



Biomedical research in developing countries: Opportunities, methods, and challenges

M. Masudur Rahman¹  · Uday C. Ghoshal² · Krish Ragnath³ · Gareth Jenkins⁴ · Mesbahur Rahman⁵ · Cathryn Edwards^{6,7} · Mahmud Hasan^{8,9} · Simon D Taylor-Robinson¹⁰

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Abstract

Health research is essential for improving global health, health equity, and economic development. There are vast differences in the disease burden, research budget allocation, and scientific publications between the developed and the low-middle-income countries, which are the homes of 85% of the world's population. There are multiple challenges, as well as opportunities for health research in developing countries. One of the primary reasons for reduced research output from the developing countries is the lack of research capacity. Many developing countries are striving to build their research capacity. They are trying to understand their needs and goals to solve their fundamental health problems, but the opportunity for research education and training remains low. The first joint research meeting of the Bangladesh Gastroenterology Society and the British Society of Gastroenterology took place in February 2020 at the Bangabandhu Sheikh Mujib Medical University in Dhaka, Bangladesh, aimed at providing an overview of medical research for young, aspiring medical researchers. This review article provides an outline of the research day and covers a number of useful topics. This review aims to provide a basic guide for early career researchers, both within the field of gastroenterology and, more generally, to all spheres of medical research.

Keywords Biomedical research · Biostatistics · Challenges · Developing country · Health research · Research

✉ M. Masudur Rahman
drmasud47@yahoo.com

¹ Department of Gastroenterology, Sheikh Russel National Gastroenterology Institute and Hospital, Dhaka 1212, Bangladesh

² Department of Gastroenterology, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow 226 014, India

³ Curtin University Medical School, Royal Perth Hospital, Victoria Square, Perth, WA 6000, Australia

⁴ Swansea University Medical School, Institute of Life Science 1, Singleton Campus, Swansea SA2 8PP, UK

⁵ Department of Gastroenterology, House G, Morriston Hospital, Swansea Bay University Health Board, Swansea SA6 6LN, UK

⁶ British Society of Gastroenterology, London, UK

⁷ Torbay & South Devon NHS Foundation Trust, Lawes Bridge, Torquay TQ2 7AA, and 3St Andrew's Place, London NW1 4LB, UK

⁸ Bangladesh Gastroenterology Society, Dhaka, Bangladesh

⁹ Gastroenterology Foundation, Dhaka 1205, Bangladesh

¹⁰ Department of Surgery and Cancer, Imperial College London, South Kensington, London SW7 2BU, UK

Introduction

Health is a crucial factor in national prosperity. Health has been accepted as a fundamental right of all people by the constitution of the World Health Organization (WHO) and the International Declaration of Human Rights [1, 2]. Health research is essential for improving global health, health equity, and economic development. Research capacity strengthening is one of the most potent, efficient, and sustainable ways to deal with national health problems and thus contributing to national development [3]. It is well recognized that scientific research has played a pivotal role in the advancement of technology and healthcare in the developed countries but developing countries, particularly the poor strata of the population in these countries, have benefitted little from this [4–6]. There are vast differences in the disease burden, research budget allocation, and scientific publications between the developed and the low- and middle-income countries (LMICs), which are the homes to 85% of world's population. Although non-communicable disease rates are similar, the burden of communicable diseases and maternal, perinatal, and nutritional disorders is 13 times higher, and the prevalence of violence/injuries is three times higher in LMICs than in high-income countries [7, 8]. Only about 10% of the global expenditure on health research and development is used for research in 90% of the health problems of the world mainly affecting the poor population, which is known as “the 10/90 gap” [4].

The challenges of health research in developing countries are different from the developed world, which are also the cause of low scientific output from these countries. Only 2% of the scientific publications in indexed journals come from developing countries [9]. One of the primary reasons for low-quantity and quality scientific research from the developing countries is the lack of research capacity [10]. Training and institutional development have been found as the key elements in research capacity strengthening [11]. Many developing countries are striving to build their research capacity to solve their local health problems. However, the opportunity for training and strengthening the research capacity remains low.

The collaboration and partnership between the developed and developing nations provide multiple opportunities for research and thus bridge this gap and resolve this inherent problem. The Bangladesh Gastroenterology Society in association with the British Society of Gastroenterology, which has a long track record for supporting the developing countries in research and education (<https://www.bsg.org.uk/international/>), organized first joint research meeting for the young gastroenterologists and trainees on February 17, 2020, at Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh. The meeting covered a variety of essential research topics. This review article aims to provide an outline of the research day to present a basic guide for early

career researchers, both within the field of gastroenterology and also in all spheres of medical research.

Why research is necessary for clinical practice

As human beings, it is in our nature to be curious about our surroundings and explore the unknown. In the past, as hunters and gatherers, we were experimenting on techniques and processes, based on assumptions and experiences. As the traditions evolved, we have matured in our thought process to the extent that we can critically think and act, based on evidence and facts. It has become a necessity for survival as human beings in this world. This follows the Darwinian principle “survival of the fittest.” Critical thinking plays a vital role in the modern world. Clinical research involves experimentation in human health and well-being. It is the systematic study into human health and disease states by observation or interventions which give rise to new and better ways of improving the health and well-being of the population. The eighteenth century saw a breakthrough in medicine when the smallpox vaccine was invented by Edward Jenner in 1798 [12]. This was following an observational study that milkmaids who developed cowpox were subsequently free of smallpox. Although this was a simple observation, followed by experimentation in humans, its impact on medical research, inventions, and innovation was huge. As we all know, the rest is medical history with the discovery of penicillin, antiseptics, anesthesia, steroids, X-ray, organ transplantation, and so on. In the field of gastroenterology, the Nobel Prize-winning discovery of *Helicobacter pylori* as a causative organism for peptic ulcer disease is fresh in our minds [13]. If it was not for the inquisitive young minds of the then medical registrar, Dr. Barry Marshall, and a pathologist, Dr. Robin Warren from the Royal Perth Hospital in Western Australia, we would have been still struggling to treat peptic ulcer disease. Notable breakthroughs in the field of gastrointestinal endoscopy include the invention of the fiberoptic endoscope [14] that paved the way to several minimally invasive interventions including polypectomy, sphincterotomy, and bile duct stone extraction via endoscopic retrograde cholangiopancreatography (ERCP), thus preventing open surgery.

Research is of high value to the population and society. It provides crucial information about disease trends, risk factors, and outcomes of interventions and allows invention and innovation in healthcare. It also informs the cost of healthcare delivery. Data and sample collection can be used for secondary research in epidemiology, health service logistics, genetic study, and public health interventions, to name but a few areas. All in all, research forms the platform for evidence-based medicine. Research is also a critical tool for evidence-based clinical practice. All of us must contribute to the research output according to our capacity. We would not be

what we are today without the research work put in by our forefathers. Without research, medicine would not progress. We would be relying on dogmas, intuition, and luck!

Clinicians depend on the results of medical research for the delivery of up-to-date healthcare. Therefore, all clinicians need to be conversant with current research in their specialty. To be able to understand research and interpret it in a way that can be fitted in with their clinical practice, all clinicians need to be familiar with the basics of clinical research. Taking part in clinical research is one of the best ways to learn the basics.

Asking a research question

The research question is the key parameter that focuses on any line of research enquiry. It is the what, why, who, and where to be asked. For example

- What is the prevalence of functional gastrointestinal disorders in India and Bangladesh?
- Why do people in town A die earlier than town B?
- Who was at the highest risk of death with hepatitis E during the epidemic in Kanpur, India?
- Which is the area with the highest incidence of infantile diarrhea in Chittagong?
- Is chloroquine useful in the treatment and as prophylaxis against severe acute respiratory syndrome corona virus 2 (SARS-CoV-2) infection?

The question has to be clear, concise, focused, and arguable, around which subsequent lines of enquiry can be framed. Aspiring researchers need to look at the world around them and frame simple questions aimed at improving the quality of patient care for the benefit of society. It is essential not to accept the status quo. A research question helps keep research focused and on track. It informs the line of enquiry, the method of research, the research protocols used, the analysis needed, and the structure of any subsequent publication.

Medical research and ethical issues

Research ethics are the moral principles that govern how researchers should carry out their work. These principles are used to shape research regulations agreed by higher education bodies such as universities, research funding bodies, the communities in which we live, or the governments. Furthermore, all researchers should also follow any local regulations that apply to their work environment. These basic precepts include honesty (honestly reporting data, results, methods, research procedures, and publication status), objectivity, integrity, carefulness, openness, respect for intellectual property,

confidentiality, and responsible publication. Other basic tenets are listed below

- Responsible mentoring of junior members of the team
- Respect for colleagues within and outside the research team
- Responsibility to the society in which we belong (including public engagement in science)
- Non-discrimination
- Competence and adherence to agreed protocols
- Legality (keeping within the law)
- Responsible animal care
- Human subject protection—respecting dignity, privacy, and autonomy

With respect to the last point, human subject protection, all participants in research studies should provide written, informed consent which conforms to the principles of the Declaration of Helsinki of 1975 [15]. Patient information leaflets detailing the research questions and procedures must be provided in transparent, lay language (funding bodies and journals may ask to see) with the opportunity for subjects to ask questions and not to feel compelled to take part. Data collected on each subject must be stored in an anonymized fashion according to the General Data Protection Regulation (GDPR) [16].

Local ethics committee approval is required to start any research. This approval governs the correctness of the research question, the feasibility of the research protocol, and the suitability of the documentation, including the consent forms and patient information leaflets. All ethical approvals need to be quoted in subsequent publications, along with a statement on conforming the guidelines upheld in the Declaration of Helsinki [15]. It is important to stress that no collaborative work can be done without full ethical approval.

It is also important in the light of the precepts outlined above to state that research misconduct includes fabrication or falsification of data and plagiarism of other people's results or their publications. The Economic and Social Research Council (ESRC) have published useful guidelines for further consultation, which can be found at <http://www.ethicsguidebook.ac.uk/EthicsPrinciples>.

Research funding

The funding required depends on the research question and its scope. For individual research training, the Commonwealth awards annual scholarships to aspiring researchers from all low- and middle-income countries, including South Asian countries like Bangladesh and India. The Chevening Foundation provides funding for Master degree courses in the UK with anyone eligible from 112 countries across the

globe, including Bangladesh, India, and South Asian countries. Candidates from Bangladesh are also eligible for research training fellowships from the Islamic Development Bank. Other sources of scholarship funding for well-established research ideas include the British Medical Research Council and the Wellcome Trust, both for young medical researchers, with the Royal Society additionally running schemes for pure scientists. Clinical training schemes include the Royal College of Physicians' Medical Training Initiative (MTI) for developing clinical skills at a junior doctor level, who can take the opportunity to get into clinical research.

The Newton Fund provides funding for scientific workshops and research exchanges, administered through the British Council. This fund is a useful step in strengthening collaborative research programs initially. Established programs may then apply to the Global Challenges Research Fund (GCRF) for larger amounts of money or bigger projects. Schemes such as the Association of Physicians of Great Britain and Ireland's "Links with Developing Countries" scheme provide useful starter funding for collaborative research projects between the UK and any Organisation for Economic Co-operation and Development (OECD)-defined low- or middle-income country. At the same time, the Tropical Health Education Trust (THET) focuses on more clinically related schemes.

Furthermore, the Charity Commission in London has a list of charitable or philanthropic organizations, which may provide funding, dependent on the research question. Finally, it is essential not to forget that many companies, such as finance to pharmaceutical industries may be interested in funding research through so-called "corporate social responsibility" programs. Funding applications for collaborative research projects with UK universities are more likely to be successful from these organizations. Moreover, many countries have their research funding government bodies. Individual philanthropic bodies such as Trusts and Foundations in many developing countries also support research to a limited extent.

Collaborative research

Most research today (particularly in the medical field) is carried out in collaboration with other scientists, clinicians, and data analysts. Very little research is produced nowadays in a single institution with only a few authors. The nature of research has meant that bigger studies are required to perform robust analysis, and this requires multicenter studies across institutions (and countries). Collaborative research brings together the skills of diverse individuals to maximize the research project. So, clinicians work with scientists to develop molecular insights into disease. These insights can lead to recognition of the targets that chemists and pharmaceutical

scientists can exploit using different drugs. Any drugs developed are then tested for safety by toxicologists. In this example, multiple skill-sets are harnessed to maximize the research effort. The synergy between the collaborators is critical to delivering the project goals. No one individual can deliver all the research aspects of a collaborative team. In collaborative research interactions are vital.

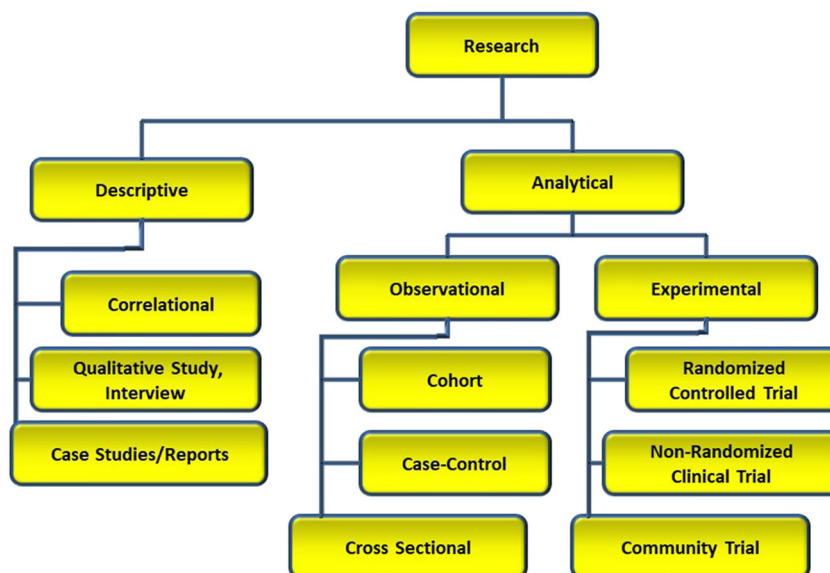
Interdisciplinary research is a growing area in science and physicists, and engineers bring substantial potential benefits to biomedical research projects by harnessing approaches and instrumentation that improve the detection and investigation of human tissues. For example, advances in nanotechnology allow printing of nanoparticles with sensors for measuring biomarkers in biological fluids and tissues. In the future, with the current advent of "Big data," there is much to learn from mining the routine clinical data collected in standard medical practice. This involves collaboration with computer scientists, who use the new tools of "machine learning" and "artificial intelligence." While these are highly technical and expensive, cutting-edge technology is beyond the affordability of many developing countries, and collaborative research with developed countries open up the new dawn to the young scientist of these countries. The global epidemiological study of functional gastrointestinal disorders by Rome Foundation conducted in 33 countries of 6 continents across the globe is a classic example of collaborative research between the developed and developing countries [17].

Research areas and the direction of the countries of the developed countries often differ from those of developed countries. Indeed, low-middle income countries often have enormous research potential in their healthcare services to address the research questions of the developed countries, but this should not be the sole driver [18]. Though research work carried out in collaboration with scientists of developed countries may primarily address their research questions, [19] it should ideally be a true partnership and should ideally be carried out in such a way so that both the communities are likely to benefit from the knowledge gained.

Types of studies and their designs

Choosing the appropriate design is a crucial step in undertaking any study to answer a research question. Figure 1 shows the different types of study designs. A study could be on a single patient (case report), a few patients (case series), observation on a population (descriptive epidemiology) and critical statistical analysis on these observations in the population to identify factors associated with the presence of a condition (analytic epidemiology), comparison between a group of patients and controls (case-control study), observation on a group of subjects under follow up (cohort study), and well-designed randomly assigned interventional study with

Fig. 1 Types of study design



appropriate randomized controlled trial (RCT). RCT may be double- or single-blind (both the study subjects and the observer are blinded to the nature of intervention in the former whereas only one of them blinded in the latter).

Depending on the period of observation in relation to the beginning of the study, it may be prospective or retrospective. For example, if an investigator looks for the development of lung cancer in future after the study has begun among smokers, this is a prospective study; in contrast, if somebody records the history of past smoking among patients after diagnosis of lung cancer, this is a retrospective design.

Prospective design is scientifically superior to the retrospective studies as the latter ones may be biased by several known and unknown confounders. Typically, observational studies including the case report, case series, and descriptive epidemiological studies are more of hypothesis-generating in nature, the case-control and uncontrolled cohort studies help to establish an association observed in the hypothesis-generating studies, and the RCTs prove these hypothesis experimentally. Figure 2 shows the levels of evidence. Randomized controlled trials and their meta-analyses, offer the best scientific evidence. For RCTs, due attention must be given to the PICO guidelines, as shown in Table 1.

It is important to note that the primary outcome measures should not be too many. The excellent study designs have very few outcome measures (typically one or two primary and two to three secondary). If the study aim is not optimal, it would not be feasible to design a good study. The aim of a good study can be summarized by the mnemonic FINER in which “F” stands for “feasible,” “I” for “interesting,” “N” for “novel,” “E” for “ethical,” and “R” for “relevant.” Sample size calculation is an essential component of the study design. For RCTs, due attention must be given to the method of randomization (simple, block, or stratified) and concealed allocation

to avoid bias. As per current guidelines, all the studies should be registered in a nationalized or international clinical trial registry after the institutional ethics clearance. A good practice is to write a summary of the study design briefly (including a flow chart) and get it reviewed by the study team members or colleagues.

The principles of statistical analysis: A primer

Before undertaking statistical analysis, one needs to ask himself/herself the following: (i) what are the types of data that are being analyzed (e.g. categorical also called

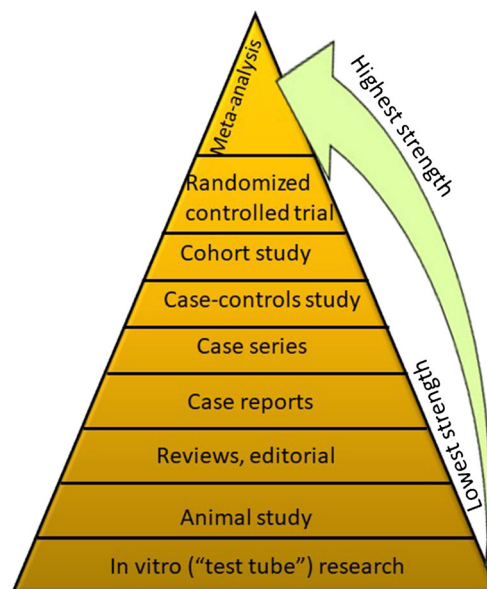


Fig. 2 Types of studies in relation to their scientific merits (The evidence pyramid)

Table 1 PICO guidelines

Abbreviations	Meanings
P	Patient, population, or problem
I	Intervention, prognostic factor, or exposure
C	Comparison or intervention (if appropriate)
O	Outcomes you would like to measure or achieve (primary and secondary)

nominal and discrete, or ordinal or continuous) and (ii) whether the data in question are normally distributed or not (normally distributed data are called parametric whereas the others are non-parametric). There are statistical tests to check for the normal distribution of the data (e.g. Shapiro-Wilk test). However, as a general rule, if the mean and median are quite different, the data are unlikely to be normally distributed; in contrast, if these are very close, the data are likely to be normally distributed.

Measures of central tendency and dispersion

The measures of central tendencies of the data include mean, median, and mode, and those of dispersion include standard deviation, range, and interquartile range. If the data are normally distributed, mean and standard deviations are the best ways to present these; on the other hand, data that are not normally distributed are best presented as median and range or interquartile range. The advantage of the median over mean is the lack of much influence of outliers. In medical science, the mode is not a popular method to present the data.

Hypothesis testing

It is also called significance testing, which is used to evaluate the researchers' belief against the null hypothesis (H_0). It suggests that the observed differences between the two groups are just by chance. The researchers need to nullify the null hypothesis based on the value of the probability (p -value). A p -value of less than 0.05 means that the probability of a null hypothesis (H_0) being correct is less than 5% (less than 5 out of 100 means less than 0.05 out of 1). In medical science, only two-sided and not one-sided p -values should be used. The calculation of p -value needs statistical tests, which are chosen depending upon the type of data, and their distribution. Figure 3 summarizes what statistical test to choose while comparing different types of data. The subsequent issues of the journal wish to bring a series of articles under the section "Postgraduate corner: Research techniques" on the topic.

Challenges of health research in developing countries

The challenges and opportunities for health research in developing countries are multifaceted, complex, and inextricably interlinked [20–23]. Table 2 summarizes the challenges and opportunities for healthcare research in low-middle income nations.

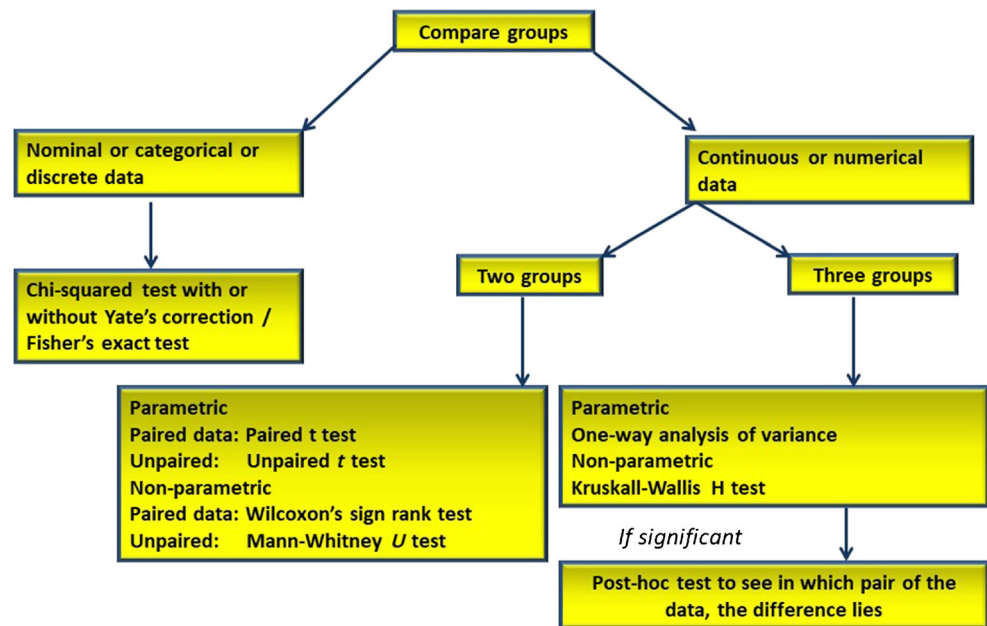
Limited facilities of research education and training for health professionals

Facilities for research education and training are fundamental requirements for the development of research infrastructure in any particular country. Training and education in research methodology are often deficient in the curricula of both undergraduate and postgraduate medical education in many developing nations. There is, therefore, a need for streamlining and modernizing the undergraduate and postgraduate curriculum. Another reason for such limitation is a relative shortage of medical workforce trained in research methodology [21]. Attainment and retention of an optimum number of researchers in biomedical research are essential for various reasons: (i) to perform research as per national priorities, (ii) to train healthcare professionals, who can evaluate health research and guide trainees and young researchers, and (iii) in the present era of evidence-based medicine, physicians should have necessary research skills to evaluate medical literature critically. All of these are lacking in many developing countries of the world as governmental priority is to feed the population, meet basic healthcare for the population, and not to train and retain skilled researchers.

Limited funding and research resources

One of the significant challenges of biomedical research is the shortage of funding and research resources to meet national health priorities. Allocation and monitoring of limited resources is another challenge. The Commission for Health Research recommended that 2% of the national health budget and 5% of the foreign aid for health program should be used for health research have been ignored by most of the LMICs [24]. Other sources of funding such as the pharmaceutical industry, trusts, foundations, and other donations are either lacking or under-utilized in many of the developing

Fig. 3 Types of commonly used statistical tests and their choice depending on types of data and their distribution



countries. In some countries, funding for medical research is non-existent.

Low priorities of health research and lack of research culture

Generally, the benefit of research is not sufficiently valued, and hence, the research is placed low on the national

Table 2 Challenges and opportunities for health research in developing countries

Challenges

- Limited facilities of research education and training for health professionals
- Lack of research culture
- Limited funding and resources
- Low priorities of health research
- Inadequate efforts for prioritization of research problems
- Ethical standards
- Limited access to health information
- Lack of collaboration opportunities due to different standards
- Missing linkages between different levels and stakeholders
- Health inequities

Opportunities

- Most health problems like disease burden and their determinants are unexplored
- A substantial number of patients
- Descriptive studies are not expensive
- People not averse to research
- Press is fond of home-grown research
- For getting promoted to higher positions (e.g. Professor), research publications are needed in many institutions

priority list in the LMICs. There is a lack of proper appreciation of health research as an essential tool for development among political leaders, policymakers, healthcare providers, and community groups in LMICs. The policymakers in these countries are not involved in knowledge-based and science-based decision making. Weak scientific leadership, assignment of scientists to other non-scientific works, poor remuneration or compelling the scientists to seek other sources of remuneration, inappropriate service conditions, and strong political influence on running of the institutions are some of the difficulties that may result in poor scientific research environment. Sometimes, researchers are seen as a threat to the person in higher positions rather than a matter of pride for an institution; therefore, they are not often supported. Teachers are overwhelmed with clinical work, and even teaching may be given a low priority, not to speak of research activity. The shortage of resources in developing countries paradoxically means the need for reliable healthcare evidence to prioritize the use of scarce resources [25].

Inadequate efforts for prioritization of research problems

A priority of the national research agenda needs to be developed based on national demands. The commission on Health Research for Development introduced the concept of Essential National Health Research (ENHR), which incorporates two approaches: (i) research on country-specific health problems is necessary to formulate sound policies and plans for field action, and (ii) contributions to global health research aimed at

developing new knowledge and technologies to solve health problems of general significance, which are also relevant to the population of the country [24]. There are inadequate efforts for prioritization of research problems in many LMICs. Limited information is available on the disease burden and their determinants, the cross-cutting issues like poverty, gender, and health policies that affect the health of the population. Such deficiency creates difficulty in setting priorities in those countries.

Ethical standards

To create and comply with ethical guidelines for human subjects consistent with the international standard is a challenge in many developing countries. Some countries lack the infrastructure for ethical and administrative regulation of research, reducing efficiency and quality. Mostly, this is the result of decision makers not having any knowledge of research.

Limited access to health information

Access to the national and international research publications is severely restricted for researchers in developing countries. This difficulty is because of the policy of pricing publications too high by the publishing houses for business purposes. Knowledge about the current status of a research question is central to the development of a good research proposal. There are also difficulties in the application of the best existing knowledge and scientific evidence to the country's health situation, if current knowledge is unavailable.

Missing linkages

The health research system is linked in many ways to different levels and different stakeholders. Health research system needs to be integrated into the national health development plans. The national health research system needs to be linked with global and regional research systems. Linkage of academic research like thesis and dissertation with the mainstream national health problems is lacking in different developing countries. Linkage of the research community, policymakers, and health services to utilize the optimum benefit of research in clinical practice and strategy formation is another challenge.

Health inequities

The health goal of sustainable development goals (SDGs) is to “ensure healthy lives and promote well-being for all at all ages.” Equity is the heart of SDGs which are found on the concept “leaving no one behind” [26]. To reduce the inequities in health between various population groups through health research addressing the health problems of the

vulnerable people and to make the benefit of research accessible to them are challenges of the developing countries.

Opportunities of health research in developing countries

Like the multiple challenges, there are also multiple opportunities for health research in developing countries. There are many unexplored health problems in developing countries. For examples, the disease burden and their risk factors are unexplored in many countries. To know the burden and determinants of these diseases do not require high-cost research projects. Descriptive studies are not expensive. Another opportunity for health research in developing countries is the availability of a substantial number of patients for clinical research. Table 2 summarizes the challenges and opportunities for healthcare research in low-middle income nations.

How to write a good paper

Writing a good paper relies on gaining experience in reading good papers. It is important to familiarize oneself with the relevant journals in the respective disciplines to recognize the types of papers which are published in a range of journals (from large international journals to local and national journals). Editors, when receiving papers, can reject them if they feel the paper is not suitable to the journal. The Editors send acceptable papers to the editorial board (or other reviewers), and the reviewers recommend the outcome (rejection, revision, or acceptance). A fundamental aspect of a “good” paper is the quality of the data contained within it. So, it is of primary importance to maximize the data quality before attempting to write the paper. When writing the paper, begin with the results; analyze and maximize the data quality; obtain the graphs, images, and tables; and perform statistics to identify significant effects. Then, write the discussion and introduction to shape the “story” of the paper.

Writing papers takes time and effort, the data generated can take several years, and it is worth planning the paper-writing when collecting data. The submission and review process can take several months (2–6 months) in itself. The writing stage can also take several months to finalize a paper. So, it is best to plan and factor in the time taken, as a rushed paper is more likely to be rejected as the reviewers (and Editor) notice the haste.

A significant reason why papers get rejected is the use of poor English in the paper. If English is not your first language, it is useful to ask for language proofreading to improve the written word. It may be possible to rely on co-authors to improve the English. It is certainly appropriate to engage all the

co-authors in the writing of the paper. They have to help if they are named in the paper. Other reasons for paper rejection include the lack of novelty in the data generated. Editors have to support the reputation of the journal and are keen to publish novel findings that receive high citation rates. Studies describing a well-known phenomenon without any novelty are dimly viewed by the Editor. Another reason for rejection is when the conclusions are not supported by the data; this can occur when authors overclaim the significance of their findings.

While choosing a journal for submission of the paper, consider the appropriateness of the journal with respect to the data. Over-reaching and submitting papers to leading journals can waste author's time and effort. Approaching the Editors or members of the editorial board is an excellent way to assess the “fit” for the paper in the journal in question.

Finally, think of the Editors (and reviewers) when writing your paper. Make it easy to read and easy to review and do not make it easy to reject—avoiding the obvious problems (English language, data analysis, highlight the novelty).

Editing and publishing a research study

Medical research papers currently are generally written in IMRAD format; IMRAD stands for introduction, method, result, and discussion. Each journal, however, may have some specific requirements, including the length of the paper. Hence, it is essential to carefully follow the instruction to the authors of that journal while writing and editing the paper. Introduction section should state the purpose of the work and provide a pertinent summary of the rationale for the study. This section should be brief, but at the same time, it should be able to draw the attention of the readers. It is good to state the hypothesis of the study, followed by its aims at the end of the introduction section. The method section should present how the work was done. This section should be stated in sufficient detail to allow other workers to reproduce the study. The statistical methods used should be outlined with enough details. A schematic diagram may be used to present the methods and the results. Result section, which reports what was found in the study, should be presented in logical sequence in the text, tables, and illustrations. It is worth reiterating that “a picture is more than 1000 words.” Discussion section typically presents what do the results mean? It should present the strengths and weaknesses of the study; strengths and weaknesses of the present data in the background of the other studies; consideration of essential differences in results; the meaning of the study, including possible explanations and implications for clinicians and policymakers; and commentary considering un-answered questions and future research.

The “7-point discussion” is a practical way to write the discussion, as shown in Table 3. The following points require consideration while writing a paper, (i) novelty, (ii) clarity,

Table 3 Seven-point discussion

1. Summary of the study and main results
2. Interpretation of the results and explanation for the findings
3. Description how the results are comparable with what else is known in the subject and review of the literature
4. Suggestion how the results might apply to other patients or diseases—applications and implications
5. Discussion on the possible effects of the results on healthcare delivery
6. Study's limitation and strength
7. List of conclusions

(iii) brevity, and (iv) avoiding verbosity and plagiarism (high degree of similarity in language with other published papers). Attention should be given to write good English, which is particularly essential for the authors whose first language is not English. A good practice is to write short sentences in active voice and avoiding a combination of sentences and dividing each section into multiple sub-sections. There are different guidelines for reporting different types of research (www.equator-network.org), as shown in Table 4.

Table 4 Reporting guidelines for main study types

Study type	Guideline	Website
Randomized trial	CONsolidated Standards of Reporting Trials (CONSORT)	www.consort-statement.org
Observational study	STrengthening the Reporting of OBservational studies in Epidemiology (STROBE)	www.strobe-statement.org
Diagnostic accuracy/-prognostic study	Standards for Reporting of Diagnostic Accuracy Studies (STARD)	www.stard-statement.org
Systematic reviews and meta-analysis	Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)	www.prisma-statement.org
Patient and public involvement (PPI)	Guidance for Reporting Involvement of Patients and the Public (GRIPP)	https://www.bmj.com/content/358/bmj.j3453
Study protocol	Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT)	www.spirit-statement.org
Clinical practice guideline	Appraisal of Guidelines for Research and Evaluation (AGREE)	www.agreetrust.org
Case report	CAsE REport (CARE)	www.care-statement.org

Selection of the journal is important. Factors to be considered in selecting a journal for publication include focus and purpose of the journal; local, regional, or global readership or whether the readers are scientists or clinicians; review process; acceptance rate; impact factor; publication schedule; print vs. online publication; credibility; and the cost of the publication. Though every author would like to publish the study in high-impact international journal, the journal editors and the reviewers also look at the novelty and the scope of the paper and whether it would be cited by others. Hence, it is good not to be over-ambitious. Revision of the paper and responding to the reviewers' comment are keys to success. It is important to remember that most reviewers are quite positive, and they are trying to improve the paper and respond accordingly.

Conclusion

Active research life is an essential component of the modern physician's portfolio to improve scientific knowledge, implement clinical treatment protocols, and promote high-quality, evidence-based service provision for the communities that we serve. Research does not have to be complicated, but it does need to adhere to the principles of scientific rigor, using a validated approach. Many research questions are purely observational, with the most straightforward ideas often being the best and the most achievable. An appreciation of statistics helps design a realistic and deliverable research protocol, but collaboration through a research network allows input from experts in data analysis at an early stage of planning. With a network of support, research is practical even for the busiest of clinicians contributing to a range of activities from sample collection for laboratory studies to clinical documentation in epidemiological or audit work. The importance of validated clinical phenotype cannot be over-emphasized. A research-active clinical community is evidenced to deliver improved patient outcomes and reduce mortality [27–29]. Being mindful of the opportunities for research in clinical practice is a key to the delivery of a better future for our patients. The role of National Specialty Societies in supporting this ambition is to promote the engagement of our members in such research activity and to support the publication of the resulting data through our peer-reviewed journals.

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Compliance with ethical standards

Conflict of interest MMR, UCG, KR, GJ, MR, CE, MH, and SDT-R declare that they have no conflict of interest.

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