.7	59.2	68.3
	Assefa [33]	SNNP	University students	710	38.2	34.65	41.79
	Ayalew [34]	Sidama	Healthcare workers	387	38.5	33.6	43.2
	Gebre [35]	SNNP	Healthcare workers	322	31.4	26.4	36.01
	Habtamu [36]	Addis Ababa	Healthcare workers	238	16	11.3	21.01
	Hagezom [37]	Tigray	Quaranted individuals	371	18.1	14.8	22.9
	Hajure [38]	Oromia	Chronic medical patients	423	55.7	51.03	60.48
	Jemal [39]	Oromia	Healthcare workers	417	58	53.25	62.71
	Necho [40]	Amhara	Disabilities	423	46.2	41.38	50.87
	Simegn [41]	Universities	University students	423	28.6	24.45	33.05
	Tsehay [42]	Amhara	Police officers	385	28.9	24.47	33.51
	Wayessa [43]	Oromia	Healthcare workers	275	21.5	16.9	26.6
	Chekol [44]	SNNP	Healthcare workers	244	51.6	45.37	57.87

(continued)

Table 1 (continued)

Focus area	Authors (Year)	Regions	Population group	Sample	Prevalence/ proportion	Lower 95% CI	Upper 95% CI
	Girma [45]	Oromia	Chronic patients	613	68.4	64.59	71.94
	Yitayih [46]	Oromia	Healthcare workers	249	78.3	72.87	83.1
	Birhanu [47]	Harari	Healthcare workers	418	61	56.26	65.6
	Dagne [48]	HCWs	Healthcare workers	388	26.8	22.57	31.38
	Kibret [49]	Amhara	Healthcare workers	305	63	57.42	68.24
	Tesema [50]	Amhara	Secondary school students	370	38.1	33.26	43.14

COVID-19 Prevention Behaviors in Ethiopia

Face Mask Use

Across 15 quantitative studies, the sample size varied from 384 to 12,056, covering a range of respondents from household members to healthcare workers to non-health-related employees. The overall pooled estimates of face mask use in Ethiopia was 67% (95% CI 60.0–76, Fig. 1). A regional analysis of mask use indicated a wide variation within and between the four major regions of Ethiopia (Fig. 2). The highest face mask use was in Addis Ababa (81%) and Oromia (83.1%) while Southern Nations, Nationalities, and Peoples' Region (SNNPR) (58%) and Amhara (61%) had much lower rates of mask use. The annual trend analysis from 2020 to 2021 indicates that mask use peaked in 2020 followed by a downward trend in 2021. A high level of heterogeneity ($I^2 > 99.64\%$, $p = 0.001$) is evident for all four regions indicating local level variations within the district. These findings are of importance as public communication campaigns should be supported with strong audience segmentation.

The sub-group analysis among different population groups (Fig. 3) indicates that mask use was significantly high among healthcare workers (81%), employees other than healthcare workers (61%), and health facility visitors (70%), followed by household heads and members (64%). Medical students and taxi drivers had lower mask use (50%). And the lowest mask use was in pregnant women (6.6%), prisoners (25.5%), and youth (26.9%). Some of the reasons provided for low mask use were unemployment, livelihood disruptions, and political context. In a study in Dessie city, Amhara, about half the respondents stated they felt discomfort while wearing a mask (Figs. 8, 9 and 10).

Handwashing with Soap

The overall pooled estimates of proper handwashing practice in Ethiopia during the COVID-19 pandemic was 79% (95% CI 73–86, Fig. 4) with highly significant heterogeneity between studies ($I^2 = 99.48\%$, $p = 0.001$). About five studies reported low prevalence of handwashing with soap, from 9 to 45%. One of the barriers to handwashing with soap was lack of availability of water and soap. The pooled estimates of proper handwashing in Addis Ababa (90%) were higher than the handwashing practices in other regional states (Fig. 5). The highest proper handwashing practice is seen in Oromia (84%) followed by Amhara (76%). Handwashing in SNNP was 65%. Handwashing with soap was highest among healthcare workers (91%) followed by health facility visitors (86%). The lowest handwashing practice was reported by pregnant women (9.6%), health facility visitors (30.5%), youth (33.3%), and prisoners (45.5%). Proper handwashing practice was high among healthcare workers (91%) (Figs. 11, 12 and 13).

Social Distancing

The practice of maintaining a distance of two meters between people seemed to be among the most difficult COVID-19 prevention behaviors to adopt in Ethiopia. The overall pooled prevalence estimate of social distancing was 60% (95% CI 39 - 80, Fig. 7) with substantial heterogeneity between studies ($I^2 = 99.91\%$, $p = 0.001$), which was lower than the pooled estimates of mask wearing and handwashing with soap. Social distancing in SNNP was lowest (41%), and the highest was reported in Addis Ababa (73%, Fig. 8). Social distancing was highly practiced among healthcare workers (89%) followed by employees outside the health sector (82%). The pooled estimates of social distancing practice were lower than the national average, among household members (25%), medical and health science students (32.4%), and health facility visitors (35.5%). The practice of social distancing was lowest in prisoners (2.1%, Fig. 8).

Among the 11 studies reviewed, eight presented data collected during the initial phase of the pandemic from April 2020 to November 2020. A study of 6,007 high-risk persons in Addis Ababa in April [20] found that respondents who had used the 8335 free call center were 1.3 times more likely to report knowledge of COVD-19 transmission routes. High levels of protective behaviors practiced by government workers point toward the effectiveness of the RCCE's early communication efforts, with 89.5% reporting proper social distancing and higher percentages reporting mask wearing (95.9%) and handwashing (94.5%) [21]. However, social distancing as a primary prevention practice was practiced less consistently than mask wearing due to the impracticalities of distancing in markets, restaurants, and public transport transit points [24] (Fig. 14, 15 and 16).

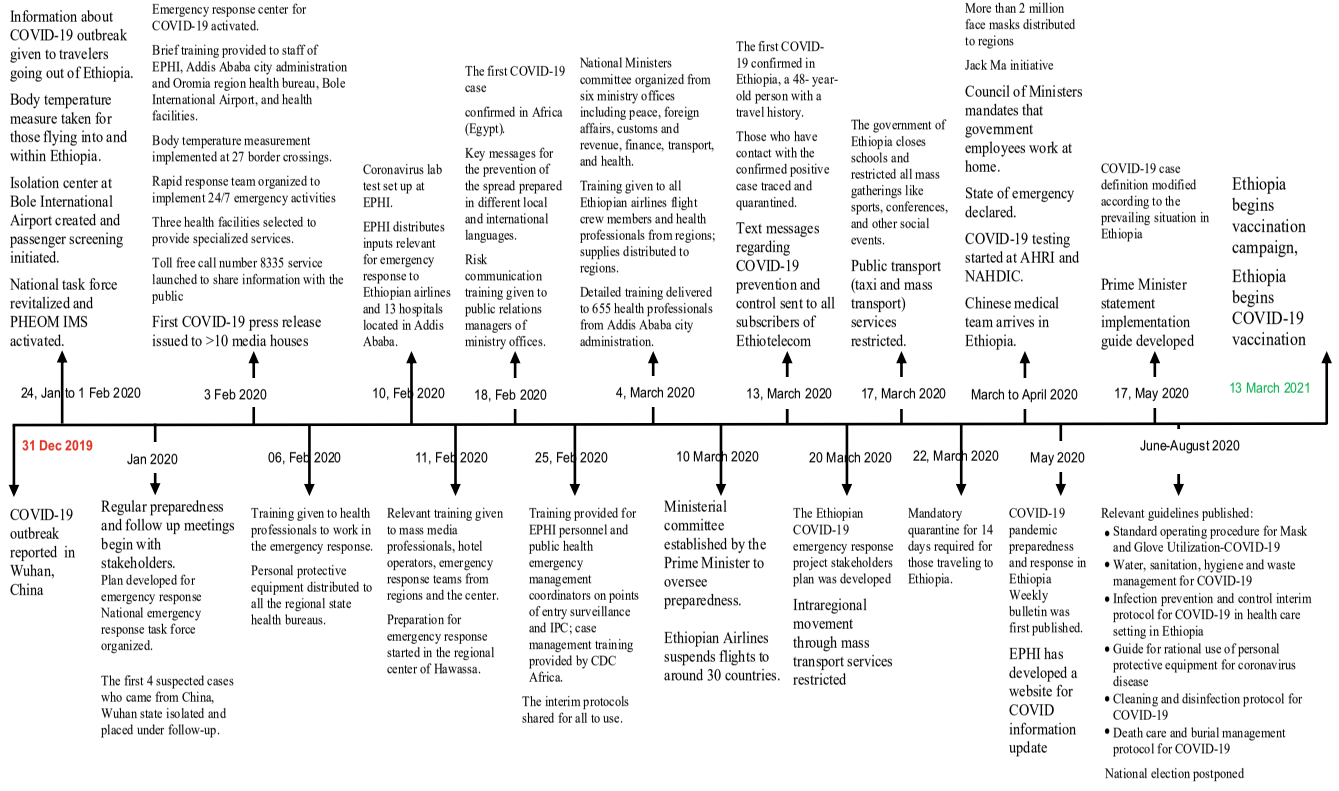

Fig. 7 Ethiopia's preparedness and response to prevent and mitigate COVID-19 pandemic: Event synthesis *Source* BMJ global health, Infectious disease of poverty, and Fana broadcasting corporate S.C. [11–14]

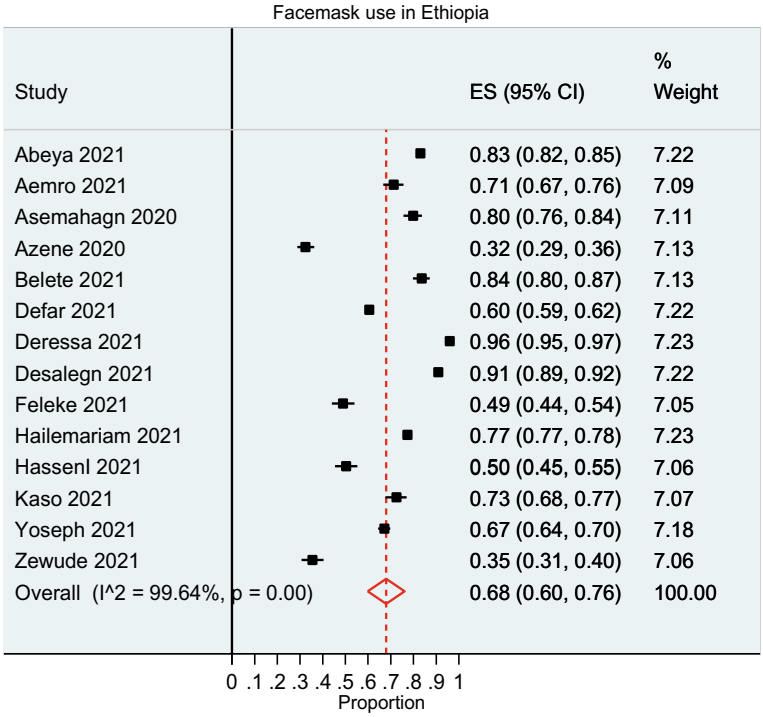

Fig. 8 Individual and pooled prevalence estimates for face mask use in Ethiopia, 2020–2021

The Mental Health Burden During COVID-19

We examined 15 peer-reviewed papers on mental distress in different sub-groups of the population. The data indicated that a parallel mental health pandemic afflicted Ethiopians, even as people are coming to terms with disruptions caused by the pandemic. The need to adequately address mental health in future waves or newer epidemics has become the most critical coping strategy to strengthen peoples' abilities to manage COVID-19 waves and their consequences.

Studies on healthcare workers in different parts of Ethiopia show that the extent and severity of the stress experienced by healthcare workers was significantly higher than in pre-pandemic times [32–35]. Levels of depression in healthcare workers ranged from 21 to 59%, and anxiety was equally high. The studies recommended a continuous assessment of healthcare workers during the pandemic to identify healthcare workers with mental distress. Women healthcare workers were significantly more likely to experience mental distress than male workers according to a study conducted in Oromia and Addis Ababa (N = 816) [51].

The general population has not been spared the anxiety, depression, insomnia, and stress of the COVID-19 pandemic. Mental discomfort experienced due to the

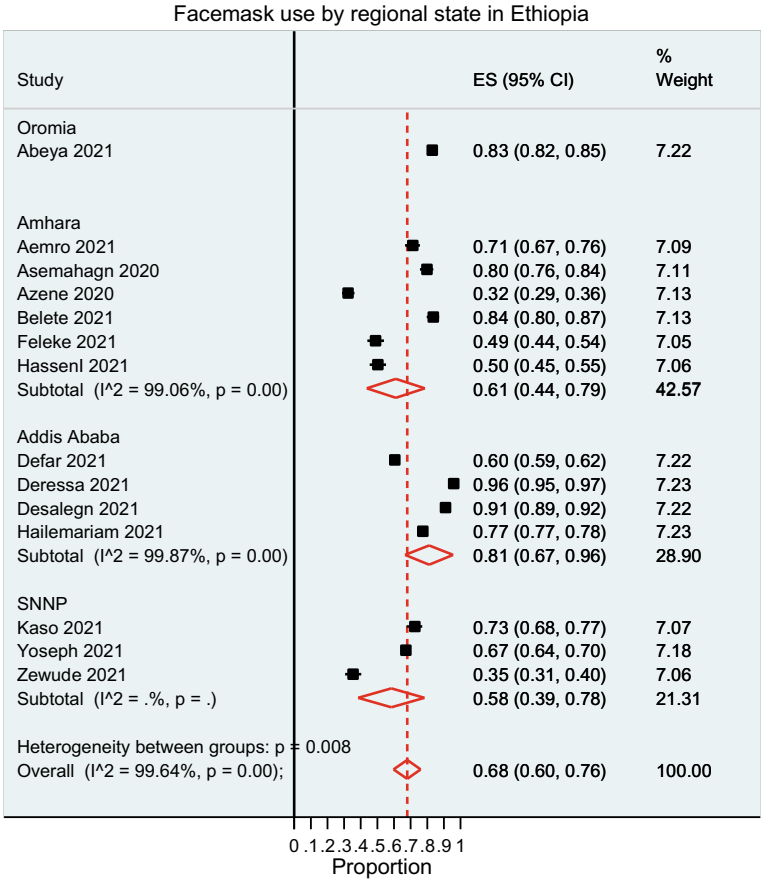

Fig. 9 Individual and pooled prevalence estimates for face mask use by region in Ethiopia, 2020–2021

COVID-19 pandemic impacted people at all levels from loss of livelihood, lockdowns, loss of loved ones to COVID-19, closure of schools and universities, and managing chronic and infectious diseases in the face of severe impacts on the availability of health services. One study on the general population (N = 660) showed that 32% of the respondents had depression symptoms, 25% experienced anxiety, and 14% felt stressed [31]. The Depression, Anxiety, Stress, and Insomnia (DASS 21) scale was used by several studies to measure mental health outcomes. Risk factors associated with mental disorders in the general population included being female, having comorbidities, having a history of medical illness, and smoking.

Patients with chronic illnesses (N = 423) also showed a high level of depression symptoms (55%) and anxiety (61%) which indicated that being female, widowed, or having poor social support were strongly associated with mental disorders [40]. A study conducted in the Tigray region with COVID-19 patients in quarantine (N = 371)

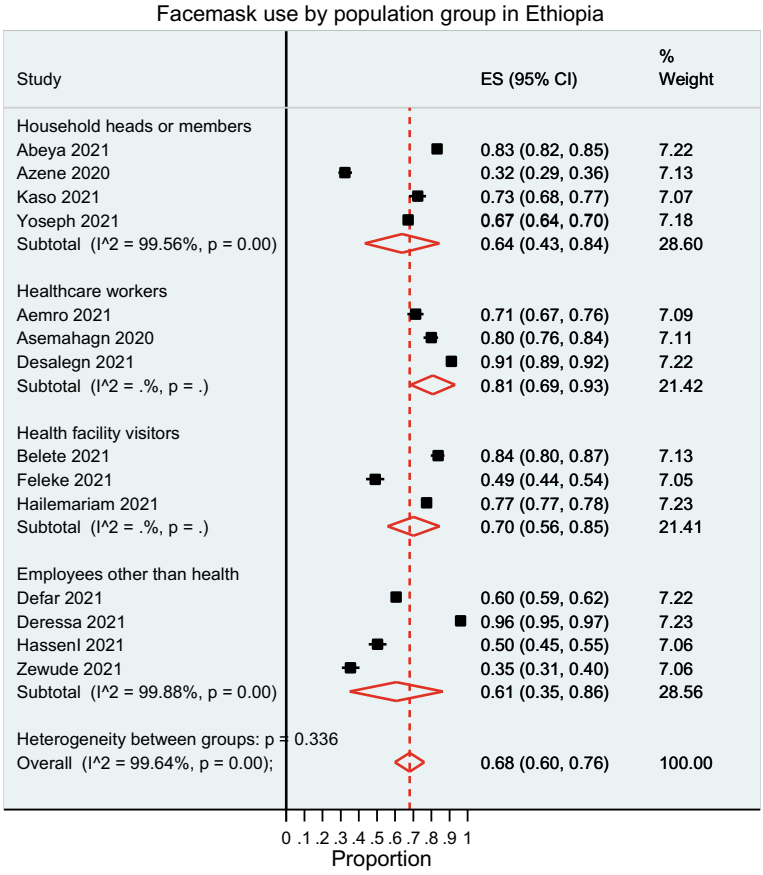

Fig. 10 Individual and pooled prevalence estimates for mask use by population in Ethiopia, 2020–2021

showed that 18% suffered from depression. Those who were female, unemployed, and felt stigmatized were significantly more likely to be depressed [37]. Persons with disabilities also showed very high levels of depression (46%) [40]. Policemen were not spared mental distress during COVID times with 29% reporting symptoms of depression and 30% showing feelings of anxiety (N = 385) according to a study from Dessie town, Amhara [42].

Pooled estimates of prevalence ratios for depression, stress, anxiety, and insomnia are provided below through forest plots (Fig. 17, 18, 19, and 20).

Figure 9 The pooled prevalence estimate of depression was 37% (95% confidence interval, 29–45) with high heterogeneity between studies ($I^2 = 98.16\%$, $p = 0.0001$).

Figure 10 The pooled prevalence estimate of stress was 49% (95% confidence interval, 38–60) with significant heterogeneity between studies ($I^2 = 98.37\%$, $p = 0.0001$).

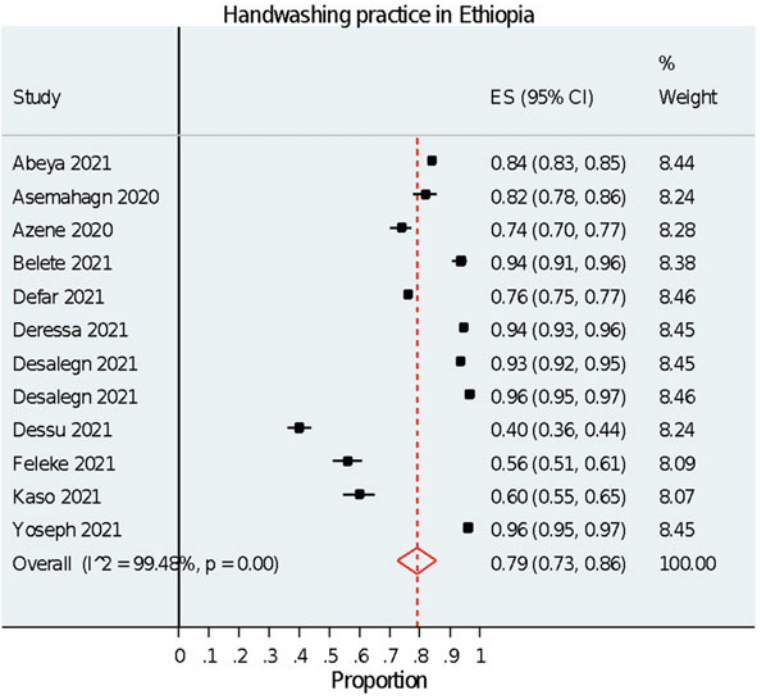

Fig. 11 Individual and pooled prevalence estimates for handwashing with soap in Ethiopia, 2020–2021

Figure 11 The overall pooled estimates of anxiety during COVID were 46% (95% CI 37–55%) with high heterogeneity between studies ($I^2 = 98.6\%$, $p = 0.0001$).

Figure 12 The pooled prevalence estimate of insomnia (sleep disorder) was 38% (95% confidence interval: 15–61) with significant heterogeneity between studies ($I^2 = 99.3\%$, $p = 0.0001$).

Discussion and Guidelines for SBC Preparedness

We focused on immediate emergency SBC preparedness in the first part of the chapter, which began even before the first case of COVID-19 was detected in Ethiopia. We outline complex implementation processes related to coordination and planning that led to a synchronized response of government agencies with many stakeholders. Some of the key factors that ensured the functioning of the risk communication efforts included: (1) the Ethiopian government's early mobilization of resources and establishment of the EOC to serve as a coordination hub; (2) inclusion of all major directorates and international partners in the RCCE, including the government's decision to work with a specialized agency with expertise in strategic communications

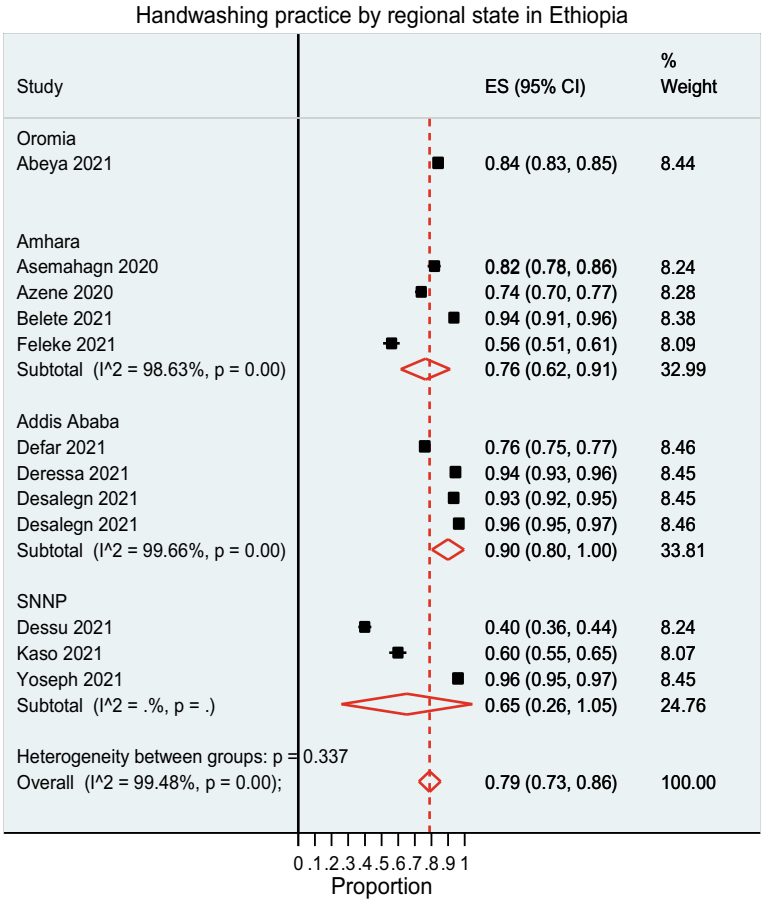

Fig. 12 Individual and pooled prevalence estimates for handwashing with soap by region in Ethiopia, 2020–2021

and public health; (3) application of the WHO/GOARN framework to guide RCCE strategy and activities; and (4) activation of regional EOCs, which further supported harmonization and implementation of RCCE activities throughout the country. SBC preparedness relies on bringing together key partners and establishing clear roles and contributions of each to implementing a consistent and cohesive RCCE strategy [8].

The chapter discusses the processes of establishing a real-time SBC response to a new emergency that threatened lives, economies, and the very fabric of society. The WHO/GOARN framework provided the structure for establishing a quick and responsive SBC program to tackle the early stages of the pandemic. The analysis of mental health needs in the country only serves to underscore the need for an ongoing effective SBC response with both short- and long-term objectives, given the pandemic's devastating impact across all domains of life. The advent of new

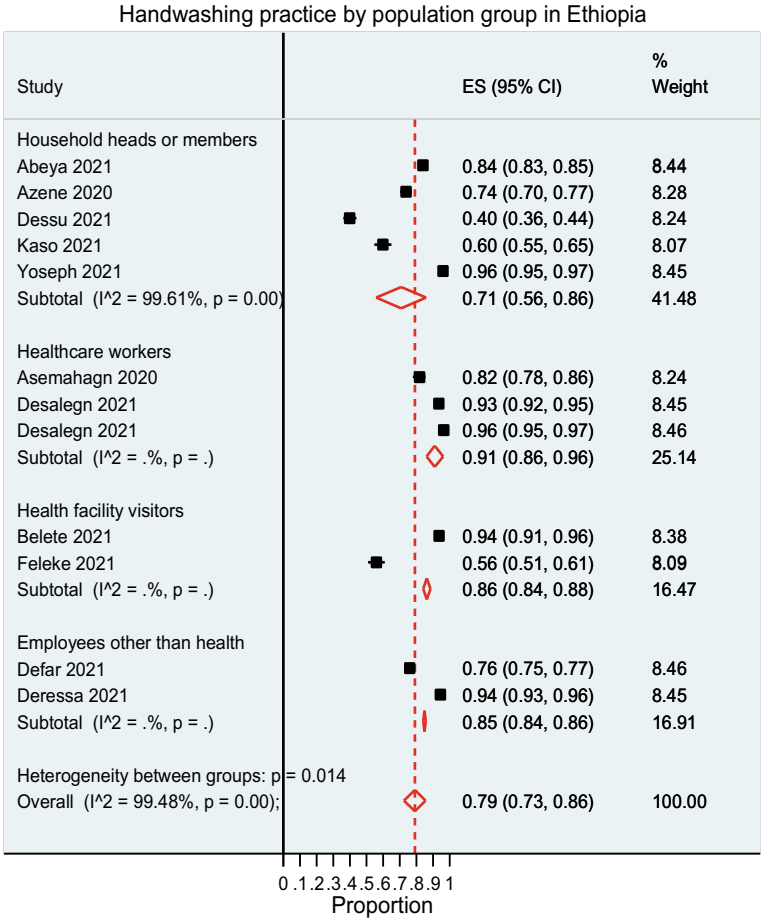

Fig. 13 Individual and pooled prevalence estimates for handwashing with soap by population segments in Ethiopia, 2020–2021

variants complicates the scenario as the virus can mutate to unleash newer and more potent waves of COVID-19. The lessons learned from the detailed description of the early response to the pandemic can be applied to emergency response for emerging infectious diseases beyond COVID-19. Using the implementation narrative of the risk communication program in the early preparedness and response stages, other countries and states can emulate the Ethiopian effort in the face of new waves of COVID-19 or emerging diseases.

Lessons learned from the Ethiopia experience include:

(a) Ensure that the country/state has well established RCCE systems which can assume a leadership role in formulating an SBC preparedness strategy.

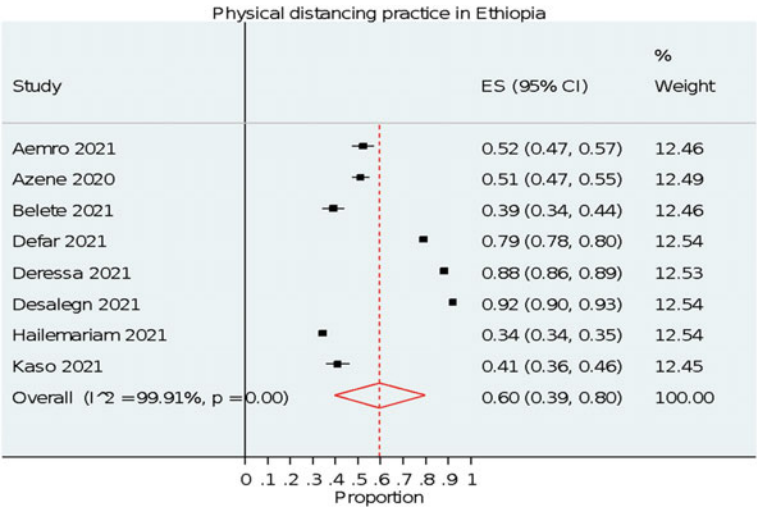

Fig. 14 Individual and pooled prevalence estimates for social distancing by region in Ethiopia, 2020–2021

(b) The WHO/GOARN framework structure should be used in formulating the response.
(c) Select a public communication partner capable of creating persuasively powerful campaigns that provide accurate, focused, and relevant information.
(d) The early days of immediate response should include trusted sources of information that can allay fears of the community.
(e) Establish a system that can activate youth volunteers and community health workers to lead some of the community engagement efforts.
(f) Coordination mechanisms should be set up at the level of the central ministries.

Evidence Related to Mask Use, Handwashing with Soap, and Social Distancing

Our chapter is limited to the role of preventive behaviors and mental health outcomes. It does not address the role of vaccines in the COVID-19 pandemic. There is evidence to indicate that after the early systematic response to the pandemic, the adoption of COVID-19 prevention behaviors remained uneven with several ups and downs between waves. The challenge of consistent adoption of mask use, handwashing with soap, and social distancing is riddled with all the barriers surrounding long-term behavior change, in addition to the enormous stress that the pandemic unleashed on unsuspecting populations. These barriers include difficulty of converting behaviors into habit behaviors, the lack of social norms and social approval around these behaviors, and living conditions within Ethiopia that prevent many people from adhering

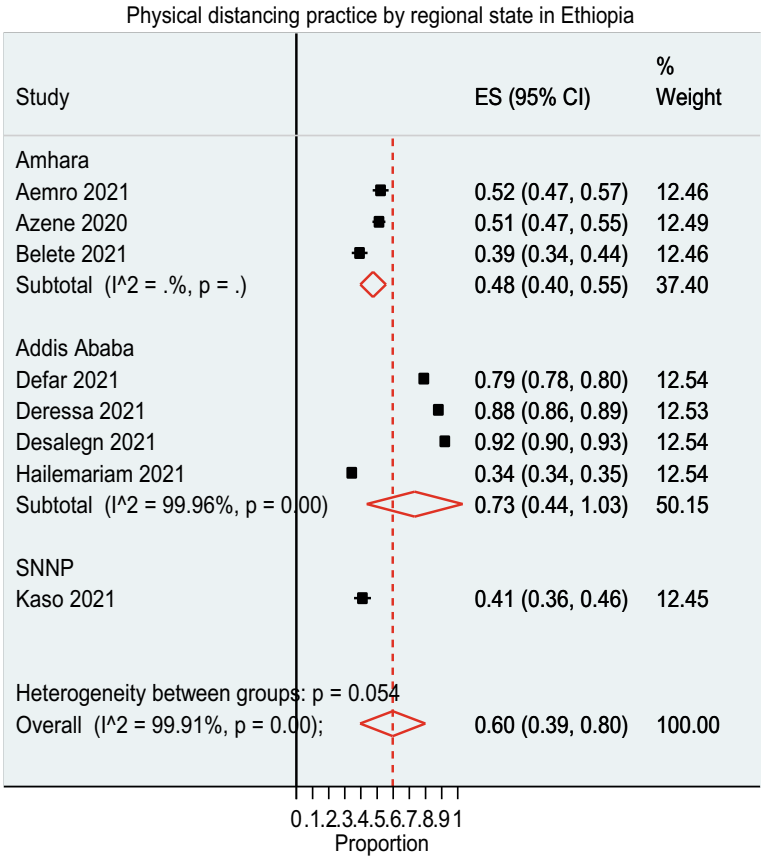

Fig. 15 Individual and pooled prevalence estimates for social distancing by region in Ethiopia, 2020–2021

to social distancing. Therefore, as the COVID-19 behavioral literature review from studies in Ethiopia suggests, adherence to the core prevention strategies needed to break the cycle of COVID-19 infections was at best uneven.

Our behavioral analysis of peer-reviewed literature revealed that people adopt behaviors inconsistently and start and stop at will, irrespective of government guidelines. This gap can be articulated as one where behavior maintenance is not consciously promoted or achieved. COVID-19 messages themselves often give the impression that these are short-term measures. However, with the pandemic entering the third year, it is necessary to develop a cogent long-term behavioral strategy that is acceptable to people.

The approach of SBC preparedness entails the development of a long-term strategic plan for all pillars of risk communication. This plan should be developed such that campaigns address the immediate needs of calming populations as well as promoting planned approaches to behavior change and behavior maintenance. SBC

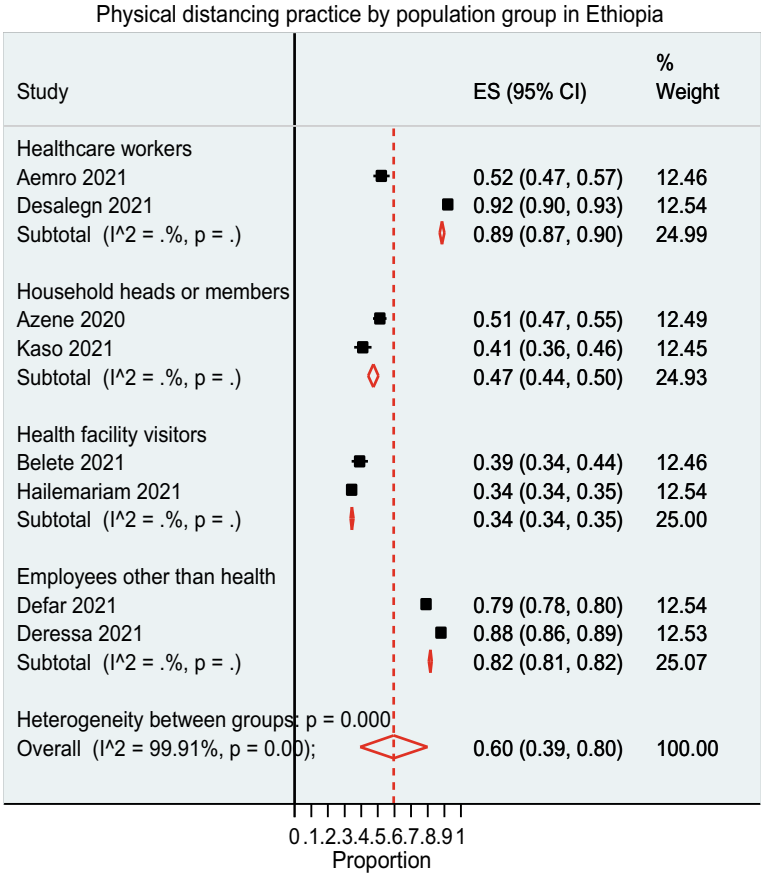

Fig. 16 Individual and pooled prevalence estimates for social distancing by population segments in Ethiopia, 2020–2021

preparedness will require each country/state to have databases of creative agencies, public health experts, and community-based organizations (CBOs) in addition to the available government resources. These agencies, public health experts in health behavior change, and CBOs need to be engaged in collectively developing SBC strategic plans.

Campaigns and community engagement efforts need to be infused with 'shared compassion', increasing people's trust and soothing their fears. By shared compassion, we mean arousing feelings of empathy within both the provider and the receiver. It is an equitable partnership when the receiver can also strengthen the provider. The provider can be a healthcare worker or a CBO or a neighbor and the receiver can be any member of the community. A positive emotional element needs to be promoted which can lead to increasing feelings of wellbeing and reducing mental distress. Community champions have successfully addressed common mental disorders in a

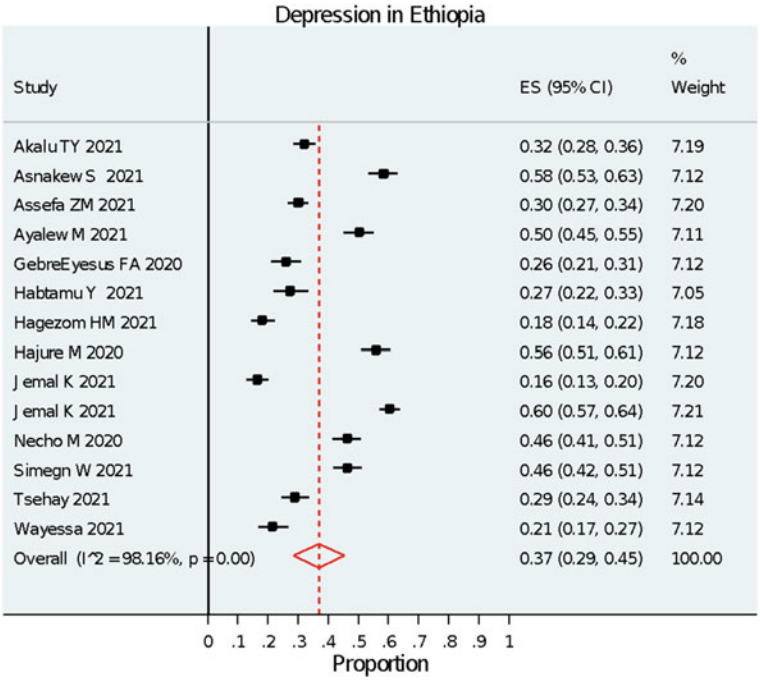

Fig. 17 Individual and pooled prevalence estimates for depression during the COVID-19 pandemic in Ethiopia

rural area of Maharashtra, India [52]. A recent needs assessment by CCP Ethiopia found that young people want to be involved in helping others [53]. A database of adolescent youth groups can also be prepared and tapped.

Going digital is essential to make public communication campaigns and community engagement activities work in real time and to amplify the reach of media campaigns. Simple tools such as the digital relay, which works offline, can be used. The digital relay can reach the last mile of the population and can be triggered to saturate populations with accurate and motivating content [54]. Digital orientation and counseling packages can be prepared for volunteers. In addition, the SBC preparedness strategy needs to include a separate social media preparedness approach. In the past two and a half years of the pandemic, our dependence on electronic media, social media, and virtual communications has increased exponentially. We need to plan a social media strategy that promotes shared compassion, reduces posts which spew hate, and provides a platform where people can seek succor from the pandemic.

Habit-level behavior change takes a long time and if we expect to achieve this sustainable behavior change at a population level, the challenge is even greater [55]. In order to achieve this level of behavior change, we need policy-makers, behavioral science experts, and public communication professionals to work together. Unfortunately, in the crisis of the pandemic, even public communication was handled by

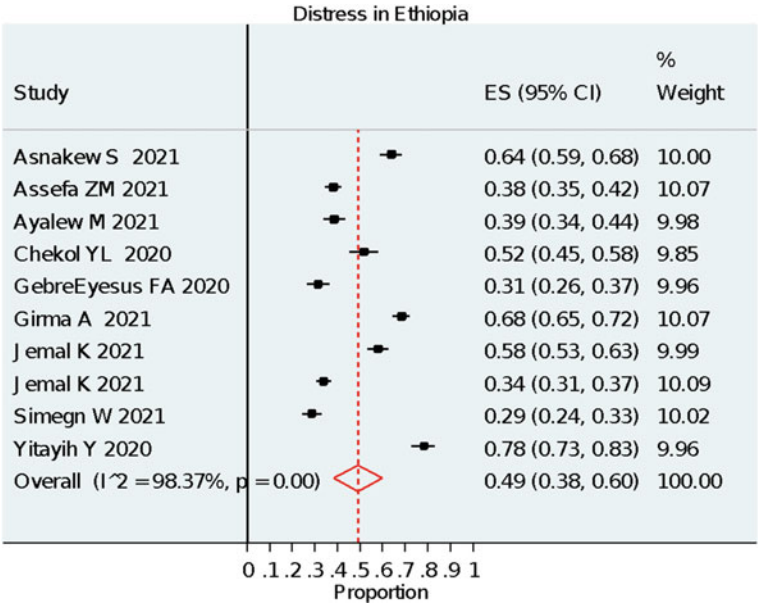

Fig. 18 Individual and pooled prevalence estimates of stress during the COVID-19 pandemic in Ethiopia

medical experts instead of behavioral science professionals. The goal of long-term SBC preparedness is to achieve sustainable change of key COVID-19 preventive behaviors. Behaviors are adopted with a short-term time frame, not as permanent change. The adoption of COVID-19 behaviors ebbs and flows with the pandemic.

As more behavioral data becomes available, looking at deeper audience segments will be essential. For example, pregnant women in Ethiopia reported only 6% mask use. Vulnerable groups need to be defined, identified, and reached since we know that COVID-19 has impacted them adversely. Similarly, campaigns should aim to reach out to people with comorbidities and chronic diseases.

Evidence from the literature review indicates that there was message fatigue during the COVID-19 pandemic. We recommend short- and long-term public communication and community engagement planning to address this issue. Tools like a rapid literature review can identify the barriers to COVID-19 behaviors. For example, discomfort in mask use and lack of social norms around preventive behaviors and other barriers can be incorporated into campaigns to address immediate contextual issues. Creative planning will be necessary to address message fatigue and maintain a campaign environment that builds confidence and trust.

The following are guidelines for SBC preparedness for sustainable behavior change in COVID-19 behaviors:

(a) SBC preparedness includes short-term and long-term behavior change strategic plans.

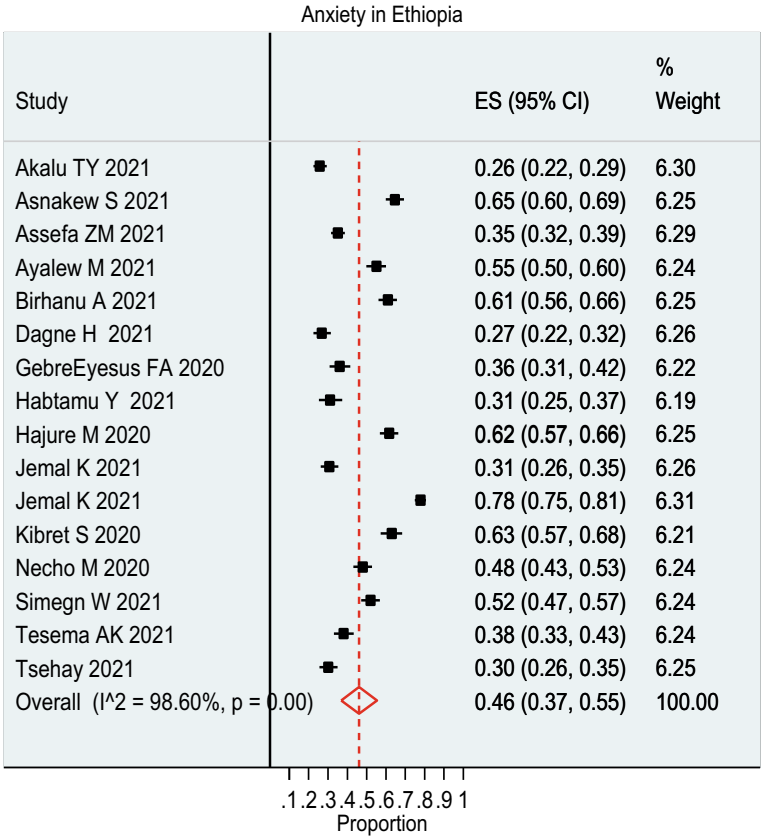

Fig. 19 Individual and pooled prevalence estimates for anxiety during the COVID-19 pandemic in Ethiopia

(b) Information that identifies barriers to COVID-19 prevention behaviors should be gathered from peer-reviewed papers and used in campaigns.
(c) Public communication campaigns should be designed to soothe and calm people rather than scare them with fear related content.
(d) Determinants of behaviors should be mapped prior to campaign design.
(e) Digital approaches that use innovations such as the digital relay need to be prioritized for amplifying program reach.
(f) A separate strategy for social media is required.
(g) Message fatigue needs to be combated with creative, engaging, and innovative campaigns.

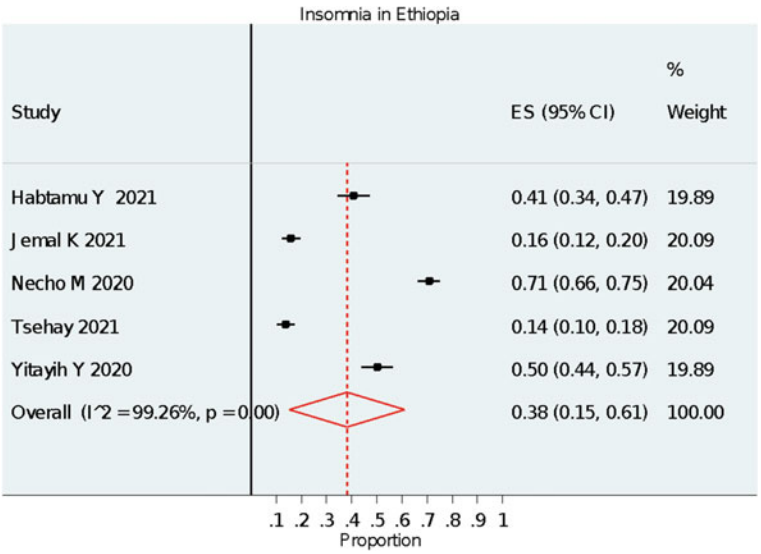

Fig. 20 Individual and pooled prevalence estimates for insomnia during the COVID-19 pandemic in Ethiopia

The Magnitude of the Mental Health Burden in COVID-19 Times

The global mental health burden triggered by the COVID-19 pandemic is staggering [56]. Ethiopia is no exception to the global trend. In this chapter, we discuss the high degree of mental distress experienced by Ethiopians during the COVID-19 pandemic. The Breakthrough Action Ethiopia report on psychological and economic distress showed that almost half (49%) of the respondents reported feeling distressed and about 44% felt nervous [57]. This parallel stress can be mitigated by providing adequate mental health support and services. The biggest challenge for mental health services is the provider gap in most countries [58]. Volunteers and grassroots champions can be trained for mental health support [59]. We suggest that community-based mental support services be integrated into the five pillars of risk communication. Integrating mental health with community engagement activities will result in promoting wellbeing and calmness.

Another learning from the mental health peer-reviewed literature was that almost every segment of the population was negatively impacted by the COVID-19 pandemic. The most affected were healthcare workers who are most susceptible to the COVID-19 infection. Consistent mental health screening of these workers is essential and those detected with symptoms must be referred for care. There is evidence to indicate that women are significantly more likely to have symptoms of depression compared to men. Developing a mental health support plan for different

population segments such as older adults, women, young people, healthcare workers, and prisoners will lead to better COVID-19 prevention outcomes.

The following are guidelines for SBC preparedness for improving mental health during the COVID-19 pandemic:

(a) Community-based mental health support should be integrated into risk communication and SBC preparedness approaches.
(b) Public communication campaigns should encourage people to talk with others in case they are experiencing symptoms of depression or anxiety.
(c) Simple mental health support videos should be developed to train volunteers. Existing resources on community-based mental health support can also be used or adapted to local situations.
(d) Counseling preparedness implies that all COVID-19 counselors and volunteers are trained.
(e) Public communication campaigns should promote calmness within households and communities to cope better with pandemic stress.

In conclusion, the chapter focuses on three crucial elements of SBC preparedness within the realm of risk communication. The first section of the chapter describes how to implement a systematic first response to a new epidemic or outbreak. The WHO/GOARN framework provides a comprehensive structure to operationalize the immediate national-level response for SBC. Ethiopia's first response was well coordinated and planned, and importantly was started before the detection of the first COVID-19 case in the country. The second section of the chapter provides pooled estimates of COVID-19 prevention behaviors in the country which show a pattern of uneven adoption. The need to develop strategic SBC approaches for both behavior change and behavior maintenance is highlighted. Finally, the third section of the chapter deals with the mental health context during the pandemic in Ethiopia. We propose an integration of community-based mental health support with SBC preparedness activities.

The guidelines for practice provided in this chapter are globally applicable, and we hope that Ethiopia's collective experience results in a better understanding of SBC preparedness in the global fight against COVID-19.

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engagement (RCCE) team under the emergency operating centre (EOC); developing the RCCE strategy; training national and regional RCCE experts; and facilitating the design and dissemination of tailored messages. Before this project, he was Deputy Chief of Party for the Health Communication Capacity Collaborative (HC3) project implemented under JHU CCP. Betemariam has a Masters in Public Health from the Gondar University. He is an alumnus of Hubert Humphrey Fellowships, Emory University.

COVID-19 in Mexico: How the Systems Approach Can Improve Our Response

Oscar San Roman Orozco, Kiera Bloch, and Robert Torino

Abstract Using Mexico as a model nation, the authors explore the systems approach for addressing COVID-19. The elements in any system are highly interconnected as they continuously influence each other. Public health challenges do not exist in a vacuum but are influenced by several factors including the social, economic, and political context. To understand any one factor, mapping the surrounding elements and analyzing the relationship between them and other elements in the rest of the system is necessary. Key elements of the impact and the response to the pandemic are examined by applying the systems thinking approach within the Mexican context. A systems analysis of COVID-19 is conducted using a systems map to illustrate the complexity of the system and to understand how to leverage the power of systems thinking to execute intersectoral, innovative, and highly impactful interventions for an improved response to the ongoing COVID-19 pandemic and pandemics in the future.

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Introduction

The COVID-19 pandemic has been classified by leading public health agencies and experts as the most profound global health crisis since the Spanish Flu swept the globe one hundred years ago. At the time of writing,[1] there have been a staggering number of confirmed cases (217,848,001) of the novel coronavirus and 4,521,828 deaths in over 200 countries and territories [1]. In addition to the devastating loss of human life and wellbeing due to COVID-19, there has been a profound impact on all domains of life which has thrown many countries into dire economic recession. It has laid bare existing social problems such as weak healthcare infrastructure, unemployment, and widespread inequality [2]. The social and economic costs of the pandemic are nothing short of devastating, with tens of millions of people projected to fall into extreme poverty. The Brookings Institute estimates that by 2030, 588 million people could live in extreme poverty, an additional 50 million people compared with pre-COVID-19 estimates. The number of people worldwide who are undernourished is expected to increase by over 132 million [3]. As is the case in most humanitarian emergencies, poorer developing nations have taken the hardest hit. Disadvantaged groups, particularly people living in poverty who are marginalized have suffered the most. And Mexico is no exception. SARS-CoV-2 spreads rapidly regardless of geographical borders and politics. It has reached almost every country in the world. This has allowed the pandemic to become a transnational threat of a similar scale as climate change, security threat, mass displacement and migration, and other systemic crises [4]. Just as the virus itself has impacted countries around the globe, due to the increasingly connected world in which we live, the actions of individuals and governments have resulted in consequences that are deeply intertwined within the existing global socioeconomic and environmental systems [5].

Since the beginning of the pandemic, governments have been under immense pressure to effectively and quickly implement mitigation strategies and policies to slow the spread of the virus and protect their populations. While governments first focused on containment and mitigation efforts within their borders by issuing varying degrees of travel restrictions, stay-at-home mandates, and enforcing mask wearing and physical distancing, the situation quickly evolved and spread into other sectors–causing widespread disruption of the economic, social, and political systems [4]. As a result, the pandemic evolved into a global-scale intergovernmental crisis [4]. COVID-19 has been classified as a 'wicked problem' for policy-makers and other stakeholders around the world because it transcends health, environmental, social, and economic boundaries [2, 5]. It presents a highly complex, multifaceted challenge. It is, therefore, important that policy-makers and public health professionals approach it as such.

Above all, the pandemic has made it abundantly clear that linear thinking is not sufficient when trying to tackle a challenge with this level of complexity. Taking into account the human behavioral aspect of COVID-19 mitigation strategies, there is a need for political will and leadership. In light of this, decision-makers are now being

[1] These are the latest numbers as of 01 September, 2021.

forced to think more critically about the causation and consequences because not doing so will have damaging effects on health as well as socioeconomic conditions [6]. Systems thinking has been growing in popularity in the public health space. It now needs to be mainstreamed at every level from individuals to society and from the public to the private sector. Transnational crises such as COVID-19, climate change, and future pandemics require a systems approach.

In the following sections, we will define and explain the systems approach and advocate for its use in place of more traditional approaches that are widely used such as theories of change and logic models.

What is Systems Thinking?

Before diving into the details of systems thinking, it is important to first define what exactly is a system. One of the most prominent scholars in the field of systems thinking, Donella Meadows, defines a system as "a set of things—people, cells, molecules—interconnected in such a way that they produce their own pattern of behavior over time" [7]. In other words, a system is a group of interacting, interrelated, and interdependent components that form a complex and unified whole. When thinking about a system, it is important to keep in mind that it tends to be nested within other systems. For example, families are part of communities that are located in towns and cities, which are, in turn, located in countries.

Systems thinking, or a systems approach, is not a methodology but rather a way of thinking and focusing on relationships. It is a way of looking at a problem in which there are many different interconnected parts—all of which form a complex whole. Many real-world problems have multiple parts that come together, interact, and influence each other in various ways. A systems approach is used when you have these types of complex, non-linear problems because it can address the many areas that are involved with these cyclical issues.

In a systems approach, we try to capture the many variables that influence a problem. This is particularly helpful in public health as there are many factors that play a role in how we deal with disease, in outbreak scenarios, and on a day-to-day basis. These variables may be related to environmental, economic, social, political, and other factors all of which impact the public health problem. For example, while COVID-19 mitigation strategies such as mask wearing, hand washing, and stay-at-home orders might seem relatively straightforward, policy-makers and public health professionals need to take into account the availability of masks, access to clean water, rampant misinformation and mistrust, and the potential lack of political will to implement and support these strategies. A key element of the systems approach is the incorporation of potential unintended consequences of policy decisions, programs, and interventions. It is also important to note that a systems approach can be applied to any public health challenge, including, but not limited to, vaccination campaigns, infectious diseases, and non-communicable diseases.

Systems are inherently incredibly complex. And it can be difficult to understand all the ways in which the factors are connected to each other. It is, therefore, helpful to create a visual representation to see all the interconnected components that are related immediately and peripherally to the root problem. Systems thinking scholars present a set of options for how to visualize a system, such as the iceberg model, connected circles, and causal loop diagrams [8]. While each of these models is different, there are a few key elements that are similar in each of them: the public health challenge (e.g., the root problem), the many factors within the system that influence the root problem, the relationships between the factors, and how the system changes in a dynamic way [7]. For the purposes of this chapter, we will refer to the visual model of a system as a 'systems map' which borrows components from the models listed above.

Overall, a systems approach is a way of thinking when approaching problems and designing solutions. This approach to problem-solving embraces the nature of complex systems as dynamic, constantly changing, and governed by history and feedback. The influence and involvement of stakeholders and the context in which systems exist are critical [9].

Linear Models of Thinking

While systems thinking has been gaining traction in recent years, policy-makers and prominent public health organizations, such as the U.S. Centers for Disease Control (CDC) and United Nations Children's Fund (UNICEF), as well as ministries of health and local departments of health, still use traditional, linear frameworks when designing and evaluating programs and policies. Logic models, or 'log-frames' are tools used most often by the public health and development sectors to plan, describe, manage, communicate, and evaluate a particular program or intervention [10]. As can be seen in Fig. 1, they visually represent the relationships between a strategy's activities and its intended effects and include the assumptions that drive the expectation that the program or intervention will be successful [10]. However, there are no clear relationships drawn between the elements and important factors such as misinformation, fear, and political will which are not taken into account. Logic models are based on linear relationships between program resources, activities, and outcomes (often broken down into short-, medium-, and long-term). Logic models are primarily used as tools for monitoring and evaluation through the development of measurable indicators that quantify the success of a particular program. While it is undoubtedly a valuable tool, there are two major shortcomings of the logic model. The depiction of the program in a linear way and the failure to embed the program within a specific context in which it is being implemented. By over-simplifying the program, logic models can create unrealistic expectations about what the program can change, especially when addressing a challenge as complex as COVID-19 [11]. That being said, the aim is not to criticize the logic model for something it was never intended to do, but to instead advocate that it is not sufficient for the current crisis.

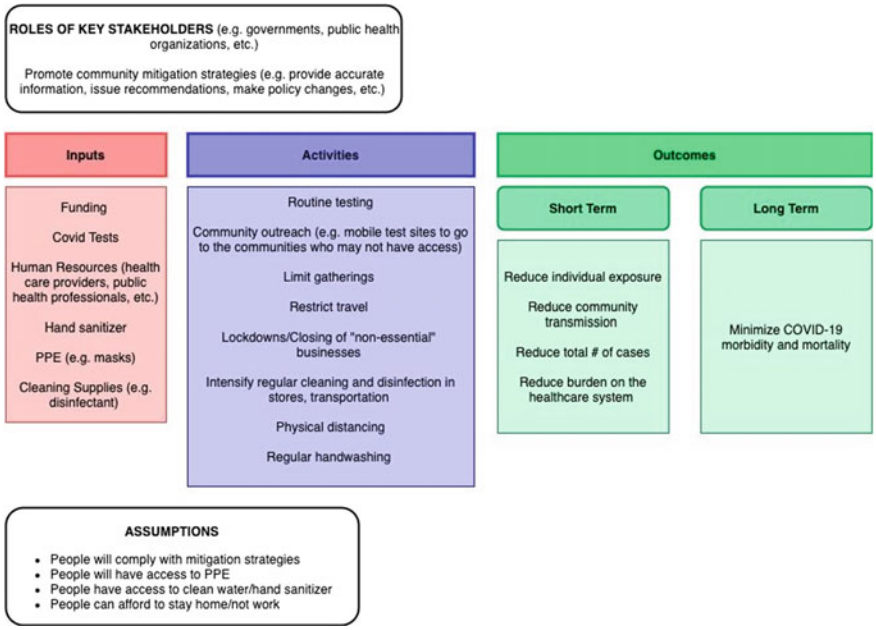

Fig. 1 Simplified logic model for COVID-19 mitigation strategies. *Source* Created by the authors

Another popular model that is widely used in the public health space is the Theory of Change (ToC). There are several different definitions of the ToC. For example, Breur et al. define it as "an approach which describes how a program brings about specific long-term outcomes through a logical sequence of intermediate outcomes", while Isabel Vogel takes it a step further and defines it as "an outcomes-based approach which applies critical thinking to the design, implementation, and evaluation of initiatives and programs intended to support change in their context" [10, 13]. While the terms 'logic models' and 'Theories of Change' are often used interchangeably and their visual depictions tend to be quite similar, there are notable differences. Existing literature notes that ToCs were developed as an extension of tools such as Logic Models or 'log-frames' in an effort to allow for a more detailed explanation of the context, underlying assumptions, and pathways of change that the linearity and rigidity of log-frames do not permit [14]. Additionally, the ToC tends to map out larger goals rather than granular programs, and because of this, it may incorporate simultaneous, complementary strategies to ultimately reach the overarching goal. As Fig. 2 shows, ToC often looks more or less like a logic model but it builds on the traditional log-frame to begin to explore, not only what is expected to happen, but also why it will happen by more explicitly highlighting the pathways between the elements. In this way, a ToC attempts to establish the underlying causes of change and works to understand the context in which a program operates. While sometimes this is represented visually, it is often included in a narrative that accompanies the model. The narrative explains in more detail the factors that exist outside the

program such as social, political, and environmental conditions that may impact the result of a program or intervention, and taken together, the Theory of Change and the supplementary narrative are perceived as 'living documents' that can be changed when there is new information and as unintended consequences arise [12].

While theories of change certainly take a more meaningful step in the desired direction compared to logic models, showing the relationships between activities and outcomes and taking into account the context and unintended consequences, they still do not capture the complexity of particular public health challenges and how they are embedded within the larger systems at play. There is a robust literature on how to develop a ToC with respect to interventions on a theoretical basis. However, there is little evidence in terms of its application to complex public health challenges [15].

Why Systems Thinking?

While using a logic model or theory of change can certainly be useful in certain scenarios, there are several public health challenges in this case COVID-19 that demand a more holistic approach that considers its complexity. The World Health Organization (WHO) recently published a report strongly advocating for the use of a systems thinking approach when developing plans for tackling complex social and health issues, which means moving beyond traditional linear approaches. As previously noted, the impact of COVID-19 goes well beyond physical health and extends to mental health, economics, education, food security, environment, and politics. Pandemics are non-linear phenomena wherein one small perturbation in the system may trigger disproportionate, exponential systemic reactions [16]. Taking all of these factors into consideration helps policy-makers and public health experts select the 'right' intervention as well as any additional interventions needed to reduce negative consequences [2]. For example, issuing stay-at-home orders has been a very common intervention. But it has massive economic implications for businesses and individuals. In order to mitigate this, other strategies such as a stimulus package and providing meals to those who may not have access to food are necessary. That being said, our mental expectations naturally follow a linear pattern, and longer-term changes or other changes to the system are often disregarded. Systems thinking is by its nature uncomfortable. It requires a rewiring of the brain to begin to see challenges that exist within complex systems. However, it is imperative that we adjust our approach before threats to public health such as future pandemics, climate change, and mass migration among others before they become more frequent. Traditional ways of thinking are simply insufficient. Rather than a linear model, creating a visual representation of a system using causal loop diagrams better captures a multi-dimensional, layered program model, while also providing a more complete understanding of the relationships among program elements, which, in turn, enables evaluators to examine influences and dependencies between and within program components [17].

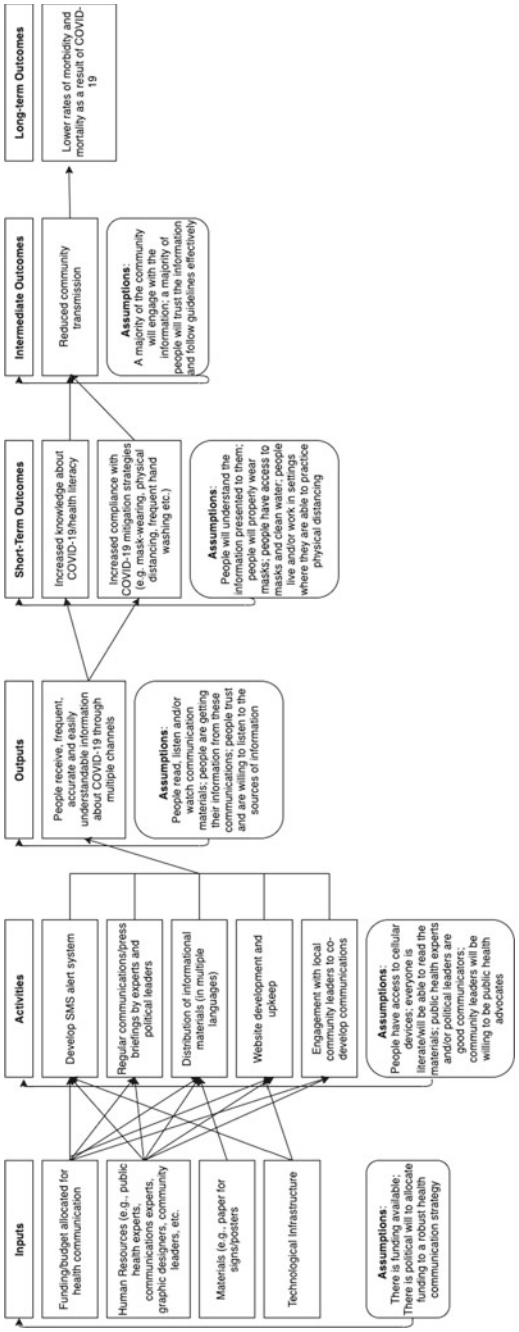

Fig. 2 Simplified theory of change for a health communication strategy to slow the spread of COVID-19. *Source* Created by the authors

In the subsequent sections, we will use Mexico as a case study and analyze how the country has addressed the pandemic and how the response may have been different or could have been improved by utilizing a systems approach.

Mexico's General Perspective

The United Mexican States consists of 32 states with approximately 124 million inhabitants, making it the 11th most populous country in the world. It is a young country with nearly 27% of its population under the age of 15. Most recent data from the OECD (Organization for Economic Co-operation and Development) shows Mexico's GDP (gross domestic product) per capita in the lowest section for this group of countries—19,127 USD. It has the highest level of income inequality among 36 countries that form the OECD. Also, within this organization, in 2017, Mexico was at the lower level regarding life expectancy—around 75 years—compared to other countries, perhaps due to it being in the lowest group on health spending. In 2016, approximately 58% of the rural residents were facing poverty. Two years later in 2018, almost 18 million people did not have any insurance coverage. Its unemployment rate is about 4.4%. Mexico scored 0.78 in the Human Development Index in 2019 compared to the US (0.928) and India (0.645), placing it in the high development section. Its expenditure on education was 4.52% in 2017 with an increased tendency. The statistics from 2018 showed that the adult literacy rate was 95.38%. Fifty-six percent of the households in Mexico have access to the internet with an annual increase of 9.58% and mobile cell phone subscriptions are 95.7% per 100 inhabitants [18].

The main causes of death in the country are diabetes and ischemic heart disease both with a common factor—obesity; ranking worldwide as the second-highest and the highest country for overweight and obesity in the overall population and in children, respectively [18]. Its share of the GDP was 1.172 billion USD in 2015. The total healthcare expenditure was 5.7%. The Mexican health system is formed by three different schemes; employment-based or social security, public institutions for the uninsured, and the private sector. This structure of the health system provides the users with a wide range of services but pushes them to be enrolled in diverse healthcare institutions. The main providers of health services are the ministries of health at different levels (state and federal). Private insurance just covers 8% of the general population. There are a total of 4,341 hospitals in the country, of which 30% are public and concentrated in urban areas, while just 3.3% are located in rural settings. Mexico has a rate of 1.9 physicians per 1,000 inhabitants and 2.8 nurses per 1,000; a lower number of physicians compared to the average of the OECD countries which is 3.3 per 1,000 [18].

COVID-19 in Mexico

The first case of COVID-19 in Mexico was diagnosed by the National Institute of Respiratory Diseases in late February 2020. This was announced at the morning conference of President López Obrador on the 28th of that month. According to the data reported to WHO, from January 3, 2020 to August 31, 2021, there were 2587.16 confirmed cases of COVID-19 per 100,000 population and 200.23 deaths per 100,000 population (Fig. 3).

Initially, the Federal Government was confident that the pandemic would not advance much. Within the following month, an aggressive information campaign and a call for 'social distancing' was initiated. The initial approach by the Federal Government was based on the sentinel model recommended by the Pan American Health Organization (PAHO). A daily press conference was held by the Vice Minister for Prevention and Health Promotion and a social distance communication campaign was implemented.

As previously mentioned, the testing system was hampered by two factors. First, testing was not widespread due to deficient infrastructure, thus only the most seriously ill could be tested. Second, this problem was compounded by very low political will with the Vice Minister describing massive testing as a 'waste of time, effort, and money' [19]. The number of tests carried out to confirm COVID-19 infection was among the lowest in the world—69.29 tests per 1,000 as of August 21, 2021 (Table 1) [20]. This testing strategy contributed to Mexico being officially reported as one of the deadliest countries for COVID-19. However, hospital capacity was reinforced by strengthening the infrastructure and expanding access to health

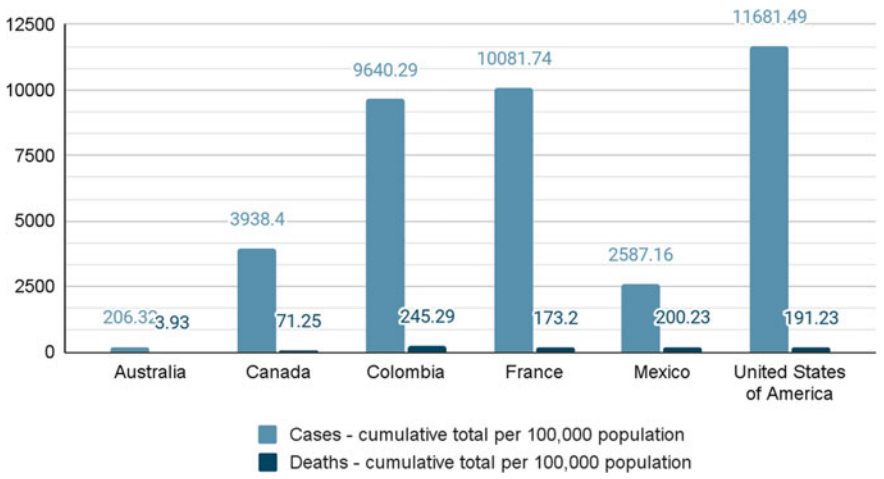

Fig. 3 Cases and deaths per 100,000 population as of August 31, 2021, in some OECD countries. *Source* Data from WHO, 2021

Table 1 Total tests performed relative to the size of population as of August 30, 2021

Country	Total tests per 1,000
Australia	1,215.70
Canada	1,063.26
Colombia	469.45
Ecuador	92.94
Mexico	70.91
United States of America	1,571.43
United Arab Emirates	7,484.31

Source A cross-country database of COVID-19 testing (2020)

services. Public hospitals added temporary beds, adapted hospitals to 'only COVID-19 hospitals', and hired additional personnel. Around 6,500 physicians and 12,600 nurses were hired on a temporary basis. The ramping up of hospital capacity resulted in almost a quadruplication of intensive care beds from 2,446 to 11,634 [21].

An underfunded health system and the relatively high level of informal labor—which affected about 60% of the population—made it particularly vulnerable to the spread of the virus due to the inability to stay home and lack of financial resources to stop working among other issues [22]. Furthermore, the pandemic also occurred at a time when there were shortages of supplies and human resources in the health system mainly due to budget cuts.

An analysis of the vaccination strategy shows that the approach was correct. It focused on mortality distribution by age group, comorbidities, and geographical distribution of the burden of mortality—the number of deaths in a municipality over the total number of deaths. Mexico's, 2,457 municipalities are divided into tertiles in which the accumulation of deaths was the changing factor. This strategy was designed by a Technical Advising Group (TAG) for COVID-19 which recommended vaccinating health personnel first followed by the population according to the risk of death due to comorbidities and in those who live in poor regions with high population density. This was consistent with the official recommendation of the WHO. There is evidence to suggest that the strategy that first protected the most susceptible and then reactivated the economy. It is most successful in the medium term [23]. Data shows that with eight vaccines approved for emergency use by the Federal Health Commission for Protection (COFEPRIS), as of August 30, 2021, around 44% of Mexico's population had received at least one dose, and 25% were fully vaccinated (Table 2) [24].

Table 2 Share of the population that has been partly or fully vaccinated against COVID-19 as of August 30, 2021

Country	Share of people fully vaccinated against COVID-19 (%)	Share of people only partly vaccinated against COVID-19
Australia	27.32	19.80
Canada	66.62	6.66
Colombia	28.56	16.70
Ecuador	45.89	9.94
Mexico	25.81	18.37
United States of America	51.69	9.28
United Arab Emirates	74.24	10.69
World	27	13

Source A global database of COVID-19 vaccination (2021)

Applying the Systems Approach to the Mexican Context

The complexity of the COVID-19 pandemic can be overwhelming, especially when attempting to implement interventions to control the impact of the virus in the community. In Mexico, the number of competing factors to consider places the policy-maker and the program implementer in a difficult position. By utilizing the systems thinking approach, the individual can better visualize this complexity and the factors in and around a potential intervention, revealing additional impacts and unintended consequences that may result from the implementation of the intervention in the real world.

To illustrate this process, a systems map using knowledge from the previous section has been created (Fig. 4). The process by which the map was created and the way to most effectively utilize it for public health purposes will be discussed in the following section.

Building the Systems Map

As previously stated, the systems approach serves the purpose of capturing and visualizing the factors surrounding an issue by mapping their potential influence. There is no standard process for creating a systems map. Whatever is easiest for the creator to understand and provides the clearest interpretation by others should be used. In the case of the map in Fig. 4, four areas surrounding the prevalence of COVID-19 in Mexico were explored: political, educational, health, and economic. These four dimensions motivated the inclusion of the factors shown in the map that influence the central factor, COVID-19 prevalence in Mexico.

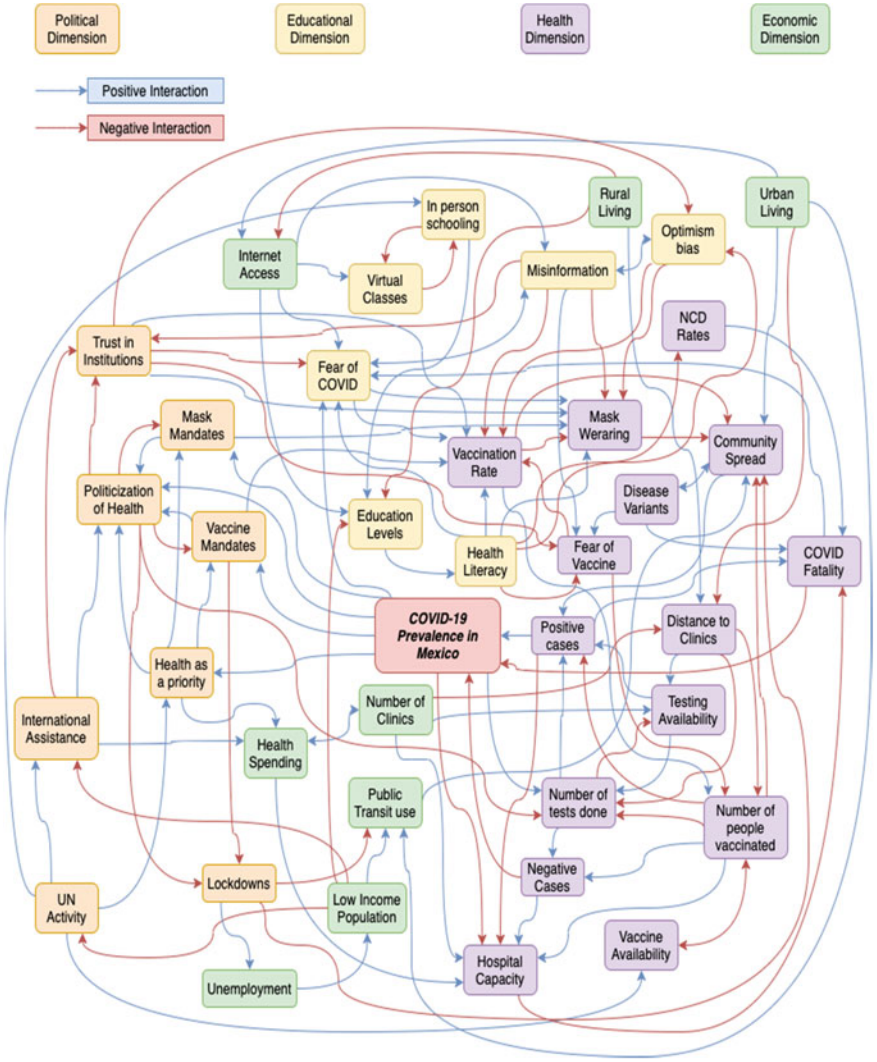

Fig. 4 A basic systems map analyzing the system surrounding the prevalence of COVID-19 in Mexico. *Note* Key themes including political, educational, health, and economic are color coded. Interactions between factors are also colo coded; with red meaning a negative interaction and blue meaning a positive interaction

This map was created by simply adding any known factors that would affect the central bubble and placing them around it in rough quadrants corresponding with their closest related dimension. It would be an immeasurable task to add an exhaustive list of factors to any systems map. The intention is not to provide a perfect tool to begin with but to provide a more accurate estimate of real-world scenarios than provided by the traditional theory of change or logic model. For this reason, it is unnecessary

to fixate on adding every possible factor. It is better to add the known factors that quickly come to mind from situational knowledge and readily available research. The map in this chapter was created using the experience of the authors of the Mexican COVID-19 response as well as additional research needed to set the context.

After the major factors were arranged around the center, more linear causal chains were added. For example, 'number of tests done' was one of the original factors in the map. However, to complete the chain, the outcomes of testing and positive cases and negative cases were added as well as the preceding factors like the availability of tests and distance to clinics. Using this logic, the remaining factors were added to the map until the relevant linear causal chains seemed complete.

The final step in the creation of this map was to code all of the relationships between factors as either 'positive' or 'negative' interactions and deliberately seek any influences between the non-linear factors. The concept of 'positive' and 'negative' reactions can be a bit confusing but they are critical to systems thinking and the use of the map as a tool for the design of programs and policies. The systems map is dynamic. At any point, all the interactions are happening at the same time. The 'positive' or 'negative' nature of one can cause a cascade of effects throughout the system. In essence, a positive reaction would be one in which both factors have the same reaction to a change in the system. As one increases the other increases. Or the opposite, as one decreases so does the other. A 'negative' interaction is often described as inverse or opposite. As one factor increases, the other decreases or as one decreases, the other increases. Every factor in the map has one of these interactions with multiple other factors. Mapping them and labeling them allow the map to better represent the dynamic nature of real-world scenarios.

As interactions are mapped, it is likely that other factors or interactions that were not previously considered come to mind. This is also common when one is deliberately looking for interactions with unrelated factors. These factors should be added to the map and their interactions fully explored as well. When the addition of factors and interactions on the map begins to feel repetitive, the map is deemed to be complete.

Important Elements of the Systems Map

Feedback Loops

The non-linearity of systems thinking and systems maps means that there are multiple-feedback loops throughout any map. Feedback loops are circular chains of events where the chain of interactions returns to the original point of disturbance in the system. In the context of Mexico, there is one example that is quite straightforward and clear. In the map (Fig. 4), the center bubble 'prevalence of COVID-19 in Mexico' has a positive reaction to 'fear of COVID'. As the prevalence increases so does general fear of the virus. The increase in fear leads to an increase in protective

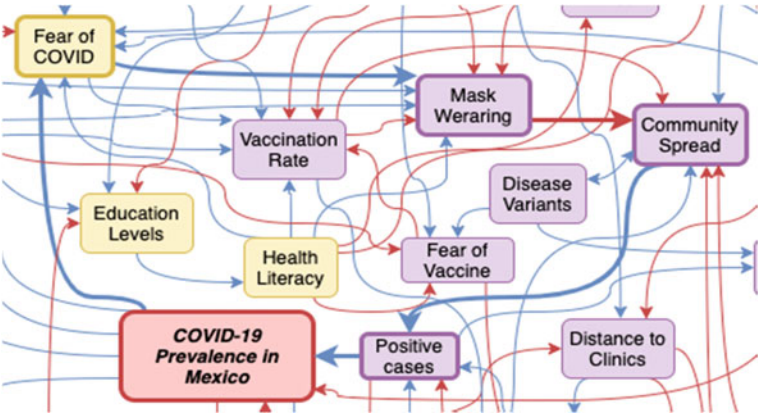

Fig. 5 A closer look at the feedback loop being referenced from Fig. 4. *Note* Factors in the loop have bold borders and interactions within the look are shown via bold arrows

behaviors, in this case, 'mask wearing'. More 'mask wearing' leads to less 'community spread' in turn leads to less 'positive cases' and finally leads to less 'prevalence of COVID-19 in Mexico', the original factor that started the interactions in the loop (Fig. 5).

Feedback loops are all over the map. Consider the following loop that takes a slightly different path through the map with the same start and end point of 'prevalence of COVID-19 in Mexico'. Increased prevalence increases fear just like in the last loop. However, increased fear also leads to more 'misinformation'. The increase in 'misinformation' leads to a decrease in 'mask wearing' and a subsequent increase in 'community spread'. Increased 'community spread' drives up 'positive cases' which in turn drives up the 'prevalence of COVID-19 in Mexico'. These are two feedback loops with the same start and end point but with opposite effects on our outcome of interest (Fig. 6).

Feedback loops exist in all systems. Understanding where they exist and how they overlap gives the public health practitioner and policy-maker a much better sense of how their intervention will change, not just the linear interactions between factors, but also the circular feedback of the system and the factors surrounding that intervention.

Leverage Points

For any looking to employ systems thinking, recognizing leverage points is a critical skill. A leverage point is a location within the system, often a single factor, that has a large impact on multiple other factors. Leverage points are recognized through the number of interactions they have in the systems map. The more interactions, the more influential a change in that factor will be on the entire system.

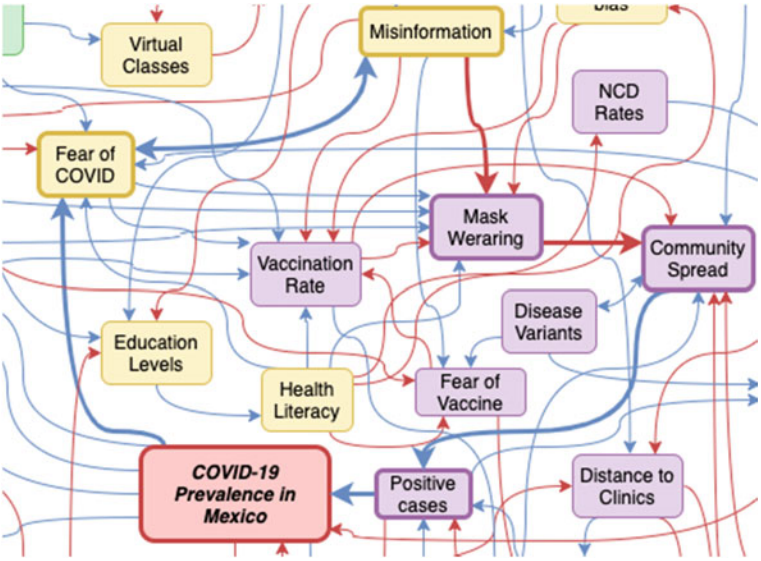

Fig. 6 A closer look at the feedback loop being referenced from Fig. 4. *Note* Factors in the loop have bold borders and interactions are shown via bold arrows

Using the Mexico systems map, one of the recognizable leverage points is 'misinformation'. This factor influences six separate factors on the map across multiple sectors. If one were to investigate a way to influence the system, the 'misinformation' factor would be the place that would have a big impact with a small change. This is the critical importance of identifying the leverage point. It is the place where the largest impact can be made in the system with the smallest input. There can be multiple leverage points in any system and affecting any of them can make large changes, but recognizing them and the downstream effects they will have on the system is critical for any systems analysis.

Unintended Consequences

One of the distinguishing factors of systems analysis as opposed to logic models and theories of change is the ability to show potential unintended consequences of an action. While the factors from other models can be identified in a systems map, it is the additional interactions between these factors and other elements in the system that offer greater insights into the overall impact of a program on the entire system. In essence, examining these interactions can provide more comprehensive information about the potential effects of the program. These effects outside of the smaller model types, whether negative or positive, are called unintended consequences. They can be identified simply by outlining the primary pathway a program is targeting in

the system and then examining all of the chains of effects each individual factor in the primary path has on the surrounding system. Often the resulting effects can be surprising and even counter to the ultimate goal of the primary chain. For example, in the map created for the Mexican context (Fig. 1), a primary goal targeting vaccination to reduce COVID-19 prevalence that is successful will cause effects beyond its own pathway. This includes a reduction in overall fear of the virus that could reduce people's motivation to get vaccinated, and thereby reduce the vaccination rate. This would be running within the system at the same time as the successful campaign to improve vaccination. For this reason, it is critical to examine the unintended consequences within a system. Programmers and policy-makers can either build in layers to address these offshoots, find the potential consequences to be negligible, or even find the consequences to be too great to overcome and scrap the proposal altogether. Without systems thinking and mapping these pathways, unintended consequences would go unnoticed (Fig. 8).

A Proposed Strategy Based on the Map

Despite a large low-income population in Mexico, educational levels appear to be high. Educational levels directly influence the health literacy of the population, which increases vaccination acceptance. A study published by Lazarus et al. projected Mexico with a vaccine acceptance rate of 76.3% due to a decrease in misinformation and related perceptions like optimism bias and ultimately improved community engagement [25]. By following this route and identifying the factors previously mentioned as leverage points, a behavioral communication strategy, focused on decreasing the optimism bias and misinformation, could be developed (Fig. 7).

An example based on evidence from two protocols developed at the Universidad Autonoma de Queretaro in Mexico shows that 'task shifting' or 'train the trainers' strategies work due to the confidence the population of Queretaro has in its peers and trained professionals [25, 26]. Both of these strategies were developed using identified leverage points from a systems analysis including educational levels, the age of the surveyed participants and patients, the lack of trust in the official institutions, and high peer support levels. The adaptation of these strategies in a national context could be assessed through Fig. 4, a broader analysis of the situation at that point in time.

Applications Beyond Mexico

Applying systems thinking to public health issues is becoming increasingly important in our interconnected world. As seen through the above example of systems analysis using Mexico as a model, many complexities in public health work are diverse and highly interconnected. By using systems thinking, public health professionals can

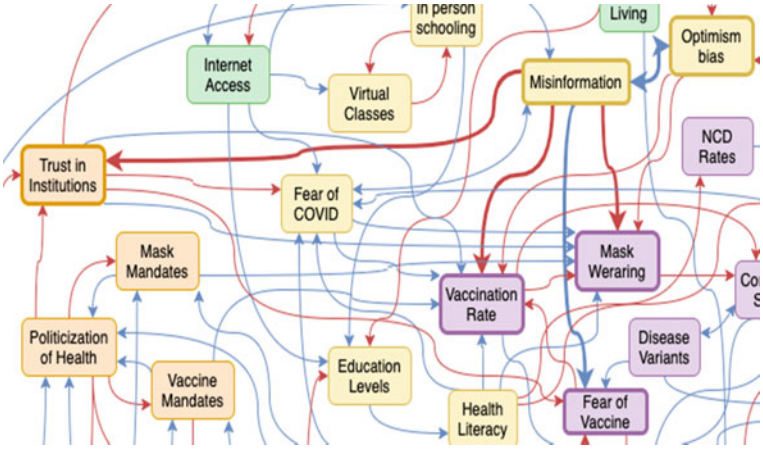

Fig. 7 A closer look at the visualization of the described 'misinformation' leverage point. *Note* Factors affected by interactions with misinformation and the interaction arrows are shown in bold

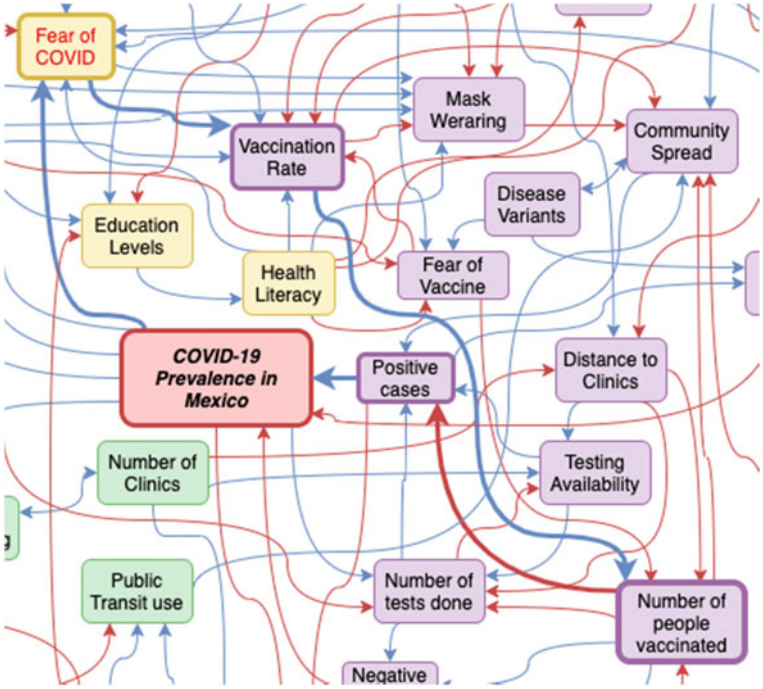

Fig. 8 A closer look at the unintended consequence described. *Note* All factors and interactions are shown in bold. The unintended consequence factor 'fear of COVID' is shown in red text

better visualize and plan for this complexity. Beyond the example of Mexico, this process can be applied to any number of issues in the public health space. One example of the use of systems thinking is in a novel course developed by New York University and UNICEF, titled "Behavioral Communication Strategies for Global Epidemics" [28]. Participants in the course start by using a systems approach to understand outbreaks and humanitarian crises in their full complexity. Through this process, participants develop strategies that have the largest impact on the system and allow them to think critically about and plan for unintended consequences. The result is a set of strategies to mitigate the spread of disease that are robust, feasible, effective, and context-specific. There is no set methodology for systems mapping and analysis other than providing wide flexibility to adjust to any challenge. Simply observe the issue of interest and choose a central factor to map around to start. From there the research and body of knowledge at the time will guide the creation of the map. An understanding of the basic components of the system as described above, will help to make the map a more useful tool. Regardless of the issue, location, and context of a systems analysis, the accompanying systems map places public health professionals in a stronger position to confidently move forward with programs and policies.

Conclusions

Systems thinking provides a new and innovative perspective to complex challenges. Any health issue in any country that increases the burden of disease needs a broad analysis of the different spheres and areas involved. Through a systems map, the loops, leverage points, and unintended consequences can be found to target new interventions or to strengthen existing ones. It is important to remember, however, that system maps have their limitations. The complexity of real-world systems is too great to be fully visualized. There are a number of immeasurable factors that are ever-changing both in number and levels of influence. A static systems map does not change the way a true dynamic system can and will. There are ways in which maps can be created for public health use. Involving as many local stakeholders as possible, keeping the scope of the map within a narrow space and time, and making adjustments to the map as time goes, on allows the best possible representativeness of the actual real-world scenario to be depicted.

The COVID-19 pandemic provides a perfect example of why systems thinking is so important. The modern world has never before seen a virus affect its entire population with such ease. There is not a single nation on this planet that has not felt the effects of the COVID-19 pandemic. In our ever more interconnected world, persons in every continent, region, nation, state, and city live within their own systems that are separate yet all influencing each other to some degree. Strategies and policies which worked in one location or community may not work at all in another, and the public health field cannot pretend that solutions are one size fits all. The intricacies of each of these levels of systems can be visualized to aid in making participatory, innovative,

and highly effective interventions and policies that can make a big impact on their target communities while minimizing the damage from unintended consequences. Systems thinking is a tool for public health professionals to take advantage of a field where undoubtedly, everything affects everything. During emergencies such as COVID-19, non-communicable diseases (NCDs), neglected tropical diseases, and issues related to water, sanitation, and hygiene, it is crucial for public health professionals to comprehend the broader system's impact. This understanding is essential to achieving more significant impact and better results for the populations they serve.

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Response to the COVID-19 Pandemic in Taiwan

Shikha Kukreti, Sriyani Padmalatha, Shau-Huai Fu, and Yu-Ching Chen

Abstract In the midst of the COVID-19 pandemic, the world witnessed a large number of infections and deaths. Due to its proximity to China, it was initially feared that Taiwan would become the country worst affected by the pandemic. However, COVID-19 has been widely controlled in the region; a few local outbreaks occurred with limited cases since the pandemic began. Taiwan leveraged its experience in containing the SARS outbreak in 2003 to respond to the COVID-19 crisis with proactive measures, early deployment, prudent actions, and transparency. Most political debate in Taiwan has centered around vaccines. However, from challenges like vaccine availability to increasing the willingness to take vaccines by the population, the Taiwan government has succeeded well. Taiwan's National Health Insurance system is a vital component of its strategy to improve the efficiency of healthcare delivery throughout the country. And the database integrated with the Centers of Disease Control provides real-time alerts to healthcare providers about patients whenever they are identified. In response to delta variant spread after a community outbreak, health monitoring measures were tightened, leading the country to successfully control the spread of the infection. Other countries can learn lessons from Taiwan's response to COVID-19.

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Background

Taiwan's success with the COVID-19 pandemic was no coincidence. An essential component of the Taiwan model was transparency. The Taiwan model, one of the most effective globally, was the product of a democratic system. Measures that Taiwan undertook to control the spread of COVID included epidemiological surveys, border control, effective monitoring, testing and tracing, investigations, and triage. The Taiwan government was willing to listen to critics and make needed changes in its policies. Taiwan's media also played an understated role in fighting the pandemic. There was some degree of vaccine hesitancy, but most of the media channels promoted appropriate behavior during the pandemic. The people demonstrated that they were responsible citizens by actively cooperating with the government. Most religious groups were willing to support the government's disease prevention policies; they postponed several religious celebrations. Everyone treated the fight against the virus as a personal matter.

Taiwan donated 50 million surgical masks to countries worldwide [1]. Taiwan collaborated with the United States and some countries of Europe to develop rapid diagnostics, anti-viral drugs, and vaccines [1]. The Central Epidemic Command Center (CECC) held regular press conferences to provide risk management and health education information. People were encouraged to keep an appropriate distance and to avoid large-scale gatherings. Financial relief and economic stimulus packages were vital measures for containing the COVID-19 pandemic in Taiwan.

Combating COVID-19

Early Response to the COVID-19 Pandemic

Taiwan's Center for Disease Control learned from some online sources that a few unusual pneumonia cases had been reported in Wuhan on December 31, 2019. Taiwan immediately sent reports to the World Health Organization (WHO) and to China's CDC [2]. Taiwan believed that the clustering of atypical pneumonia in Wuhan was a sudden severe, unusual, and incidental event that required quick attention and action from the WHO and from China's CDC.

Taiwan operationalized prudent action, rapid response, and early deployment into its epidemic prevention system. All passengers arriving from Wuhan were checked. Taiwan strengthened its case reporting and hospital infection control of the health care system in January 2020. In January 2020, China convened an advisory committee on atypical pneumonia followed by establishing a Level 1 travel notice in early January in Wuhan, where the outbreak was attributed to a new disease labeled 2019-nCoV by the WHO. Subsequently, Taiwan's CDC classified COVID-19 as an emerging infectious disease on January 15. Taiwan had previously contained an outbreak of

SARS (severe acute respiratory syndrome) in 2003 and had experienced the H1N1 pandemic flu in 2009.

Taiwan was the first country in the world to conduct onboard screening of passengers arriving on direct flights from Wuhan to get all arriving travelers to complete a health declaration [3]. The CDC played a vital role in disease prevention in the early days. It implemented a disease prevention plan that consisted of two phases. The first phase, Preparedness Planning, was activated when suspected cases of COVID-19 were reported in neighboring countries but there was no community transmission. The second phase, Contingency Planning, was activated after the first phase during the pandemic. On January 20, 2020, while sporadic cases were reported from China, the CDC in Taiwan set the CECC in motion to handle severe infectious pneumonia under the auspices of the National Health Command Center, with the Minister of Health and Welfare as its designated commander [4]. The CECC facilitated the efforts of several ministries, including the ministries of transportation, economics, education, labor, and the environmental protection administration, in a comprehensive effort to check this emerging public health crisis.

Containment

The first outbreak in Taiwan occurred shortly before February 16 and ended by April 11, 2020. The second outbreak started a little before January 12 and ended on February 9, 2021. The third outbreak started shortly before April 20, 2021; the highest peak of reported cases occurred on May 28, 2021. Between the first and second outbreak, Taiwan had a period of 273 days when there were no reported local infections other than an isolated case with an unknown source reported on August 2, 2020 and a local case reported on December 22, 2020. The latter was a woman in her 30 s who came in close contact with Case No 765, the *New Zealand pilot* who had been associated with a cluster of infections among pilots. Further, during a period of 69 days, there were no reported cases between the second and third outbreaks. However, this situation did not last long. Starting in April 2021, multiple clusters of cases occurred that were related to the flight crew from the airlines at Taoyuan International Airport (the Taiwan's largest airport situated near the capital city of Taipei). These outbreaks resulted in a sharp increase in cases far exceeding the levels observed in 2020. The reasons for the sharp increase of cases were possibly non-compliance with quarantine rules and an abbreviated period of mandated *quarantine for pilots*. In addition, the highly contagious and virulent Delta variant breached Taiwan's borders. On June 5, 2021, Taiwan reported its first domestically transmitted case of the Delta variant of the coronavirus.

Taiwan has a four-tier epidemic alert system like that of New Zealand but with more stringent criteria to reach level four. It uses a level 3 alert system which includes several restrictions and closures. A level 4 alert system is typically activated after a maximum of 100 cases are reported per day. On May 20, 2021, the alert level was extended to level 3 in Taiwan which included guidelines requiring that individuals

wear masks, stay outdoors, and limit social gatherings to 10 persons. A semi-level four lockdown was implemented in June 2021 in several villages in Pingtung County. Unlike New Zealand and Australia, where strict but relatively short lockdowns were used successfully to control the spread of infection, Taiwan avoided a national lockdown since it did not reach the threshold to implement these measures. Figure 1 illustrates daily confirmed COVID-19 cases per million population, comparing Taiwan, Australia, New Zealand, and global data. The Bureau of Consular Affairs pulled up all foreign nationals not holding a valid ROC (the Republic of China, i.e., Taiwan) Resident Certificate on arrival. Taiwan was gradually able to control the outbreak. After the Central Epidemic Command Center assessed the situation, it announced in late November 2021 that a Level 2 epidemic alert would continue to be in place until December 13, 2021 [5].

Taiwan's COVID-19 vaccination program started in March 2021. Its vaccination rates were lower during the third outbreak than in many high-income countries. This was due to the lack of willingness of healthcare workers and the general population to get vaccinated [6]. On top of this, the Delta variant B.1.617.2 showed up in the community. While some feared the worst with only 0.1% of the population fully vaccinated, the outbreak was contained. Fourteen days after it was identified, the increase in cases due to the Delta variant appeared to slow down. And, there was a rapid expansion of the vaccination program.

Initially, Taiwan relied on vaccines imported through COVAX. Countries like the USA helped Taiwan get Moderna and BioNTech and Japan helped Taiwan get the AstraZeneca vaccine. Taiwan also began domestic production of vaccines. *Taiwan's law prohibits the import of Chinese vaccines* for use in humans. Currently, 76.6% of

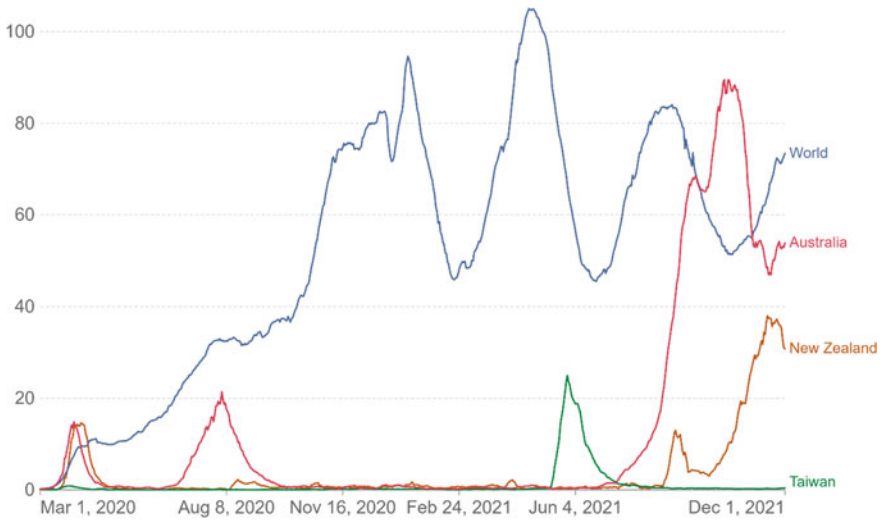

Fig. 1 Daily confirmed COVID-19 cases per million population, comparing Taiwan, Australia, New Zealand, and global data (7-day rolling average). *Source* Johns Hopkins University CSSE COVID-19 data

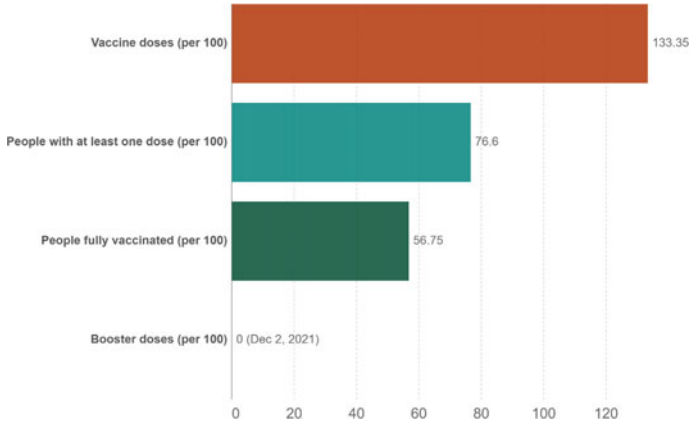

Fig. 2 Cumulative COVID-19 vaccination status of Taiwan's population. *Source* Official data collated by our world in data

Taiwan's population is vaccinated with one doze and 57% of the population is fully vaccinated [7]. Figure 2 illustrates the cumulative COVID-19 vaccination status in Taiwan**.** Recently, in response to the emergence of the Omicron variant, the CECC announced that COVID-19 vaccine booster shots will be given to people who have completed their COVID-19 vaccine doses five months earlier [5]. Taiwan's government withstood criticism from the opposition party and shared its local vaccine in partnership with the U.S. National Institutes of Health, which clearly established Taiwan as playing a contributing role in the global health community.

Preparedness of Healthcare System

Taiwan's healthcare system is fully covered by National Health Insurance (NHI) which was introduced in 1995. Taiwan currently allocates 6.5% of its GDP (gross domestic product) on a progressive, low-cost healthcare system characterized by excellent accessibility, comprehensive coverage, and short waiting times. It has also established a national data collection system to support research and future planning. Funding is covered by payroll-based premiums. The government provides generous premium subsidies for low-income households, civil servants, and others as a single-payer system. Private providers provide preventive, primary, specialist, hospital, and mental health services. Long-term care was recently added to this list. Out-of-pocket costs include co-payments for outpatient care, prescription drugs, and coinsurance for hospital stay. Private health insurance consists primarily of disease-specific cash indemnity policies [9]. The financial structure of Taiwan's NHI system is shown in Fig. 3.

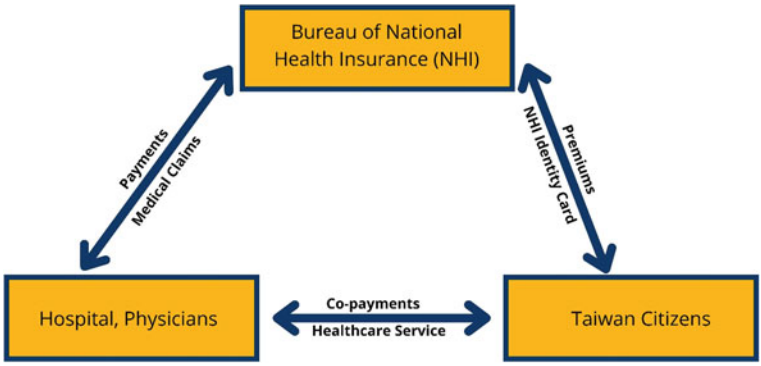

Fig. 3 The financial structure of the Taiwanese National Health Insurance system. *Source* Financial structure of Taiwan's NHI system [8]

Pandemic preparedness of Taiwan's healthcare system was impressive. Because of the application of an early containment policy, Taiwan successfully lowered the impact of SARS-CoV-2 [10]. Taiwan began to increase its case finding by proactively seeking outpatients with severe respiratory problems who tested negative for influenza and re-tested them for COVID-19. A free hotline number (1922) was set up to report COVID-19 patients and cases with suspicious symptoms. During the peak of the pandemic, the hotline reached its total capacity. Consequently, the government decided that each major city should have its own hotline.

Persons under quarantine were provided with food and frequent health checks. The government had had the same experience during the SARS outbreak in 2003. Taiwan's health care planner had developed a public health response mechanism to facilitate speedy action for the next emergency. Taiwan's well-trained and experienced healthcare workforce could quickly responded to the crisis, activated emergency management structures, and addressed them during an emerging outbreak [4, 10]. The government made every effort to inform and reassure the public through daily simple health messaging that was timely, accurate, and transparent.

Healthcare resources were important for controlling the pandemic. Shared contributions and efforts of all interdependent stakeholders ensured the availability of pharmaceutical supplies. There were drug shortages because of disruptions in overseas manufacturing and stock-outs in pharmacies. Taiwan's health system met this challenge through active management, transparency, and well-timed communications, which are all-important to ensure a stable supply of essential medications during a pandemic. An example of such activities was organizing meetings between commercial associations and pharmaceutical manufacturers, to respond to future critical shortages created by COVID-19, and careful inventory control to predict such shortages. Sources of and applications for critical active pharmaceutical ingredients and medications were actively investigated and reviewed. The government developed a financial stimulus package and reimbursement plans for the costs associated with

these critical supplies. The supply–demand balance ruling was reinforced to ensure rational distribution, allocation, and stockpiling of medications [11].

Similarly, in hospital settings, high levels of vigilance and an immediate response to changes in the outbreak situation took place within specific timelines. The safety of hospital team members was essential for delivering health services to save patients' lives. Therefore, infection control measures were undertaken in hospital settings. There was emergency preparedness of the hospital administration. Activities conducted included education, surveillance, patient flow, partitioning of hospital zones, and prevention of a systemic shutdown by using the 'divided cabin, divided flow' strategy [12]. Also, some routine services like elective surgery and minor procedures were cancelled to increase service capacity to respond to the increasing number of COVID-19 cases. This was key to a quick transformation from regular services to COVID-19 care [13]. Strategies were put in place to reduce the use of personal protective equipment by building sample collection stations for COVID-19 testing outside hospitals which also reduced the time required for sample collection.

One hospital in Taiwan introduced a strategy in its emergency department that included a double triage and a telemedicine protocol. This strategy helped in reducing the exposure time and the risk of frontline healthcare workers contracting the infection while managing patients suspected of having COVID-19 [14]. If any cases or contacts were identified, they were moved to a nearby hospital or the Long-term Care Facility (LTCF) or other quarantine locations. Testing was repeated one week later on persons who had encountered the virus.

Border control and travel restrictions were key in preventing COVID-19 [15]. Because of Taiwan's unique culture and economy, the government used a unique approach to combat the COVID-19 pandemic. The NHI has a big data system and has added to it digital contact tracing, mobile geo-positioning, automated self-restriction monitoring, and the ability to follow up on COVID-19 cases. Thus, actions taken to control the pandemic also contributed to addressing future problems.

Community Response

According to media reports, the Taiwanese population did an excellent job of preventing COVID-19. They contacted confirmed cases who were isolated at home for 14 days. Local health agencies contacted people in home isolation to check up on them twice a day. If individuals developed symptoms, they were admitted to the hospital.

Most importantly, people collaborated with telecom companies. The government introduced an electronic self-assurance monitoring system to identify the location of people in home quarantine by detecting mobile phone signals connected to the exchange tower. If quarantined individuals moved away from the nearest cell tower, an assigned worker received a notification via SMS, after which immediate follow-up was carried out that could result in fines or forcible quarantine. Figure 4 provides the flow of community screening of COVID-19 cases based on information from the

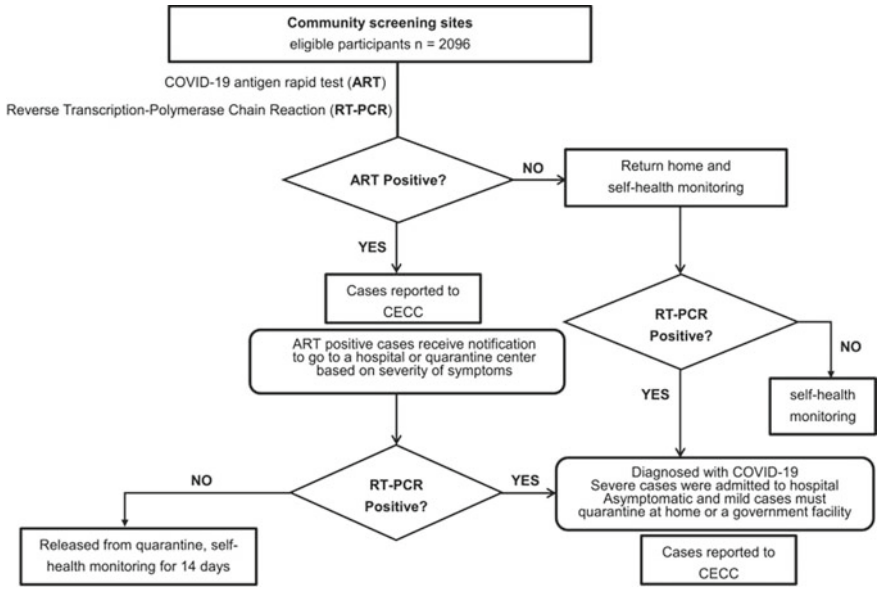

Fig. 4 The flow of community screening for COVID-19 cases according to the CECC. *Source* International Journal of Infectious Disease [16]

CECC. Quarantined individuals were required to remain at home for the entire 14-day period. Both central and local government agencies partnered to provide services such and daily follow-up calls. They made transportation arrangements and provided household services such as settlement planning for people without a residence. They also organized food delivery and garbage collection services. The Tourism Bureau organized a subsidy plan for hotels. Homeless patients were provided government-funded shelter by cooperating hotels. From April 1 to July 31, 2021, the hotels were reimbursed USD 37 per room.

In the early stages of the COVID-19 pandemic in January 2020, schools delayed opening for two weeks. Schools were not closed for longer durations. The Ministry of Education (MOE) framed rules for the suspension of classes and organized and earmarked medical supplies for schools to protect students from COVID-19 infection. Schools cooperated by monitoring students, disinfecting classrooms, and organizing activities to ensure that both teachers and students were safe and followed safety guidelines. Social distancing measures were announced on April 1, 2020 and the public was urged to maintain social etiquette and follow social distancing.

In Taiwan, disease prevention measures require a legal basis before they can be implemented. And these measures must be supervised by citizens. To gain people's trust and support, the Central Epidemic Command Center (CECC) was activated. The CECC held routine press conferences releasing the latest information on COVID-19 and clarifying disinformation through various channels. The citizens applauded CECC's efforts. As of April 2020, Taiwan had put in place public mask mandates.

It was an island-wide mandate to wear masks outside the home. The people not only complied but also required accountability from their politicians. Historically, Taiwan has always led the fight against contagious diseases. Even during the colonial period when the country was occupied by the Japanese, medical officials attempted to eradicate infectious diseases. Other related regulations and recommendations for mass transportation, businesses, public gatherings (large or medium scale), community management, large commercial sites, and administration of quarantine in hotels were also implemented. The public followed self-care safety measures intended to stop the spread of COVID-19. Unlike in many other countries, the people in Taiwan demonstrated excellent behavior.

The Economic Effects of the Pandemic

Taiwan experienced a negligible impact on its economy thus disproving the widely held belief that controlling infection must always come at the cost of economic growth. Several factors contributed to Taiwan's early success by controlling the COVID-19 outbreak. These included border control, a strict quarantine policy, efforts to ensure a sufficient supply of critical medicines, transparent public education, advanced medical facilities, and a well-established national health insurance program with access to technology and big data [17]. As a result, Taiwan began to assume a leading role in a new global health initiative in sharp contrast to its sole efforts to control the SARS outbreak 17 years ago. As a result, businesses remained operational even during the Level 3 alert from May 19 to July 23, 2021.The work-from-home policy was not adopted in Taiwan. The CECC imposed strict border control measures to temporarily stop all foreigners without a permanent residence permit from entering Taiwan.

From August 2021, the pandemic continued to subside with sporadic domestic cases with unknown sources of the infection. Taiwan maintained a nationwide Level 2 epidemic alert but has relaxed the rules on domestic social events, gatherings, travel, and catering. However, its export-dependent economy is highly vulnerable to a global recession. Taiwan did not experience the extreme economic effects felt elsewhere when extreme lockdown measures were put in place. The country was able to carry on business and manufacturing as usual although retail revenue decreased. Taiwan's population had freedom of movement. Schools, offices, and restaurants remained open. During February 2021, retail and restaurant sales increased by 0.5% compared to the same period the previous year. This was important since private consumption accounts for over half of Taiwan's GDP [18].

The island is vulnerable to reduced global trade flows because it has an export-oriented economy. Taiwan's exports and its overall economy were affected by weaker external demand and supply chain disruptions. The NDC (the National Development Council) announced the five industries most heavily affected by the pandemic. The airlines and travel industries were the hardest hit when border controls were reinforced and the demand for air travel suddenly dropped. Consequently, local EVA and

China Airlines carriers with their subsidiaries were ordered to cancel or limit flights to many destinations. The number of passengers on domestic airlines declined by 50% in February 2020 and are expected to decline further as COVID-19 continued to spread around the globe. The hotel industry and non-essential retail businesses were significantly impacted because of the collapse of consumer and business expenditures caused by travel restrictions, long quarantines, and social distancing measures. Eighty-seven percent of exports from Taiwan to China are intermediate products. The biggest export area is electric components. Manufacturing and supply chains were predicted to be deeply affected by the pandemic since the factories for electronic parts are in China. In 2021, drops of as much as 50% in annual profits for electronics companies and machine tools exported to China were predicted. In addition, 45% of Taiwan's total production of petrochemicals was exported to China. So, the oil production and distribution sector experienced significant losses due to the pandemic. On the other hand, there was an increase in sales of some products such as semiconductors industry communications technology (ICT).

International demand for the Taiwan's signature hi-tech products grew sharply because of the expansion around the world of online activities and videoconferencing to support work from home and social distancing guidelines. The Ministry of Economic Affairs (MOEA) indicated a 40.4% growth in Taiwan-based companies during the pandemic period which demonstrated an increase in export purchases of USD 11.58 billion since February of 2021 and an annual growth of 4.3%. This reflected a 24% increase in the demand for manufactured electronic goods in a single year. Taiwan's world-leading semiconductor industries also did well. The Semiconductor Manufacturing Company (TSMC), a contract chipmaker, stated that the company's first-quarter profits had increased by 42% compared to the previous year [17]. Figure 5 illustrates the increased global demand for the chips from Taiwan Semiconductor Manufacturing Company Limited (TSMC).

In 2019, the government endorsed a wide-range relief package of USD 35 billion equivalent to 5.5% of its GDP. Several government agencies provided funding for the package. One example is the renovation and strengthening of Taiwan's tourism industry supported by USD one billion toward the tourism infrastructure and efforts to make Taiwan a major tourist destination. The MOEA provided USD 3.25 billion for a financial bailout aimed toward regenerating local consumption and supporting businesses undergoing difficulties—a rescue measure for airlines, hotels, and travel agencies. The MOEA also focused on the country's large number of small businesses, service sectors, and family businesses such as night market vendors and hairdressers. They were qualified to get upto 30% of their power and water bills. Upto 40% of their salaries were subsidized. The MOEA provided stimulus coupons to its local consumers as part of its efforts to promote consumption and boost the local economy. The Ministry of Labor provided special funding together with additional funds of USD 2.07 billion to alleviate unemployment among young people, support those who were unemployed, subsidize those with unpaid leave. Subsidies were also provided for self-employed individuals. Exports are the major contributor to Taiwan's GDP and account for more than 65% of its GDP. In spite of Taiwan's vulnerability to decreases in global trade, it was able to reduce its dependence on Chinese travelers and

Fig. 5 Increase in global demand of Taiwan Semiconductor Manufacturing Corporation Limited (TSMC) chips. *Source* Taiwan Semiconductor Manufacturing Co Ltd. (TSMC)

improved its industrial blueprint [11]. Based on data from 2019 and 2020, Taiwan's public debt was 33.6% of the GDP in 2019 [19]. It was projected to decrease to 32.3% and 30.7% of the GDP in 2020 and 2021, respectively [20]. The central part of Taiwan's public debt was domestic and was owed in New Taiwan Dollars (NTD). The unemployment rate in 2019 remained stable at 3.8%. It was projected to rise a little to 4.4% in 2020 due to the COVID-19 pandemic. Figure 6 shows an increasing trend of the industrial production index in October 2021 compared with the same month in 2020. An ageing population, low birth rates, and a still tense relationship with China are Taiwan's immediate challenges.

In early 2020 (first quarter), Taiwan's economy remained stable. However, the pandemic caused a reduction in growth in the second and third quarters due to global recession, unemployment, and drops in income [20]. At the start of 2021, Taiwan's investments in China began to take place due to insecurity and decreased revenues caused by U.S.-Chinese trade relations. As of March 2021, export orders of Taiwan-based companies grew more than 40.4% compared to USD 40.26 billion in February 2021 [19].

Education

Taiwan was among the few countries where schools functioned normally during the pandemic. To secure the safety of students and staff, the Ministry of Education (MOE) established general guidelines for college campuses. These included task forces at

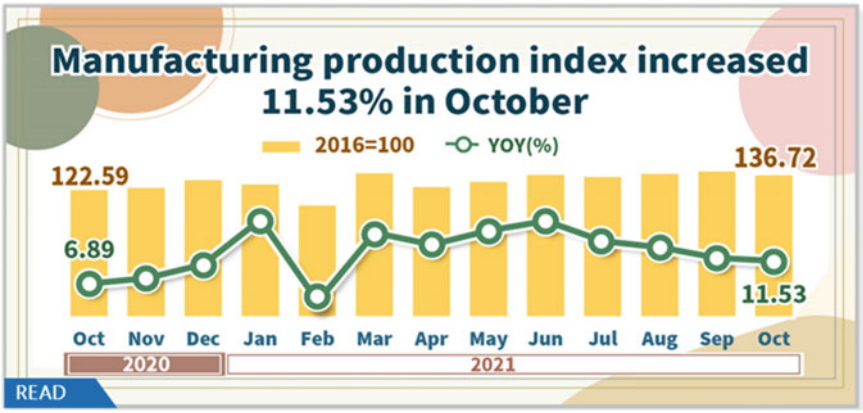

Fig. 6 Increase in the industrial production index in October 2021 compared with the same month in 2020, which included the manufacturing sector. *Source* Department of Statistics, Ministry of economic affairs, Taiwan

universities and risk screening based on data on travel history, contacts, and disease clusters. Education on general hygiene, indoor use of masks, self-quarantining and care, ventilation and sanitization of indoor spaces, and group activities was provided. Guidelines were put in place for reporting suspected cases and on how to deal with school closures and make-up classes. Adjustments were made to school schedules and preparation was made for online education. At that time, schools were partially closed, and few students were allowed to go to school. Most of them were learning from home. It was announced that classes should be suspended if even one student or staff member tested positive. The school was expected to be closed for 14 days if it had two or more confirmed cases of COVID-19. As of June 18, 2020, there were seven confirmed cases at six Taiwanese universities. Only one university had to close and offer online education; it was only closed during standard 14-day period. In addition, distance learning options were put in place for international students and quarantined students.

Distance and online learning are, as of now, part of the norm and this will continue. Institutions of higher education provide resources and training for their teachers and students. This provides a general platform on which all aspects of distance learning can be obtained by both teachers and students and includes instruction on the use of various software programs. The Internet is offered at a discount for low-income students as well as for students who are unable to obtain face-to-face instruction. Several open-source platforms for online courses, such as Taiwan Massive Open Online Course (MOOC), Open Edu, and Taiwan LIFE Insurance Company Limited are made available.

The experiences in Taiwan suggest that with appropriate measures in place including both containment and mitigation procedures, it is possible to safely reopen colleges and universities. Strategies should include access to information, contact tracing, quarantining, proper hygiene and sanitation measures, social distancing, and wearing masks.

Concluding Comments

Taiwan's response to COVID-19 shows how a country can quickly address an emergency and protect its citizens. Taiwan proved its potential as a global leader in the area of public health response and preparedness. Its success was due to the joint efforts of the government, health workers, and the citizens of Taiwan. A combination of small gestures and big data gave Taiwan an unprecedented edge over other countries for controlling the pandemic. Future endeavors will include population-based preventive behavior, especially in regions with fast spreading SARS-CoV-2 variants.

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COVID-19 in Brazil: Overall Impact and Singularities

Antonio Vaz de Macedo

Abstract Since its outbreak in late 2019, the COVID-19 pandemic has spread at an alarming rate across the globe, with a case tally of over 370 million and a death toll of more than 5.6 million as of late January 2022. Ranking third among the world's most affected hotspots, Brazil was by far the hardest hit among its Latin American neighbors, with over 25 million cases and a death toll in excess of 625,000, which places it second worldwide. The actual toll is likely higher. It is underestimated because of limited testing and inconsistency in nationwide cause-of-death reporting. Brazil is one of the largest developing free market economies in the world. It is, however, tainted by having one of the highest socioeconomic disparities, with roughly a fifth of its population living under the poverty line, with little access to basic sanitary facilities. On the positive side, Brazil has the largest publicly funded healthcare system in the world. Despite having lagged behind vaccination rollout initially, it took a giant leap over the past six months, which resulted in two-thirds of its population being vaccinated. There was also a tremendous drop in both SARS-CoV-2 cases and death rates. Unfortunately, cases have begun to swell again with the advent of Omicron. In this chapter, we discuss the overall impact of the COVID-19 pandemic in the country, with a particular focus on underserved minorities.

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Introduction

A Little on Demographics

Brazil is the sixth most populous country in the world, comprising 2.7% of the world's population, with over 212 million inhabitants. Its free market economy is the eighth largest in the world by purchasing power parity (PPP). Its projected gross domestic product (GDP) comprising 2.38% of the world's share decreases to 1.73% and twelfth position if the nominal GDP is considered [1, 2]. Notwithstanding its somewhat privileged status, Brazil is tainted for having one of the highest socioeconomic disparities globally. It holds the 87th place in the world according to per capita GDP (or 86th if we consider PPP) [1–3]. Almost a fifth of its population (38.1 million as of the 2018 national census update) is said to be under the poverty line (USD 100 per capita per month), most of which (72.7%) is self-identified as Blacks and *Pardos* (Browns). These minorities (13.5 million) have a monthly per capita income of a mere USD1.9 a day (cut-off adopted by the World Bank for the extreme poverty line) [1, 4–7]. According to recent updates provided by the last nationwide census, Brazil has over 13 million of its people living in *favelas* (slums), a population surpassing that of Portugal and Greece [8, 9]. These slums are overcrowded, multigenerational households with little access to sanitary conditions. Given this scenario, one can foresee the grim future that can be caused by a pandemic.

Despite a slight drop over the past decade, Brazil's illiteracy rate remains high, with over 11.5 million (7.0%) of its age-adjusted population still unable to read. The last National Census Bureau (IBGE) update showed that the main reason for this was that young people needed to join the workforce to help support their families [10–12]. Almost 20% of the country's population is over 60 years of age. This age group is most vulnerable to COVID-19. The illiteracy rate is two times in Blacks (9.9%) as compared to Caucasians (4.2%), reflecting the low socioeconomic and educational status of the most underserved racial and ethnic minorities in the country [13].

Of greater immediate concern is that overall unemployment has affected over 12.0% of the country's available workforce with informal jobs. Unpaid leave represents more than 50% in over a third of the states in Brazil [14]. Despite government support schemes with stimulus and cash transfer programs for the most needy and underprivileged, including a monthly aid package of roughly USD 100,00 for up to two family members during the first wave of the pandemic and the *Auxílio Brasil* of around USD 7,500, which is expected to benefit more than 14.5 million families during the current (third) wave, many have not yet benefited from these measures [15]. While logistical issues may partly explain this, since the deposits are conditioned upon having access to and knowing how to handle a specific mobile application from the country's main government owned bank, fraud at various levels has prevented these benefits from reaching the people in need. This has rendered many of those who lack savings and are bread winners unassisted. It is estimated that of the 60 million Brazilians who are eligible for the benefit, up to six million represent small rural workers who largely depend on family farming for their livelihood [11, 12].

While Brazil's food supplies are still somewhat sustained, millions struggle to stay above the poverty line. Concurrently, violence rates are also on the rise, as depicted by recent accounts of domestic violence [16].

Overview of the Chapter

Two years after the COVID-19 pandemic began, it became clear that its overall impact on the country depended upon intertwined health, social, and political actions. The heterogeneity of the vaccination rollout further underscored the importance of providing equitable access to preventive and therapeutic resources around the country without which Brazil could face dreadful consequences. Hence, a global approach is key to overcoming the impact of COVID-19 [17].

This chapter provides an overview of the first two years of the COVID-19 epidemic in Brazil from social and political perspectives. While highlighting Brazil's regional and social disparities, it sheds light on how these have modulated the impact of the pandemic in the country.

This review is based on official and scientific data drawn from PubMed, Medline, and SciELO databases as well as from publicly available sources including press releases presumed to contain timely and credible information. Since Brazil lacks standardization of these datasets, the COVID-19 databases need to be improved. Reliable data should be shared across regions and states. This is key to providing a reliable picture of the evolving status of the pandemic in the country.

The Wider Scope of the Pandemic

Since its outbreak in late 2019, the COVID-19 pandemic spread at an alarming speed across the globe, with a case tally of over 370 million and a death toll of more than 5.6 million as of late January 2022. Ranking third among the world's most affected hotspots, Brazil was by far the hardest hit among its Latin American neighbors. Brazil had over 25 million cases, a death toll in excess of 625,000, and an overall fatality rate of 2.5% [4, 18, 19]. The actual toll is likely higher. It is underestimated because of limited testing and inconsistency in cause-of-death reports [18, 19]. Despite global efforts and billions of dollars of investment, no vaccine was available in Brazil at scalable and nationwide levels until the first quarter of 2021 [20]. Apart from the evidence provided around mid-July 2020 on the benefit of dexamethasone (and other steroids) in patients with COVID-19-related acute respiratory distress syndrome (ARDS), no other treatment was shown to reduce mortality from this disease until 2021 [21]. Many of the currently available treatment options for COVID-19 have yet to be approved in the country.

The unfavorable pandemic scenario with which the world was faced during the third quarter of 2021 was recently reinforced by the appearance and worldwide

increase of SARS-CoV-2 viral Variants of Concern (VOC) which have already been shown to be resistant to novel medications, particularly monoclonal antibodies (mAbs), thus resulting in treatment failure and limiting treatment options [22, 23]. With the advent of the SARS-CoV-2 B.1.1.529 Omicron VOC in late January 2022, the Food and Drug Administration (FDA) of the United States of America (USA) decided to revoke its emergency use authorization (EUA) for two mAbs against COVID-19, namely casirivimab and imdevimab, manufactured by Regeneron Pharmaceuticals, and bamlanivimab and etesevimab, by Eli Lilly. There is a lack of evidence regarding the effectiveness of these treatment options for patients at high risk of developing severe disease caused by Omicron, which currently accounts for virtually 100% of cases in the USA, Brazil, as well as in other parts of the world [24, 25]. The Brazilian Regulatory Agency, ANVISA, has not yet withdrawn its EUA but has advised that extra caution be taken and sound clinical judgment be made when prescribing this treatment amid the current upsurge of Omicron cases [26]. As possibly effective therapeutic options for mitigating the risk of severe disease, hospitalization, and death due to Omicron, the FDA recently laid stress on the effectiveness of sotrovimab, the only previously available anti-SARS-CoV-2 mAb with activity against this variant, and ritonavir boosted nirmatrelvir (Paxlovid®), remdesivir, and molnupiravir, for which it issued an EUA in the USA. Neither Paxlovid® nor molnupiravir have yet been approved by ANVISA in Brazil. While Omicron cases seem to be less severe, case rates are skyrocketing worldwide and have not yet peaked in Brazil [27, 28]. Hence, it remains to be seen how the country will cope with the third wave of the pandemic.

The Brazilian COVID-19 Epidemic: An Overview

Seventy five percent of Brazil's population depend on its Unified Health System (*Sistema Único de Saúde -SUS),* recognized by the World Health Organization (WHO) as the world's largest publicly funded unified healthcare system to date. In fact, it was supposed to have celebrated its 30th birthday in 2020 [29]. Because of the COVID-19 pandemic, both the public and private healthcare sectors (including individual health plans) have been faced with the challenge of providing support to the country's more than 210 million residents. During the first two waves of the pandemic, the health system failed in its efforts to keep pace with the increased need for healthcare personnel. This was further aggravated by the lack of specialized medical staff for managing mechanical ventilation and other life support measures [30]. Even though Brazil has an overall physician per inhabitant ratio of 2.3/1,000, which is greater than most of its middle-income neighbors, the majority of its medical workforce is concentrated in the cities [31, 32].

SARS-CoV-2 serology or polymerase chain reaction (PCR) testing coverage remains at regrettably low levels in Brazil [33]. Intensive care unit (ICU) occupancy reached alarming rates, nearing 80–100% in even the most well-equipped cities. In

the northeast region, for instance, around mid-2020, it reached desperate levels, with some states witnessing a virtual collapse of their local health systems.

Furthermore, over the past couple of years, virtually coinciding with the pandemic, the country has been engulfed in ever worsening political turmoil, with counterattacks between state governors and the country's President, Mr. Jair Bolsonaro, and between the executive leader and the country's Supreme Federal Court (SFC), the highest organ of the Brazilian judiciary. This has greatly hampered concerted efforts to fight the pandemic ever since it began. While grappling with the best response to prevent the spread of SARS-CoV-2 across the nation, the President has found himself colliding with his own Health Ministry's recommendations. On May 15, 2020, Brazil's Health Minister, Mr. Nelson Teich, announced his resignation after disagreement with the President regarding the use of hydroxychloroquine, which was backed by the President at the time, and the adoption of social distancing measures. Mr. Teich was the second in a row to fall after the previous minister, Mr. Luiz Henrique Mandetta, was sacked less than a month before [34, 35]. As the disease spread during the third wave of the pandemic, mounting tensions between Mr. Jair Bolsonaro and his cabinet, the National Congress, and SFC led to great unease across the nation. There is ongoing concern about the stability of the country's somewhat young democratic institutions [36].

Although a political crisis would be highly unwelcome at a time when united efforts are needed to tackle COVID-19, Brazil seems to be heading in that direction. Such divergence between its most prominent leaders comes at a delicate time when the country is faced with an overall health, social, economic, and political crisis in the midst of a swelling pandemic. There have been nationwide protests from both sides, with its executive, legislative, and judicial powers at odds on several matters. Such political unrest is bound to increase the impact of the pandemic, especially on the most vulnerable. The country is faced with the challenge of navigating a delicate civil military balance amid a new surge of COVID-19 cases and health system overload. The scientific community and the people are puzzled by the opposing views conveyed by the country's leaders [36].

Several lockdown restrictions were gradually eased across the country when the first and the second wave receded. Some might argue that there is no one-size-fits-all approach to prevent an upswing in the SARS-CoV-2 epidemic curve. Early experience in some developed countries such as Sweden, which actually tried to challenge the need for strict social distancing policies and relied on herd immunity as the way out of the crisis, also could not refute the effectiveness of social distancing measures [37]. Because of the lack of universally available testing in Brazil, an upsurge in both the disease burden and the death toll is being witnessed countrywide. Therefore, to decrease the transmission of the Omicron SARS-CoV-2 variant while gradually lifting restrictions and tackling economic stagnation requires aggressive surveillance by widespread testing and contact tracing, for which the country is ill-prepared [36].

The Imperial College London, UK, undertook a study that showed that 300,000 deaths could have been prevented if the government had followed the WHO's and

the Health Ministry's guidance during the first year of the pandemic [38]. Not implementing preventable measures has led to the present tragic situation in Brazil.

On the positive side, Brazil has the largest publicly funded healthcare system in the world. Despite having lagged behind in vaccination rollout initially, the country took a giant leap over the past six months, which resulted in two thirds of its population being vaccinated and a tremendous drop in COVID-19 cases and deaths.

There have been a number of private and public as well as volunteer and non-governmental organization (NGO) initiatives to counter the problem of inadequate supplies, particularly of personal protective equipment (PPE), respirators, and testing kits. Food supplies were made available through partnerships fostered by community leaders in the *favelas,* where average wages dropped by over 70% [9]. Research, still highly underfunded, has been accelerated particularly in the vaccine arena. On March 2, 2021, Brazil officially connected with the COVAX Facility as part of the "Access to COVID-19 Tools (ACT) Accelerator" partnership program launched in April 2020. This is a global collaboration led by the WHO to foster the development, production, and equitable access to new COVID-19 diagnostics (e.g., halving the costs of SARS-CoV-2 rapid tests), therapeutics, and vaccines and to ensure access to other supplies such as supplemental oxygen, PPE, and treatment [39]. On December 20, 2021, in accordance with the COVAX operating landscape, the ACT-Accelerator vaccine pillar, in light of the global vaccination target of 70% by mid-2022, Brazil agreed to make a vaccine donation of over 10 million doses to low-income, neighboring countries in need. Such collaborative efforts could pave the way towards more equitable access to the COVID-19 vaccine around the globe [39, 40].

Despite the apparent success of the vaccination rollout in the country, which, in a sense, managed to compensate for the initial inertia in the authorization of vaccines against SARS-CoV-2 (lagging behind other upper-middle income countries such as Chile and Mexico), Brazil witnessed a myriad of flaws within its public healthcare system, both in its management and infrastructure. This was in stark contrast to the private sector. The lack of mass testing and viral spread tracking, coupled with the lack of preparedness and leadership in setting strict social distancing and lockdown measures, was further aggravated by the nationwide political turmoil, with ever-changing Ministers of Health, mentioned above. Anti-science efforts, downplay of disease severity, the spread of fake news, and inadequate government support for COVID-19 treatment schemes (the so-called 'COVID-19 kit') further underscored the interference of the Federal Government in the country's public health policies, the most controversial of which was its vaccination plan [20, 41].

Table 1 shows some demographic characteristics of Brazil.

Table 1 COVID-19 epidemic in Brazil: overall demographics

Surface area (million km^2)	8,16
Population estimate (2021)	213,317,639
Population over 60 years of age (60–64/ ≥ 65)	15.7% (4.9%/10.8%)
Life expectancy (2018): years (men/women)	76.3 (72.8/79.9)
Urban population (%)	87.6%
Race (2019) (%)	Caucasian 42.7, *Pardos* 46.8, Blacks 9.4, Indigenous/Asian: 1.1
Indigenous population	896,917
COVID-19-affected indigenous peoples	162
Percent of infected population (%) (ratio)	12.5 (1/8)
Daily RT-PCR tests: n/100,000 (7-day moving average)	77
Daily RT-PCR test positivity (%) (7-day moving average)	77.29
Daily RT-PCR tests: confirmed cases (n) (7-day moving average)	125.178
Physician per inhabitant ratio	2.3/1,000
GDP per capita (2019) (R$ 1,0 = USD 0,19)*	R$ 35.161,70 / U$ 6,680.72 (2022)
People under poverty line: U$1.90/day (PPP 2011) (%)	4.6
Unemployment rate (Q3 2021) (%)	12,6
Illiteracy rate (2019) (%)	6.6
Month with highest average, number of cases (daily average)	January 28, 2022: 260,806 (183,443)
First recorded COVID-19 death	March 13, 2020
Month with highest average deaths, number of deaths (daily average)	April 8, 2021: 4,148 (2,822)
Total reported cases/ratio# (Jan 29, 2022)	25,050,601 (~1/8)
Total cases in indigenous lands (official data/APIB data#)	58,619/ 64,516
Total reported deaths/ratio	626,170 (~1/337)
Total deaths in indigenous lands (official data/APIB data#)	864 / 1260
Vaccinated—1st dose: n, % population	164.409.885 (76.53)
Fully vaccinated —2 doses or single dose (*Janssen*) population	149.539.549 (69.61)

(continued)

Table 1 (continued)

Surface area (million km^2)	8,16
Total vaccine doses administered	313.949.434

Note Data as of January 29, 2022, unless otherwise specified
#Data as of January 30, 2022
Legend COVID-19: coronavirus disease 2019; RT-PCR: real-time reverse transcriptase polymerase chain reaction; *Pardos*: mixed race individuals; GDP: gross domestic product; U$: United States dollars; R$: Brazilian reais; Q3: third quarter; APIB: Articulation of the Indigenous Peoples of Brazil
Primary data sources The World Bank, *Instituto Brasileiro de Geografia e Estatística* (IBGE) [10], Johns Hopkins University—Center for Systems Science and Engineering (CSSE) [18], Our World in Data [2, 10, 18, 20, 42–45]

Public and Private Healthcare Systems and the COVID-19 Pandemic in Brazil

Brazil has two healthcare systems, the larger of which is its public system, the so-called Unified Health System (SUS), which covers the entire nation and is offered to every citizen with no direct costs. The SUS has been recognized by the WHO as the world's largest publicly funded healthcare system to date [29]. Seventy five percent of Brazil's population depends on it. The second is the private sector, which may be individually or collectively paid for and acts in a supplementary manner. It is currently regulated by Brazil's National Agency of Supplementary Health Care, ANS [41]. In Brazil, private health care providers are required to refund the SUS when any procedure covered by the provider is undertaken by the public healthcare service. Unfortunately, the country's private healthcare service is tainted with access barriers and inequalities. As of 2021, for instance, 14 companies reached 40% of the market while only 20–25% of the population had access to private healthcare assistance. Moreover, 70% of these people live in the southeastern region where healthcare resources and intensive care unit (ICU) bed capacity are considerably higher as compared to the other regions in the country [46].

According to the Brazilian Society of Intensive Care Medicine, there are currently 45,848 ICU beds in the country—2.2 beds per 10,000 residents. In the case of the 22,844 beds available for SUS patients, this ratio drops to a mere 1.4 SUS bed per 10,000 residents. It is even lower in some regions, particularly in the northern (mainly Amazonian) and northeastern regions [47]. Around 21.5% of the ICU beds available in the public sector were originally private, and about 64% were offered by philanthropic entities. Thus, the number of beds actually offered by the public service is even lower. This is due to the fact that hospitals in Brazil can simultaneously merge both public and private healthcare networks. Additionally, about 31% of all ICU beds in Brazil are in the private healthcare sector. A report from the Oswaldo Cruz Foundation (*Fiocruz*), which is considered the most prominent institution of science and technology in the health field in Latin America and is under the Brazilian Ministry of Health, showed that the private healthcare network, despite being accessed by

fewer than a quarter of the country's population, has a higher proportion of ICU beds per user (62.6 per 100,000 users) than the SUS (13.6 per 100,000 population) [48]. This SUS ratio may be even lower. There are reports showing that it is as low as 7.1 beds per 100,000 inhabitants. According to the Institute of Studies for Health Policies, ICU capacity should be doubled across 53% of the Brazilian territory to prevent the collapse of the public healthcare system like the one that occurred at the beginning of the COVID-19 pandemic in 2020 [48].

There is great discrepancy in patients with COVID-19 treated by the public and private health services. For instance, according to a report from the Intensive Medicine Association of Brazil (AMIB), 106,546 COVID-19 patients were hospitalized from March 1, 2020 to March 10, 2021. Of these, 4,405 (69.83%) were assisted by the private sector and 32,141 (30.16%) by the public system. A higher proportion of SUS patients required mechanical ventilation as compared to those in the private healthcare system (64.00% vs 39.60%, respectively) [49]. Likewise, overall ICU mortality rates were higher (51.90% vs 28.90%) among those assisted by the public than among those in the private sector [49]. This may be partly explained by the fact that SUS patients were placed under mechanical ventilation for a shorter period of time than those in the private health system (11.5 days vs 14.0 days, respectively) since the latter is equipped with better infrastructure for managing COVID-19 patients as compared to the public healthcare system, particularly in the proportion of ICU beds.

Despite an array of emergency government policies aimed at increasing investments in the public healthcare system to combat the pandemic, corruption and misuse of healthcare resources greatly contributed to the abyssal differences seen between the systems. Some of the imbalances relate to lower ICU bed occupation rates in private hospitals as compared to those in the SUS, which rendered several beds idle in the former. Solving this issue is somewhat challenged because there is widespread underreporting of ICU bed occupation in the private setting. For example, in the states of São Paulo and Rio de Janeiro, the private and public sector data are merged. The Brazilian National Health Council (CNS) recently advised the Ministry of Health and the state and municipal health authorities to apply a single policy for ICU bed occupation, which should be guided solely by demand and not by the location of beds in the public or private settings, as has been done in several European countries such as France, Italy, Spain, and Ireland [50, 51]. This led to a bill being passed by which the use of beds located in private hospitals would be made available to SUS patients with acute respiratory distress syndrome (ARDS) due to suspected or confirmed COVID-19. The ever-changing numbers of beds in private hospitals needs to be reported at regular intervals [51]. Despite resistance from a number of private sector enterprises, a few public–private partnerships, particularly those seen in São Paulo and Rio de Janeiro, enabled private companies to handle the costs of temporary ICU facilities in public spaces such as parks and football stadiums [52]. Such joint efforts, however, tended to be limited because of the lack of resources. Moreover, private healthcare companies tended to charge a lower price for individual, family, and collective healthcare plans which, in turn, resulted in offering services of lower quality than the standards recommended by the ANS [53, 54].

Although the number of hospital beds were more than doubled in both the public and private sectors and several medical schools waived end-of-course examinations to increase the number of newly graduated healthcare workers to be integrated into the frontlines, the healthcare system failed to keep pace with the increased need for healthcare personnel. This was further aggravated by the lack of specialized medical staff for managing mechanical ventilation and the like, particularly during the first wave of the pandemic around mid-2020 [30]. Even though Brazil has an overall physician per population ratio of 2.3/1,000 which is greater than that of most of its middle-income neighbors, the majority of its medical workforce is concentrated in cities [55].

Brazil's Indigenous Peoples and COVID-19

With 87.6% of Brazil's population concentrated in overcrowded urban centers, SARS-CoV-2 cases in rural areas and villages initially lagged behind those in urban centers. This did not prevent the almost 900,000 indigenous people (~0.5% of Brazil's population), who live sparsely around the country, from being hit by the virus. These minorities, among which 57% live on officially recognized indigenous lands, comprise more than 300 ethnic groups and are spread around 12.5% of the country's territory in 723 officially protected lands (according to the data from the last complete census in 2010) [45, 50]. Roughly a third of these people live in urban centers, which results in their not being counted for epidemiologic purposes. Thus, SARS-CoV-2 infection in these populations are largely underestimated.

Needless to say, 274 different dialects and idioms is another serious challenge for getting messages across to these people. In 1999, with a view to better adjusting the Brazilian healthcare system to the needs of the indigenous people and enhancing their access to healthcare, the Federal Government created an indigenous healthcare 'subsystem' consisting of 34 Special Indigenous Health Districts [12]. A decade later, in 2010, a Special Secretariat for Indigenous Health, linked to the Ministry of Health, was created, setting the stage for providing greater focus on this underserved population.

Despite these advancements, according to the Articulation of Indigenous Peoples of Brazil (APIB), the largest indigenous organization in the country, as of June 14, 2020, 2,390 people among 93 indigenous groups, most of which were from the Amazon Rainforest, had been infected by SARS-CoV-2, and 236 had died [44]. By the end of 2020, 44,648 indigenous people had been infected, among whom 605 (1.3%) had died; 41,589 had recovered from the disease [50]. The death rate doubled by January 30, 2022, with 1,260 having passed away [44]. In fact, at the beginning of the pandemic, some feared that these native communities would be 'wiped out', in reminiscence of the tragic impact of previous outbreaks such as that in the 1950s and 60s, which is said to have killed roughly a third of the *Yanomami* near the border of Venezuela [56].

As in the general population, the elderly were the most affected by COVID-19 among the indigenous tribes. Tribal chiefs, the so-called '*caciques*', are highly regarded for their lifelong wisdom and leadership role within their tribes. Death among these tribal pillars is a great loss and is a trigger that unsettles these people. As a matter of fact, COVID-19 can be particularly devastating for indigenous groups whose tribes are smaller. The *Juma* tribe, for instance, lost its last individual in February 2021, *Aruká Juma*, an 86-year-old man who died due to severe complications of the disease. There is a need to draw greater attention to other ethnic groups given the widespread reports of COVID-related deaths among *Pardos* and Blacks, as well as to individuals living in the northern region, which accounts for the largest share of poor people in the country [57–59]. Such socioeconomic heterogeneity in access to healthcare, diagnosis, and treatment clearly places these people at greater risk of getting COVID-19 and of dying from the disease [60].

In the past, in response to the COVID-19 pandemic, some indigenous communities began to split into smaller groups and to seek refuge in the forest. They gathered material for hunting and fishing and set up camps. Some took measures into their own hands by setting up roadblocks and barriers warning outsiders to stay away from their villages. They also avoided going to urban centers, which, however, became a problem when food stocks ran out [61].

There might be a greater threat of SARS-CoV-2 for some 100 groups who live in strict isolation from the outside world. These forest dwellers were impacted by an alarming increase (~58% on a year-on-year comparison between 2019 and 2020) in illegal logging, gold mining, and land grabbing in the Amazon region [62]. This is an old but, as yet, largely unresolved issue resulting from centuries of rapacious agricultural development, cattle raising, and colonial exploitation, rendering these people particularly vulnerable to foreign diseases and infections [63]. From a broader perspective, the disruption in food supply chains, in consonance with the increase in food insecurity worldwide, represents another downturn for these peoples. They also suffer from tuberculosis, malaria, and other mosquito-borne diseases that are endemic not only among forest dwellers, but also in several urban areas across the country [60, 64].

With the support of non-governmental organizations (NGOs), both the federal and state governments should design policies directed at this particularly vulnerable population to reduce the spread of SARS-CoV-2 and to ensure that indigenous lands are kept protected from invasion and deforestation [62, 65]. In a pandemic scenario, these should include preventative measures, such as the use of masks, vaccination, and widespread testing, to curb viral spread, make timely diagnosis, and facilitate access to effective healthcare.

SARS-CoV-2 Testing in Brazil

Underreporting has been a major issue since the beginning of the COVID-19 pandemic in Brazil in late February 2020 [66]. This was at least partly due to the

underdiagnosis that resulted from the lack of widespread SARS-CoV-2 testing across the country owing particularly to the lack of coronavirus real-time polymerase chain reaction (RT-PCR) kits [67]. According to data from the Ministry of Health, most of these tests were performed in the southeastern region of the country as opposed to its mid-western region, where the lowest number of tests were reported (an exception was the Federal District, which harbors the capital city's headquarters). Likewise, in the northern region of Brazil, remote locations in the Amazon Rainforest posed an additional challenge for getting testing kits and other healthcare resources to their final destination [50]. For several months, most SARS-CoV-2 diagnoses were made through quick blood and antibody-based tests such as those based on lateral flow immunoassays (LFIA). Fortunately, from mid-2020 onwards, the Federal Government increased public expenditure on RT-PCR tests, the gold standard for diagnosing COVID-19 [50, 68]. Since the so-called 'quick tests' basically rely on the detection of SARS-CoV-2-specific IgM and IgG, which typically take around 10–14 days for seroconversion, they are appropriate for surveillance. COVID-19 remains largely underdiagnosed, rendering real time reporting and management not possible [69, 70]. Although there were a number of drawbacks for both types of tests regarding the timely delivery of testing kits across the states, the RT-PCR tests posed the additional challenge of the high costs of the basic testing kit components. The ever-increasing market demand, the lack of appropriate equipment, the inadequate number of qualified people for conducting the tests and of specialized centers and laboratories, as well as the barriers for the transportation of samples from one place to another, were serious challenges [67, 71]. The WHO has emphasized the importance of mass testing since this is the main means to track the virus and reduce the spread of SARS-CoV-2, with around 30% of infected individuals being virtually asymptomatic yet capable of spreading the virus [72]. Therefore, the lack of a robust, publicly sponsored testing policy, along with the sluggishness in the distribution of test kits across the country rendered the COVID-19 pandemic notorious for being mismanaged. This was especially true for locations in which social distancing was not possible such as in the *favelas* and indigenous villages.

More recently, during the so-called 'third wave' of the pandemic, self-testing kits were shown to be an important strategy for containing the spread of the virus in Europe and the USA [73]. As of January 2022, the Brazilian Health Regulatory Agency, ANVISA, approved the use of at home COVID-19 testing kits and is now waiting for the Ministry of Health to decide on how to report test results and how to distribute these kits across the country [74].

The Imperial College London COVID-19 Response Team, UK, a WHO collaborating center for infectious disease modeling, studied the possible factors driving spatial and temporal fluctuations in COVID-19 fatality rates following hospitalization across 14 state capitals in Brazil. The SARS-CoV-2 Gamma variant spread rapidly across the country, causing significant infections and deaths. More than half of the hospitalized patients died over sustained time periods [38]. The authors found that the geographic and temporal fluctuations in Brazil's COVID-19 in-hospital fatality rates were primarily associated with geographic inequities and shortages in healthcare capacity. They projected that roughly half of the country's COVID-19-related

hospital deaths could have been prevented. The authors concluded that investments in healthcare resources, healthcare optimization, and pandemic preparedness are critical for decreasing the rates of morbidity and mortality resulting from a highly contagious and deadly pathogen such as SARS-CoV-2, particularly in low- and middle-income countries such as Brazil [38].

SARS-CoV-2 Vaccination in Brazil

Manaus, the capital city of the State of Amazonas, was the first to see its healthcare system completely collapse amid an exponential increase in the number of SARS-CoV-2 cases less than two months after the start of the pandemic in the country, in March 2020. In June, the cumulative rate of seropositivity reached 52%, after which it started to decline, suggesting that herd immunity had been achieved [75]. The demand for mass graves also began to decline. Nonetheless, only a few months later, Manaus faced a devastating second wave of COVID-19 after witnessing the emergence of the P1 lineage of SARS-CoV-2, which was shown to be more contagious and was able to reinfect individuals. This not only became a matter of global concern, but represented a great setback for any hope of achieving herd immunity to the infection [76]. In Sweden, where hopes were high in this regard, particularly at the beginning of the pandemic, it eventually became clear that herd immunity was a far off dream, further fostering the notion that widespread vaccination is the best means to reduce the spread of the virus [77]. Bearing this in mind, pre-clinical and clinical trials were undertaken at unprecedented speed, resulting in the development of several next generation vaccines, some of which started to be rolled out by December 2020, just a year after the COVID-19 pandemic began in Wuhan, China [78].

In Brazil, the second half of 2020 was marked by failed attempts of the scientific community and of several state governments to ensure that the Federal Government could make deals with vaccine makers in order to acquire the basic supplies and infrastructure needed to set up a nationwide vaccination program. Despite efforts of the Ministry of Health, the lack of interest of the government in acquiring vaccines and related supplies resulted in the country lagging behind several others even though both the BNT162b2 vaccine developed by Pfizer and BioNTech and CoronaVac developed by the Chinese company Sinovac Biotech could have been made available by late 2020 [79, 80]. After struggling amid public pressure involving Brazil's Regulatory Agency (ANVISA), state governors, the scientific community, and biotechnology partners, namely the Butantan Institute, the Institute of Technology in Immunobiologicals (*Bio-Manguinhos*), and *Fiocruz*, Brazil finally started its vaccine roll out on January 18, 2021. It scheduled four sequential vaccination phases, the first of which would focus on healthcare workers, older adults (over 60 years of age) and those residing in institutional settings, and indigenous people [50, 81].

A year on, as of January 18, 2022, this state funded nationwide vaccination program included vaccines from the main companies available, i.e., BNT162b2 (Pfizer/BioNTech), ChAdOx-1 (developed by the University of Oxford and

Astra-Zeneca in partnership with *Biomanguinhos/Fiocruz* in Rio de Janeiro), AD26.COV2.S (developed by Janssen, Johnson & Johnson), and CoronaVac Sinovac Biotech, in partnership with the Butantan institute, in São Paulo [81, 82]. While some negotiations were made with the Covax Facility Consortium (coordinated by the WHO), others were cancelled, namely that with the Gamaleya Institute in Russia responsible for Sputnik V [83, 84].

Despite a number of anti-vaccine statements spurred by the Federal Government and an ever-growing 'anti-vaxxer' movement, by the end of December 2021, the Ministry of Health announced that the country would have more than 400 million doses of vaccines against COVID-19 available for Brazilian citizens [85–87]. By then, the country had witnessed a steep drop in COVID-19 cases and deaths and a considerable decline in hospitalizations [19]. One of the probable reasons for the success of the vaccination program in the country, despite an initial period of inertia, relates to its century-long program of publicly sponsored vaccination across the country, coupled with the availability of state-funded facilities aimed at large-scale vaccine production and distribution [41].

Figure 1 depicts the current status of the COVID-19 vaccine roll out across different regions and states in Brazil [17].

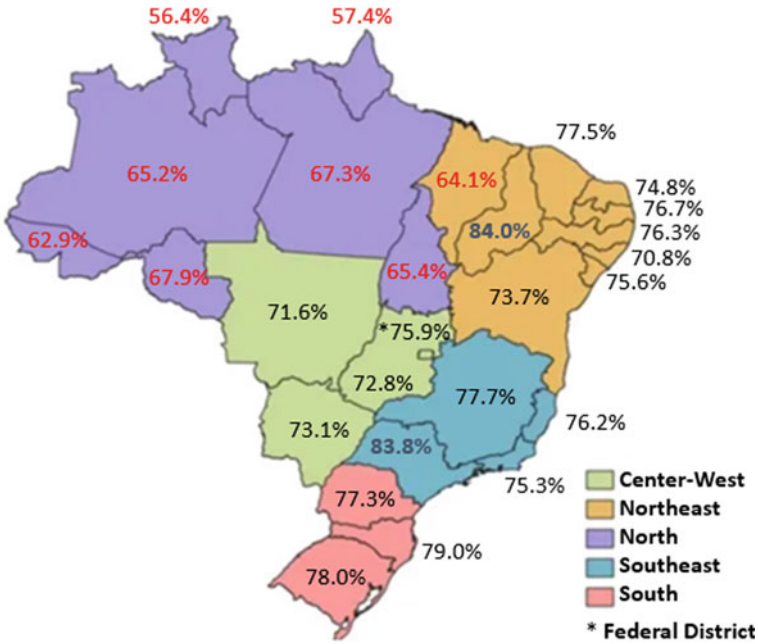


Fig. 1 Map of Brazil depicting its five regions and the current vaccination rate distribution among its 26 states and its federal district, January 28, 2022. *Source* Portal G1-Bem Estar—Vacina—Consórcio de veículos de imprensa [17]. *Adapted from* Brasil Consórcio de veículos de imprensa [17]

A significant proportion of the globe, particularly the African continent, remains largely unvaccinated with rates of vaccination less than 10% as of January 24, 2022 [20]. As a result, potentially more virulent and/or more contagious lineages of SARS-CoV-2 are bound to appear and circulate around the world, as the coronavirus has been shown to undergo myriad mutations. The advent of Omicron, for instance, in late 2021, shows how the virus can spread and reinfect individuals despite high rates of vaccination across the globe, although those who have been vaccinated with a complete vaccine schedule including a booster shot have a significantly lower chance of hospitalization and death (estimates in Switzerland point to an almost 50-fold drop of deaths due to COVID-19 for those with a complete schedule) [22, 23]. Several countries are suffering the consequences of the so-called 'third wave' of the pandemic [88]. Even though vaccines have conferred at least partial protection against the Omicron strain, infection rates have swelled across all regions, with a resulting increase in hospitalizations and deaths as well as loss of healthcare staff due to COVID-19. This was not different in Brazil, where both infections and deaths took an over 100% leap every day or so. The situation was worsened by the concomitant spread of a new strain of influenza A virus in the country (the H3N2 subtype). On the positive side, the vast majority of COVID-19 cases (of which Omicron already accounts for almost 100% in all regions) were mild, except among those who were unvaccinated.

Widespread vaccination is key for both individual and collective protection, as has been made clear by real world evidence. The odds of becoming severely ill are greatly reduced by vaccination [18, 19]. Vaccination also seems the most effective way for preventing the healthcare system from collapsing.

The Epidemic Curve in Brazil and Its Latest Trends

At the beginning of the pandemic, several states, particularly those in the northeastern region of Brazil, witnessed an overspill of both the public and the private healthcare systems, with healthcare workers facing the ethical dilemma of having to make heart-wrenching life-and-death choices. Manaus was the first to see its healthcare system completely collapse amid an exponential increase in the number of SARS-CoV-2 cases less than two months after the start of the pandemic in Brazil. The demand for mass graves began to decline some two months later. Such disruption in the healthcare system around mid-2020 hit hard virtually the whole country. In its richest southeastern region, calamity struck the state of Rio de Janeiro, where, because of the caseload, a number of patients had to be taken to hospitals over 100 miles away from their hometowns, after having queued relentlessly for hours outside the city's largest hospitals. This situation was aggravated by a government fraud scheme in which medical and protective gear were acquired. This further hampered efforts aimed at providing the needed healthcare support. São Paulo, the richest and most populous state in the country, was faced with a tireless struggle to achieve a social distancing rate of over 50% (the goal being 70% then). After witnessing the

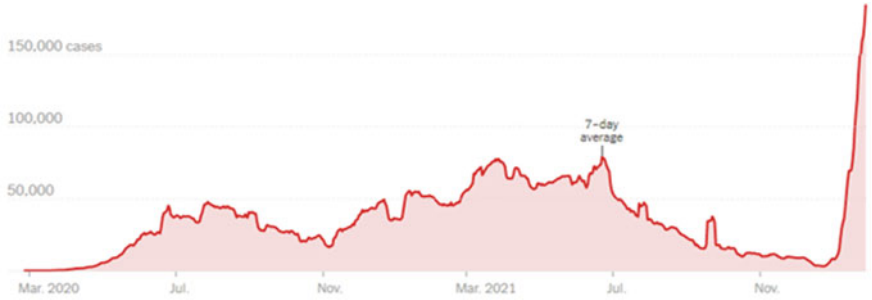
first recorded death in the country on March 13, 2020, a few months later, by July 2020, it had already more reported deaths than other highly affected countries such as Italy and Spain [4, 18]. Measures to counteract the epidemic, such as an amplified vehicle rotation restriction decreed in May 2020, were judged to be utterly futile after a mere couple of days. Instead of reducing the circulation rates across the city, it resulted in over 300,000 people (many of whom were unmasked) using public transport, with dire consequences. Such grim circumstances recurred at even greater rates during the second wave of the pandemic in the second quarter of 2021.

Based on daily updates of COVID-19 deaths and reported cases by the Ministry of Health, with data stratified at state level, SARS-CoV-2 attack rates (Rt) dropped dramatically following the adoption of social distancing measures in compliance with WHO recommendations [19]. Nonetheless, except for a mere three of its 27 (including the Federal District) states, this was not shown, at first, to bring the Rt below 1, which starkly contrasted with data published in other countries that had adopted strict lockdown policies [89, 90]. In early May 2020, a study from the Imperial College London, UK, showed that Brazil had the highest SARS-CoV-2 transmission rate in the world, with an initial reproduction number (R0) consistently in the range of 3–4 across all states [37]. As shown in this study, attack rates (and deaths) varied widely across states and regions, ranging from 3.3% in São Paulo to 10.6% in Amazonas. In fact, as of early May that year, five states (São Paulo, Rio de Janeiro, Ceará, Pernambuco, and Amazonas) were responsible for 81% of the reported deaths in the country. No matter how dismal these figures may appear, Brazil still remained far short of the 60–70% herd immunity said to be needed to prevent an upsurge of SARS-CoV-2 infection should control measures be weaned off [37, 91–93].

As for the latest trends in the country, according to data from the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University, as of January 29, 2022, an average of 183,443 cases per day were reported in Brazil over the past week, which reflects an increase of 166% from the preceding two weeks. The same situation occurred with respect to death rates, which increased by 166%**.** Thus far, January 2022 has been the month with the highest average cases per day (over a period of seven days). April 2021 was the month with the highest average deaths per day in the country [18, 94].

As of mid-January 2022, less than 50% of the indigenous people had been vaccinated with a complete dose schedule, despite being part of a priority group according to the federal vaccination rollout plan. As for the booster dose, a mere 13.5% (103,878 of 755,000) of those living within protected lands had received it by late December 2021. Moreover, SARS-CoV-2 testing was very low among these people, further defying the measures needed to decrease the impact of the disease [95].

On January 28, 2022, the Brazilian drug regulator agency, ANVISA, approved the use and marketing of COVID-19 self-tests provided some minimal requirements for registration were ensured [96]. However, while becoming part of the country's testing policies might help to tackle this unmet need, self-test kits will not be readily available to the public since they have to undergo licensing. Companies have been



	Daily average (Jan 28, 2022)	14-Day Change	Total Reported
Cases	183,443	+166%	25,050,601
Deaths	471	+166	626,170

Fig. 2 Overall trend of COVID-19 case and death rates since the start of the pandemic in Brazil, March 2020 to January 2022. *Adapted from* The New York Times [94]. *Primary source* Center for Systems and Engineering (CSSE) at Johns Hopkins University [18]

asked to build a dedicated platform accessible through QR codes to keep track of the positive cases [96].

Figures 2 and 3 depict the overall trend of COVID-19 case and death rates since the start of the pandemic in Brazil in March 2020 [18, 94].

Concluding Remarks and Future Perspectives

Brazil has faced a terribly difficult period in the past two years since the COVID-19 pandemic began. It is ranked among the most highly affected countries worldwide both in the number of cases and the number of deaths. The situation has been aggravated by a lack of strong leadership from the government, political turmoil, misleading policies, and fake news. The lack of unbiased countrywide policies and large-scale SARS-CoV-2 RT-PCR testing, as well as the use of futile approaches to combat COVID-19 have contributed to the dire straits with which the country is currently faced. Of note is the lack of specific policies for the most vulnerable such as the indigenous people and the poor. The lack of access to healthcare facilities, particularly due to high treatment costs, has further undermined the efforts aimed at combating the pandemic. Likewise, anti-vaccination (resulting in persisting SARS-CoV-2 vulnerable 'bubbles') and "anti-science" have hampered the attempts to impact the pandemic in Brazil. The state of the pandemic is not homogenous. Significant differences in resource availability among its regions and states explain the variable impact of the pandemic across the country.

In a country already battered by endless hardship, in which health policy has virtually turned into health politics, any concerted efforts aimed to combating the

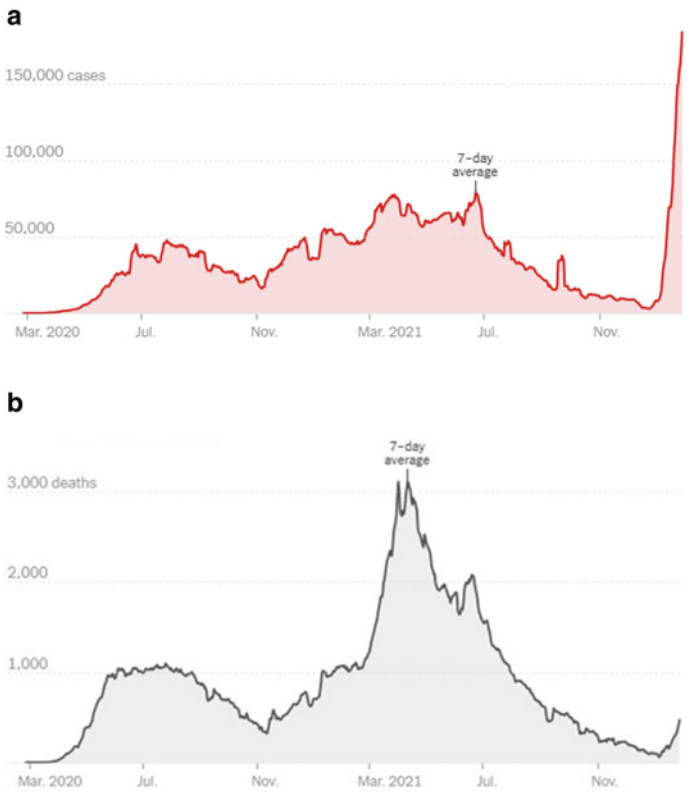


Fig. 3 **a** New reported cases per day since the outbreak in Brazil from March 2020 to January 2022. **b** New reported deaths per day since the outbreak in Brazil from March 2020 to January 2022. *Adapted from* The New York Times [94]. *Primary source* Center for Systems and Engineering (CSSE) at Johns Hopkins University [18]

pandemic are grossly undermined. Needless to say, with the public health, political, and economic collapse in the country, going against the tide seems inconceivable and somewhat naïve at a time where the entire world is grappling with the pandemic. Social support systems that are able to provide a solid safety net for those in need are urgently required. It now seems that SARS-CoV-2 is here to stay. It remains to be seen how the country will cope with the COVID-19 waves to come.

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Iran's Experience with the COVID-19 Pandemic: Focusing on Vulnerable Populations

Amir Moghanibashi-Mansourieh, Maliheh Arshi, and Amirhesam Arabgari

Abstract Iran was one of the first countries to be affected by the COVID-19 pandemic. The onset of the pandemic coincided with the serious ongoing economic problems that Iran was facing and which have seriously impacted the lives of Iranians. According to official statistics, there were about six million infections and 130,000 deaths due to COVID-19 by December 2021. Quarantine, social distancing, and other health protocols had an adverse impact on mental and social health. Vulnerable groups, including children, women heads of households, the homeless, drug addicts, and the disabled were at higher risk. Although initially governmental and non-governmental organizations were not prepared to manage the pandemic, overtime serious efforts were made to implement innovative measures in the areas of education and mental health service provision. Economic conditions in Iran have adversely impacted all these measures. The authors discuss Iran's experience with COVID-19 focusing on the health, social, psychological, and economic factors and draw lessons from these experiences.

Introduction

Iran is situated in southwest Asia. It borders Armenia, Azerbaijan, Turkmenistan, and the Caspian Sea in the north and Afghanistan and Pakistan in the east. The country's western and northwestern neighbors are Iraq and Turkey, respectively. Its border in

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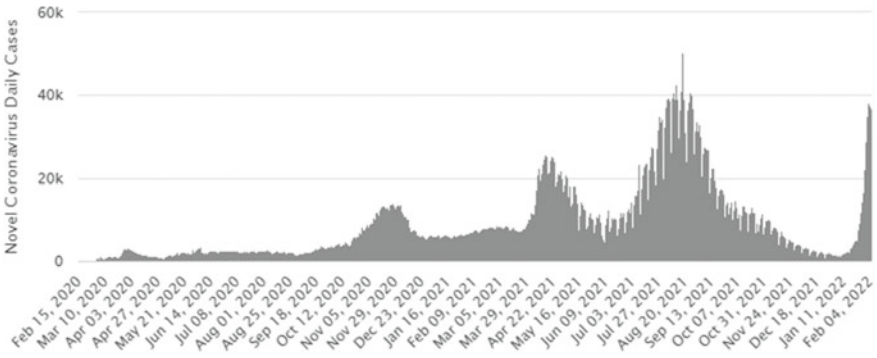

Fig. 1 Number of daily new confirmed cases per million people in Iran from February 15, 2020 to February 04, 2022. *Source* COVID-19 data repository by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University

the south extends to the Sea of Oman and the Persian Gulf. The capital city of Iran is Tehran.

Iran, the second largest country in the Middle East, has a population of over 80 million. Persian speakers make up about 60% of its population. Non-Persian speaking ethnic groups include Kurd (7%), Baloch (2%), Lor (2%), and Bakhtiari. Azeri-speaking Turks (24%) reside in the northwest and west. Turkmens (2%) live in the northeast. And the Qashqai tribe lives in the south. Arab tribes, with a population of about 2% of the country, reside in the southwest.

The COVID-19 pandemic in Iran was officially confirmed for the first time on February 20, 2020 in the city of Qom which is located 148 km from the capital [1]. A few weeks after the first positive case was identified, the Iranian Ministry of Health announced that the virus had infected all the provinces of Iran [2]. Figures 1 and 2 show the number of daily cases and deaths in Iran from February 15, 2020 to February 15, 2022.

The onset of the COVID-19 pandemic coincided with the end of the solar year, the Persian new year or *Nowruz* (March 21) which marks the beginning of spring. On this day people go for shopping and the streets are over-crowded. During the Nowruz holidays families travel, gather together, and organize ceremonies to celebrate.

Economic Conditions

Iran is currently experiencing one of the most challenging economic and social periods in recent decades. The economic crisis was at its peak in May 2018 when the former US President Donald Trump violated the Iran Nuclear Non-Proliferation Treaty and then withdrew. US sanctions have seriously affected Iran's economy which is dependent on its oil industry. The largest decrease in the gross domestic product (GDP) resulted from these sanctions in 2020 when GDP decreased to 6.8%.

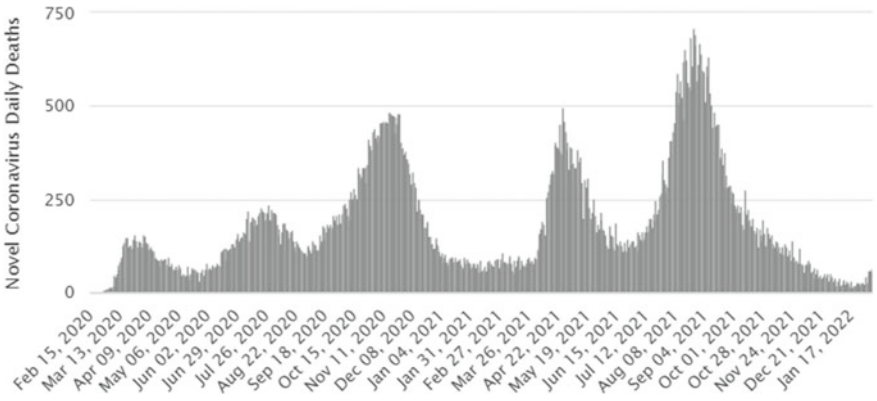

Fig. 2 Number of daily deaths in Iran from February 15, 2020 to January 17, 2022. *Source* Worldometers. https://www.worldometers.info/coronavirus/country/iran/#graph-deathsdaily

This shrinking trend in Iran's economy continued during the COVID-19 pandemic. In the spring of 2021, GDP decreased to 3.5% [3].

According to the Iranian Statistics Center, the inflation rate in Iran in 12 months upto July 2021 was 44.2%, the highest ever. Instability and rising inflation led to rising living costs putting more pressure on low-income groups as rising inflation increased the prices of basic commodities [3].

According to the Director General of Insured Affairs of the Social Security Organization, approximately 1.2 million people lost their jobs due to the COVID-19 pandemic. This figure was higher among women than among men [4]. According to a study conducted by the Higher Institute for Social Security Research, on average in 2020, 30.6% of the population lived below the absolute poverty line. This figure was 15.5% in 2017 and 21.6% in 2018 [5].

Sanctions had a significant impact on the availability of drugs in the Iranian market. Some drugs (such as Remdesivir, Dexamethasone, and Interferon Beta), which showed promising results, are now produced in Iran. At times there were drug shortages because of the increase in the number of hospitalized patients. The country was also in short supply for drugs to treat chronic non-communicable diseases. Iran had high rates of chronic non-communicable diseases such as cancer, diabetes, high blood pressure, etc. even before the pandemic. Due to the limitations of the Iranian banking system, raw materials for drug manufacture as well as for medical equipment and supplies for hospitals and medical centers were inadequate. Because of the sanctions, there are restrictions for importing high-tech equipment. Although, some personal protective equipment (PPE) (such as face masks, disinfectants, etc.) are now manufactured in Iran, there are restrictions on advanced testing and hospital equipment due to the sanctions [6].

Health System Response to COVID-19 Pandemic

The National Committee for COVID-19 Control instituted at the highest level to combat COVID-19 has as its members the President, members of the cabinet, and other relevant bodies. This committee took decisions on health, political, economic, social, and disciplinary measures. In the beginning, laboratory equipment in Iran was available only at the few centers in the capital. Diagnostic kits and laboratory technology were inadequate. But within a short time, the number of tests and laboratories was increased throughout the country. Laboratories were set up in medical universities. As of March 28, 2020, 90 laboratories set up in 31 provinces were able to perform diagnostic tests on a daily basis [7].

When the number of cases increased, the government implemented a social distancing plan. According to this plan, citizens had to keep a distance of at least two meters from each other when they were outside the house. Citizens did not have the right to leave the city and they could not move between cities. Fines were imposed for violations. Public venues as well as schools, colleges and universities, movie theaters, and venues for national sports were closed. And office hours were decreased [7].

One hospital was identified in each city to admit patients diagnosed with COVID-19. In response to the spread of the infection and the increase in the number of referrals, the number of hospitals admitting COVID-19 patients was increased. To reduce the burden on hospitals, a number of comprehensive healthcare centers were converted into outpatient admission centers or 24/7 centers and 16/7 centers. With the participation of other sectors, sports spaces, hotels, commercial centers, and exhibitions were used as inpatient and outpatient centers [7].

According to the Presidential Center for Strategic Studies, new information and communication technologies were used for COVID-19 monitoring and control. For instance, by connecting the Ministry of Health database to the e-government network of the Ministry of Communications and by monitoring telecommunication information through mobile networks, more than 112 land and air travel companies were banned from providing travel services to persons who did not observe quarantine rules. However, there were many problems while implementing these control measures. An outbreak map helped to monitor and control the pandemic by collecting telecommunications information on sick people and identifying provinces with high numbers of incoming and outgoing passengers. Outbreak risk points (combined calculation of traffic points of the infected as well as traffic flow) were calculated [8].

The Ministry of Health, Treatment, and Medical Education, as the custodian of health, launched an electronic COVID-19 self-assessment system at salamat.gov.ir3 to screen people suspected of having the disease. By entering the national code, anyone in the country could respond to simple questions on COVID-19 self-assessment and receive necessary guidance in accordance with the latest instructions from the Ministry of Health. After screening, suspected case were contacted and

provided advice. This information was later used to register and schedule individuals for the vaccination program [9, 10].

Given the increase in referrals and the number of patients hospitalized, the workload of medical staff greatly increased. The country's healthcare system had never before faced such a crisis or encountered such high workloads. Lack of information about this new disease and the behavior of the virus, non-availability of drugs, and lack of PPT equipment impacted the country's healthcare system especially in the early days of the pandemic [11].

To understand the challenges faced by hospitals and health staff at the frontline in the fight against COVID-19, a study was undertaken by the Tehran University of Medical Sciences in 11 faculties, 17 hospitals, and several research centers. Through interviews with 22 managers of different wards of hospitals, management challenges were identified (Box 1) [12].

Box 1 Management challenges

Managerial challenges included lack of preparedness, serious delays in making decisions, inability to provide protective equipment and medicines, and lack of financial resources.

Manpower challenges included stress and fear among health personnel of getting the infection, unwillingness of some to work, increased workload of specialized manpower, shortages of specialized manpower, and psychological problems faced by health staff.

Educational challenges included closure of the clinical educational system and widespread protests of medical students.

Research challenges included verification of herbal treatments through research, observance of scientific and ethical criteria, and electronic data collection.

Another study showed that the critical challenges for the management of COVID-19 were: limited information, insufficient attention to political, social, cultural, economic issues, lack of community participation, high workload of healthcare workers, work burnout, mismanagement of resources, lack of up-to-date and agreed upon guidelines for tracking contacts and patient flow, mental health problems, and lack of support for vulnerable groups [13]. Estimates indicated that family relationship networks and friendly gatherings that took place in different parts of the country caused the infection in 20 to 60% of the situations [14].

Vaccination

The COVID-19 vaccination program began in February 2021 in Iran with a limited number of Russian vaccines. More vaccines arrived three months later but they were less than 900,000 doses. Many of the promises made by the officials were not fulfilled because of the inadequate vaccine supplies. There was no domestic

vaccine production despite having forecasted that the vaccine would be manufactured by the summer of 2021. On September 23, 2021, the government imported more vaccines, thereby, accelerating the vaccination program. Currently, Sino farm, Bharat Biotechnology, Oxford AstraZeneca, Sputnik, and COViran Barekat vaccines are being used in Iran [13, 15]. According to the Ministry of Health, by January 27, 2022, a total of 60,601,957 people received the first dose; 53,873,978 the second dose; and 15,936,852 received the third vaccine dose [16].

Research shows that persons who were vaccinated had more confidence in the vaccine, the manufacturers, the government, and the health authorities [15]. However, there were individuals and groups who opposed vaccination. A study that was conducted on people over 18 years using combined quantitative and qualitative methods showed that regardless of the type of vaccine, a high proportion of people in Tehran were willing to get vaccinated. More than half of them wanted imported vaccines. The qualitative study which was conducted to better understand the experiences and perceptions of the residents in Tehran, showed that some people had doubts about the vaccine. The study highlighted their ambiguities about vaccine. There were safety concerns about the adverse effects of the vaccine and distrust of health officials and vaccine manufacturers. These were the reasons why people refused to get vaccinated [13].

Mental Health Consequences and Interventions

Even before the COVID-19 outbreak, mental health indicators in Iranian society were not favorable [17, 18]. The first study on mental health conducted in 2000 revealed that about 21% of the population was diagnosed with psychological problems. The second study conducted in 2012 indicated that 23.6% of the population was diagnosed with psychological problems and required psychiatric services. According to the findings of the 2015 study, the rate was 23.4% [17, 19].

According to the Secretary of the COVID-19 Mental Health Committee that conducted national research on 25,000 people in January 2021, almost a year after the COVID-19 pandemic began, showed that 29.7% of the population suffered from psychological disorders. This was a significant increase when compared to 2015. Among the study participants, 14.9% were already infected. Of these, 39.6% had psychological problems. Four percent of these people were already infected. And of these had lost a loved one at the time of the research and 40.8% suffered from mental health problems. These findings indicate that mental disorders were exacerbated by the pandemic [20].

Research on the anxiety status of more than 12,000 people found that frequency and severity of anxiety symptoms were significantly higher in people with infection. The level of anxiety among women was significantly higher than among men. The level of anxiety in the age group of 21–40 years was significantly higher than in other age groups. The higher the level of education, the more significant was the level of anxiety. The more people followed the news regarding COVID-19, the greater

was their anxiety. The level of anxiety among people who lost a family member, acquaintance, or friend was significantly higher [1].

The study indicated that COVID-19 caused many psychological problems such as stress, anxiety, depression, paranoid thoughts, and loneliness. Psychological interventions such as spirituality-based therapies for obsession, cognitive behavioral therapy, reality therapy, and acceptance and commitment-based therapy, could perhaps help reduce the effects of the disease. This study also showed that positive psychological traits of individuals such as self-care, conscientiousness, psychological toughness, social support, resilience, sense of cohesion, hope, sense of humor, and spiritual health contributed positively in addressing these problems [21].

Based on the statistics provided by the Director General of the Consultation and Psychological Affairs of the State Welfare Organization, a number of calls by couples related to family disputes during the quarantine period were made. The number of disputes between couples were three-fold higher in this period. Some of the couple disputes were related to how to observe health guidelines such as when a family member could go out of the house. With the closure of schools and the presence of children at home, many marital disputes arose over the upbringing of children. Home stay also resulted in violence including verbal and physical violence. Sometimes severe violence was reported [22].

To provide mental health services, a psychological self-assessment system was made available through the website of salamat.gov.ir. People could ask questions, receive feedback, and get access to self-care education on mental health. In addition, individuals could call 4030 and 1480 phone lines and get directly connected to mental health experts to get their services. They could also be referred to comprehensive health service centers for face-to-face services [1].

The Mental Health Committee of the National COVID-19 Committee provided educational materials related to mental health and offered information to the public on various visual, written, and audio platforms.

Formulation of guidelines for psychosocial support of patients and their family members and notifying them to health centers where other measures were undertaken to control the pandemic [23]. Guidelines for psychosocial support were provided to the survivors and families of the deceased. In Iran's culture, customs for mourning ceremonies are very important. Burial is part of the mourning process which provides an opportunity for mourners to express their feelings and emotions over the death of their loved ones and also enables them to vent their feelings. Given COVID-19 restrictions, the possibility of holding ordinary mourning ceremonies by gathering people in the third, seventh, fortieth day ceremonies as well as visits by friends and relatives was impossible. Therefore, the survivors not only lost their loved ones, but also could not gather and pay their respects to the deceased. They felt that their loved ones had died alone and without their support. Being next to someone who is seriously ill is an important expression of love. But, because of physical distancing, the infected person passed away without the presence of the family. And the bereaved family members remained with intense regret, feelings of guilt, and helplessness. The absence of a mourning ceremony, not being able to say goodbye to the loved one, not seeing the body before burial, and imagining the pain and suffering the dead

may have endured, left painful memories which remained with the survivors. Death resulting from COVID-19 made the mourning process difficult and had devastating long-lasting effects on the survivors [22].

Social Consequences and Responses

Distancing or limiting interactions were the most effective methods to counter infection, reduce the burden of the disease, and prevent the collapse of the healthcare system. But this strategy was not without cost. It had serious emotional and social consequences.

In Iran's society, household work and maintenance of children is still the woman's responsibility. At the same time many women are engaged in economic activities. The stay-at-home policy further increased women's responsibilities [24].

A Tehran municipal poll showed that in 16% of Tehran households, family tensions increased due to staying at home. In 58% of the families, the tension between the couple increased and 46% experienced an increase in the tension between parents and children [24].

Education of millions of students across the country was stopped to prevent the spread of the virus. The pandemic crisis showed that in less developed areas of the country, there was inadequate access to the Internet, laptops, and tablets, preventing students from seeking virtual education [24].

The changing socioeconomic environment due to the COVID-19 pandemic changed fertility preferences. According to the National Household Census, about 30% of single people postponed their marriage plans. In addition, about 24% of people, postponed their decision to have a child. According to this research, financial and economic concerns associated with the COVID-19 pandemic as well as public concerns about the future were the main reasons given by respondents for delaying their decision to have children [25].

Vulnerable Groups

The impact of the COVID-19 on vulnerable groups was more complex. Vulnerable groups included the homeless, substance users, the disabled, women, the elderly, and children. Vulnerable groups suffered more severe psychological, social, and economic problems during the pandemic.

The Homeless and Substance Users

At the beginning of the COVID-19 pandemic, due to fear of spreading the disease in enclosed areas, some responsible organizations stopped the plans to provide compulsory treatment to drug users and reduced admission of substance users into mid-term residential treatment centers. A large number of prisoners were also released. One of its consequences of the lack of a coherent support program was an increase in the number of the homeless [26]. NGOs and experts came together to form a working group with the help of the government and international organizations to address this situation to reduce harm. COVID-19 protection items were provided to more than 2,500 homeless people, mostly drug users. Preventive educational material tailored to the target group's conditions were developed (for example, podcasts were prepared and hotspots were broadcasted); patients were diagnosed and suspected cases were referred to health centers; and support was provided at the policy and decision-making levels [27].

With the increase in the number of diagnostic facilities and equipment, the State Welfare Organization ensured that everyone who entered treatment centers had a medical certificate showing a negative PCR test. In most cities, PCR tests were conducted for homeless drug users. According to a study conducted in Tehran, in the first seven months of 2021, more than 11,000 PCR tests were conducted in homeless drug users which resulted in the diagnosis of 6.04% i.e. 696 positive cases [28].

Women Headed Households

Female-headed households including widows, divorced women, wives of drug users, prisoners, and unemployed men, self-employed women and girls, and wives of disabled men were among the vulnerable. According to official statistics, there were three million female-headed households in the country. Many of these women worked in non-formal occupations to meet the needs of their families and most did not have valid employment contracts, nor did they receive minimum wages. Thus, their livelihoods and occupational health were affected. They faced problems because of lack of job security, unsafe working environments, and lack of access to social support. With the outbreak of COVID-19, these women's informal jobs were impacted and the incomes were greatly reduced. Although some women were covered by supportive institutions such as the State Welfare and Relief Committee, a major challenge for women in non-formal jobs was the lack of a comprehensive information system to provide data on the type of business and to identity women working in this field. This made it difficult to provide effective support for women working in the informal sector.

Women heads of households usually reside in very small houses and the constant presence of children in the house placed several restrictions on these women. The closure of schools required that tools such as tablets and mobile phones be provided

to the children. Imposing these extra expenses on women who had lost their jobs created difficult conditions for them. Thus, the disease led to an economic crisis. This made it impossible for women to renew their contracts. They could no longer pay house rent and had to move to poorer neighborhoods and smaller houses [29].

The National COVID-19 Committee approved loans were provided for house rent, housing deposit, and job creation. These women were also offered livelihoods and sanitary packages [30].

The Children

Quarantine conditions for children under 12 years caused anxiety and fear and affected the formation of the child's personality. Children's social interactions were severely hampered as they could not go to school and could not be with their friends. They were also subjected to verbal and domestic abuse at home.

Around 210,000 elementary schools and about 760,000 high school students dropped out of school because of the pandemic. It was difficult for poor parents to buy smart phones and internet packages. Consequently, these children were not equipped for learning at home. Social harm caused another problem that these children faced [31].

Despite the opposition of scientific groups and non-governmental organizations, the collection plan for street children was started before the pandemic. Mobile vans patrolled in the streets to transfer them to welfare centers. This plan continued even after the pandemic.

Disabled People

The State Welfare Organization (SWO) is responsible for caring for and providing services to the disabled. Currently, it provide services to 1,531,705 individuals with disabilities. During the COVID-19 pandemic, SWO made several attempts to control the disease in the disabled through various measures including education, care, and support. According to the evaluation report of the Research Center of the Islamic Parliament, SWO was able to prepare and compile educational packages and create several communication channels for the disabled. Care and support were mostly concentrated in rehabilitation centers which covered 52,200 disabled people [32].

A considerable portion (65.96%) of the population covered by SWO was, outside, these centers and so was deprived of support during the crisis. An alternative strategy was to meet the needs of the target community through distance education. Lack of an appropriate response due to the continuing crisis exacerbated the problem. Research findings showed that COVID-19 affected the livelihoods of the disabled. A survey conducted on the disabled showed that about 80% of these people needed immediate financial assistance [32]. A large percentage of the target community

(67.7%) reported that the closure of alternative rehabilitation centers had adverse effects. The SWO showed that 2.72% of the clients living in rehabilitation centers tested positive for COVID-19. Of these, 0.26% died [32].

The Elderly

The elderly constitute 9.9% of Iran's 83 million population. This number is constantly increasing. According to one study, the elderly first received information on COVID-19 from their families, then from television, and finally from virtual networks. The pandemic caused significant changes in their lives, including changes in lifestyle, communications, and leisure time. They feared of spreading the disease to other family members and peers. This led to feelings of obsession, depression, and powerlessness in the elderly [33]. They had to stay home for long periods of time. And their children and acquaintances could not visit them which intensified their feelings of isolation [34].

Prior to the pandemic, in many large cities, the elderly followed a daily program of walking and aerobic exercise in the park. During the pandemic, city parks and sidewalks were closed at various times, which led to physical inactivity and social isolation of the elderly [35].

For some of the elderly, COVID-19 came from a divine will. It was considered to be a divine test. Others believed that it originated biologically and treatment was possible [33].

Lessons Learned

The unfavorable economic situation due to the sanctions was aggravated by the COVID-19 pandemic. The pandemic affected all programs that were designed to address the economic crisis in Iran. Vulnerable groups suffered more because they had complex health needs even before the pandemic. The virus exacerbated their health, economic, and social problems.

The following lessons were learned during the pandemic:

- To address this and future pandemics, policy-makers should have a comprehensive view of the disease that includes psychological, social, and economic dimensions. A comprehensive integrated health system should be organized to address the problems.
- It is important to strengthen health sector capacity by providing adequately trained health professionals at all levels of the healthcare system.
- There is a need for a comprehensive monitoring system which includes vulnerable groups. Accurate statistics of vulnerable groups such as women heads of households, the disabled, children, etc. are needed for different parts of the country.

- It is important not to politicize the healthcare system. Iran was affected by severe sanctions under the heading of 'maximum pressure which affected the government's ability to provide diagnostic, health, psychological, social, and economic services to the people, especially to vulnerable groups.
- Additional inputs are needed for people living below the poverty line. It is critical to ensure that there is an equitable distribution of health services.
- The pandemic revealed that the government cannot by itself provide healthcare to the population in Iran. The wave of privatization of health services, which has accelerated during the past decades, must be re-examined to design public and private health services for Iran's population.

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Correction to: Global Perspectives of COVID-19 Pandemic on Health, Education, and Role of Media

Saroj Pachauri and Ash Pachauri

Correction to:
S. Pachauri and A. Pachauri (eds.), *Global Perspectives of COVID-19 Pandemic on Health, Education, and Role of Media*, https://doi.org/10.1007/978-981-99-1106-6

In the original version of the chapter, the following correction has been incorporated:

In chapter18 "Stigma Mechanisms in a Globalized Pandemic in India: A Theoretical Framework for Stigma", the text "The members in the GRID COVID-19 Study Group are the co-authors of this chapter. Dr Anirban and Dr Balaji are representing the GRID COVID-19 Study Group in the author byline as the corresponding authors" has been included.

In chapter 20 "The Public Health Response to COVID-19 in the UK: A View from the Frontline", the disclaimer text "The views expressed in this chapter are entirely her own, based on her professional experiences, and not indicative of her organization's in any way.", has been included.

The correction chapter and the book have been updated with the changes.

The updated versions of these chapters can be found at
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