



Healthcare workers' perspectives on the COVID-19 vaccine and boosters for themselves, their patients, and their communities: a mixed methods study

Shana A. B. Burrowes¹ · Sharon M. Casey² · Sidney Dobbins³ · Taylor Hall⁴ · Mengyu Ma³ · Ruqiyya Bano³ · Mari-Lynn Drainoni^{1,5} · Elissa M. Schechter-Perkins⁶ · Christopher Garofalo^{7,8} · Rebecca B. Perkins² · Natalie Pierre-Joseph⁹

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Abstract

Aim To examine experiences and attitudes of a diverse sample of clinical and non-clinical healthcare workers regarding COVID-19 vaccines and boosters for themselves, their patients, and their communities.

Subject and methods We conducted a sequential exploratory mixed methods study; 52 healthcare workers participated in qualitative interviews between April 22 and September 7, 2021, and 209 healthcare workers completed surveys between February 17 and March 23, 2022. Interviews and survey questions asked about personal attitudes toward COVID-19 vaccination and boosters and experiences discussing vaccination with patients.

Results Participants were predominantly White (56% and 73%, respectively) and female (79% and 81%, respectively). Factors motivating healthcare workers to take the vaccine were the belief that vaccination would protect themselves, their families, patients, and communities. Healthcare workers were accepting of and had high receipt of the booster, though some had diminished belief in its effectiveness after becoming infected with SARS-CoV-2 after initial vaccination. Race related mistrust, misinformation related to vaccine safety, and concerns about vaccine effects during pregnancy were the most common barriers that providers encountered among their patients and communities.

Conclusions Healthcare workers' primary motivation to receive COVID-19 vaccines was the desire to protect themselves and others. Healthcare workers' perception was that concerns about safety and misinformation were more important barriers for their patients than themselves. Race-related medical mistrust amplified concerns about vaccine safety and hindered communication efforts.

Keywords Healthcare workers · Vaccines · Vaccination hesitancy · Misinformation · COVID-19 boosters · COVID-19 vaccines

Shana A. B. Burrowes and Sharon M. Casey contributed equally.

✉ Rebecca B. Perkins
rbperkin@bu.edu

¹ Section of Infectious Diseases, Department of Medicine, Boston University Chobanian and Avedisian School of Medicine, Boston, MA, USA

² Department of Obstetrics and Gynecology, Boston University Chobanian and Avedisian School of Medicine and Boston Medical Center, Boston, MA 02118, USA

³ Boston University School of Public Health, Boston, MA, USA

⁴ Graduate of Medical Sciences, Boston University Chobanian and Avedisian School of Medicine, Boston, MA, USA

⁵ Department of Health Law Policy & Management, Boston University School of Public Health, Boston, MA, USA

⁶ Department of Emergency Medicine, Boston University Chobanian and Avedisian School of Medicine and Boston Medical Center, Boston, MA, USA

⁷ Department of Family Medicine and Department of Obstetrics and Gynecology, Sturdy Memorial Hospital, Attleboro, MA, USA

⁸ Family Medicine Associates of South Attleboro, South Attleboro, MA, USA

⁹ Department of Pediatrics, Boston University Chobanian and Avedisian School of Medicine, Boston, MA, USA

Introduction

The 2019 novel coronavirus disease (COVID-19) has resulted in over 500 million cases and more than 6 million deaths globally (World Health Organization 2022b). COVID-19 vaccines have been shown to be effective in preventing infection (Fowlkes et al. 2021), serious illness, and death (Lopez Bernal et al. 2021; Tenforde et al. 2021). Acceptance of COVID-19 vaccines, which were approved for public use in countries across the globe in late 2020 and early 2021 (Oliver et al. 2020; World Health Organization 2022a), will continue to play a major role in combating the pandemic. Healthcare workers were among the first to have access to and receive COVID-19 vaccines, at a time when data on safety and effectiveness were limited to clinical trials (Green-McKenzie et al. 2021; Thomas et al. 2022). Prior to Emergency Use Authorization, as few as 36% of healthcare workers indicated an intent to be vaccinated, although by the fall of 2021 up to 76% of healthcare workers in different settings had received at least one dose (Green-McKenzie et al. 2021; Reses et al. 2021; Shekhar et al. 2021; Thomas et al. 2022).

Several studies have highlighted COVID-19 vaccination hesitancy among healthcare workers, as well as their patients and the wider community (Biswas et al. 2021; Centers for Disease Control and Prevention 2022b; Finney Rutten et al. 2021; Fiolet et al. 2022). Pre-pandemic evidence showed that healthcare workers are the most trusted sources of vaccine information and positively influence patients to receive recommended vaccines (Smith et al. 2006). Researchers found higher rates of COVID-19 vaccine acceptance and vaccination rates among patients who received recommendations from their healthcare provider (Finney Rutten et al. 2021). A recently published study evaluated trust in COVID-19 vaccine information, and showed that clinicians influence public vaccine perceptions and health-related social norms (Latkin et al. 2021). Given the role healthcare workers play in vaccine acceptance among patients, it is important to involve a diverse sample of healthcare workers in studies about COVID-19 vaccine hesitancy. Importantly, healthcare workers other than physicians also have direct patient contact and can be a key source of support and information for patients (Kangovi et al. 2020; Peteret et al. 2008).

With the emergence of new SARS-CoV-2 variants, such as Omicron, which decrease vaccine effectiveness against infection, and the need for additional vaccine doses to retain protection against severe disease and death (Fiolet et al. 2022; Tenforde et al. 2021), it is critical to further understand healthcare workers' experience with the initial COVID-19 vaccine series and the evolution of their views on and acceptance of boosters over the course of

the pandemic. To examine this, we conducted a sequential exploratory mixed-methods study in a diverse sample of both clinical and non-clinical healthcare workers working in Massachusetts during the pandemic regarding attitudes toward COVID-19 vaccines and boosters for themselves, their patients, and their communities.

Materials and methods

Study design

We carried out a sequential exploratory mixed-methods study including qualitative interviews and a cross-sectional online survey with persons who work in healthcare settings in Massachusetts. English-speaking healthcare workers aged 18 years and older were eligible to participate. We established a Community Stakeholder Advisory Board and recruited members from various healthcare settings and areas of medicine, including emergency, family medicine, obstetrics and gynecology, and pediatrics, as well as auxiliary services such as public safety, environmental services, interpreter services, and social work.

Interview guide development

We created a semi-structured interview guide grounded in the constructs of the health belief model (Rosenstock et al. 1988). The interview guide was divided into two subsections; the first focused on adult vaccination in general and the second discussed the COVID-19 pandemic and the COVID-19 vaccine. Topics explored included healthcare workers' attitudes toward routine vaccines compared to the COVID-19 vaccine, reasons to accept or decline vaccination, barriers and facilitators to vaccinate, and perceived knowledge on vaccine safety and effectiveness. Participants were also asked how they obtained information related to the vaccine and how much they trusted these information sources. The interview explored whether the COVID-19 pandemic changed the way participants feel about vaccines in general, and if cultural or religious beliefs played roles in shaping these views. Those with direct patient interactions were asked about their willingness to recommend the COVID-19 vaccine to their patients, and about their patients' attitudes toward vaccination. Demographic information included age, sex/gender, race/ethnicity, country of origin, time in the United States for those born elsewhere, number of people in household, religious preference, role in healthcare, healthcare setting, area of expertise in healthcare, and geographical work location.

Interview participant recruitment and data collection

Members of the Advisory Board participated in interviews and also recommended additional participants from their networks. In total, we contacted 72 persons to participate in the interviews and 72% ($n = 52$) agreed. Healthcare workers included physicians, midwives, nurse practitioners, nurses, emergency medical technicians (EMTs), medical assistants, and other support staff.

Participants provided verbal informed consent, and qualitative interviews were conducted one-on-one with a trained qualitative researcher and digitally audio-recorded. Consistent with qualitative interview techniques, the interviewer asked open-ended questions with follow-up probes. Interviews were completed between April 22 and September 7, 2021 (See Fig. 1 for Massachusetts COVID-19 timeline) and averaged 1 hour in length, ranging from 30 to 80 minutes. Interview participants were compensated for their time.

Survey development

Following completion of the qualitative interviews, a survey was developed based on findings from the interviews and feedback from members of the Advisory Board. A summary of the interview results were presented to the Advisory Board and members gave input on topics that should be included in the surveys. The survey was presented in several sections, which paralleled those in the interviews, including (1) attitudes toward COVID-19 vaccination and boosters for themselves, patients, and others, (2) reasons for refusal of the primary vaccine series or boosters, and (3) reasons why those initially declining vaccination later accepted. The

survey was built using REDCap, a secure web-based application used to collect and manage research data (Harris et al. 2009, 2019). The survey was initially pilot tested by eight healthcare workers and refined before distribution.

Survey recruitment and data collection

The survey was disseminated using the snowball sampling method, where Advisory Board members and the study team shared the survey link with potential participants from their networks of healthcare workers practicing in Massachusetts. Individuals who participated in the study were subsequently asked to refer other potential participants. Upon clicking the REDCap survey link participants were introduced to study information, including the study purpose and eligibility criteria. Eligible participants included healthcare workers who worked in Massachusetts during the COVID-19 pandemic. Surveys were conducted between February 17 and March 23, 2022. Survey participants were compensated for their time.

Data analysis

Qualitative interviews

Interviews were reviewed and transcribed verbatim by members of the study team (Charmaz 2014; Elo and Kyngäs 2008). Transcripts were imported into NVIVO version 12 (released in March 2020) for coding and analysis. Consistent with content analysis methods, transcripts were coded in an iterative process and themes were developed and refined based on participant responses (Charmaz 2014; Elo and Kyngäs 2008). Both inductive and deductive coding were performed to create a codebook which was based on

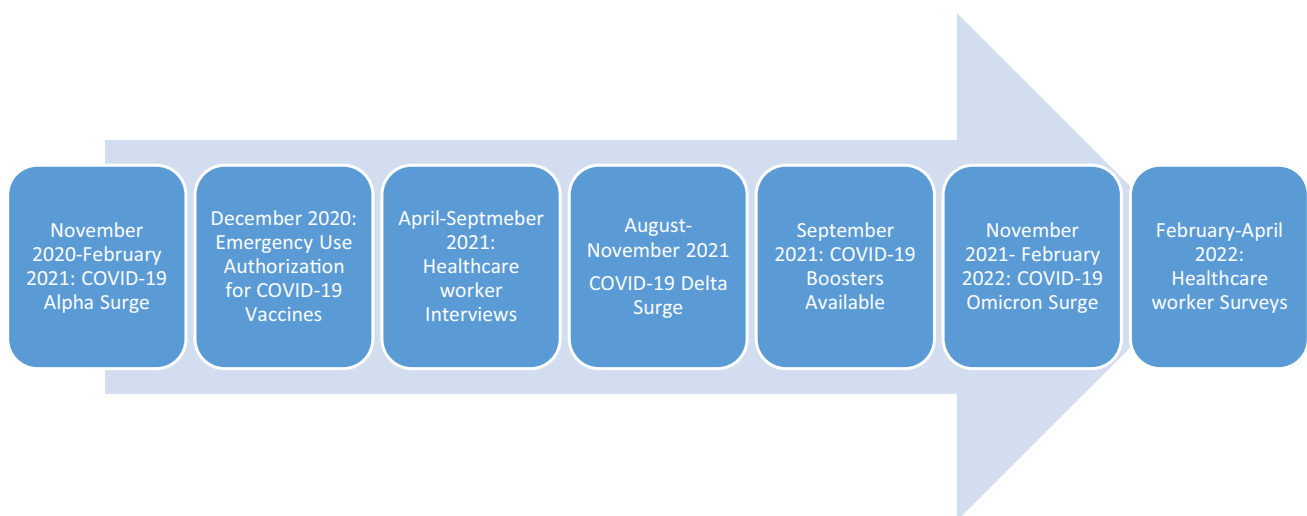


Fig. 1 Timeline of COVID-19 in Massachusetts and Research Project Activities: the series of events from the onset of the COVID-19 Alpha surge in November 2020 in Massachusetts to the completion of data collection in April 2022

the Consolidated Framework for Implementation Research model (Damschroder et al. 2009), but also included additional themes that emerged through transcript analysis. At least two researchers independently coded each transcript; weekly meetings were held to compare consistency in code application and to resolve discrepancies and make any needed codebook modifications

Survey

Anonymous data were exported from REDCap for analysis. Descriptive statistics were calculated and presented in tables. Categorical variables were collapsed. Open-ended responses were compared to the codebook developed for the qualitative interviews to determine any new themes. All statistical analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC, USA). The institutional review board at Boston University Medical Center approved both the interview and survey studies.

Results

Demographics

Qualitative interview participants

Table 1 details the demographics of the sample. Fifty-two healthcare workers participated in the interviews and all but one had received the COVID-19 vaccine. Participants ranged in age from 22 to 74 years, and were predominantly White (52%, $n = 27$), and female (79%, $n = 41$). Respondents were primarily physicians ($n = 19$, 37%), nurse practitioners/midwives ($n = 8$, 15%) and EMTs ($n = 6$, 11%), and worked in hospitals ($n = 24$, 46%), outpatient clinics ($n = 17$, 33%) or ambulances ($n = 6$, 11%). Areas of healthcare included obstetrics/gynecology ($n = 11$, 21%), emergency ($n = 9$, 17%), and ICU/critical care ($n = 4$, 8%). All participants worked in the state of Massachusetts during the pandemic. Most ($n = 36$, 69%) were born in the United States, and practiced Christianity ($n = 35$, 67%). Most reported having three or more people living in their household ($n = 38$, 73%) (Table 1).

Qualitative interview themes related to facilitators and barriers to vaccine acceptance

We identified two themes regarding views of and facilitators and barriers to COVID-19 vaccines and boosters: (1) Healthcare workers generally had positive attitudes toward COVID-19 vaccines and boosters that facilitated their acceptance; (2) Barriers cited by healthcare workers, more so for their patients and the wider community than for themselves, included misinformation, safety concerns, race-related medical mistrust, and inequitable vaccine roll-out.

Healthcare workers generally had positive attitudes toward the COVID-19 vaccine and boosters that facilitated vaccine acceptance

Overall, participants were accepting of COVID-19 vaccines and boosters for themselves and they reported that they routinely educate family, friends, and patients of the importance of vaccination. Although boosters were not available at the time of the interviews, most participants indicated that they were open to receive them if they became necessary. Motivational drivers to vaccinate included the belief that the vaccine was safe and effective, and wanting to protect themselves, their families, friends, patients, and their communities. Participants felt the benefits outweighed risks associated with vaccination and considered themselves a role model for their families and patients (Table 2). One participant explained their motivation as follows:

Honestly, it was probably a little bit external, it was probably knowing that I needed to represent to my kids that a vaccine was possible, and then I needed to represent to my co-workers... And I had to be someone who would step up and be like no, I'm getting this, I'll tell you how it is, it was ok, you know (P03-OBGYN MD).

Participants also reported that the vaccine provided some relief in the midst of constant exposure to SARS-CoV-2 and the uncertainty surrounding the virus. One participant stated:

...because it felt like we're walking into a dangerous situation, every day, and then, knowing that like being vaccinated would protect me from death was, was a relief, right (P02-Emergency Medicine MD).

One factor that bolstered participants' comfort and support of the COVID-19 vaccine was their knowledge and understanding of vaccine development. Participants reported that they mainly referenced information from the World Health Organization (WHO), or Centers for Disease Control and Prevention (CDC), as well as scientific journal articles to learn about COVID-19 vaccines, such as vaccine side effects, vaccine safety, manufacturing processes, and vaccine clinical trial results. The ability to comprehend primary sources of scientific information was a key element in supporting vaccination (Table 2). One participant explained:

...there's always skepticism about...taking a vaccine that is new. However, after I did research into the technology behind it, it turns out that the RNA technology is really not all that new, they've been using it for cancer vaccines and that type of thing for, for almost a decade... if there was something really wrong with this technology it would have come up 10 years ago (P09-Emergency Medicine MD).

Table 1 Demographics of interview and survey participants

Variable	Interviews/n (%) (N = 52)	Surveys/n (%) (N = 209)
Age (years) ^a		
18–35	12 (23)	85 (41)
36–45	11 (21)	58 (28)
46–55	19 (37)	44 (21)
≥56	10 (19)	23 (10)
Gender		
Female	41 (79)	170 (81)
Male	11 (21)	37 (18)
Transgender/non-binary	0	2 (1)
Race/Ethnicity		
Asian	3 (6)	19 (9)
Black/African-American	9 (17)	20 (10)
White	29 (56)	152 (73)
Mixed race	3 (6)	4 (2)
Prefer not to say	8 (15)	14 (7)
Hispanic/Latinx		
Yes	11 (21)	16 (8)
No	29 (56)	186 (89)
Prefer not to say	12 (23)	7 (3)
Country of birth		
United States	36 (69)	170 (81)
Outside United States	16 (31)	39 (19)
Household number		
1	5 (10)	19 (9)
2	9 (17)	49 (23)
3–7	38 (73)	141 (68)
Religion		
None	14 (27)	112 (54)
Christianity	35 (67)	68 (32)
Other ^b	3 (6)	29 (14)
Healthcare worker role		
Advanced Practice Provider (NP, CNM, PA)	8 (15)	14 (7)
Emergency Medical Technician/Paramedic	6 (11)	18 (9)
Medical or Patient Care Assistant	2 (4)	14 (7)
Nurse (RN, LPN)	5 (10)	38 (18)
Physician	19 (37)	71 (34)
Social worker/Mental health specialist	1 (2)	14 (7)
Other ^c	11 (21)	40 (19)
Healthcare setting		
Ambulance	6 (11)	16 (7)
Hospital	24 (46)	129 (62)
Outpatient clinic	17 (33)	47 (23)
Other ^d	5 (10)	17 (8)
Area of healthcare		
Emergency	9 (17)	27 (13)
Family medicine	6 (11)	10 (5)
ICU/critical care	4 (8)	13 (6)
Internal medicine	3 (6)	18 (9)
Obstetrics/gynecology	11 (21)	23 (11)
Pediatrics	5 (10)	67 (32)

Table 1 (continued)

Variable	Interviews/n (%) (N = 52)	Surveys/n (%) (N = 209)
Other ^e	14 (27)	51 (24)
Work location ^f		
Cape and Islands/South Shore	7 (14)	33 (16)
Central MA/Western MA	2 (4)	17 (8)
Greater Boston metropolitan area/North Shore	43 (82)	159 (76)
MA = Massachusetts		

^aAge; Interviews: 18–25 years ($n = 4$), 26–35 years ($n = 8$), 56–65 years ($n = 8$), ≥ 66 years ($n = 2$). Survey: 18–25 years ($n = 5$), 26–35 years ($n = 81$), 56–65 years ($n = 21$), ≥ 66 years ($n = 2$).

^bOther religion; Interviews: Judaism ($n = 3$). Survey: Hindu ($n = 8$), Islam/Muslim ($n = 2$), Judaism ($n = 10$), Judaism/Buddhism ($n = 1$), Meditation/The Golden Rule/Spirituality ($n = 2$), Orthodox ($n = 1$), Not specified ($n = 4$).

^cOther healthcare worker role; Interviews: Clinical Support Specialist ($n = 1$), Community health worker/Wellness advocate ($n = 2$), Director of Interpreter Services ($n = 1$), Environmental Services ($n = 1$), Patient Navigator ($n = 1$), Public Safety Officer ($n = 2$), Laboratory director/Research scientist ($n = 1$), Respiratory Therapist ($n = 1$). Survey: Dietician ($n = 2$), Laboratory director/Research scientist ($n = 7$), Lactation Consultant ($n = 1$), Pharmacist/Pharmacy technician/Pharmacy liaison ($n = 5$), Phlebotomist ($n = 4$), Physical/Occupational therapist ($n = 4$), Program manager/Administrator ($n = 8$), Imaging technician ($n = 2$), Not specified ($n = 7$).

^dOther healthcare setting; Interviews: Academic ($n = 2$), Community ($n = 1$), Homecare agency ($n = 1$), Remote ($n = 1$). Survey: Academic ($n = 1$), Dental setting ($n = 1$), Health Department ($n = 2$), Nursing home/Assisted living facility ($n = 2$), Remote ($n = 2$), School health center ($n = 2$), Multiple ($n = 3$), Not specified ($n = 4$).

^eOther area of healthcare; Interviews: Ambulatory (1), Nursing home/Assisted living facility/Elder care ($n = 1$), Research (1), Orthopedic Surgical Practice (1), Primary Care (1), Psychiatry (1), Public Health (1), Renal Medicine (1), Social Work (1), Not specified ($n = 5$). Survey: Administration ($n = 2$), Anesthesiology/Surgery ($n = 6$), Behavioral Health ($n = 1$), Dentistry ($n = 1$), Inpatient ($n = 5$), Laboratory/Research ($n = 6$), Neurology ($n = 1$), Nursing home/Assisted living facility/Elder care ($n = 1$), Public health ($n = 3$), Radiology ($n = 1$), Multiple ($n = 1$), Not specified ($n = 23$).

^fWork location; Interviews: Central MA ($n = 1$), South Shore ($n = 6$), Western MA ($n = 1$), Greater Boston metropolitan area ($n = 41$), North Shore ($n = 1$), Cape and Islands ($n = 1$). Survey: Cape and Islands ($n = 4$), South Shore ($n = 29$), Central MA ($n = 11$), Western MA ($n = 6$), Greater Boston metropolitan area ($n = 151$), North Shore ($n = 8$).

Another stated: ...I had read the articles. I had read what the CDC put out. I had watched the papers as they reported the results of the various vaccines, and I knew that all the ones I could get were efficacious and the small differences between them we're not meaningful to me (R03-Infectious disease MD).

Barriers cited by healthcare workers, more so for their patients and the wider community than for themselves, included misinformation, safety concerns, race-related medical mistrust, and inequitable vaccine roll-out

Healthcare workers' perception of barriers to vaccination in patients

Healthcare workers' perception was that misinformation regarding the COVID-19 vaccine was barrier to vaccination and a major source of vaccine hesitancy for patients.

Healthcare workers stated that frequently cited barriers to vaccination among their patients were concerns related to vaccine safety and efficacy, especially due to the rapid timeline of vaccine research and development. Healthcare workers reported that most patients received information from social media or the lay press, which often contained misleading or simply incorrect information (Table 2). Social media was a prominent source of misinformation and several participants noted that patients reported conspiracy theories, including the government use of COVID-19 vaccines to control people or the use of vaccines to inject microchips into the population. One participant stated:

The main concern is the one that you see in mainstream media like Facebook, like the vaccine has a chip or it has something to do with the government, or they try to dominate you using the vaccine (P24-Medical Assistant).

Table 2 Illustrative interview quotes

Summary Theme	Illustrative Quotes
1. Healthcare workers generally had positive attitudes toward the COVID-19 vaccine and boosters that facilitated vaccine acceptance	
a. Healthcare workers generally had positive attitudes toward the COVID-19 vaccine and boosters <ul style="list-style-type: none"> - They wanted to protect themselves and their families/patients - They felt like the benefit of the vaccine outweighed any risks - The vaccine provided some relief in the midst of constant exposure to COVID and the uncertainty around the virus. 	<p>“...there was so much fear around the potential of getting infected and then not knowing what it would do to your body, and so the idea that we could be protected and I’m still doing our jobs without having to worry about that fear I think that’s a big reason why a lot of us were excited to get it.”- (P14- Pediatrics MD)</p> <p>“...you couldn’t argue against it. I mean it made you safe at work, it made you safe at home, and made the people around you safe...”- (P05-ICU MD)</p> <p>“I would love to be able to hug my patients again, I would love to be able to feel like I am not risking them in any way, shape or form by coming closer to them.”- (P19- Pediatrics MD)</p> <p>“...I felt even if it’s not as effective as they’re claiming that this is better than nothing. If the alternative is getting COVID and dying” (P08- Pediatrics MD)</p>
b. Research articles, government agencies (particularly the FDA and CDC) and work place education are the main sources of information about COVID vaccines for healthcare workers.	<p>“...So I did look at, you know, the FDA makes all their materials from their EUA meeting public. So you know, anyone who has the curiosity and, obviously, you need somewhat of a scientific background to make it easier to interpret but they’re still pretty clear cut, so I did look at you know what their documents said to see if there was anything and I educated myself a bit...”-(P06- Internal Medicine MD)</p> <p>“...once they started talking about it on the news I started looking at kind of CDC recommendations and then going and actually doing some research of the primary, the primary data myself, so I can kind of make my own opinions.”- (P09- Emergency Medicine MD)</p> <p>“I read the first few studies that came out, that’s where I got my information on efficacy in terms of reduction of severe infection.”-(P18- OBGYN MD)</p> <p>“...I did resort to some more kind of the media and picking up points made in the media and follow through. But also to kind of chase down ah myths and/or, you know, beliefs so that I could understand them, to kind of negotiate those discussion that I would anticipate maybe having with patients.”-(P05- ICU MD)</p>
Barriers cited by healthcare workers, more so for their patients and the wider community than for themselves, included misinformation, safety concerns, race-related medical mistrust, and inequitable vaccine roll-out	
a. Providers cited misinformation as important barriers to vaccination <ul style="list-style-type: none"> - Misinformation about the effects of the COVID vaccine on fertility is common and a driver of vaccine hesitancy 	<p>“And they’re like ‘oh, you know, this is what happens, something comes out and then like 20 or 30 years later, you hear this is this horrible side effect’. Like autism from the MMR.”- (R09-Midwife)</p> <p>“But there is like this theoretical, kind of theory that if they took the vaccine that their capacity to become pregnant over the next year or so might be compromised, and they didn’t know what to do...”-(P05- ICU MD)</p> <p>“...she was hesitant about giving it to her daughter because there’s daughter’s 21. She’s like ‘oh, what if she, what if it makes her not be able to have kids or something’”- (R09-Midwife)</p>

Another common concern that healthcare workers heard from patients, friends and family was related to fertility and potential negative impacts of the COVID-19 vaccine during pregnancy. One participant noted the following concern from a family member:

...she was hesitant about giving it to her daughter... She’s like ‘oh, what if it makes her not be able to have kids or something’ (R09-Midwife).

Healthcare workers’ perception of shared barriers to vaccination for themselves and the patients they serve

Race-related medical mistrust impacted vaccination rates among both healthcare workers and the patients they serve. Concerns about historical race-related medical mistreatment such as the Tuskegee trials (Centers for Disease Control and Prevention 2021), as well as the persistent prevalence of race-related discrimination in healthcare settings,

Table 2 (continued)

Summary Theme	Illustrative Quotes
<p>b. Concerns about the safety and efficacy of the vaccine was a primary driver of vaccine hesitancy</p> <p>- The speed at which the vaccine was developed was concerning and some people felt like this made the vaccine experimental</p>	<p>“I’ve been told that there’s a lot of concern about does, do the mRNA affect your, you know, your genome...”- (P06-Internal Medicine MD)</p> <p>“...my only hesitation was that it’s a new, a new technology for vaccines. And that, and that it uses um messenger RNA , to do this, and that you know I do, I do believe that with new technologies and particularly when you start to work with things that are kind of making things in your body, it’s hard to really, there’s no way you can anticipate any of the effects.”- (P05-ICU MD)</p> <p>“...but it was just such an interesting experience, or not experience but um situation, where the science just sped ahead and, you know at lightning speed in terms of getting these vaccines made and some people viewed it as like the greatest miracle and they were celebrating and taking pictures and sharing it with family and, and then other people were like no, too fast, too soon, too untrustworthy.”- (P06 -Internal Medicine MD)</p> <p>“...I was a little bit hesitant because I, I felt like you know, the vaccines came out so quickly.”- (P20- Public Health Nurse)</p> <p>“..I think all of the side effects like oh, is it really safe, they don’t trust the vaccine, how can you be that fast.”- (R09-OBGYN Midwife)</p> <p>“One of the biggest barriers it’s just the uncertainty of it, and what it’s going to do inside of your body, and I think that’s just because one it’s hard to find that information, two a lot of the information isn’t really known...”- (P14- Pediatrics MD)</p> <p>“...I heard some people sort of say ‘no, I don’t want to be the guinea pig’, and did not get it, or waited to get it, I, it seemed that as time went on more and more people got it, nurses got it.”-P04</p>
<p>c. Safety concerns during pregnancy is a barrier to vaccination</p>	<p>“... other people feel like especially being pregnant, they didn’t, they want to wait until after they have the baby...”- (P04-OBGYN Midwife)</p> <p>“...for women who were actually pregnant, there was the concern about, you know, if I’m pregnant what is it going to do to the baby, you know, and what’s going to happen.”- (P05-ICUD MD)</p>
<p>d. Race related medical mistrust was a barrier to vaccination in both healthcare workers and members of the community that they serve</p>	<p>“My cultural beliefs are definitely that the government is definitely not for minority people, and given that the history of like you know, and in my culture where we’ve learned about all the different times that the government has used our people as guinea pigs”- (P25-Pediatrics Patient Navigator)</p>

led to reduced confidence in medical care. One participant explained their feelings of race-related mistrust in government-sponsored science as follows:

...my cultural beliefs are definitely that the government is definitely not for minority people and given that the history... in my culture where we’ve learned about all the different times that the government has used our people as guinea pigs (P25-Medical/Patient Care Assistant).

These experiences coupled with COVID-19 misinformation have impacted vaccination efforts in minority communities, as one participant stated:

People from the Black community, who look like me, who don’t want to take the vaccination because they’ve

heard it was a way for them to wipe us out [the Black race] (R04-OBGYN Advanced Practice Provider).

In addition to race-related mistrust in vaccine development, the inequitable roll-out of the vaccine across the state exacerbated vaccine inequities due to limited access. Participants noted that the communities most impacted by COVID-19, including minority communities, were not prioritized for vaccination efforts, and that the location of large vaccination sites were not easily accessible to these communities. One participant stated:

I live in one of the communities that have some of the highest rates of COVID and we can have very few testing locations and no vaccine locations when the vaccine first came out, so that was a very negative

experience for me not being able to find something that was convenient... (P16-Mental health specialist).

Overview of the survey sample

Two hundred and eleven participants completed the survey. Two participants who had left the healthcare profession were excluded from analyses. Of the 209 participants, 41% ($n = 85$) were between 18–35 years. Similar to interview participants, most survey participants were female ($n = 170$; 81%) and White ($n = 152$; 73%). Healthcare workers across the spectrum were represented; 71 physicians (34%), 38 nurses (18%) and others including EMTs ($n = 18$; 9%), medical assistants ($n = 14$; 7%), and social workers ($n = 14$; 7%). Survey respondents primarily worked in hospital ($n = 129$; 62%) or outpatient clinic settings ($n = 47$; 23%). Similar to interview participants, COVID-19 vaccine uptake among survey respondents was high ($n = 206$; 99%) (Table 1).

Survey participants' vaccine and booster uptake

Several events occurred between the interviews and the surveys (Fig. 1). Despite these events, positive attitudes toward vaccination were similar in to those noted during the interviews, with participants indicating a desire to protect themselves, their family, and their community (Table 3). One participant noted:

I basically wanted to get the vaccine to move forward in society. With what's going on, I wanted to be part of the solution not the problem (147-Pediatrics Medical/Patient Care Assistant).

Additionally, COVID-19 booster uptake was also high 85.9% ($n = 177$). Of the 29 persons who did not receive a booster, reasons included not thinking it was necessary or needed, lack of mandates, not yet being within the eligibility window either post initial vaccination or post COVID-19, concerns due to currently being pregnant, not wanting to feel ill again after experiencing side effects from the initial vaccine course, or losing faith in the vaccine after contracting COVID-19 after vaccination.

Vaccine and Booster Uptake-Patients, Friends, and Others

Survey participants were asked about willingness of patients, friends, and family members to be vaccinated (Table 4). Nearly all ($n = 188$, 90%) indicated that they did recommend or discuss the vaccine with patients, family, and friends. Survey participants noted similar reasons to interview participants as to why patients, family, and community members

declined vaccines: concerns about long term side effects and vaccine safety ($n = 158$; 84%), concerns related to pregnancy, beliefs that prior infection was protective ($n = 83$) and/or that wearing masks was sufficient ($n = 82$), mistrust in the government, and desire for autonomy in vaccination decisions. Most ($n = 174$, 83%) noted that some patients, family, or others initially declined the vaccine but later accepted. Healthcare workers noted that for some people, the experience of watching millions of people receive vaccination with few side effects and notable protection against disease was motivating ($n = 61$ 35%). Others chose to vaccinate when cases began to rise again ($n = 60$; 34%). However, the most common reasons healthcare workers noted among those who accepted vaccination after initially declining were mandates for either work or school ($n = 125$; 72%) or travel ($n = 34$; 60%). Utilization of vaccine boosters differed from the primary series. Over 56% ($n = 106$) of healthcare workers noted that some patients, family, and others took the primary vaccine but declined the booster. The main reasons for declining the booster were that an individual ($n = 49$; 46%) contracted COVID-19 after they had been vaccinated, wanted to wait until they had a free day to deal with side effects ($n = 26$; 25%), believed masks were sufficient protection, or felt boosters were unnecessary because they had not yet contracted COVID-19 ($n = 47$; 44%). Some healthcare workers noted that patients felt they were protected enough with the first two doses and thought that “extra” vaccines were too much.

Discussion

This mixed methods study explored the attitudes and experiences of healthcare workers, with COVID-19 vaccination. Overall, healthcare workers in this study had high COVID-19 vaccine uptake and expressed positive attitudes toward vaccines and boosters, which may stem from their use of primary scientific sources to obtain vaccine information. We found that our participants' belief in vaccine safety and efficacy and a desire to protect themselves and others were motivating factors for vaccination. The constant exposure to SARS-CoV-2 in the workplace also encouraged healthcare workers to be vaccinated. Importantly, positive attitudes remained stable between 2021 and 2022, despite additional COVID-19 surges and waning vaccine effectiveness against infection with new variants. We also found that booster uptake was high, and hesitation to take the booster was primarily due to healthcare workers not thinking it was necessary or not yet being eligible for their booster. Healthcare workers reported that patients and the lay community had persistent concerns about safety, fuelled chiefly through misinformation obtained via their primary information sources: social media and the lay

Table 3 Survey participants' views on COVID-19 vaccination and boosters for themselves

COVID-19 vaccination and infection history among those who received a COVID-19 vaccine ($n = 206$) ^a		
COVID-19 vaccination type	Yes/n (%)	No/NA/n (%)
J&J/Janssen	5 (2)	
Moderna	108 (52)	
Pfizer	93 (45)	
Received COVID-19 booster	177 (86)	29 (14)
Booster vaccination type		
J&J/Janssen	2 (1)	
Moderna	93 (53)	
Pfizer	82 (46)	
Had COVID-19	67 (33)	139 (67)
Before vaccination	16 (24)	
After vaccination	43 (64)	
Before and after vaccination	8 (12)	
Health problems lasting >1 month after COVID-19	19 (28)	
Children vaccinated against COVID-19 ^b	89 (43)	116 (57)
Why did you decide to get the COVID-19 vaccine?($n=206$) ^c	<i>n</i>	%
Protect myself/avoid illness	186	90
Protect my family	176	85
Protect my patients and my community	165	80
Vaccination was mandated at my work	75	36
Vaccination was required for travel	29	14
Why did you decline the COVID-19 booster? ($n=29$) ^c	<i>n</i>	%
Not needed	6	21
No time	2	7
Not mandatory	6	21
Other	17	59

^aDid not receive a COVID-19 vaccine $n = 2$, no response $n = 1$.

^bNo $n = 14$, N/A or I do not have children younger than 18 years old who are vaccine eligible $n = 102$, No response $n = 1$.

^cPersons can choose multiple responses therefore totals exceed 100%

press. Race-related mistrust of the medical system amplified these concerns.

Given the important role that healthcare workers play in the COVID-19 pandemic and the impact their views on vaccines have on their patients and the community around them, several studies have sought to examine their views on the vaccine and factors that support uptake. Consistent with our findings, research shows that healthcare workers report feeling more susceptible to and at higher risk of infection with SARS-CoV-2 and this in turn drives their motivation to be vaccinated (Al-Metwali et al. 2021; Biswas et al. 2021). While we found that healthcare workers in Massachusetts largely believed that COVID vaccines were safe and effective, other studies noted concerns about safety and effectiveness among healthcare workers (Biswas et al. 2021; Li et al. 2021; Verger et al. 2021). A review of 35 studies (29 conducted prior to vaccine availability, 6 after) on the

intention to receive the COVID-19 vaccine in healthcare workers across the globe, noted that concerns about vaccine safety and efficacy were common reasons underlying hesitancy. Of note, the rapid development of COVID-19 vaccines also contributed to hesitancy in several studies (Biswas et al. 2021).

With the emergence of new strains and waning immunity, COVID-19 boosters became necessary. Though the need for boosters could serve to undermine confidence in the vaccine, we found that among most of our participants this was not the case. Interview participants were open to boosters if they became necessary and this view was consistent with our survey results, which demonstrated high booster uptake. Other studies of healthcare workers found that intention to accept a booster was variable. A study of healthcare workers in the United States highlighted that vaccine hesitant persons were also hesitant to receive the booster even though they felt that

Table 4 Survey participants' views on vaccination and boosters for patients, family members and others

Among people you know (patients, family members, others) declining COVID-19 vaccination, what are their main reasons? (<i>n</i> = 188)	<i>n</i>	%
Concerned with short-term side effects (do not want/have time to feel sick)	78	42
Concerned with long-term side effects/do not believe vaccine is safe	158	84
Fertility concerns	59	31
Do not believe it is necessary because they are using masks or have not gotten sick	82	43
Do not believe it is necessary because they had a prior infection	83	44
Waiting to speak to another provider about their specific medical conditions	18	10
Will not tell me why	23	12
Other ^a	43	23
Among those declining boosters, what are their main reasons? (<i>n</i> = 106) ^b	<i>n</i>	%
Wish to delay until they have a free day to deal with side effects	26	25
Do not believe it is necessary because they are using masks or have not gotten sick	47	44
Had COVID-19 prior to vaccination	24	23
Had COVID-19 after vaccination	49	46
Waiting to speak to another provider about their specific medical conditions	7	7
Will not tell me why	10	9
Other ^c	29	27
Among those who initially declined COVID-19 vaccination and later accepted, what are their main reasons? (<i>n</i> = 174)	<i>n</i>	%
Mandate for work/school	125	72
Travel requirement	60	34
Accumulation of safety and effectiveness data (i.e., waiting for others to get the vaccination before feeling it was safe)	61	35
Rising COVID-19 rates (e.g., a new surge incases)	60	34
Discussed concerns with me or their primary care provider	42	24
Protect family member	48	28
Other (indoor dining, attend public or family event, etc.)	26	15

^aReasons for declining the COVID-19 vaccine included a need for personal freedom, concern about safety in pregnancy, misinformation and conspiracy theories around the vaccine, concern that the vaccine was developed too quickly, persons do not want to be experimented on, and political and religious views.

^bReasons for declining the COVID-19 booster are not mutually exclusive. Percent will add up to more than 100%

^cReasons for declining the COVID-19 booster included patients did not think it was medically necessary and thought that the primary series was sufficient, safety concerns in pregnancy, the desire to not get ill with the booster after experiencing side effects with the primary vaccine series, and disappointment that they got ill with COVID even after taking the primary COVID vaccination

a booster would be necessary to maintain immunity (Pal et al. 2021). Among a nationally representative sample of Czech healthcare workers, intention to take the booster was high overall (71.3%) but varied by worker type. Medical professionals such as physicians were more likely to take the vaccine, whereas allied health professionals such as nurses and laboratory technicians were more hesitant (Klugar et al. 2021).

Preferred information sources influenced vaccine hesitancy in our study. Healthcare workers in this study utilized the WHO, CDC, and scientific journals as primary sources for COVID-19 vaccine safety, efficacy, and development and did not rely on social media as a source of information. A study that explored Italian healthcare workers' sources of information regarding the COVID-19 vaccine reported that similar to our study, most participants used sources such as the WHO for

information. However, unlike our study there were differences in which healthcare workers utilized scientific articles. In the Italian study, nurses, technicians, and administrative staff were more likely to rely on social media for information compared to doctors, pharmacists, and biologists. Relying on less scientifically rigorous sources of information may partially explain why nurses and auxiliary nurses were more hesitant about accepting COVID-19 vaccine (Papini et al. 2022). However, other research found that access to scientific data/information about the COVID-19 vaccine does not necessarily result in acceptance. A study of providers in France, Belgium, and Canada show that, even after the release of safety and efficacy data, their initial hesitancy was not assuaged (Verger et al. 2021).

Although most healthcare workers in our study held positive views regarding COVID-19 vaccination, they perceived

that misinformation and safety concerns were major barriers and drivers of vaccine hesitancy in their patients. Similar to other studies, healthcare workers stated that patients had concerns about the safety, side effects, and efficacy because they perceived that vaccine development was rushed (Li et al. 2021). Consistent with other literature, healthcare workers in our study stated that patients reported concerns related to fertility and vaccine effects in pregnancy (Diaz et al. 2022). Healthcare workers in our study believed that many patients' fears about the vaccine stemmed from misinformation acquired from social media—an issue that has been prevalent throughout the pandemic. In a recent study that monitored online data from social media platforms to examine COVID-19 vaccine misinformation and its contribution to vaccine hesitancy, 83% of the information posted on social media was false and 10% was misleading (Islam et al. 2021). Another study exploring COVID-19 vaccine attitudes in healthcare workers in the UK found that social media misinformation influenced emerging concerns of safety in COVID-19 vaccination (Manby et al. 2022). Circulating conspiracy theories on social media platforms were also reported as concerns regarding vaccine hesitancy among some participants (Islam et al. 2021).

Healthcare workers offered insight into how they believed mistrust of medical systems and the government contributed to COVID-19 vaccine hesitancy and low vaccination rates among Black Americans (Dong et al. 2022; Reitsma et al. 2021). Prior research has similarly shown that mistrust of medical systems, deeply rooted in systemic racism, was a key contributor to vaccine hesitancy in racial and ethnic minority patients (Dong et al. 2022; Siegel et al. 2021), with some Black patients stating that the effects of the Tuskegee Experiment still impacts them today (Dong et al. 2022). Medical mistrust extends beyond vaccine acceptance; cumulative negative experiences interacting with medical systems throughout generations shape the idea that medical systems cannot be trusted and will continue to marginalize minority communities. A study of predictors of COVID-19 vaccine hesitancy in December 2020, showed that 62% of Black participants answered yes when asked if they had ever experienced racism or discrimination due to their race, and 8% of Black participants responded yes when asked if they were ever mistreated by medical professionals (Savoia et al. 2021). Thirteen percent of all minority participants in that study stated that they would never get vaccinated against COVID-19, while 47% displayed differing levels of hesitancy.

The fear of marginalization of minority communities that was noted in the interviews and surveys did in fact occur during the vaccine rollout, as problems with prioritization of vaccine locations and lack of availability to high-risk communities occurred in Massachusetts and other areas of the US (Nguyen et al. 2022). A review of strategies to improve equity and uptake of the COVID-19 vaccine in Black communities stated vaccination sites should not only be convenient but also

trusted such as barbershops, churches, etc. (Dada et al. 2022). Research from Boston Medical Center highlighted how a community centered approach that utilized community sites and mobile sites to reach individuals with the highest social vulnerability index resulted in the administration of over 100,000 first doses (Assoumou et al. 2022). A study in New York City showed that members of the Black Nurses Association were able to partner with community organizations to vaccinate over 22,000 people via community sites (Brown-DeVeaux et al. 2021). Given that COVID-19 is likely to remain an important public health concern, states will need to ensure that community testing and vaccination remain accessible and affordable, particularly in high risk communities.

Though our study provides insights into COVID-19 vaccination in healthcare workers and patients, it does have some limitations. Our study consists of a small sample size of diverse healthcare workers and professionals in the state of Massachusetts, a state that has consistently had higher vaccination rates than other states across the nation (Centers for Disease Control and Prevention 2022a). This limits the ability of our findings to be generalizable to healthcare workers in other geographic areas. Furthermore, the COVID-19 pandemic is a fluid situation and changes rapidly; therefore, participants' views and attitudes were in response to the state of the COVID-19 pandemic at a specific time and may not reflect the current state of the COVID-19 pandemic. Periodic research on COVID-19 vaccine attitudes and strategies among health care workers with larger sampling and wider geographic coverage should be undertaken as pandemic conditions change.

The study does however have several strengths. Primarily we share findings from a diverse sample of healthcare workers with direct and indirect patient care, including environmental services and security personnel. Most healthcare workers interviewed expressed positive attitudes toward the COVID-19 vaccine and were willing to provide vaccine recommendations to their patients, family members, and friends. Additionally, we show that over time there was consistency among interview and survey participants, highlighting several areas that can be targeted for future campaigns to address barriers to vaccine uptake. Drivers that motivate COVID-19 vaccination among healthcare workers were reflected by their knowledge, obtained from primary scientific sources, about vaccine safety and effectiveness and their willingness to protect others around them, including patients. Despite the availability of information on the COVID-19 vaccines, widespread misinformation on the internet and social media about the vaccine raised concerns for some people and negatively impacted vaccination rates, especially among the larger, non-medical community. This underscores the importance of promoting and reinforcing evidence-based science and combating misinformation. Furthermore, the persistent race-related mistrust between healthcare workers and patients among marginalized communities needs to be

addressed to ensure equity and more thorough messages on vaccine recommendations. Findings from this research can provide information for local organizations and public health authorities to help address barriers to vaccination acceptance and to determine best strategies for improving vaccination rates moving forward among health care workers, their patients, and the wider community.

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Data availability The data that support the findings of this study are available on request from the corresponding author, [RP]. The data are not publicly available due to their containing information that could compromise the privacy of research participants.

Code availability N/A

Declarations

Ethics approval The institutional review board at Boston University Medical Center approved both the interview and survey studies.

Consent to participate All participants provided informed consent to participate in the study.

Consent for publication All participants provided informed consent for their de-identified data to be published.

Conflicts of interest The authors have no competing interests to declare that are relevant to the content of this article.

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