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Building public confidence in innovative mRNA vaccines

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Building public confidence in innovative mRNA vaccines

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Editorial: Building public confidence in innovative mRNA vaccines

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Editorial on the Research Topic
Building public confidence in Innovative mRNA vaccines

When we began work on this series some 2 years ago, we were acutely aware of a hardening minority of global public opposition to vaccination. We did not, however, imagine that over the intervening months, vaccination in general, and mRNA vaccines in particular, would escalate into a political wedge issue that threatens to undermine the foundational role of immunization in public health.

Building public confidence in vaccines in general, and mRNA vaccines in particular, is more important now than ever. The rapid development and launch of COVID-19 vaccines was estimated to have saved over 14.4 million lives within the 1st year of their availability (1). Unfortunately, the pandemic also led to an unprecedented politicization of public health that significantly eroded confidence in vaccinations (2). Confidence in mRNA vaccines has taken the hardest hit. For example, several US states have actively tried to undermine access to mRNA vaccines for COVID-19 (3), a Japanese Nursing Ethics Association has recently questioned the safety of self-amplifying mRNA vaccines (4), and a high-level government report on pandemic response in Slovakia has suggested banning mRNA vaccines altogether in that country (5).

A global study analyzing over 740,000 tweets on X (formerly Twitter) about mRNA vaccines and therapeutics found that 69.5% expressed negative sentiment, while only 13.0% were positive (6). The Global Listening Project, a large-scale initiative dedicated to generating insights into key dimensions of societal preparedness to build social cohesion and prepare society for times of crisis, found that in 2023, only 66% of people would accept a newly approved mRNA vaccine (7). Additionally, despite many studies highlighting the safety and effectiveness of mRNA COVID-19 vaccines in children (8), vaccination uptake in this population has been very low across multiple jurisdictions (9, 10).

These challenges obscure mounting evidence that mRNA vaccines have already led to significant public health benefits and could accomplish a great deal more given the platform's potential for rapid adaptation to address novel pathogens, as well as emerging applications for preventing and treating non-infectious disease, specifically in oncology. Delivering on this promise will require better understanding and management of issues around mRNA vaccine hesitancy, and we hope this series of studies from a range of countries and populations will help accomplish this objective.

Trust (or lack thereof) in governments drives confidence in COVID-19 and mRNA-based vaccines. A study in the Democratic Republic of Congo found that publicly vaccinating the head of state increased acceptance, but only among those who trusted the head of state and who were aware it occurred (Collart et al.). A US study found that, despite eroded trust in federal and public health agencies, disadvantaged communities maintained reasonable trust in the municipal government for accurate COVID-19 vaccine information (Shiman et al.). A Canadian study highlighted the important role that community organizations can play in supporting vaccine confidence as trusted purveyors of information insulated from people's mistrust in government (Ashfield et al.).

Several studies in this series look at vaccine acceptance in specific populations. A study assessing vaccine acceptance among cancer patients in Jordan found that key drivers of vaccine acceptance included concern around COVID-19 infection and strong peer encouragement to be vaccinated (AlMasri et al.). Another study assessing vaccine preferences among pregnant and lactating women in Bangladesh and Kenya and found that non-mRNA vaccines were preferred due to safety concerns driven by media coverage (Schue et al.). A study of Canadian healthcare providers highlighted the importance of specialized communications training on having vaccine conversations with patients and found that virtual simulation games could increase confidence in this context (Doucette et al.). Finally, an intervention study in younger Canadian adults showed that short videos about COVID-19 based on messaging that focused on either altruism or individualism could increase willingness to be vaccinated (Batra et al.).

This series of studies highlights the importance of adopting constructive approaches to restoring public health confidence in vaccination, particularly mRNA vaccines. Efforts should prioritize grass-roots interactions within countries and targeted populations utilizing tailored messaging and communications strategies that address the specific concerns expressed by these communities. In an era where vaccine confidence faces multifaceted challenges, it is critical to spotlight research that advances vaccine advocacy and explores innovative approaches to building community influence in our collective efforts.

Author contributions

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Community organization perspectives on COVID-19 vaccine hesitancy and how they increased COVID-19 vaccine confidence: a Canadian Immunization Research Network, social sciences and humanities network study

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Background: COVID-19 vaccines play a critical role in reducing the morbidity and mortality associated with SARS-CoV-2 infection and despite vaccine availability, disparities in COVID-19 vaccine uptake among Canadian subgroups exist. Community organizations are uniquely situated to relay important vaccine messaging around all vaccines, understand components of vaccine hesitancy, and facilitate vaccine uptake within the communities they serve. The objective of this research was to solicit community organizations perspectives specific to COVID-19 vaccines and explore strategies of increasing vaccine uptake within their communities.

Methods: A qualitative focus group study was held in the spring of 2021 with 40 community organizations from across the country. Discussions focused on COVID-19 vaccine communication and awareness within their communities, vaccine misinformation, and strategies to increase vaccine acceptance and access. Data were analyzed utilizing thematic and inductive techniques.

Results: Vaccine hesitancy was identified among staff and clients. Vaccine confidence, complacency, convenience, and mistrust in government and authorities were identified as contributors to vaccine hesitancy. Community organizations utilized innovative and novel methods to encourage vaccine uptake and increase vaccine confidence. Leveraging established trusting relationships was key to successful messaging within communities.

Conclusion: Community organizations used innovative methods, built on established trust, to increase vaccine confidence within their communities and among their staff. Community agencies played an important role in COVID-19 vaccine uptake within subgroups of the Canadian population. Community organizations are key public health partners and play a critical role in increasing COVID-19 vaccine confidence.

KEYWORDS

COVID-19, community organizations, vaccines, vaccine hesitancy, trust, vaccine confidence

Introduction

Vaccination is one of the most effective ways of preventing morbidity and mortality associated with vaccine preventable diseases, yet despite progress vaccination coverage has plateaued (1). The Coronavirus disease 2019 (COVID-19) pandemic has highlighted the important role of public health in disease prevention, detection, and in promoting health. Similar to other infectious disease vaccines, COVID-19 vaccines play a critical role in protecting against severe disease, hospitalizations and death (2). Despite efforts to make COVID-19 vaccination available to all Canadians, disparities in vaccine uptake remain among certain subgroups (3). Mainstream public health messaging is necessary to convey the importance of widespread vaccination to the general public and to dispel disinformation related to vaccines and vaccinations (2, 4). Throughout the COVID-19 pandemic vaccine misinformation and disinformation proliferated (5). Traditionally the term misinformation refers to false or misleading content shared without harmful intent, although the effects can still cause harm, in contrast to disinformation where false information is purposefully spread with the intent to deceive, gain political and/or economical gain (5). COVID-19 misinformation went beyond health aspects and included political responses to the pandemic, origins of the virus, and the severity of the virus (5). These challenges further highlight the need for targeted public health communication strategies to enhance vaccine uptake among 'under-reached' and disadvantaged subgroups of Canadians (6, 7). Community organizations play a critical role in facilitating the uptake of vaccine promoting messaging within the diverse populations they serve. There are several terms utilized to describe individuals who have been underserved, marginalized, vulnerable, racialized, colonized, disadvantaged and/or discriminated against, this paper will use the term disadvantaged throughout.

This qualitative research was conducted with the purpose of soliciting community organizations' perspectives of COVID-19 vaccines and to explore ways in which these organizations work to increase COVID-19 vaccine acceptance among disadvantaged populations. Community organizations targeted in this project included charities, unions, professional associations, community-based organizations, faith groups and social enterprises that provide health care related services to a wide variety of individuals.

Background

A worldwide COVID-19 pandemic was declared by the World Health Organization on March 11, 2020 (8). This disease spread rapidly throughout the world with cumulative cases exceeding 183 million and more than 4 million deaths worldwide (9). Prior to the COVID-19 pandemic, international public health organizations were concerned about a decrease in uptake of routine childhood vaccinations and increasing vaccine hesitancy resulting in global resurgences of some of the most contagious vaccine preventable diseases (10). The public health response to falling vaccination rates includes the development of social marketing campaigns creating awareness and education around the importance of vaccination (11). The development and implementation of the COVID-19 mass vaccine program is an example of public health response to a public health crisis. Certain groups and populations are at higher risk of SARS-CoV-2 infection the virus that causes COVID-19 including essential workers, those working or living in congregate conditions, group living, Indigenous and remote communities, and marginalized and racialized communities (7).

Communities marginalized through structural factors such as racism, disability, economic disparities, sexual orientation, colonialist health care legacies, and many other structural determinants of health experience inequities in health outcomes including contracting chronic and infectious diseases (7). These inequities in health outcomes extend to an increased risk of SARS-CoV-2 infection, one Canadian example of this is the effect of colonization leading to ongoing racism that continues to impact the healthcare of Indigenous people including higher rates of SARS-CoV-2 infection (7, 12).

In Ontario, one of the Canadian provinces most severely impacted by SARS-CoV-2, infections have taken a disproportionate toll on individuals and families of disadvantaged and racialized urban neighbourhoods (6). Between May 20, 2020, and July 16, 2020, 83% of people in the city of Toronto with reported SARS-CoV-2 infection identified as a racialized group and 51% of reported cases were living in households considered lower income (13). As of August 28, 2021, 67.3% of individuals over the age of 12 years living in Ontario have been fully vaccinated (14). However, there remains a significant proportion of individuals unvaccinated (14).

Vaccine hesitancy—a delay in acceptance, or refusal to get vaccinated despite the availability of vaccine services is framed as a behavior that results from a complex decision-making process; vaccine hesitancy involves three conceptual factors inclusive of confidence, complacency, and convenience (15). Vaccine confidence is defined as trust in the effectiveness and safety of vaccines; the system that delivers them, including the reliability and competence of the health services and healthcare providers; and the motivations of policy makers who decide on the needed vaccines (15). Vaccine complacency occurs when the perceived risks of vaccine preventable disease are low and vaccination is deemed unnecessary (15). Vaccine convenience is when physical availability, geographical accessibility, ability to understand, and appeal of vaccine services affect the decision to be vaccinated (15). Individuals who are vaccine hesitant may accept some vaccines and refuse others, delay some vaccines, or accept vaccines but be hesitant to do so (15). Using the example of COVID 19 vaccines, emerging evidence from the United States, Canada, and the United Kingdom indicates high vaccine hesitancy prevalent among disadvantaged groups (16, 17). Engaging with organizations and community partners that service these disadvantaged

communities has been identified as a priority to help address health disparities and better understand vaccine hesitancy (7, 13, 18).

Reported in Canada and around the world were high levels of community transmission and record numbers of intensive care hospitalizations which resulted in widespread and restrictive public health measures to stop the spread of disease, such as stay at home orders, mandatory masking, physical distancing, and limits on social gatherings (19).

For example, Canadians witnessed the largest vaccine program in Canadian history, including the rapid development of mass vaccine clinics and distribution of vaccines to individuals aged 12 years and older. At that time, two mRNA vaccines (Pfizer-BioNTech & Moderna) as well as two viral vector vaccines (AstraZeneca/COVISHIELD & Janssen) were authorized for use in Canada (2). The initial approach to vaccination in Canada was to prioritize individuals at highest risk of hospitalization and death from SARS-CoV-2 infection as well as a first dose approach (2, 20). This strategy prioritized vaccination among adults in order of descending age, those living in community, and long-term care settings as groups of people who had suffered the highest morbidity and mortality from the first wave of COVID-19 and were at high risk for poor outcomes (20). Rapidly evolving evidence around vaccine efficacy against various COVID-19 variants, vaccine side effects, and adverse events following vaccination led to frequent revisions to the guidelines around who should receive what type of vaccines, vaccine mixing, and the associated risks (2, 6).

The ongoing and increasingly higher transmissibility of the SARS-CoV-2 virus created greater urgency for widespread uptake of vaccines to achieve community immunity (21). Community organizations have unique perspectives into the views and challenges their clients face and are increasingly prominent in delivering health and social services to the public (22). Therefore, the purpose of this research study was to better understand community organizations' perspectives about COVID-19 vaccines and to understand their experience of COVID-19 vaccine acceptance among the people who access their services. The research question guiding this research was: How can third sector community organizations increase COVID-19 vaccine acceptance?

Methods

Qualitative descriptive research studies are appropriate for understanding a phenomenon, process, or the perspectives of participants and allows for a straightforward description of the experiences and perspectives of participant representatives of community-based organizations regarding COVID vaccines and vaccination processes (23).

Recruitment & ethical considerations

Recruitment flyers were distributed electronically among an established network of third sector community partners that served a diverse array of individuals. Recruitment messages were also posted on Twitter, LinkedIn, a blog and via email to invite individuals that were accountable for pandemic related communication strategies within these community health organizations to participate in the research study. There was an anticipated sample size of 30–40 participants whose final number was determined through appropriate participant involvement providing rich data and data saturation (24).

Ethics approval was obtained through Western University's Research Ethics Board (Application #118259). To be included in the study, participants had to be working as a paid employee in a community organization in Canada for at least 1 year, be involved in either communications or management of the organization and be able to communicate in English. Participants were excluded if they were under the age of 18 years.

Data collection

Semi-structured focus groups were conducted via Zoom communications between April 7, 2021, and May 6, 2021. Zoom was selected as the preferred method of collecting the data as it is an effective method of conducting virtual focus groups (25). Use of virtual focus groups allowed for geographical diversity of participants while maintaining public health restrictions. Data was collected from participants who represent organizations from across Canada. Participants were asked about their experiences communicating with clients about COVID-19 vaccines and vaccine awareness, vaccine communication and misinformation, challenges clients face accessing or understanding COVID-19 vaccine information, and strategies they are using to support and facilitate COVID-19 vaccine access and acceptance. The focus group questions were reviewed for clarity and relevance with one of our community agency partners. Experienced moderators led each session (LD, AK), research assistants took notes during each session (SA, GU), the sessions were audio recorded and professionally transcribed.

Data analysis

Data collection and thematic analysis occurred concurrently using the "3C's" framework of vaccine hesitancy guided the data analysis (15). Vaccine confidence, vaccine complacency and vaccine convenience make up the three determinants of vaccine hesitancy in the model adopted by the World Health Organization's working group on vaccine hesitancy (15). Two researchers iteratively reviewed the transcripts organized using NVivo software. Interview notes and transcripts were read and re-read by two members of the researcher team. Codes were grouped together into sub-themes guided by the 3C's framework. Once initial coding was completed the codes were reviewed by an interdisciplinary team of researchers. Discrepancies were discussed until a consensus was reached. Data codes were tracked and documented to include exemplar quotes from interview transcripts to demonstrate the meaning of the code. Recruitment of focus group participants continued until no new themes, patterns, or codes were generated from the data and became repetitive in nature.

The thematic analysis process was used to organize the data into themes and subthemes informed by the multidisciplinary research team; that is, themes were deductively generated using the framework and inductively generated from participant responses. Following preliminary data analysis, subthemes and overall findings were discussed among the interdisciplinary research team which consisted of members from the disciplines of public health policy and knowledge translation, computer sciences, and nursing (26). The data analysis

process was approached in a systematic and methodical manner to ensure that the results were meaningful and useful (27).

Ensuring trustworthiness throughout the data analysis process was important to ensure that the research findings are acceptable and useful (28). Trustworthiness was determined through credibility established through prolonged engagement (through repeated reading of transcripts and listening to audio transcripts) and dependability (the research process was conducted in logical steps and clearly documented for readers to examine the research process) (28). Through iterative team discussion discrepancies were discussed further until consensus was reached.

Findings

Forty-one organizational representatives from Ontario, British Columbia, Quebec, and Alberta participated in 11 focus groups. One organization, with a presence in Canada, served a global mandate, 8 organizations were nationally (Canadian) focused, 7 organizations provided services across one province, 1 organization provided services to 2 provinces, and 23 organizations provided local community-focused services within 1 province, and 1 organization did not specify location of services. These organizations serve a wide variety of individuals: the general population, youth and their families, individuals living with cancer or chronic disease, seniors and individuals living with disabilities, immigrants, and low income, marginalized and vulnerable populations. Participating organizations were diverse in terms of their organizational mandate and consequently the pandemic affected their day-to-day operations in a variety of ways. Obligated by the early COVID-19 public health safety strategies, many organizations shifted to virtual or online services. However, some organizations provided essential services that could not be performed virtually and are described below. All organizational representatives reported an increase in their workload to adjust to mandated pandemic restrictions and to ensure their staff and clients remained safe. Yet community organizations employed innovative strategies to enhance uptake of vaccines that are discussed in detail below and summarized in a table in Appendix A.

Thematic findings

Vaccine hesitancy was the major theme present in the data. Vaccine confidence, vaccine convenience, vaccine complacency and mistrust in the government and large organizations were identified as four sub-themes.

Vaccine hesitancy among staff and clients

Vaccine hesitancy was prevalent among staff within the participant organizations as well as within the communities they serve. Several focus group participants reported, "There was hesitancy among our staff" (Participant 11) and "surprisingly our biggest lack of vaccine confidence is with our staff … we have an 80% vaccination rate which is good but it's still not great … so it tends to be more with the staff" (participant 3).

Vaccine hesitancy was also noted by many participants as prevalent among individuals within the communities that these organizations serve: "there's a bit of hesitation around the vaccine" (participant 14). Vaccine hesitancy was identified among newcomers to Canada and particularly among the South Asian community, "there's quite a bit of vaccine hesitancy within these communities [newcomers] because there is quite a bit of hesitancy within the South Asian community right now" (participant 5).

Several organizations identified that accessing vaccine information in a language that individuals could understand was one of the factors relating to vaccine hesitancy among these newcomer groups. "If you do not use a medium or language that people understand, you are not communicating" (Participant 37). Beyond newcomers, individuals who immigrated to Canada years ago may not have the English language skills to understand and make vaccine decisions from mainstream public health messaging. Participant 9: "Maybe they have lived in Canada for 30 years and they still may not speak English."

Reported reasons for vaccine hesitancy included: fear for personal/family safety, morbidity, and mortality from unknown short and long-term vaccine side effects. Participants reported that individuals accessing their organizations had questions and expressed concerns about vaccine-related ill health, the impact of the vaccine on pregnant and yet-to-be pregnant individuals, concerns related to their children's health and fear of vaccine-related death. These concerns were identified by participants through the iterative questions they received as reflected below:

> "is it going to make me sick" (Participant 38); "there was hesitancy and once you find out one stat about one person dying because of one vaccine, there's so much hesitancy because of that one thing"; (Participant 9); "is it safe for me, I may become pregnant, you know is it going to be safe for me if I'm going to have a baby" (Participant 38).

The rapid development of vaccines "how come they were approved so quickly, what steps did they skip, can we trust it, is it safe" (Participant 38) and concern that messenger RNA vaccines would alter an individual's DNA "is it going to change my DNA" (Participant 38) also contributed to vaccine hesitancy among individuals served by community organizations.

Vaccine confidence

Vaccine confidence is defined as trust in (i) the effectiveness and safety of vaccines; (ii) the system that delivers them, including the reliability and competence of the health services and health professionals and (iii) the motivations of policy makers who decide on the needed vaccines (15). Vaccine confidence was identified as a factor in vaccine hesitancy among staff within some organizations. Participant 4 reported "more unexpected was that there continued to be a lack of confidence among staff. We had offered to provide training and education, webinars, to staff and early on executive directors declined, they said there's really not much interest, we are not concerned about that, but then when they started to offer the vaccine to staff, they did encounter challenges."

One organization (Participant 3) that served older adults in a long-term care setting identified a lack of vaccine confidence among staff that they did not see among the long-term care residents. The participant reported excellent uptake of vaccines among clients living in long-term care settings in comparison to organizational staff stating that, "our biggest lack of confidence is with our LTC staff … so it tends

to be more with the staff than it is with the clients and residents, and that's speaking for community and LTC."

Rapidly changing and conflicting information on vaccine side effects was also identified as a factor in vaccine confidence. Changing guidelines about the risks and side effects of the COVID-19 AstraZeneca (AZ) vaccine caused significant fear and anxiety among individuals, some already with compromised health; "So the panic I had within the group … oh no I do not want AZ" (participant 39), and "the whole issue about AZ vaccine in causing blood clots because some of the medication in cancer does cause blood clots" (participant 12). Participants found it challenging to support the information needs of clients related to their concerns about vaccine side effects. Of note was the concern about vaccine related risk of blot clot and one participant (7) stated that "… we always find the science is moving very quickly, but the science is not moving fast enough for them to answer some of the questions that they [clients] have" (participant 7).

Evolving information around the prevalence and risk of Vaccine Induced Thrombotic Thrombocytopenia after vaccination with AZ vaccine among different age groups caused many individuals to fear this specific vaccine brand. Participants reported a lack of transparency around the risk with this particular vaccine causing some clients to emphatically refuse vaccination with AZ vaccine. "They do not want Astra Zeneca because of the media flip flopping" (participant 28) … they specifically want Pfizer and not Astra Zeneca" (participant 33).

Trust/mistrust

Participants noted a lot of government and large corporation mistrust within communities. "It's very difficult to share government resources when there's already so much government mistrust … We have a lot of clients from very vulnerable communities who do not trust the system." (Participant 7) Community organizations heard from their clients that they did not trust vaccine information coming from large government and health related corporations. Participant 21 reported; "quite a bit of trust has been sort of lost, or there's been back and forth on trust when it comes to large organizations" and "I noticed there was a lot of distrust around the World Health Organization." Participants reported that their clients expressed concern about being lied to as reflected by the following: "… one day they say one thing, and the next day the opposite, so people are wondering are scientists lying, who can we actually trust, who can we believe" (Participant 21).

Vaccine prioritization of specific groups of individuals (Indigenous, older adults Canadians) by provincial and federal bodies that was intended to safeguard individuals who were most vulnerable to SARS-CoV-2 infection appeared to have the opposite effect and served to further erode trust in the government. Participant 7 reported that vaccine-priority groups felt as though they were identified for experimentation purposes. Senior groups and Indigenous communities wondered, "why are we going first" "are we lab rats" "do they want to see what happens to us first." One participant identified the historical legacy of unethical experiments conducted by governments with racialized groups of people may have fueled some of this mistrust among individuals. "Some of them were talking about Tuskegee, and [mistrust] is so deep and so dense" (Participant 7).

Community organizations found that maintaining trusting relationships was key to providing science-informed guidance and keeping their clients/communities safe during the pandemic. "The strategies employed by our agencies were very much about building and maintaining trust and using the established trust that they have" (Participant 4). Science-informed guidance was described by one participant as having: "…accurate scientific information in conjunction with people in the community, at the point where the information is going to be accurately represented to them in a way that is accessible and understandable" (Participant 21).

Beyond maintaining trust, several participants identified that building from a foundation of trust within their communities was key to increasing vaccine confidence, "the trust piece is huge." Another participant identified the integration of COVID 19 information into already established programming was helpful and doing things such as:

> "… developing presentations that people could attend into our existing community program groups that we already had, we intentionally had multiple workshops around vaccines and we would have our nurses who are part of the newcomer clinic present. So, there was already some trust there, when it came to it they knew the nurse" (Participant 11).

Previously established relationships with community workers, health promotors, peer leaders, and nurses were specifically identified as helpful in supporting vaccine decision-making. This established trust was identified as key in vaccine uptake in some specific populations, "we have actually gotten really good uptake from people who are experiencing homelessness which is great, and I think that part of it is just the trust we have been able to develop" (Participant 11).

The use of empathetic and compassionate listening was also identified as important to developing and maintaining trusting relationships among community members. "I try to lead with compassion and empathy and relate to what it is they they are going through" (Participant 21). Participants reported that listening to individuals' expressed frustrations, challenges, fears, anxieties, and disappointments was an important part of vaccination communication.

> "I don't want to shut them down because to me that's quite dismissive, and the way in which we will share with them, we want to say we're having a dialogue, so if you're going to shut down their concerns why are they going to listen to what you have to say" (Participant 21).

Vaccine convenience

Vaccine *convenience* is when physical availability, ability to understand (language and health literacy) and appeal of immunization services influence vaccine uptake (15). Participants reported that their organizations used innovative and novel approaches within their communities to enhance vaccine convenience. One example of one organization's efforts to increase vaccine appeal was demonstrated through hosting a virtual games night, Participant 10 stated:

> "it's for the community and we've done so far 3 or 4 of them with great success, the community loves them we honestly in December when she had this idea was supposed to be a one off and so it was supposed to be let's do this Zoom trivia night where we invite people to see how much they know about this vaccine that's coming, but we never thought it would be this recurring event."

Clients of this community organization provided feedback that participating in this event provided them with accurate vaccine

information and moved them from being vaccine hesitant to vaccine acceptant. Some individuals credited this event to changing their decision to be vaccinated against COVID-19, "she told us yesterday that it was only because of our last vaccine trivia night that she was convinced that she should go do the vaccine." (Participant 10).

Another innovative approach was the use of community ambassadors to increase vaccine convenience. "We have this vaccine engagement community ambassador project where we recruit peers who are resident leaders, who are newcomers themselves, who speak that language and live in those priority neighbourhoods" (Participant 2). Community ambassadors used a variety of approaches to encourage vaccination; participants reported they would, "knock on doors and engage neighbours and try to help them book vaccine appointments; so it really is like doing grass roots health promotion through these peer supporters" (Participant 2). The community ambassadors engaged in one-on-one verbal communication, posted on prominent social media platforms, went door to door to educate about vaccine opportunities, and/or interviewed and presented on various media platforms. Participants also identified that alternative social media platforms were successfully used to convey information in various community groups. WhatsApp (a social media communication app) was a prominent method of communication among some refugee groups and migrant farm workers; "WhatsApp is the primary way to reach migrant farm workers who do not maybe even have cell access but they have got WIFI on the farm" (Participant 4) and "A lot of Syrian refugees that we work with, the only information source is WhatsApp" (Participant 19). These platforms were key to disseminating accurate information about COVID-19 vaccines and how to access them.

Vaccine convenience within the 3C's model also identifies language as a key component of vaccine convenience (15). Some organizations recognized the relevance of health literacy as an important determinant of health. "We had to take into consideration that a lot of our clients may not be receiving traditional forms of communication about COVID, whether it be language barriers, or a lack of access to the internet or traditional news media" (participant 11) and "if you do not use a medium or a language that people understand you are not communicating" (Participant 37). Similarly, Participant 11 reported that:

> "We did a much more concerted effort with our ethno-racial communities … we made a concerted effort in translating these [vaccine] presentations to some of the languages in the communities we serve that are not necessarily the basic languages that you would see in public health …. We do the [vaccine] presentation but also have a voice recording over it so that they could follow along if they didn't have the literacy level to understand the written form of it" (Participant 11).

Another participant identified focused messaging for their clients

> "… we do create messaging specifically for young people and we really try to pull out the pertinent information and do a lot of plain language review … we've really leaned on that health literacy team's expertise to support us in creating communication" (Participant 6).

Vaccine complacency

Some participants identified vaccine complacency among their organizational staff and within the public they serve. Vaccine *complacency* occurs where perceived risks of vaccine-preventable diseases are low and vaccination is not deemed necessary (15). Canada's vaccine rollout plan identified individuals working with vulnerable populations as candidates for priority COVID-19 vaccine access to protect those most vulnerable to the disease (2). However, despite vaccine availability, some individuals did not act upon the opportunity to get vaccinated and reported wanting to wait until more of the population was vaccinated prior to getting their own vaccine, "I'm just going to wait till everyone else does it and see what happens to them (participant 27)."

Other ways vaccine complacency was seen was through doubt and non-belief that SARS-CoV-2 infection was of concern. Participant 7 reported, "I've dealt with a couple skeptics who do not believe that it is anything more than a flu."

Discussion

Community organizations providing services to a wide array of groups across Canada participated in focus groups regarding perspectives on COVID-19 vaccines within those communities. A wide variety of individuals were represented by the participating organizations including: the general population, youth and their families, individuals living with cancer or chronic disease, seniors and individuals living with disabilities, immigrants, and low income, and marginalized populations. Vaccine hesitancy was reported among staff, volunteers, and clients within many of the participant organizations. Three determinants of vaccine hesitancy, *confidence, convenience, and complacency,* previously identified within the population in relation to other well-established vaccines were applicable to COVID-19 vaccines (15).

The organizations in this study identified areas of need within their various communities and independently took on COVID-19 vaccine promotion and education. These findings are consistent with research conducted in Amsterdam and New York City where community organizations identified and developed solutions to unique challenges in the form of pandemic response among communities marginalized by race, immigration status, religion, social class, and gender (29). As valuable public health partners, the community organizations in our study demonstrated innovative methods of vaccine education and supported vaccine confidence within their communities. The importance of a trusting relationship between those providing vaccine education and individuals making vaccine decisions has been well established in the literature (30). Building on a foundation of established trust the organizations developed novel approaches to engaging in health promotion and addressing vaccine hesitancy within their communities. Some examples of the novel approaches to maintain and enhance trust included the use of community-based vaccine ambassadors, tailored vaccine promotion on social media platforms specific to subgroups of the population and facilitated communication and education through various methods of translation.

The use of community ambassadors was an innovative and personalized approach to public health vaccine messaging different than widespread public health vaccine messaging (31). This

personalized approach is consistent with the findings of another study that used parents as vaccine advocates as a part of a community-based approach to reduce vaccine hesitancy (32). Further research that evaluates the role of a community ambassador and the impact on vaccine confidence and vaccine uptake within communities is warranted.

Mistrust in government and large organizations was identified as a factor in vaccine confidence among some participants and their clients within this study. These findings are consistent with preliminary non population-based research studies from other countries (Norway and the United Kingdom) that have also identified trust a variable in COVID-19 vaccine hesitancy (33, 34). Trust is a well-established component of vaccine confidence as one of three determinants of vaccine hesitancy (15).

While trust is a well-established component of vaccine confidence, the COVID-19 pandemic has demonstrated the ongoing health disparities that affect ethnically diverse populations across Canada (7, 35). Populations that have historically experienced health and social inequities were at greater risk of contracting COVID-19 and having more severe disease (7). Historical injustices to Indigenous, racialized, and vulnerable individuals have created justified mistrust within the government (36, 37). The mistrust extends to healthcare providers as Indigenous people and other disenfranchised groups with Canada experience persistent and systemic racism and its impact on healthcare (12). Contemporary examples of how Indigenous, black, racialized, and low-income individuals experience the healthcare system leads to a lack of confidence and trust in the system (38). Our findings are consistent with other research that evaluated attitudes and perceptions around human papillomavirus and influenza vaccines and found mistrust prevalent among racial and ethnically diverse populations (39). Understanding vaccine confidence among these populations is critical as they are among the most vulnerable to COVID-19 and vaccination is key in protecting these individuals from associated morbidity and mortality.

More work needs to be done to further understand how healthcare providers and government systems can work to build trust within these diverse groups of clients served by these community organizations. The important work that these community agencies are doing within their communities demonstrates that a foundation of trust is critical to forming long lasting relationships. Listening and giving voice to these important agencies may provide valuable knowledge that could help inform the healthcare system on effective techniques for establishing and building trust.

Limitations

Research involving individuals' response to an emerging health crisis such as the COVID 19 pandemic is a fluid and evolving process. This research was conducted within a specific time frame within the pandemic therefore, findings should be interpreted with these specifics. A sample of community organizations from across the country were included in this study, therefore findings may not represent all community organizations within Canada. This study was conducted in the English language and may not include the perspectives of community organizations that communicate in other languages. The 3C's framework of vaccine hesitancy was utilized to guide data analysis however, other frameworks may highlight the findings from different perspectives.

Conclusion and considerations for further research

Findings from this study suggest that vaccine hesitancy was evident among community-based organizations across Canada, their staff, volunteers, and the people they serve. The 3C's framework of Vaccine Hesitancy is applicable to these new vaccines. Research that builds on these findings would contribute to our understanding of how healthcare providers and government systems can work to build trust within these specific subgroups of the Canadian population. The important contribution of these community agencies in support of vaccine uptake reinforces the need for a foundation of trust perceived as critical to successfully reaching under-served individuals. Public health organizations may benefit from establishing strong partnerships with community-based organizations to leverage the foundation of trust already established as a way to increase vaccine confidence regarding all forms of vaccine preventable diseases. Identifying, funding, and partnering with these organizations could be instrumental in combatting vaccine hesitancy, and provide safe, ethical, and culturally appropriate healthcare to equity deserving individuals.

Contributions to knowledge

What does this study add to existing knowledge?

- Vaccine hesitancy exists towards the novel COVID-19 vaccines.
- The 3C's model of vaccine hesitancy is applicable to the novel COVID-19 vaccines.
- Community agencies were important public health ambassadors and used novel methods to increase vaccine confidence.

What are the key implications for public health interventions, practice, or policy?

- Identifying and funding community agencies within Canada is instrumental in providing safe, ethical, and culturally appropriate healthcare to disadvantaged individuals.
- Learning from community organizations may provide valuable knowledge on effective techniques to foster trust as a method to increased vaccine confidence and decrease vaccine hesitancy.
- While focused on COVID-19 immunizations, these findings may translate into supporting uptake of other mandatory vaccinations.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Western University Research Ethics Board Application 118259. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

SA: Data curation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. LD: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. GU: Data curation, Investigation, Project administration, Writing – review & editing. MB: Conceptualization, Methodology, Validation, Writing – review & editing. AK: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial of financial relationships that could be constructed as a potential conflict of interest.

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Appendix A

Methods to enhance vaccine acceptance among community organizations.

Building and maintaining trusting relationships	Communicating in various languages and dialects
Use of traditional communications methods	Providing information in creative and innovative ways
Use of community ambassadors	Translation of vaccine information
Identifying local community needs	Identifying and correcting vaccine misinformation*

*Details of these methods are described in the findings section of the manuscript above.

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"Be honest and gain trust": a population health study to understand the factors associated with building trust in local government related to COVID-19 and vaccination in three historically disinvested neighborhoods in New York City

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Background: Distrust in government among people of color is a response to generations of systemic racism that have produced preventable health inequities. Higher levels of trust in government are associated with better adherence to government guidelines and policies during emergencies, but factors associated with trust and potential actions to increase trust in local government are not well understood.

Methods: The COVID-19 Community Recovery study sampled participants from the New York City (NYC) Department of Health and Mental Hygiene's NYC Health Panel, a probability-based survey panel who complete health surveys periodically. Participants who lived in one of three historically disinvested communities in NYC where the NYC Department of Health and Mental Hygiene has dedicated resources to reduce health inequities were included. The cross-sectional survey was fielded from September 30 to November 4, 2021 and could be self-administered online or conducted via CATI (Computer Assisted Telephone Interviewing) in English, Spanish, and Simplified Chinese (Mandarin and Cantonese by phone). Demographic data were summarized by descriptive statistics. Crude and adjusted logistic regression analyses were used to assess factors predictive of trust in local government as a source of information about COVID-19 vaccines. Open-ended responses about strengthening residents' trust in local government were coded using an iteratively generated codebook.

Results: In total, 46% of respondents indicated NYC local government was a trusted source of information about COVID-19 vaccines, relatively high compared to other sources. In bivariate analyses, race/ethnicity, age group, educational attainment, length of time living in NYC, and household income were significantly

associated with identifying NYC government as a trusted source of information about COVID-19 vaccines. In multivariable logistic regression, no variables remained significant predictors of selecting local government as a trusted source of information. Key recommendations for local government agencies to build residents' trust include communicating clearly and honestly, addressing socioeconomic challenges, and enhancing public COVID-19 protection measures.

Conclusion: Study findings demonstrate that nearly half of residents in three historically divested NYC communities consider local government to be a trusted source of information about COVID-19 vaccines. Strategies to increase trust in local government can help reduce community transmission of COVID-19 and protect public health.

KEYWORDS

COVID-19, vaccines, trust, local government, population health

1. Introduction

Distrust of government entities among people of color is a response to generations of systemic racism that have produced preventable health inequities (1). Government-sanctioned policies, including redlining, although now federally banned, may still be practiced by institutions and have had subsequent and pervasive harms (2, 3). The effects of structural racism have negatively impacted housing quality, school funding, accumulation of intergenerational wealth, and other conditions that fuel a disproportionate burden of poor health outcomes and lower life expectancy in some urban neighborhoods with a higher proportion of people of color (4, 5).

To redress these injustices and to work in collaboration with community partners and residents to build healthier neighborhoods, the New York City Department of Health and Mental Hygiene (NYC Health Department) operates three place-based Bureaus of Neighborhood Health (BNH), which serve and are physically located in historically disinvested neighborhoods in North and Central Brooklyn, South Bronx, and East and Central Harlem (6). The NYC Health Department BNH are housed in spaces with co-located social service providers or clinical partners, and offer direct programming to residents as well as ongoing partnership and support to community partners. Residents of these neighborhoods are primarily Black and Latino (7). The COVID-19 pandemic has had disproportionate cumulative effects in these neighborhoods, including high rates of death due to COVID-19. From the start of the pandemic in February 2020 to the collection of data considered in this paper in October 2021, the age-adjusted COVID-19 mortality rates within the BNH catchment areas exceeded the citywide average (Brooklyn BNH: 387 per 100,000 people; Bronx BNH: 444; Harlem BNH: 325 compared to NYC average: 271) (8). Due to the legacy of structural racism and other injustices, residents of these three neighborhoods were already experiencing disproportionately high rates of chronic and infectious diseases prior to the onset of the COVID-19 pandemic (9). The disproportionate burden of COVID-19 cases, hospitalizations, and deaths drew renewed attention to the local inequities caused by this legacy.

COVID-19 prevention and mitigation efforts in these neighborhoods were a continuation and expansion of existing strategies to address broader health issues, including bi-directional communication with trusted messengers such as community based-organizations, faith-based leaders, school administrators, and other community leaders. These channels of communication helped to provide the NYC Health Department with important insight about residents' fears and misconceptions, and simultaneously allowed accurate and timely health messages to be disseminated to residents, which are key elements to fostering trust between community and government (10, 11). This work was complemented by another essential tenet of the emergency response: direct communications from the NYC Health Department in the form of Public Service Announcements, public transit campaigns, regularly televised press conferences, webinars, in-person presentations at churches and other local gathering sites, street canvassing, and other outreach activities.

Simultaneously, misinformation and conspiracy theories related to SARS-CoV-2 and the COVID-19 vaccines grew, and gained traction on social media platforms (12). Anti-vaccination groups actively worked to develop distrust, capitalizing on the fear and worry of vaccine side effects (13). Believers of conspiracies tend to distrust government and scientific messaging and use conspiracies to create explanations for occurring problems. For marginalized communities, conspiracies can also stem from historical manifestations of racism in the form of institutionalized abuse towards that community (14). Perceived speed at which vaccines were developed and other specific concerns contributed to overall hesitancy to take the COVID-19 vaccines (15).

One study found that during the first year of the COVID-19 pandemic, Americans' trust in government declined; decrease in trust was most pronounced among women, individuals who identified as Republicans, Black Americans, and individuals with lower educational attainment (16). Another study found that trust in government related to information about COVID-19 is associated with age, political party

Abbreviations: NYC health department, NYC department of health and mental hygiene; BNH, bureaus of neighborhood health; CATI, computer assisted telephone interviewing; CI, confidence interval.

affiliation, race, and religious affiliation; this study found that Black Americans had the lowest levels of trust in government compared to other races (17).

Distrust in government can hinder public health efforts, particularly during large-scale emergencies such as the COVID-19 pandemic when government and healthcare institutions are rapidly issuing emerging guidance and instituting emergency measures (18). Guidance was also sometimes contradictory as the situation changed and new things were learned, such as changing guidelines around mask wearing early in the pandemic when the airborne nature of COVID-19 was not well understood. Trust in state and local government has been found to be associated with adhering to COVID-19 protective measures including mask-wearing and social distancing (17). Distrust in government may also contribute to poor mental health and burnout among public health professional; the national Public Health Workforce Interests and Needs Survey found that 28% of employees in 2021 had been challenged or undermined by non-experts (19). Therefore, building trust in government through transparent, timely, consistent, and meaningful efforts to improve local conditions and community health is a critical underpinning of a successful – and equitable – emergency response (11).

Valuable research has contributed to our understanding of why individuals may refuse the COVID-19 vaccination specifically, and how trusted messengers can increase uptake of the vaccine (20). However, less is understood about what factors contribute to trust in local government among residents of historically excluded communities. Therefore, it is important to understand how to build upon that trust to better serve these communities during future health emergencies and routine public health efforts.

This paper presents findings from the COVID-19 Community Recovery Survey conducted in three historically disinvested NYC communities where the local public health department has been working for several decades to build trust and credibility. Because these neighborhoods are similar with respect to demographic composition, historical disadvantage, and having a physical presence of and increased investment from the local health department, the neighborhoods are considered in aggregate as the BNH catchment area in all analyses. This paper explores demographic, social, and economic characteristics associated with reporting local government sources as trusted sources of information about COVID-19 vaccines, presents recommendations from the community to increase trust in local government, and considers the implications for these findings for urban health departments in the United States.

2. Methods

2.1. Participant recruitment

COVID-19 Community Recovery study participants were recruited from the NYC Health Panel, a probability-based survey panel established in 2020 to supplement existing population-based health surveys (21). All panel members were 18 years or older and lived in NYC. At the time of the survey there were approximately 13,000 panel members. All 4,478 members who lived in one of 12 Community Districts or one of 25 ZIP code tabulation areas of the three BNH catchment areas were invited by mail, email, and/or text to participate. The geographic area included in the study is illustrated in Figure 1.

Each eligible NYC Health panelist received between three and six invitations to encourage participation. Method of invitation was based on the contact information that was provided during the NYC Health registration survey (email, mail and/or text). The survey was open from September 30, 2021, to November 4, 2021, and was electronically self-administered or conducted via CATI (Computer Assisted Telephone Interviewing) by a trained NYC Health Department interviewer. Participants provided informed consent verbally for interviewer-administered surveys and in written form for electronic surveys. Interviewers also phoned participants who did not respond to previous survey invitations to boost participation. All participants who completed the survey were offered a $10 gift card. Both self-administered and CATI surveys were offered in English, Spanish, and Simplified Chinese (Mandarin and Cantonese by phone).

2.2. Measures

The COVID-19 Community Recovery Survey questions spanned seven broad domains: impact of the COVID-19 pandemic on general healthcare, prescriptions, and mental health; attitudes towards COVID-19 vaccines and knowledge of NYC COVID-19 testing services; trusted sources of information for the vaccine; perceived community resilience and assets needed for recovery; trust in local government; social determinants of health; and familiarity with their local BNH office building. Participant demographics were collected during the initial NYC Health registration survey in either June 2020, September 2020 or May 2021; additional measures were collected at the time of the COVID-19 Community Recovery survey for variables that might have changed over time (e.g., zip code, gender). Trust in local government as a source of information about COVID-19 vaccines was measured with the following multiple select item: "*Where have you gotten information about the COVID-19 vaccines that you trust?*" Ten response options were provided, along with an open-ended "*other source*" option and the exclusive option "*There is no information you trust.*" Key findings from the trust in local government domain are presented in this paper.

2.3. Weighting and analysis

Detailed methods of the NYC Health panel construction (formerly known as Healthy NYC), as well as survey weighting and analytic methods of the COVID-19 Community Recovery Survey, have been described previously (21). Briefly, survey data were weighted to the residential adult population in the respective geographic area of interest to account for selection bias and nonresponse bias in analyses about trusted sources of information about COVID-19 vaccines. A survey respondent's final weight is the product of several factors, including the initial probability of selection from the panel, nonresponse adjustments, pooling factors, and calibration. Demographic data were summarized by descriptive statistics; unweighted percentages and 95% Confidence Intervals (CIs) were reported (Table 1). Bivariate logistic regression models were used to measure the crude association between considering local government as a trusted source of COVID-19 vaccine information and participant

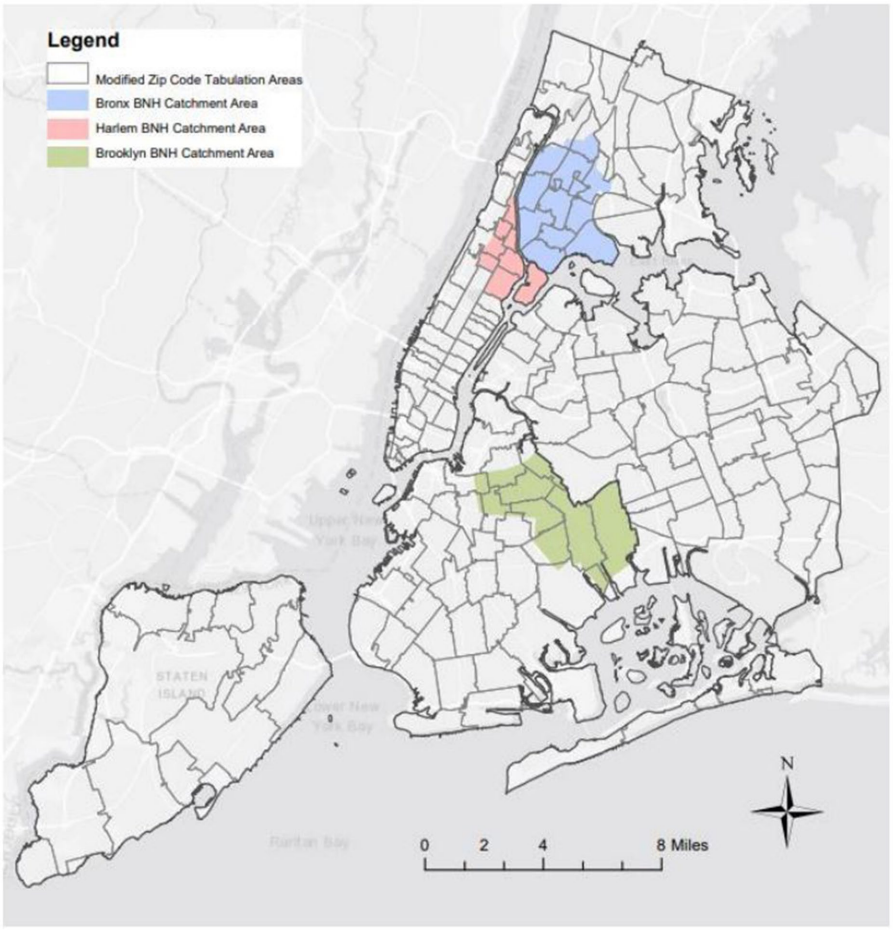

FIGURE 1
Geographic area surveyed in COVID-19 Community Recovery Survey.

demographics. All analytic models use survey weights to ensure the study sample reflects the weighted distribution of characteristics in the Bureau of Neighborhood Health catchment area neighborhoods. The following participant demographics were included: race/ethnicity, age group, individual educational attainment, birthplace, years lived in NYC, household language, household poverty status, public housing status, and vaccination status. Due to the low rate of missing data (<4%), a complete case analysis was conducted under the assumption that missing data was missing at random. Demographics that were significantly associated with local government as a source of trusted information in bivariate analyses were included in a multivariable model. A significance level of $p < 0.05$ was used to determine statistical significance. Model diagnostics were assessed to ensure no assumptions were violated. Open-ended responses about how local government can strengthen residents' trust were coded using an iteratively generated codebook, initially developed based on the first 200 responses and revised to capture new themes as they emerged. Each response was coded separately by a primary and secondary qualitative analyst (LJS and FD) who then met to discuss any disagreements in coding and come to consensus. Each response was coded with all applicable codes; many responses are included in multiple themes. Quantitative analyses were conducted in SAS Enterprise Guide 7.15. Qualitative analyses were conducted in Microsoft Excel.

This project was reviewed and deemed exempt research by the NYC Health Department's Institutional Review Board.

3. Results

3.1. Study participants

Of the 4,478 invited NYC Health panelists, 1,358 unique participants (30.3%) completed the COVID-19 Community Recovery Survey online ($n = 1,181$) or through CATI ($n = 177$). Demographic characteristics of all survey participants are presented in Table 1. Among the 1,358 survey respondents, 29.5% lived in the Brooklyn BNH catchment area, 32.0% in the Bronx BNH catchment area, and 38.5% in Harlem. Most participants were Latino or Black (38.5% and 32.9%, respectively); ages 25–64 years (74.7%); had at least a high school degree (87.6%); and lived in households that were English-speaking only (54.9%), had income less than 200% of the Federal Poverty Level (52.4%), and were not in public housing (80.6%). Of note, 91.2% of the study sample reported having received at least one

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TABLE 1 Demographic characteristics of COVID-19 Community Recovery Survey participants; *N* = 1,358.

	N	%
BNH catchment area		
Brooklyn	401	29.5
Bronx	434	32.0
Harlem	523	38.5
Age group		
18–24	51	3.8
25–44	565	41.9
45–64	443	32.8
65+	291	21.6
Race/ethnicity		
Latino/Hispanic	508	38.5
Black, non-Latino	435	32.9
White, non-Latino	258	19.5
Asian non-Latino	73	5.5
Other/Multi-race, non-Latino	47	3.6
Gender		
Woman	968	71.5
Man	362	26.8
Transgender man, transgender woman, non-binary person, or other gender not mentioned	23	1.7
Individual education attainment		
Less than high school degree	169	12.5
Grade 12 or GED (high school graduate)	268	19.8
College 1 year to 3 years (some college, technical school, or associate's degree)	335	24.7
College 4 years or more (college graduate)	299	22.1
Graduate degree or professional degree	284	21.0
Birthplace		
United States, excluding U.S. territories	853	63.3
Puerto Rico, Guam, U.S. Virgin Islands or other U.S. territory	74	5.5
Outside of the United States	420	31.2
Years lived in NYC		
Less than 5 years	115	8.5
5 to 10 years	124	9.2
More than 10 years	1,110	82.3
Household language		
English-speaking only household	741	54.9
Multi-lingual or non-English speaking household	609	45.1
Household poverty status*		
Annual income <200% Federal Poverty Level	661	52.4
Annual income ≥200% Federal Poverty Level	601	47.6
Lives in public housing (NYCHA†)		
Yes	254	19.4
No	1,057	80.6
Vaccination status		
Received at least one dose of a COVID-19 vaccine	1,277	91.2
Has not received a COVID-19 vaccine	119	8.8

*Poverty status was determined relative to 200% of Federal Poverty Level given the high cost of living in NYC. In 2021, 200% Federal Poverty Level was $53,000 for a household of four people.
†New York City Housing Authority.

TABLE 2 Frequency of reported source of trusted information about COVID-19 vaccines, age-adjusted and weighted to the residential adult population in the respective geographic area of interest.

Trusted sources of COVID-19 vaccines	Weighted #†	%	95% CI
Friends and family	327,500	33.2	(29.1–37.5)
Community religious leader (such as a pastor, priest, minister, rabbi, or imam)	65,800	6.6	(4.9–8.9)
A doctor or other health professional	537,700	54.8	(50.1–59.3)
NYC government (website, social media, or printed materials)	453,600	45.3	(40.8–49.9)
NY State and federal (CDC) government (website, social media, or printed materials)	466,400	46.8	(42.3–51.4)
Newspapers (online or in print)	194,200	19.1	(16.2–22.3)
Television news channel	349,500	35.3	(31.4–39.3)
Radio	107,500	10.5	(8.1–13.6)
TV ads	199,400	20.0	(16.7–23.9)
Social media	100,700	10.5	(7.9–13.7)
Facebook (WRITE IN)	24,700	23.9	(15.6–34.8)
Twitter (WRITE IN)	7,600	6.1*	(3.1–11.6)
Instagram (WRITE IN)	11,300	9.7*	(5.1–17.7)
Other social media	16,200	16.3	(8.9–27.7)
Other source	63,800	6.3	(4.5–8.6)
There is no information that I trust	62,800	5.7	(4.1–7.9)

*Estimate should be interpreted with caution. Estimate's Relative Standard Error (a measure of estimate precision) is greater than 30%, or the 95% Confidence Interval's half width is greater than 10, or the sample size is too small making the estimate potentially unreliable.
†Rounded to the nearest 100.

dose of the COVID-19 vaccine, compared to 82.7% of adult NYC residents who had received at least one dose as of October 1, 2021 (22).

3.2. Government as trusted source of COVID-19 vaccine information

As shown in Table 2, the most frequently reported source of trusted information about COVID-19 vaccines was *a doctor or other health professional* (54%), followed by *NY State and Federal (CDC) government* (47%) and *NYC government* (46%). Other common responses included *television news channel* (35%), *friends and family* (33%), *tv ads* (20%), *newspapers* (20%). Only 11% of respondents selected *radio,* 10% selected *social media* and 7% selected *community religious leader*. Six percent reported that there is no information they trust, and 7% listed another source.

Bivariate logistic regression model results are reported in Table 3. Race/ethnicity and age group were significantly associated with selecting NYC local government as a trusted source of information about COVID-19 vaccines (p-value = 0.003 and 0.011, respectively). Black, non-Latino participants (OR = 0.43; 95% CI: 0.26, 0.70) and Latino/Hispanic participants (OR = 0.54; 95% CI: 0.34, 0.87) had lower odds of considering NYC local government as a trusted source compared to white participants. Living in NYC for more than ten years was associated with decreased odds of trusting local government (living in NYC >10y compared to less than 5y: OR = 0.70; 95% CI: 0.35, 1.38; p-value = 0.044). Those with higher levels of educational attainment had increased odds of trusting NYC local government compared to those with less than a high school degree (college graduate compared to less than high school degree: OR = 3.29; 95% CI: 1.93, 5.61; graduate or professional degree compared to less than high school degree: OR = 3.74; 95% CI: 2.13, 6.58; p-value <0.001). Living in a household with an annual income at or above 200% of the Federal Poverty Level was also predictive of trusting local government compared to living in a household with income below 200% (OR = 1.54; 95% CI: 1.06, 2.24; p-value = 0.024).

In the multivariable logistic regression model, no independent variables remained significantly associated with selecting NYC local government as a trusted source of information about COVID-19 vaccines (Table 3), potentially in part due to the interrelated nature of some demographic variables (i.e., living in public housing and household poverty below 200% of Federal Poverty Level).

3.3. Ways to strengthen trust in local government

Survey participants responded to the open-ended question, *"During this stage of the pandemic, what should the local NYC government do to strengthen your trust in it?"* Out of 1,358 total survey participants, $n = 144$ responded with "NA"; $n = 80$ responses were not codable; $n = 51$ responded that they did not know; $n = 237$ did not respond to this question. The remaining 846 (62.3%) provided a codable response to this question, including that they already trusted the government ($n = 101$), that the government could not be trusted regardless of any attempts to strengthen trust ($n = 24$), and with suggestions to strengthen trust in government. Key themes and subthemes about how to strengthen trust emerged from the codable responses; these themes are presented in Table 4. The most common themes are presented in more detail below.

3.4. Communicate clearly and honestly (n = 316)

Several subthemes emerged related to government communication with the public. Participants made general comments about the importance of consistent and frequent communication from local government, including appreciation for what was perceived as a lot of information shared throughout the pandemic and a desire for more information. Some responses indicated specific information to be shared, for example, *"Continue to share the number of cases and*

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TABLE 3 Crude and adjusted odds ratios of reporting NYC Local Government as trusted source of information about COVID-19 vaccines.

	Crude OR (95%CI)	*p*-value	Adjusted[§] OR (95% CI)	*p*-value
Age group ($n_c = 1,265$; $n_a = 1,137$)[†]				
18–24 years	Ref	0.011*	Ref	0.277
25–44 years	1.64 (0.70, 3.85)		2.00 (0.77, 5.17)	
45–64 years	1.09 (0.46, 2.54)		1.75 (0.69, 4.48)	
65+ years	0.75 (0.31, 1.81)		1.30 (0.49, 3.43)	
Race/ethnicity ($n_c = 1,237$; $n_a = 1,137$)				
White, non-Latino	Ref	0.003*	Ref	0.308
Black, non-Latino	0.43 (0.26, 0.70)		0.71 (0.38, 1.34)	
Latino/Hispanic	0.54 (0.34, 0.87)		1.07 (0.58, 1.95)	
Asian, non-Latino	1.18 (0.54, 2.56)		1.54 (0.62, 3.84)	
Other/Multi-race, non-Latino	0.79 (0.27, 2.34)		1.03 (0.38, 2.77)	
Gender ($n_c = 1,267$)				
Man	Ref		N/A	
Woman	0.94 (0.65, 1.37)	0.541	N/A	
Transgender man, transgender woman, non-binary person, or other gender not mentioned	1.98 (0.50, 7.89)		N/A	N/A
Individual educational attainment ($n_c = 1,269$)				
Less than high school degree	Ref	< 0.001*	Ref	0.064
High school graduate	1.67 (0.97, 2.93)		1.81 (0.97, 3.36)	
Some college, technical school, or associate's degree	1.73 (1.04, 2.89)		1.68 (0.92, 3.07)	
College graduate	3.29 (1.93, 5.61)		2.45 (1.24, 4.82)	
Graduate degree or professional degree	3.74 (2.13, 6.58)		2.84 (1.35, 5.96)	
Birthplace ($n_c = 1,262$)				
United States, excluding U.S. territories	Ref	0.971	N/A	N/A
Puerto Rico, Guam, U.S. Virgin Islands or other U.S. territory	0.94 (0.51, 1.74)		N/A	
Outside of the United States	0.96 (0.66, 1.41)		N/A	
Years lived in NYC ($n_c = 1,264$; $n_a = 1,137$)				
Less than five years	Ref	0.044*	Ref	0.565
Five to ten years	1.43 (0.60, 3.40)		1.63 (0.66, 4.04)	
More than ten years	0.70 (0.35, 1.38)		1.33 (0.64, 2.78)	
Household language ($n_c = 1,264$)				
English-speaking household only	Ref	0.595	N/A	N/A
Multi-lingual or non-English speaking household	1.10 (0.77, 1.57)		N/A	
Household poverty status ($n_c = 1,264$; $n_a = 1,137$)				
Annual income <200% Federal Poverty Level	Ref	0.024*	Ref	0.552
Annual income ≥200% Federal Poverty Level	1.54 (1.06, 2.24)		1.14 (0.74, 1.76)	
Lives in public housing (NYCHA[‡]) ($n_c = 1,229$)				
Yes	Ref	0.786	N/A	N/A
No	0.94 (0.62, 1.43)		N/A	
Vaccination status ($n_c = 1,262$)				
Received at least one dose of a COVID-19 vaccine	Ref	0.829	N/A	N/A
Has not received a COVID-19 vaccine	0.92 (0.44, 1.93)		N/A	

*Significant at *p*-value < 0.05 level. [†]nc = sample size for crude mode; na = sample size for adjusted model; missingness in the data was < 4%. [‡]New York City Housing Authority. [§]Model adjusted for age group, race/ethnicity, individual educational attainment, years living in NYC, household poverty status, living in public housing, and vaccination status.

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TABLE 4 Key themes from residents' suggestions to strengthen trust in local government.

Theme	Frequency (*n*)	Subthemes	Illustrative quote
Communicate clearly and honestly	316	Share information	"Be transparent with statistics and new information."
		Be truthful	"Be honest and gain trust."
		Change communication strategies	"I think the government assume[s] everyone has a TV or some form of media to see the constant barrage of information. I think there should be info given out at transit hubs or bus and train stations or any other place people congregate."
		Be consistent in messaging and actions	"Every outlet should have been on the same page. The governor was saying one thing and the mayor would say something completely different."
Address socioeconomic challenges	144	Address housing	"More rent support."
		Address public safety	"Enforce public safety in MTA subways."
		Provide financial support	"Give another stimulus check to help pay bills and get more food."
		Address unemployment	"Employment or getting people help that are still unemployed."
		Provide food resources	"Give people food."
Enhance public COVID-19 protection measures	91	Increase/continue protective policies (e.g., mask mandates, vaccine requirements)	"…They should have kept the mandatory mask[s] cause it's spreading without people wearing…mask[s]."
		Increase enforcement of existing protective policies (e.g., masks on public transit)	"Enforce mask wearing on public transportation."
Increase vaccination rates	80		"Not to let their guard down. Keep pushing for higher vax rates."
Increase/continue local outreach	74	Community engagement	"Keep reaching out to the public and community leaders."
		Be visible	"Be more present."
Protect vulnerable populations (e.g., older adults, low-income families, people experiencing homelessness)	53		"What they can do is check on the older population. My neighbor, I have to buy her groceries because she is old and does not want to go outside with all the COVID. Check on who is old, who needs help, bring them groceries like in early COVID…"
Take responsibility	44	Model behaviors	"Wear masks where the public is required to wear masks and take City COVID regulation enforcement more seriously."
		Accountability for officials	"At the end of the pandemic, whenever that may be, I think the local government should acknowledge the mistakes they made and map out a plan for future pandemics."
Enact other policy change (e.g., bail reform, increased paid sick time, sanitation, immigration policy)	38		"Stop evicting and deporting undocumented people."
Follow science	30		"Focus less on economic factors and more on science."
Provide general support	29		"Have more help for the community."
Decrease public COVID-19 protection measures	27		"Accept… freedom of choice and stop mandating vaccinations."
Expand testing services	16		"Expand rapid testing at corner stores, bodegas, and churches."
Change or keep specific school policies	16		"Make sure all teachers and staff are vaccinated (no excuses) and tested weekly."
Address mental health issues	12		"Provide more funding for mental health."
Provide PPE	5		"Get masks to every household at least once a week for free to everyone in the house."
Support local businesses	5		"Continue making vaccination a mandate and helping stores and restaurants reinforce it."
Improve COVID-19 vaccine efficacy	3		"Keep looking for a safe vaccine that would stop you from getting COVID even after the vaccine."
Other response	n/a		n/a

deaths daily." Others more generally described the importance of providing accurate information as the situation evolves, illustrated by the responses *"continue with updated scientific information as our knowledge develops about COVID"* and *"more explicit information about the science they are using to drive decisions"*.

Another subtheme emerged about the need for transparency and truthfulness. Some participants implied that government has been *"holding back information,"* and many indicated that being forthcoming with all information was necessary to build trust.

Participants also suggested changes to current communication strategies, such as waiting to release new information until it is confirmed, mailing out information, and more intentionally countering widespread misinformation.

Finally, participants encouraged better consistency across government messaging. Responses indicated that messaging *"about vaccines and boosters has vacillated,"* and that messaging has been inconsistent and confusing. Similarly, participants pointed out specific instances where actions felt contradictory to public messaging and potentially undermined the message. For example, one respondent said, *"Allowing people to go out and do things [that require vaccination] with a single dose of the vaccine although you are not fully vaccinated until you are two weeks after your second dose sends mixed messages"*.

3.5. Address socioeconomic challenges (*n* = 144)

Another theme was to address social and economic challenges in the neighborhood to strengthen trust in local government. Participants identified specific supports they expected of a trustworthy and well-functioning local government, especially related to housing, food, unemployment, public safety, and financial support. Participants emphasized the social and economic hardships exacerbated by the pandemic and expressed expectations that government should address the high costs of housing through rent relief or lowered property taxes, disrepair of rental units including public housing units, and predatory landlords; participants also identified the need for government to provide free groceries or other food resources and to provide direct financial support to individuals and families. Considerations for the most vulnerable were elevated: participants felt a trustworthy government would prevent evictions and providing housing to people experiencing homelessness. One respondent highlighted long-term benefits of more intensive government support to address socioeconomic issues: *"The local NYC government should be focused on providing affordable housing, basic income, food stamps, employment, childcare, healthcare,* etc. *to all people in NYC so that when the next pandemic hits, the general standard of living is higher"*.

3.6. Enhance public COVID-19 protection measures (*n* = 91)

Ninety-one participants wrote-in responses related to maintaining or increasing public measures of protection. Of these, approximately 30 participants explicitly expressed support for vaccine mandates at places of employment and at restaurants and other public spaces, and approximately 20 explicitly expressed support for mask requirements in public spaces. One person said that to build trust the government should *"stop rushing to get everything back to normal,"* while another suggested that a trustworthy local government should *"not give in to all the whining and complaining about vaccines, mask wearing and social distancing"*.

Other responses related to this theme focused on enforcing existing protective measures such as checking vaccination cards in businesses that required vaccines and enforcing masking requirements on buses and trains.

3.7. Other major themes

Other common themes include increase vaccination rates, increase/continue local outreach, protect vulnerable populations, and take responsibility. Respondents described that the local government should "*keep pushing for higher vax rates*," engage with and be visible in the community, and "*continue to take care of the people who have been the worst affected*." The theme of take responsibility reflects two subthemes: model behaviors and accountability for officials. Model behaviors referred to government but especially to local law enforcement. Respondents advised that government and law enforcement should "*wear masks where the public is required to wear masks and take city COVID regulation enforcement more seriously*." Responses that mentioned accountability for officials include holding elected officials accountable by voting them out in future elections if important promises are broken and that "*the local government should acknowledge the mistakes they made and map out a plan for future pandemics*".

4. Discussion

Findings from a cross-sectional study in three historically disinvested neighborhoods in NYC demonstrate that 46% of adult residents in these communities consider local government to be a trusted source of information about COVID-19 vaccines. At a national level, preexisting data about trust in government is complex and often conflicting. In a large survey of Facebook users across 48 states, health professionals and scientists were listed among the most trusted sources of information about COVID-19 vaccines (23). However, national polls indicate that overall trust in government has remained relatively low over the past two decades: in April 2021, only 21% of Americans trust the government to do what is right "just about always" or "most of the time" (24). Moreover, misinformation about COVID-19 vaccines has permeated public perception, implying that social media and word of mouth are also believed sources of information. National data from the Kaiser Family Foundation COVID-19 Vaccine Monitor indicate that 80% of Americans believe to be true or are uncertain about at least one incorrect sentiment related to COVID-19 vaccines (25). Building trust between residents and their local government is a highly complex issue that the NYC Health Department, like many health agencies, continues to work towards and grapple with. These findings provide a baseline assessment of trust among residents in three historically disinvested neighborhoods specifically with respect to COVID-19 vaccine information which can be used as a point of comparison at future timepoints. They also provide an opportunity for NYC local government to learn from perceptions of the pandemic response, and

strengthen communication and other strategies to build credibility and public trust, in preparation for future emergency response.

While significant resources have rightfully gone to supporting religious leaders and community-based organizations to promote accurate COVID-19 messaging, these findings imply the need for continued resources and support for direct government outreach, community engagement, and communication campaigns as information regarding public safety as the pandemic continues to evolve. Relationship development requires time and consistency. Through consistent physical presence of the NYC Health Department in these neighborhoods by the work of the Bureaus of Neighborhood Health, relationships between residents and local government, as well as community partners and local government, have been intentionally cultivated and likely contributed to the perception of local government as a trusted messenger on this topic. These findings provide support for the need for continued and consistent government investment and engagement in historically disinvested neighborhoods.

The bivariate results identify populations that are less likely to trust government about COVID-19 vaccines, including people with less than a college degree, Black and Latino residents, those living in NYC for more than ten years, residents living in low-income households, and those living in public housing. Respondents are from neighborhoods that have been subjected to generations of systemic disinvestment; lower educational attainment and poverty persist due to government policies that dictated mortgage lending practices and school funding (26–28). Results could help inform priority populations for consistent and meaningful outreach. The multivariable model results demonstrate a marginally non-significant association between educational attainment and trust in local government; given the weighted study population skewed towards lower educational attainment, further research is warranted to better understand the relationship between education and trust in government. Further, some demographic subgroups had small sample size (e.g., people identifying their race as non-Latino Asian, transgender and gender non-conforming people). These categories were intentionally not collapsed into other subgroups to avoid further erasure of already systemically excluded communities, but small sample size yielded wide confidence intervals. Intentional oversampling of underrepresented populations in future survey panels can support better understanding of the experiences of these groups.

Issues of vaccine hesitancy, vaccine confidence, and vaccine acceptance, are complex and nuanced. Prior to the approval of any COVID-19 vaccine, social media surveillance revealed that social media users living in New York or London were more likely than those in Mumbai, Beijing, or Sao Paolo to post about a lack of confidence in vaccine safety and to distrust government promotion of the COVID-19 vaccines (29). In practice, public policies that instill fear of government also played a role in acceptance; for example, fear of Public Charge among undocumented people was a barrier to accepting the vaccine even among those confident in the vaccine itself (30). Vaccine hesitancy is a dominant narrative portrayed specifically about the perceptions of communities of color (31). However, a recent study used thematic analysis to understand themes across stories of NYC residents in low-income neighborhoods who were uncertain about the COVID-19 vaccines but ultimately decided to accept the vaccine (32). Among key reasons for vaccine acceptance were a strong sense of social solidarity and the desire to have a positive impact in their communities. Better understanding the motivators for receiving COVID-19 vaccines can help to shape public communications that build, rather than undermine, trust. Further, public communications, supported by enforced policies, that emphasize community spirit rather than individualism may be most effective in improving community health, particularly as it concerns a highly transmissible virus that thrives on social interactions to spread.

Overwhelmingly, qualitative data highlighted the need for clear, transparent, and consistent communication from all government bodies to build trust in local government entities. Some of the strategies recommended by residents are already in place but responses identify a lack of visibility. Better coordination between government agencies and increased consistency between local, state, and federal messaging may help to build needed trust. Eliminating contradictory messaging was elevated as a key theme to build trust, corroborating findings from Van Scoy et al. (33). The Centers for Disease Control and Prevention issues guidance for effective emergency communication, but many key pillars of this model were disregarded during the COVID-19 pandemic (34). For example, the guidelines recommend allowing subject matter experts to deliver public communications rather than elected officials. However, during the early phases of the COVID-19 outbreak in NYC many health messages were delivered directly by the Governor or Mayor. Public perception that health decisions were made by officials without medical or public health credentials might contribute to distrust. The guidelines also reiterate the importance of consistent messaging and framing around the nature of constantly evolving information, but this framing was missing from many public communications about the state of the COVID-19 pandemic and specifically the implications of vaccination (e.g., the shift from the narrative that vaccines will prevent against transmission to "breakthrough infections" to vaccines as protection against severe disease rather than infection). Critically evaluating COVID-19 related public health communications, revisiting tested methods of emergency communication, and recommitting to best practices is essential in preparation for future health emergencies.

Respondents also highlighted the need for government to address social and economic challenges to build trust. Based on responses, some participants appear to conflate the powers of local and federal government, for example by requesting additional stimulus checks from local government. However, the responses clearly indicate that a trustworthy government will ensure that the basic needs (e.g., food, shelter) of its constituents are met; systemic disinvestment in these specific neighborhoods likely exacerbates the need for government support related to socioeconomic concerns. Realistic mechanisms for government to provide basic needs to impoverished communities in NYC requires deliberate consideration. Policies that decrease food insecurity (e.g., government-funded food as medicine programs), and increase economic stability (e.g., universal basic income, increased living wage) could bolster trust by allowing government to better meet basic needs of its constituents.

A key theme was support for prevention measures, such as vaccine and mask mandates, including that increasing such measures would increase trust in local government. Despite narratives in the media and perceptions of politicians, prior research corroborates these findings. A study conducted by the Pew Research Center in August 2021 found that 62% of participants reported that the health benefits of COVID-19 restrictions on public activity have been worth the costs (35). Similarly, qualitative data from this study elevated the expectation

that government should protect vulnerable populations. Disproportionate media attention has been paid to school closures and restrictions on college campuses without nuanced discussion of the role infections in children played in household transmission to more vulnerable family members. Increased government attention to protecting older adult populations and those with chronic comorbidities, as well as increased media coverage of efforts that were made to protect the most vulnerable populations, may serve to build public confidence in the response. A desire for government to protect the most vulnerable is also at odds with the current communications to assess personal risk rather than having public policies in place to protect vulnerable members of a community. Policies that protect the health of vulnerable populations in public spaces, including updating the ventilation systems of public buildings to improve indoor air quality, convenient provision of no-cost masks to the public, and requiring masking in healthcare facilities or on public transit, may strengthen trust in government by demonstrating government-issued protections for at-risk community members.

The findings from this study present a snapshot of residents' perspectives at a particular point in time during the COVID-19 pandemic. The context of the pandemic conditions at the time of data collection likely influenced perspectives of residents. The survey was conducted nearly twenty months after the first cases of COVID-19 were diagnosed in NYC, and during a period of lower community transmission between the peak of the Delta wave in Summer 2022 and the Omicron wave in Winter 2021. At the time of data collection, COVID-19 vaccines had been readily available in NYC for all individuals age five and older for several months, and as of October 1, 2021, 82.7% of adult NYC residents had received at least one dose of a COVID-19 vaccine (22). Notably, among our survey sample, 90.8% of respondents reported having received at least one dose of a COVID-19 vaccine.

Public policy also contributes to perspectives at a given point in time. New York State policy at the time of the survey required masks in public indoor spaces and the Key to NYC policy required NYC indoor venues including restaurants, fitness facilities, and entertainment spaces to check for proof of COVID-19 vaccination prior to entry (36). These policies were suspended on February 10 and March 7, 2022, respectively (37, 38). In May 2022, NYC reached a "high alert" level in the NYC Government's own COVID alert system that intended to trigger renewed indoor masking requirements, but NYC Mayor Adams did not reinstate such requirements (39). When taken in the context of these study findings related to consistency in messaging and actions and increasing COVID-19 public prevention measures, it is possible that actions such as these could serve to lessen trust in local government.

4.1. Limitations

This study demonstrates associations between some demographic characteristics and trust in local government as a source of information about the vaccine, but as data are drawn from a cross-sectional study the ability to draw causal inferences is limited. Although the data were collected from a probability-based study panel, there are some limitations in generalizability particularly relevant to the findings presented in this paper. Most notably, neighborhood residents who opted to participate in a NYC Health Department survey may differ from other residents in important ways; as noted previously, the study sample was more likely to have received a dose of the COVID-19 vaccine than NYC residents overall at the time of data collection. As the panel is, by definition, residents willing to engage with the NYC Health Department, they may be more likely than residents who did not consent to join the panel to trust local government. Further, the neighborhoods included in this study differ from the overall population of NYC in several important ways, including demographic characteristics and historical context. As such, findings may not be generalizable to the broader NYC population. Additionally, because a complete case analysis was conducted, multivariable modeling may be subject to bias if the assumption that data were missing at random does not hold. Given the low level of missingness (<4%), the magnitude of potential bias is expected to be small. Finally, the perspectives of neighborhood residents who speak and read a language other than English, Spanish, or Chinese are not represented. Despite these limitations, the study contributes valuable information about the perspectives and recommendations of residents living in low-income communities about how to build trust in local government.

4.2. Conclusion

Study findings showed that there was a reasonably large proportion of residents in the three historically disinvested neighborhoods in NYC that viewed local government as a trusted source of information about COVID-19 vaccines, and that the long-standing relationships with the NYC health department is a factor that can be further leveraged to increase trust and coordination of vaccinations in these often-excluded communities. Resident feedback and suggestions, including those displayed in Table 4, serve as a potential roadmap for strategies that can be implemented to gain or increase public trust. Strategies to increase trust in local government include clear, transparent communication and providing government support to address social and economic challenges. Study participants supported government-enacted protective measures to reduce community transmission of COVID-19 and expected government to take such measures to protect themselves, vulnerable populations, and the City at large.

Data availability statement

The datasets presented in this article are not readily available due to privacy restrictions. The data that support the findings of this study are available from authors upon reasonable request and with permission of NYC Department of Health and Mental Hygiene. Requests to access the datasets should be directed to LS at lshiman@health.nyc.gov.

Ethics statement

All protocols were carried out in accordance with relevant NYC Department of Health and Mental Hygiene guidelines with respect to informed consent, data storage, and other considerations. This project was reviewed and deemed exempt research by the NYC Health Department's Institutional Review Board (Protocol #21-053). Informed consent was received from all study participants at the time of the survey.

Author contributions

LS: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. FD: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing. CN: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing. BB: Conceptualization, Investigation, Writing – review & editing. RD: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing. SD: Conceptualization, Data curation, Formal analysis, Writing – review & editing. ML: Conceptualization, Funding acquisition, Investigation, Writing – review & editing. JP: Conceptualization, Investigation, Methodology, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Identifying modifiable factors associated with COVID-19 vaccine hesitancy and acceptance among cancer patients in Jordan

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Introduction: Vaccines stand amongst the most effective medical interventions for the management of infectious diseases, and are pivotal tools for public health. The acceptance of vaccines is heavily influenced by perceptions of efficacy, safety and other modifiable factors.

Purpose: This cross-sectional study sought to identify and examine the modifiable factors that can help address COVID-19 vaccine hesitancy and acceptance among cancer patients.

Methods: The study was conducted between February and April 2021 using an online survey questionnaire comprising of four domains. The survey was administered to cancer patients in Jordan.

Results: Among the 1,029 cancer patients who completed the online questionnaire (response rate= 73%), 58% (n=597) expressed willingness (intent) to take the vaccine. Notably, 72.5% (n=433) of those intending to take the vaccine were currently undergoing treatment. Knowledge and awareness played a significant role, with 54.3% considering them essential for vaccine acceptance. Fear of infection significantly influenced vaccine acceptance ($p<0.001$), with 66.8% expressing concern about potential infections. Peer encouragement was also a crucial factor, as 82.4% regarded it as an important driver for influencing vaccine acceptance ($p<0.001$).

Conclusion: Peer encouragement, awareness, and fear emerged as the primary modifiable factors associated with greater vaccine acceptance by patients with active malignancies. Study results suggest that providing personalized and tailored information about vaccinations, focusing on safety and potential interactions with cancer and its treatment, are potentially excellent strategies for improving vaccine acceptance among cancer patients.

KEYWORDS

COVID-19 vaccine, coronavirus, vaccine acceptance, vaccine hesitancy, public health, vaccination, cancer patients, modifiable factors

1 Introduction

Vaccine is among the most effective medical interventions for preventing and managing infectious diseases (1). The emergence of Coronavirus disease 2019 (COVID-19) has caused over 758,000,000 confirmed cases and 6,859,093 recorded deaths as of 2023, as reported by the World Health Organization (WHO) (2, 3). In Jordan, there are over 14,000 COVID-19 deaths as of 2023 (2). Some populations, such as cancer patients, are known to be particularly vulnerable to COVID-19 infection. Individuals with cancer have been shown to experience worse clinical outcomes and increased mortality from COVID-19, particularly those who are receiving active therapy or have advanced malignancy (4, 5). Although, there is substantial evidence in support of COVID-19 vaccines' effectiveness, especially at preventing infection and severe disease (6–8), many people still express hesitancy towards using them (9, 10).

Hesitancy affects a wide range of people, ranging from those who absolutely reject all vaccinations to those doubt vaccines in special circumstances (2, 10). Vaccine hesitancy is complex and context-specific, varying across time, place and vaccine type. It is influenced by factors such as complacency, convenience and confidence. Most of these factors that influence vaccine hesitancy can be categorized either as modifiable or non-modifiable (11). The former group includes media impact, social acceptance, and worries about safety and efficacy, while the latter group includes disease and patient characteristics. Due to its unfamiliarity, lack of evidence about its efficacy at the time of introduction, and uncertainty about the long-term safety profile, cancer patients are often more prone to scrutinize but also accept the COVID-19 vaccine. Evidence shows that patients with active malignancies are more likely to hold misconceptions about contraindications to receiving the COVID vaccine due to their malignant disease (11). Fear of developing COVID-19 symptoms and infection have been known to help boost vaccine acceptance or adoption among cancer patients (12). The purpose of this study was to assess the willingness (intent) of cancer patients to receive the COVID-19 vaccine and describe possible strategies to improve vaccine acceptance based on their perceptions.

2 Materials and methods

The study utilizes a cross-sectional observational design to assess the attitude of cancer patients towards the COVID-19 vaccine, and pinpoint possible factors leading to vaccine hesitancy and poor acceptance of this medical intervention. Study participants were: (a) randomly selected from a pool of patients with active malignancies at the King Hussein Cancer Center, (b) over the age 18 years, and (c) were able to provide informed consent, during the 2-month sample period from February until April 2021. The study took place shortly after Jordan's Food and Drug Administration (JFDA) approved the use of a number of vaccines for preventing the spread of COVID-19 in February 2021. Consent to participate in the study was obtained verbally from all participants who enrolled in the study. They were contacted by phone and were informed that study participation was voluntary and they can withdraw at any stage of the study. A link to the survey was sent to all participants after consenting. The online questionnaire was self-administered; follow ups were conducted within 3 days if no response had been received.

2.1 Survey questionnaire

A self-administered questionnaire was created to assess the perceptions of cancer patients towards the COVID-19 vaccine shortly after its arrival in Jordan. A literature review and a discussion was conducted with a group of experts to develop a questionnaire that contained question items appropriate for the target group: cancer patients. Face and content validity were tested with specialists involved with cancer patients during the COVID-19 pandemic including: physicians, nurses, psychosocial workers, survey specialists, clinic coordinators, statisticians and patients. The final version of questionnaire comprised 4 domains: demographics and disease characteristics, history of COVID-19 infection, vaccine awareness, and vaccine hesitancy. A majority of the questions required short answers or dichotomous (yes/no) responses, allowing for a more complete dataset (i.e., responses without excess missing data).

The first Domain consisted of questions about patient demographics and disease characteristics stratified by survey participant groups. Collected demographic information included age, gender, marital status, number of children (if applicable), monthly income, level of education, and occupation. Disease characteristics included confirmed diagnosis, treatment modalities, and current tumor stage. The second domain of questions asked about COVID-19 infection, including previous infection and associated symptoms. One question asked about patient's fear of getting the coronavirus infection. In the third domain, 5 question items were used to assess patient awareness of vaccines and their baseline vaccine practices (e.g., previous seasonal flu vaccination practice, knowledge of the COVID-19 vaccine itself). The fourth and final domain of questions asked about possible vaccine hesitancy, their experience with the vaccination process, and the motives behind their reluctance.

2.2 Statistical tools

Study data were analyzed using IBM SPSS statistical software, version 28.0. The descriptive analysis reported on sample characteristics by frequency and percentage. The sample was divided into two groups based on their willingness (intent) to receive the COVID-19 vaccine: those willing (did intend to receive) and those not willing (did not intend to receive). A comparative analysis was conducted between these groups, utilizing cross tabulations for categorical data and employing Chi-Square or Fisher exact tests to assess for associations. Univariate tests were carried out to identify variables (confounding factors) that were included in the binary logistic multivariable regression analysis, this model was used to identify and describe statistically significant predictors of COVID-19 vaccine acceptance. The

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dependent variable for the model was operationalized as a binary response (Yes & No).A p value of < 0.05 was considered statistically significant.

3 Results

Among the 1410 participants who received the survey link, 1029 patients completed the survey for a response rate of 73%. Table 1 shows the sample demographics: 495 males (48%), 534 females (52%), 74 (7%) who were single, 775 (75%) married, 67 divorced (6%), and 113 (10%) widowed. For the sample's income distribution, 48% had a monthly income of less than 500 JOD (Jordanian Dinar), while 22% had a monthly income ranging between 500 and 1000 JOD. Those with a monthly income exceeding 1000 JOD constituted 20% of the total sample. Educational attainment was distributed as follows, 52% held an undergraduate degree, 16.9% had a postgraduate degree, 10% had primary education, 20% had tertiary education and 1% had secondary education. For work status, 49.9% were full-time employees, 13.3% worked part-time, 26.8% were housewives, 7.5% were retired, and 2.3% were unemployed.

When asked about previous treatments, 48.8% had undergone surgery, 35.5% had received chemotherapy, 7.5% had received hormonal therapy, a small percentage had received radiotherapy (less than 1%), or targeted therapy (less than 1%), and 7.2% reported no previous treatment. For current treatment status, 21.6% reported no current treatment, 28.5% had undergone surgery recently, 24.4% received chemotherapy, and a small percentage received radiotherapy (15.7%), hormonal therapy (3.4%), targeted therapy (5.3%), or bone marrow transplantation (BMT, less than 1%).

Cancer stages among the 998 survey participants (there were some missing data in the overall sample) were as follows: 22.2% were in stage I, 30.4% in stage II, 38.5% in stage III, and 5.7% in stage IV. Additionally, 6.5% were in the pre-treatment stage, 14% were in the post-treatment stage, and 79.3% were in the active treatment stage.

Of the total sample, 127 patients (12.3%) were diagnosed with COVID-19 infection. The most frequently reported symptom was fatigue, affecting 49.6% of them, followed by muscle ache (44%), anosmia (33.8%), fever (24.4%), sore throat (22.8%), and headache (11.8%). Less common symptoms were diarrhea, reported in 6.2%, and Ageusia, reported in 2.3%. Notably, 37.7% of the patients either experienced very mild symptoms that went unrecognized or were entirely asymptomatic. These results highlight the wide range of presenting symptoms associated with COVID-19 among cancer patients in Jordan. (Figure 1).

Among survey participants, 432 (42%) were not willing (did not intend) to take the vaccine, while 597 (58%) expressed a willingness (intent) to take the vaccine. Comparison between these two groups revealed no significant differences by demographic characteristics such as age, gender distribution, number of children, marital status, income, type of work, and previous treatments status (Table 2). In addition, health practices such as receiving the seasonal flu vaccine were found to be similar between the two groups.

TABLE 1 Sociodemographic characteristics of survey participants, from a pool of cancer patients at the King Hussein Cancer Center, Jordan (Feb-April 2021).

Characteristic		N=1029
Gender	Male	495 (48%)
	Female	534 (52%)
	Total	1029
Marital Status	Single	74 (7%)
	Married	775 (75%)
	Divorced	67 (6%)
	Widow	113 (10%)
	Total	1029
Income	Less than 500 JD	492 (48%)
	500- 1000 JD	326 (22%)
	More than 1000 JD	211 (20%)
	Total	1029
Education	Primary Education	96 (10%)
	Secondary Education	13 (1%)
	Tertiary education	209 (20%)
	Undergraduate degree	537 (52%)
	Postgraduate degree	174 (16.9%)
	Total	1029
Work	Part-time	137 (13.3%)
	Full-time	514 (49.9%)
	Housewife	276 (26.8%)
	Unemployed	24 (2.3%)
	Retired	78 (7.5%)
	Total	1029
	Surgery	503 (48.8%)
Previous treatment	Chemotherapy	366 (35.5%)
	Hormonal therapy	78 (7.5%)
	Radiotherapy	5 (<1%)
	Targeted therapy	2 (<1%)
	None	75 (7.2%)
	Total	1029
	Surgery	294 (28.5%)
Current treatment	Chemotherapy	252 (24.4%)
	Radiotherapy	162 (15.7%)
	Targeted therapy	55 (5.3%)
	Hormonal therapy	35 (3.4%)
	BMT	8 (<1%)
	None	223 (21.6%)

(Continued)

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TABLE 1 Continued

Characteristic		N=1029
	Total	1029
Stage	I	229 (22.2%)
	II	313 (30.4%)
	III	397 (38.5%)
	IV	59 (5.7%)
	Total	998
Treatment stage	Pre-treatment	67 (6.5%)
	Post treatment	145 (14%)
	Active treatment	817 (79.3%)
	Total	1029

As for vaccine hesitancy, a different pattern emerged when analyzing the data. Participants who expressed a willingness (intent) to take the vaccine exhibited a higher level of knowledge and awareness of the different types of vaccines, as compared to those who reported being hesitant (72.1% vs. 27.9%, p<0.001).

The former, as compared to the latter group, also had a lower likelihood of previous COVID-19 infection or diagnosis (48.8% vs. 51.2%, p=0.025), higher levels of fear of COVID-19 infection (63.2% vs. 36.8%, p<0.001), and greater trust in the vaccine's ability to protect them from the infection (67.8% vs. 32.2%, p<0.001).

Perception of future risk was another factor that influenced vaccine hesitancy and acceptance. Patient who expressed worry about contracting the virus in the future were more likely to accept the vaccine. Beliefs about the vaccines' efficacy at preventing virus acquisition and its positive impact on people's lives also influenced acceptance. Interestingly, proper education on the vaccine seemed to be associated with stronger vaccine acceptance. For example, many patients who initially expressed hesitancy about the vaccine were willing to take it after receiving proper education. Finally, other factors such as fear of infection or death represented primary motivators of vaccine acceptance in the study. This was followed by the desire to enhance education and awareness, and peer encouragement affected vaccine acceptance as well.

Overall, these data highlight the complex interplay of factors influencing COVID-19 vaccine acceptance, including knowledge and awareness, fear, beliefs, personal experiences, and social influences. Understanding these factors can help inform strategies to address vaccine hesitancy and promote vaccination acceptance.

Although results reported in Table 3 reveal that willingness (intent) to take the COVID-19 vaccine by different diagnosis group were not statistically significant (P-value 0.069), the breakdowns by these diagnosis groups suggests that vaccine hesitancy varied notably across certain groups. For instance, the patients with Pancreatic Cancer demonstrated the highest hesitancy rate at 62.5%, followed by Breast Cancer (46.9%), GI Cancer (45.1%), and Head & Neck Tumors (48.1%). Conversely, patients with Gynecological cancers had the lowest hesitancy rate at 28.6%, while the others fell within the range of 34.0% to 50.0%, including Lung Cancer (34.3%), Eye Tumors (36.8%), Leukemia (37.5%), Brain & CNS Tumors (34.0%), Urology (40.2%), and Orthopedics & Spine (50.0%). This variation points to a potential need to better tailor diagnosis-specific approaches to these groups, in order to reduce vaccine hesitancy and improve acceptance.

In the multivariable regression model (Table 4) significant predictors of vaccine acceptance included: positive life changes, peer encouragement, fear of death or getting infected with COVID-19, enhancement of education and awareness, not under current treatment, and awareness of the different COVID-19 vaccine options. For example, positive life changes were found to be associated with a higher likelihood of willingness (intent) to take the vaccine (Odd ratio (OR) = 1.828, $p < 0.001$), as was peer encouragement; it also played a significant role in increasing vaccine acceptance among cancer patients (Wald Chi-square= 82.202, $p < 0.001$). Similar observations were made for enhancing education and awareness, and fear of death or getting infected (OR = 0.352, OR = 0.121, respectively) ($p < 0.001$).

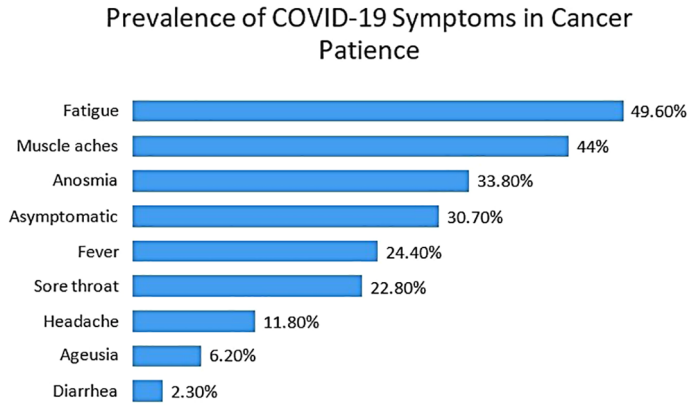

FIGURE 1
Prevalence of COVID-19 symptoms among patients at the King Hussein Cancer Center, Jordan (Feb-April 2021).

TABLE 2 Comparison of patients who were willing versus those who were not willing to take the COVID-19 vaccine, King Hussein Cancer Center, Jordan (Feb-April 2021).

Variables		Will not take COVID 19 Vaccine N (%) 432 (42%)	Will take COVID 19 vaccine N (%) 597 (58%)	*P*
Age	Mean (SD)	50.51(14.17)	51.55(13.3)	0.227
	Min - Max	18 - 86	18 - 86	
Gender	Male	217 (43.8%)	278 (56.2%)	0.245
	Female	215 (40.3%)	319 (59.7%)	
Marital Status	Single	35 (47.3%)	39 (52.7%)	0.433
	Married	319 (41.2%)	456 (58.8%)	
	Divorced	33 (49.3%)	34 (50.7%)	
	Widow	45 (39.8%)	68 (60.2%)	
Income	< 500 JD	202 (41.1%)	290 (58.9%)	0.533
	501- 1000 JD	145 (44.5%)	181 (55.5%)	
	> 1000 JD	85 (40.3%)	126 (59.7%)	
education	Primary	38 (39.6%)	58 (60.4%)	0.155
	Secondary	3 (23.1%)	10 (76.9%)	
	High school	89 (42.6%)	120 (57.4%)	
	Under graduate	240 (44.7%)	297 (55.3%)	
	Post graduate	62 (35.6%)	112 (64.4%)	
Work	Part time job	58 (42.3%)	79 (57.7%)	0.118
	Full time	208 (40.55%)	306 (59.5%)	
	House wife	124 (44.9%)	152 (55.1%)	
	Don't work	15 (62.5%)	9 (37.5%)	
	Retired	27 (34.6%0	51 (65.4%)	
Previous treatment	None	23 (30.7%)	52 (69.3%)	0.175
	Surgery	216 (42.9%)	287 (57.1%)	
	Radiotherapy	2 (40%)	3 (60%)	
	Hormonal therapy	39 (50%)	39 (50%)	
	Chemotherapy	152 (41.5%)	214 (58.5%)	
	Immunotherapy	0 (0)	2 (100%)	
Current treatment	None	76 (34.1%)	147 (65.9%)	0.122
	Surgery	128 (43.5%)	166 (56.5%)	
	BMT	3 (37.5%)	5 (62.5%)	
	Radiotherapy	65 (40.1%)	97 (59.9%)	
	Hormonal therapy	18 (51.4%)	17 (48.6%)	
	Chemotherapy	118 (46.8%)	134 (53.2%)	
	Immunotherapy	24 (43.6%)	31 (56.4%)	
Cancer Stage	Early	221 (40.8%)	321 (59.2%)	0.361
	Late	199 (43.6%)	257 (56.4%)	

(Continued)

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TABLE 2 Continued

Variables		Will not take COVID 19 Vaccine N (%) 432 (42%)	Will take COVID 19 vaccine N (%) 597 (58%)	*P*
Treatment status	Not under current treatment	94 (36.4%)	164 (63.6%)	0.041
	Under current treatment	338 (43.8%)	433 (56.2%)	
Have you previously received the influenza vaccine?	Yes	85 (41.5%)	120 (58.5%)	0.875
	No	347 (42.1%)	477 (57.9%)	
Do you take the influenza vaccine yearly?	Yes	129 (44.2%)	163 (55.8%)	0.369
	No	303 (41.15%)	434 (58.9%)	
Are you aware of the different COVID-19 vaccines?	Yes	151 (27.9%)	390 (72.1%)	<0.001
	No	281 (57.6%)	207 (42.4%)	
Do you know about the side effects of the vaccine?	Yes	97 (38.5%)	155 (61.5%)	0.212
	No	335 (43.1%)	442 (56.9%)	
Have you been previously infected with the COVID-19 Virus?	Yes	65 (51.2%)	62 (48.8%)	0.025
	No	367 (40.7%)	535 (59.3%)	
Are you worried about getting the virus in the future?	Yes	284 (36.8%)	488 (63.2%)	<0.001
	No	83 (63.8%)	47 (36.2%)	
Do you think that the vaccine will stop you from acquiring the virus	Yes	167 (32.2%)	352 (67.8%)	<0.001
	No	265 (52%)	245 (48%)	
Do you think that the success of the vaccine will positively affect your life?	Yes	187 (32%)	397 (68%)	<0.001
	No	245 (55.1%)	200 (44.9%)	
Which of the following reasons will drive you to take COVID-19 vaccine?	Fear of getting infected or death	187 (66.8%)	93 (33.2%)	<0.001
	Enhance Education and awareness	95 (45.7%)	113 (54.3%)	
	Peer encouragement	56 (17.6%)	263 (82.4%)	
If you are not willing to take the vaccine, Do you think your decision to take the vaccine may be affected after proper education?	Yes	151		NA
	No	281		

4 Discussion

The prevention of infections is crucial for patients with impaired immunity, such as those with cancer, as infections can lead to higher morbidity and mortality rates (1). Despite the apparent benefits of immunization in preventing infections, many cancer patients are hesitant to receive vaccines. Currently, there is a lack of published data on COVID-19 vaccine hesitancy or acceptance specifically among cancer patients in Jordan. This study aimed to identify various factors that contribute to vaccine hesitancy in this particular population, some of which overlap with factors reported in general population surveys while others are unique to cancer patients.

This study sheds light on the willingness (intent) of cancer patients in Jordan to take the COVID-19 vaccine. It highlights the need to consider both disease-specific factors and modifiable factors when addressing vaccine hesitancy and acceptance in this vulnerable population. Understanding the drivers behind vaccine intention can help inform strategies to increase acceptance rates among cancer patients, ensuring their protection against COVID-19 and reducing associated risks.

The findings of this study reveal that over half of the surveyed cancer patients (n = 597; 58%) expressed willingness (intent) to receive the COVID-19 vaccine. Their acceptance rates are similar to those reported among cancer patients in Lebanon and Tunisia, where acceptance rates were 55% and 50.5% respectively (10, 11). The study identified both non-modifiable disease-specific factors and modifiable factors that influence the decision-making process. Interestingly, there was low heterogeneity observed across different demographic groups, indicating that demographic factors may not

TABLE 3 COVID-19 vaccine acceptance by cancer diagnosis group among patients of King Hussein Cancer Center, Jordan (Feb-April 2021).

Variables			Won't take COVID 19 Vaccine (432)	Will take COVID 19 vaccine (597)	TOTAL	*P*
Diagnosis Grouped	Breast Cancer	Count (%)	122 (46.9%)	138 (53.1%)	260	0.069
	Urology	Count (%)	66 (40.2%)	98 (59.8%)	164	
	GI Cancer	Count (%)	69 (45.1%)	84 (54.9%)	153	
	Brain & CNS Tumor	Count (%)	32 (34.0%)	62 (66.0%)	94	
	Gynecology	Count (%)	24 (28.6%)	60 (71.4%)	84	
	Orthopedics & Spine	Count (%)	37 (50.0%)	37 (50.0%)	74	
	Lung cancer	Count (%)	24 (34.3%)	46 (65.7%)	70	
	Head & Neck Tumors	Count (%)	26 (48.1%)	28 (51.9%)	54	
	Leukemia	Count (%)	12 (37.5%)	20 (62.5%)	32	
	Eye Tumor	Count (%)	7.0 (36.8%)	12 (63.2%)	19	
	Pancreatic Cancer	Count (%)	5 (62.5%)	3 (37.5%)	8	
	Others	Count (%)	8 (47.1%)	9 (52.9%)	17	

significantly impact vaccine intention, contrary to what has been reported in the literature (11, 12). The decision to receive the vaccine seemed to be driven more by necessity, considering factors such as pandemic severity, vaccine safety and efficacy data, and government policies.

Study findings indicated that patients with early-stage disease showed higher willingness (intent) to take the COVID-19 vaccine, as compared to those with late-stage disease (59.2% vs. 56.4%), but this difference, however, was not statistically significant (p=0.361).

These findings are similar to a study conducted in Hong Kong, which also failed to definitively demonstrate significant differences in vaccine acceptance among their participants at different stages of cancer (13). Nonetheless, a systematic review conducted by Prabani et al, 2022 (14), found that patients with advanced stages of cancer (stages III and IV) had lower acceptance of the COVID-19 vaccine. Another study conducted on cancer patients in Turkey showed that patients with stage IV cancer had significantly higher levels of vaccination fear compared to patients with stage II cancer (15).

These mixed findings in the literature may be attributed to cultural differences and awareness gaps among various study participants. Cultural differences are known to influence attitudes and beliefs towards vaccination, and variation in level of awareness can affect perceptions of vaccine benefits and risks.

Another important finding of the present study was that the decision to get vaccinated among cancer patients was largely influenced by treatment status. A majority of patients who were not under treatment were willing (intent) to take the vaccine more so than those who were undergoing treatment; this differs from findings by Brko et al., 2021, which indicated that 75% of cancer patients in Serbia who were in the active cancer treatment phase, early or metastatic stage did not receive the vaccine (16). Research by Heudel et al., 2021, found that less than 10% percent of cancer patients undergoing active treatment refused to get vaccinated (17). Again, variations in these findings suggest hidden roles of cultural differences in determining vaccine acceptance, some of which reflect the uncertainty about vaccine efficacy and safety throughout the

TABLE 4 Multivariable (Binary Logistic) regression model of modifiable factors associated with COVID-19 hesitancy, King Hussein Cancer Center, Jordan (Feb-April 2021).

Outcome: Vaccine acceptance	Regression Coefficient	WALD	P-value	Odds Ratio (95% CI)
Positive life changes	.603	12.656	<0.001	1.828 (1.311-2.548)
Peer Encouragement		82.202	<0.001	–
Fear of death or get infected with COVID-19	-2.116	82.120	<0.001	0.121 (0.076-0.191)
Enhancement of Education & awareness	-1.043	22.514	<0.001	0.352 (0.229-0.542)
Not under Current treatment	.979	23.708	<0.001	2.662 (1.795-3.947)
Awareness of the different COVID-19 vaccines	.722	16.520	<0.001	2.059 (1.453-2.917)
Constant	.374	2.798	.094	1.453 (-)

(Vaccine acceptance were adjusted for the significant factors in the univariate analysis as follow: treatment status, awareness of different types of vaccine, positive life changes, peer encouragement, fear of death or being infected with COVID-19, & enhancement of Education & awareness).

COVID19 pandemic for those patients in ongoing active treatment. Clearly, patients who had more knowledge about the vaccine options were more likely to get the vaccine, highlighting the importance of proper education and awareness for these cancer patients. Suggesting that empowering physicians to provide the critical brief advice could be lifesaving. The healthcare sector could implement priority programming to help facilitate access to the COVID-19 vaccines to high-risk cancer patients, supporting physicians to more routinely provide information about COVID-19 and encouraging vaccination (18). The importance of having healthcare professionals promote vaccination and reduce vaccine hesitancy has been highlighted in the emerging evidence base, including the previously reported findings of Villarreal-Garza et al., 2021 (19).

The study findings exhibit that there was a minimal impact of proper health education on the decision-making process with a slight self-predicted increase in agreeability among patients (25%) upon combating misinformation. Another study on the impact of education on cancer patients showed increased agreeability with the vaccine and a heightened belief in efficacy, safety, and advocacy (20). A Polish survey reported that education and marital status were both significantly associated with willingness (intent) to take the COVID-19 vaccine (14); although these factors were not associated with similar patient willingness (intent) in our study. Geographic and cultural differences may have played a role in these inconsistent findings.

Our study found that a significant percentage of participants (67.8% and 68%) who were willing to receive the COVID-19 vaccine believe in the vaccine's efficacy and anticipated success ($p < 0.001$). This finding aligns with those of Brodziak et al., which showed that a positive attitude towards getting vaccinated was critical for acceptance among the majority of Polish patients enrolled in their study (73.7%) (21). A considerable body of literature emphasizes the importance of building proper knowledge and understanding through official campaigns and credible spokespersons (22). In the our study, 45.6% of participants expressed the value of peer encouragement on influencing their decision-making. This finding is consistent with the research of Jarrett et al. they showed and highlighted the role of the social system in increasing education and awareness (22). These findings and results also underscore the potentially vital role that social media and community engagement can play in diminishing vaccine hesitancy and increasing acceptance. Media and social media campaigns are known as potent tools for disseminating information and educating the public, especially vaccine information that can be trusted and is accurate. Trusted community sources and support groups are other tools that can further foster trust among cancer patients, and thereby help debunk vaccine-related misinformation. A 2020 study by Wilson & Wiysonge found a strong correlation between organizing activities on social media and public skepticism towards vaccine safety. The study documented a significant relationship between foreign disinformation campaigns and a decline in vaccination coverage (3).

The pandemic's psychosocial impact on cancer patients is another factor to consider when thinking about ways to improve vaccine uptake. During the health crisis, it was evident that most cancer patients exhibited a higher level of generalized anxiety and specific concerns about death. During the pandemic, fear and anxiety played significant roles in influencing patients' willingness (intent) to get vaccinated. A substantial percentage (63.2%) of our study participants expressed fear towards being infected with COVID-19, a factor that likely drove many of our cancer patients' decisions about the COVID-19 vaccine. By understanding the powerful role fear plays in shaping vaccine acceptance, the medical and public health communities can develop and better tailor, more inclusive public health campaigns and interventions to address vaccine hesitancy and improve acceptance among cancer patients. These findings align well with previous research by Erdem et al., 2022, where they demonstrate that a majority (86.7%) of cancer patients who accepted the vaccine had heightened anxiety towards the virus, as measured by the COVID-19 phobia scale (C19P-S) (15).

The present study also points to the importance of peer-led education programs in reaching and helping unvaccinated patients to get vaccinated. This program approach may be underused in vaccine campaigns and could help address some of the observed vaccine hesitancy reasons in cancer patients. Our study also found that previous COVID-19 infection was associated with a decreased likelihood of vaccine acceptance. This association could be attributed to the presumption of long-term immunity after recovery and reduced fear among those who had been previously infected.

Future research and COVID-19 vaccine campaigns should consider these various factors identified in our study. Among the key research needs might be the need to conduct follow-up studies so that changes in attitudes and vaccine acceptance among cancer patients could be documented as these individuals recover from the pandemic. Capturing this information could provide valuable insights into the evolving dynamics of cancer patients' needs and strategies that health systems are developing or using to address vaccine hesitancy and acceptance in this vulnerable population.

4.1 Strengths and limitations

The present survey study possesses several notable strengths that contribute to its robustness. Firstly, the large sample size employed in the research facilitates a fairly comprehensive representation of cancer patients with diverse malignancies. As such, study findings could be generalizable to a broader range of cancer patients. In addition, the inclusion of a heterogeneous mix of different cancer disease types ALSO enhanced our study's ability to capture the nuances and variations in vaccine acceptance across the various cancer diagnoses. Furthermore, the utilization of a multistage data analysis approach added depth and rigor to the methodology used, allowing for a more thorough exploration of the different factors that are influencing vaccine acceptance among the cancer patients in Jordan. These strengths collectively enhance the

reliability and applicability of the study's findings. However, it is important to acknowledge several limitations of the study. First, the data collection occurred during a specific phase of the COVID-19 pandemic, and the study may not fully capture the evolving dynamics of the health crisis. The introduction of new vaccines and the dissemination of updated information may have led to shifts in cancer patients' perspectives on vaccination, potentially rendering our findings less generalizable to later stages of the pandemic. Furthermore, the study focused on a specific geographical region and may not encompass the diversity of perspectives and experiences of cancer patients in different contexts. Additionally, the data were self-reported, which introduces the possibility of recall bias and social desirability bias. While we made efforts to mitigate these biases, they remain inherent limitations of survey-based research. Finally, the study is cross-sectional, which limits our ability to establish causal relationships or capture the potential changes in attitudes over time.

5 Conclusions

Efforts to combat the COVID-19 pandemic and facilitate recovery have accelerated the development and usage of effective COVID-19 vaccines. However, vaccine hesitancy, potentially resulting in low acceptance rates, continues to pose a risk, prolonging the severity and impact of COVID-19 on patients with active malignancies. In our study, we identified awareness about vaccines, fear of infection, and peer encouragement as pivotal modifiable factors associated with increased vaccine acceptance (reduced hesitancy) among cancer patients at our medical center in Jordan. Recognizing and understanding these modifiable factors provide oncologists and healthcare providers with pathways to address vaccine hesitancy by offering personalized advice, resources, and healthcare interventions to cancer patients. Moreover, it allows providers to establish better trust with their patients regarding vaccine safety, side effects, and appropriate usage. These factors are globally relevant and can be integrated into government (e.g., public health) guidelines to optimize COVID-19 vaccination uptake at national and regional levels. They can also guide the development of more effective peer-led educational campaigns aimed at enhancing confidence and trust in vaccines, especially among patients with active malignancies—the most vulnerable group concerning this respiratory infection.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Institutional Review Board/King Hussein Cancer Center (IRB-KHCC). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

RA: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. MM: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. RD: Data curation, Formal Analysis, Writing – original draft. KA: Formal Analysis, Writing – review & editing. YS: Formal Analysis, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Presidents and vaccines: head of state inoculation as a tool for vaccine promotion

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Introduction: Vaccine hesitancy, an important threat to global health, has increased since the onset of the COVID-19 pandemic. The public vaccination of high-profile figures, such as heads of state, has been touted as a potential tool for increasing vaccine acceptance among the general population. However, systematic information on such role modelling is lacking and existing studies focus on a small number of high-income countries. We take advantage of the COVID-19 pandemic to fill this gap.

Methods: Through a systematic search of internet sources, we first document that most global leaders supported the vaccination campaign and actively communicated their vaccination status to the public. We then turn to a case study to provide experimental evidence on vaccine role modelling for a country in Africa – the region that is most lagging behind in achieving universal immunization coverage. We rely on a randomized survey experiment with 600 citizens in the Democratic Republic of Congo and take advantage of the fact that the Congolese President publicly received a COVID-19 vaccine during the survey period.

Results and discussion: Our findings demonstrate that the impact of political leader's role modelling is moderated by trust and depends on media outreach and access. When trust in leaders is lacking, or news on their actions is inaccessible, alternative ambassadors and effective communication methods become crucial in motivating and informing the public. This may be especially relevant in fragile states and remote regions.

KEYWORDS

immunization, vaccine hesitancy, institutional trust, public health, Democratic Republic of Congo

1 Introduction

Leaders as diverse as United States President Joe Biden and Iran's Supreme Leader Ayatollah Ali Khamenei have come forward on television to receive a COVID-19 vaccine. The idea is that, by getting vaccinated publicly, leaders signal that they are confident in the vaccine's effectiveness and safety, thereby promoting vaccine acceptance among the broader population. Other heads of state, including Germany's Angela Merkel and France's Emmanuel Macron have revealed that they got vaccinated, but did not publicize the moment on television or with a picture. A small minority of heads of state publicly refused to get vaccinated. What is the relative frequency of these choices? And, to what extent do these leaders' choices influence vaccine acceptance? These are the questions we address.

First, we create a public database of heads of state with systematic information on their support for COVID-19 vaccination, whether they are vaccinated themselves, and whether they distributed images of the inoculation. We find that 168 out of 173 global leaders (97%) explicitly supported the vaccination campaign. Most of them (80%) also made public that they received a COVID-19 vaccine, and 78% of those vaccinated publicized the news with a picture or video. We can therefore conclude that most global leaders thought it was important to communicate their vaccination status to the public using more than words.

Existing studies suggest that role modelling by political leaders helps to promote vaccine acceptance among the population. However, few studies support this with experimental evidence, and most focus on a small number of high-income countries. This study aims to fill this gap by providing experimental evidence on vaccine role modelling for a country in Africa – the region that is most lagging behind in achieving universal immunization coverage (1). We turn to the Democratic Republic of Congo, a country that has been particularly affected by declining vaccine confidence during the COVID-19 pandemic (2).

We conducted a survey with 600 Congolese citizens. Through a randomized survey experiment, 1/3 of respondents was prompted to consider the hypothetical vaccination of their president, while another 1/3 of respondents was prompted to consider the hypothetical vaccination of the Congolese Cardinal (of the Catholic Church). We compare their stated willingness to accept a COVID-19 vaccine to that of a control group who did not receive such prompt. While the survey was ongoing, president Tshisekedi publicly received a COVID-19 vaccine. We compare stated vaccine acceptance of respondents interviewed before and after Tshisekedi's vaccination. Our analyses rely on multivariable logistic regressions controlling for respondent and household characteristics, and we formally assess the influence of potentially confounding unobserved characteristics.

While the hypothetical vaccination of the Cardinal had no significant impact on vaccine acceptance, the results for the president were moderated by public trust. For Congolese who report trusting the president, the survey experiment boosted acceptance from 27 to 52%. For those who mistrust the president, it decreased acceptance from 17 to 11%. When the president got vaccinated during the survey period, vaccine acceptance increased from 15 to 35%, but only for respondents who were aware of the president's vaccination. These findings demonstrate that the impact of political leader's role modelling is moderated by trust and depends on media outreach and access. When trust in leaders is lacking, or news on their actions is inaccessible, alternative ambassadors and effective communication methods become crucial in motivating and informing the public. This may be especially relevant in fragile states and remote regions.

In what follows, we first situate our contribution in the literature on vaccine hesitancy. We then present our database on vaccine role modelling of global leaders. Section 4 describes the context in which our case study took place. Section 5 presents our data and methods, while results are presented in Section 6. We conclude with a discussion of our findings in Section 7.

2 Vaccine hesitancy: causes and remedies

The World Health Organization (WHO) defines vaccine hesitancy as a "delay in acceptance or refusal of safe vaccines despite availability of vaccine services" (3). A growing body of evidence links vaccine hesitancy to demographic factors (such as gender and age), socioeconomic factors (including educational attainment and ethnic origin), as well as citizen's perceived efficacy and safety of vaccines, which in their turn depend on previous vaccination history, (mis)information, and levels of trust in public authorities [e.g., (4–7)]. Given these determinants, it is unsurprising that vaccine hesitancy varies substantially, not only across countries, but also within countries, across different subsets of the population (8). Regarding COVID-19 vaccination, for instance, Solís Arce et al. (9) documented a wide cross-country variation in vaccine acceptance ranging from 30 percent in Russia to 97 percent in Nepal, but also large disparities within countries, such as an 18 percentage point difference between United States respondents who continued studies after secondary school and those who did not.

Importantly, vaccine-hesitant individuals may refuse some vaccines, but agree to others. The above-mentioned determinants may thus relate to the characteristics of a specific vaccine or vaccination process (3). In the case of the COVID-19 pandemic, factors that played a role in vaccine hesitancy included the many asymptomatic cases of COVID-19 which fed the idea of a rather harmless disease, the urgency surrounding the vaccine development which led some to doubt the reliability of clinical trials, and the social and economic disruption associated with the pandemic which turned out to be fertile ground for conspiracy theories (10–12).

In (2019), the WHO listed vaccine hesitancy among the main threats to global health (2023). Since then, COVID-19 caused a severe regress in global vaccination coverage and a sharp decrease in vaccine confidence (2, 15). To turn the tide and restore immunization progress, WHO, UNICEF, and other health partners announced "The Big Catch-Up" during the World Immunization Week (16). Through targeted efforts, the organizations aim to strengthen health care workforces, improve health service delivery and "build trust and demand for vaccines within communities" (16).

Scholars have argued that vaccine demand needs to be actively promoted by comprehensive communication campaigns to improve the perceived efficacy and safety of vaccines (17, 18). While there is a large body of evidence on what and how to communicate [see, e.g., (19–25)], less is known about who should communicate to reach maximum impact, and existing studies mainly focus on the United States [e.g., (26–28)].

Pioneering work, carried out across six countries, distinguished between the impact of COVID-19-related social distancing messages delivered by a well-known medical expert, a government official, a Hollywood actor, or a social media celebrity (29). The message had the largest impact on respondents' stated intentions when delivered by the health expert, followed by the government official, who outperformed celebrities. The authors argue that, while celebrities have been shown to influence opinions about health and well-being at large, during times of crisis, health experts and government officials – who manage the crisis and are held accountable for it – may exert greater influence on public opinion.

The most prominent government official is arguably the head of state. Heads of state can influence citizen's life and attitudes, not only

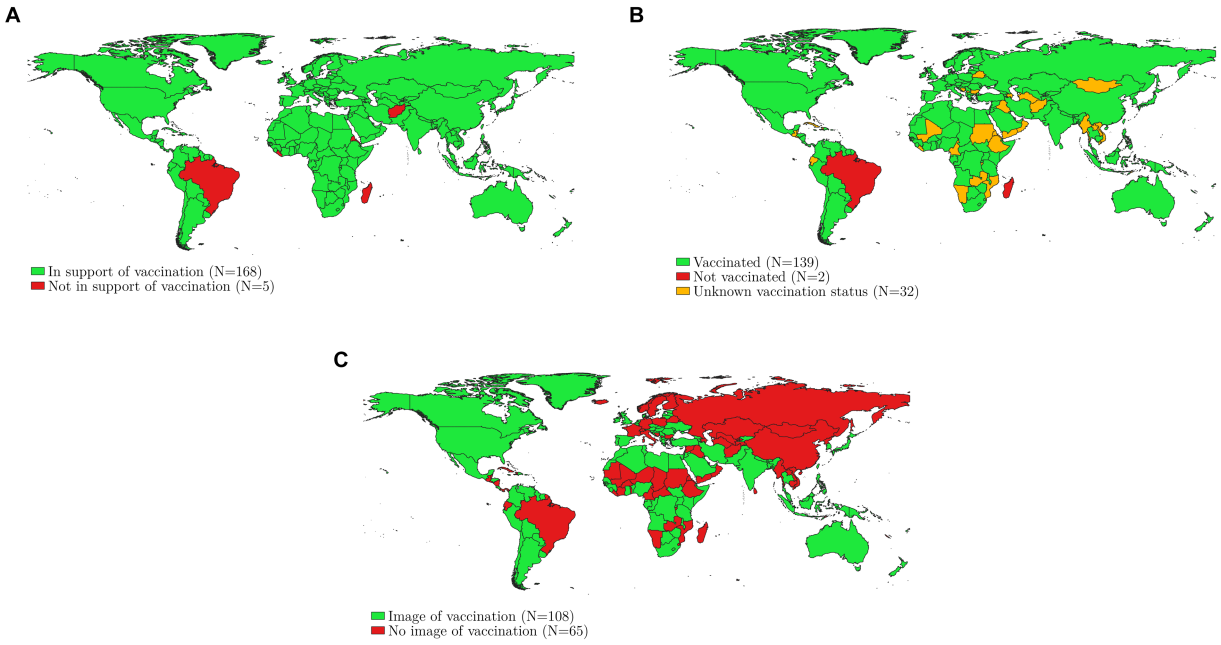

FIGURE 1
These maps provide information on 173 global leaders' endorsement of COVID-19 vaccination. Panel **A** indicates whether heads of state supported the vaccination campaign, Panel **B** indicates whether heads of state got vaccinated themselves, Panel **C** indicates whether an image of the vaccination was made available to the public. Own compilation, Supplementary Appendix 1 provides coding details.

by implementing policies, but also by communicating with the public, both with words and symbolic actions (30). This is in line with the social identity model of leadership, according to which leaders do not simply *represent* citizens' attitudes and opinions, but can also *change* those, be it only for the subset of citizens that perceives the leader as part of the 'ingroup' (31, 32). That both words and actions by heads of state can have tremendous impact on crisis management, both positive and negative, has been amply demonstrated in the COVID-19 crisis. Both Brazil's Jair Bolsonaro and USA's Donald Trump, for instance, have aggravated the health crisis by downplaying the health risk of COVID-19, opposing measures to prevent its spread, and instead promoting remedies known to be ineffective (32–34). Conversely, several heads of state, including prime ministers Jacinda Ardern of New Zealand and Sanna Marin of Finland, have been credited with a better-than-average management of the health crisis (35).

One low-cost action that a head of state can take is to get vaccinated publicly. With this action, political leaders can arguably signal to the public that vaccines are safe and effective, thereby building public confidence in vaccines (18). Recent (quasi-) experimental research from a small number of high-income countries shows that citizens often follow cues from their political party's elites, including when it comes to COVID-19 vaccination intentions (26–28, 36). For instance, while President Trump was mostly known for having anti-vaccination attitudes, he did receive a COVID-19 vaccine and, in one interview on Fox News, recommended citizens to get vaccinated as well. Levering this video in an online randomized experiment with millions of YouTube users, Larsen et al. (27) found that it significantly increased vaccination rates in treated United States counties.

We aim to contribute to this literature by systematically documenting the vaccine role modelling behavior of global leaders during the COVID-19 pandemic. In addition, we add experimental evidence on the impact of such role modelling from a low-income country context.

3 Presidents as vaccine ambassadors

We systematically collected information on the vaccine role modelling behavior of global leaders. We started from the October 2021 version of the Political Leaders' Affiliation Database (PLAD), which contained information on the leaders of 173 countries around the world on December, 31, 2020 (37). If, by the time of the roll-out of the COVID vaccines in a country, the head of state had changed, we updated the PLAD dataset. Supplementary Appendix 1 describes our coding procedure in detail. Figure one graphically presents the data; Panel A indicates whether heads of state supported the vaccination campaign, Panel B indicates whether they got vaccinated themselves, Panel C indicates whether an image of the vaccination was made available to the public.

We find that 168 out of 173 leaders explicitly supported the vaccination campaign (Figure 1, Panel A). Among those who did not, are two very explicit anti-COVID-vaccine presidents – Madagascar's Andry Rajoelina and Brazil's Bolsonaro – and three presidents who 'tolerated' the vaccination campaign, despite a lack of personal acts or words to support it (President Isaias Afwerki from Eritrea, President George Weah of Liberia, and Supreme Leader of Afghanistan Hibatullah Akhundzada). We found that 139 leaders (80%) received a COVID-19 vaccine but could not confirm the vaccination status of 32 leaders (Figure 1, Panel B). Moreover, 108 leaders (78% of those vaccinated) distributed a picture or a video of their vaccination (Figure 1, Panel C). We can therefore conclude that most heads of state thought it was important to

communicate their vaccination status to the public using more than words.

The extent to which heads of state can act as credible vaccine ambassadors likely depends on the public trust they enjoy. Systematic reviews documented that a lack of trust in governments is associated with vaccine hesitancy and refusal across a wide range of countries (38–40). While quantitative evidence for low-income countries is scant, existing studies point in the same direction. Blair et al. (41) and Vinck et al. (42), studying Ebola outbreaks in Liberia and DR Congo, find for instance that respondents with low trust in government institutions exhibit less compliance with recommended behavior changes and a lower willingness to take up an Ebola vaccine. Moreover, Stoop et al. (6), leveraging data from 22 African countries, highlight that institutional mistrust – including mistrust in the head of state – is an important barrier to reaching universal child immunization. Such trust is often context-dependent and varies across subsets of the population (43). In some groups, anti-establishment sentiment can be so high that vaccination support by certain public figures can backfire (28).

In what follows, we turn to the DR Congo to analyze the impact of President Tshesekedi's COVID-19 vaccination on citizen's vaccine acceptance.

4 COVID-19 in DR Congo

President Tshisekedi got vaccinated with Moderna on September 13th, 2021. This is late compared to other African presidents (44). He initially went against the vaccine promotion strategy of his own government by refusing to get vaccinated for 6 months, casting doubt on the AstraZeneca vaccine,[1] and even promising to launch a Congolese 'anti-COVID' product at a meeting in Berlin in August 2021 (46). Less than 2 weeks after that statement, he made a U-turn and received his COVID-19 vaccine live on Congolese television. The news was distributed by diverse national media channels, Facebook, and Twitter.

It is not clear to what extent the news of Tshisekedi's vaccination (and his initial reluctance) reached Congolese citizens. Since only 19.4% percent of households owns a television, only a minority would have been directly exposed to images of the president's live vaccination. A larger proportion of households owns a radio (37.6%) or phone (51.8%). But, according to the latest data, internet penetration at home stands at only 1.3%, and a mere 1.5% of women and 5.5% of men aged 15–49 are estimated to access news on either radio, newspaper, or television on a weekly basis (13).

By the time President Tshisekedi got vaccinated, DR Congo had officially reported 56,000 COVID-19 cases and 1,066 deaths, or a death toll of just 0.0012% for a population of 90 million (44). But, with low testing and tracing capacity, these are likely underestimates. Looking at a highly visible (and exposed) subpopulation, namely members of parliament, the death toll reaches 5 % (47). Out of 640 Congolese parliamentarians, 32 died from COVID-19 (48). These high-profile cases fed the popular belief that COVID-19 is a disease of the urban elite, and therefore not a concern for 'ordinary' Congolese (49). Combined with conspiracy theories as well as the need of a largely poor population to provide in one's livelihood, this led to overall low compliance with containment measures, such as lockdowns and restrictions on travel and public gatherings (50).

DRC received its first vaccines in March 2021, in the form of 1.7 million AstraZeneca doses from the COVAX vaccine sharing scheme, but rollout was delayed due to safety concerns, and eventually around 75 percent of these doses were re-exported to make sure they were used before they expired (48). September 2021 marked a new phase in the vaccination campaign, with the arrival of vaccines from Sinovac, Johnson & Johnson, Moderna and Pfizer (51–53). The president's public vaccination with Moderna thus coincided with the arrival of mRNA vaccines in the country, and these were in first instance intended for 15 priority provinces, among which North-Kivu, where our research takes place (54). While vaccination rates increased with the arrival of these new vaccines (51), many Congolese remained reluctant. WHO statistics indicate that by December 2022 less than 7 doses per 100 population were administered in DRC (55).[2] Only Yemen, Eritrea and Papua New Guinea ranked lower.

Aside from rumors and conspiracy theories, the low vaccination rate was compounded by the country's limited healthcare infrastructure, low numbers of health workers and broader governance issues, including rampant corruption and political instability (56). These governance issues not only affect the country's ability to provide basic services to its citizens but also erode general trust of Congolese citizens in public institutions and President Félix Tshisekedi. A December 2021 opinion poll by the Congo Research Group (57) revealed that only 29% of Congolese surveyed had a positive opinion of Tshisekedi. In contrast, the Congolese Cardinal, Fridolin Ambongo Besungu, was trusted by 47%.

Within this context, we analyze the potential of president Tshisekedi to act as a vaccine ambassador and influence Congolese citizens' COVID-19 vaccine acceptance by getting publicly vaccinated himself.

5 Data and methods

5.1 Data collection

We present results based on 600 in-person interviews conducted in the period September–October 2021. Our survey took place in Lubero territory, one of the six territories that make up North Kivu, a province that spans almost 60,000 km^2 (Figure 2). The province contains abundant natural resources, encompassing minerals, biodiverse protected areas, and fertile agricultural land. It has however been plagued by violence for over two decades, and currently still counts more than 100 armed groups within its borders (58). Lubero

1 In late 2020, AstraZeneca paused the rollout of its vaccine after reports emerged of a small number of people who had developed blood clots after receiving the vaccine. This led to some concerns among the public about the safety of the vaccine and prompted some governments to temporarily suspend its use (45).

2 By March 2022, 5.7% of the population received at least one dose of a vaccine and 1.03% were fully vaccinated. Of those vaccinated, 48% received the Johnson & Johnson vaccine, while 42% received an mRNA vaccine (25% Moderna and 17% Pfizer), 7% received Sinovac and 2% AstraZenica (51).

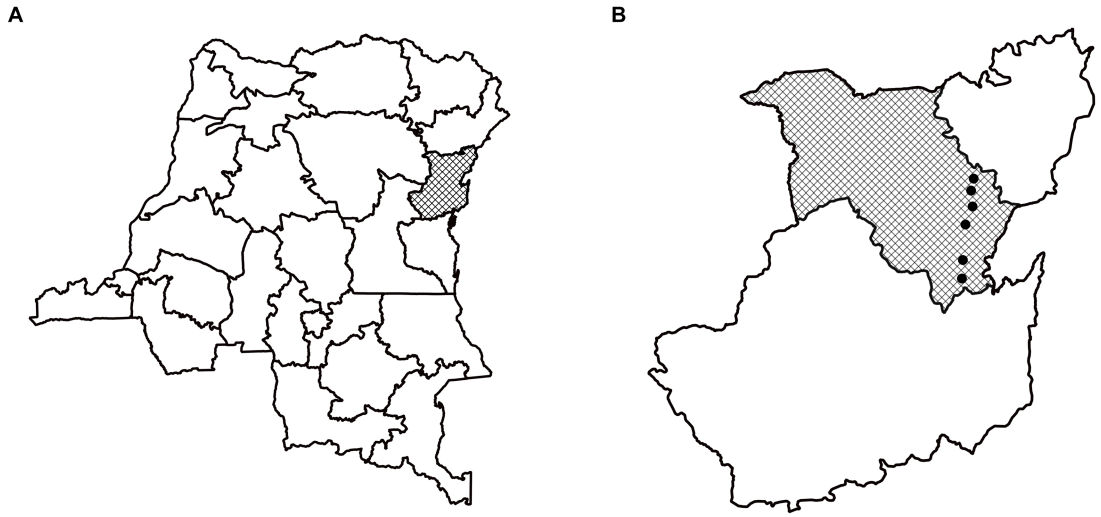

FIGURE 2
Panel **A** indicates the province of North-Kivu within the DRC. Panel **B** indicates the territory of Lubero within North-Kivu and the location of our six study villages.

territory is predominantly rural, and the majority of residents engage in agriculture.

Within Lubero territory, we conducted surveys in six localities (Figure 2, Panel B). These localities were selected because they were part of a broader ongoing study on the impact of electricity provision in communities nearby Virunga national park (59). A team of 16 enumerators first conduced a census in each locality, yielding a total of 11,577 observations on households' geographic position and their socio-economic status through visual checks of the house and its construction materials. We then randomly selected 600 households to be surveyed, stratified by the construction quality of their houses, and proportional to the population size of the locality.

5.2 Measuring vaccine acceptance and institutional trust

The survey recorded respondent's willingness to get vaccinated through the question "Let us assume a vaccine against Coronavirus was available for you, would you take it?."[3] Answers were given on a four-point Likert scale (certainly, probably, probably not, certainly not). Our binary measure for stated vaccine acceptance equals one for those respondents who indicated they would certainly or probably take a COVID-19 vaccine, and zero otherwise.

Our survey also measured institutional trust. Building on an earlier study in the same region (42) we asked the following question, for five institutional levels (local, municipality, provincial, national, president) and the cardinal: "In general, to what extent do you believe the following authorities represent the best interests of the Congolese population?." We then repeated this question specifically about these actors' management of the COVID-19 crisis. Respondents were asked to indicate their trust on a scale from 1 to 5 (1 being associated with the highest level of trust, and 3 being neutral). We recategorized those variables as binary taking the value one if a respondent indicated a trust value of 1 or 2, and zero otherwise.

5.3 Design

We embedded a randomized survey experiment in the questionnaire. Before answering the question on vaccine acceptance, 1/3 of respondents ($N = 203$) was prompted to consider the hypothetical vaccination of their president: "Assume the president, Félix Tshisekedi, were to take the vaccine live on television." As Congolese have little trust in the president, but relatively high trust in the church, another 1/3 of respondents ($N = 202$) was prompted to consider the hypothetical vaccination of their cardinal: "Assume the cardinal, Fridolin Ambongo Besungo, were to take the vaccine live on television." The remaining 1/3 of respondents ($N = 195$) was directly asked the question on vaccine acceptance, without a prompt. We compare the stated vaccine acceptance of the respondents in the two treatment groups to that of the control group.

To our own surprise, President Tshisekedi got publicly vaccinated while our survey was ongoing, and we had already interviewed 114 (19%) of our respondents. We take advantage of this opportunity to analyze whether stated vaccine acceptance differed between respondents surveyed before and after Tshisekedi's public vaccination. However, since Lubero territory is remote and poorly endowed with public infrastructure, many respondents have no direct access to news outlets, thus were likely not aware of the presidential vaccination. We explore the role of information transmission by leveraging the following question, which we added in our surveys conducted after the president's public vaccination: "Do you think the president, Félix Tshisekedi, received a vaccine against Coronavirus?"

3 At the time of the survey, COVID-19 vaccines were not yet available in the study region.

5.4 Statistical analyses

The survey experiment relies on a randomized design, resulting in treatment and control groups that are balanced on average across all observed covariates (see Supplementary Appendix 2). We can hence investigate its impact by comparing mean stated vaccine acceptance across those treated and untreated relying on t-tests. In addition, we run a set of multivariable logistic regressions with stated vaccine acceptance as the outcome variable. Specifically, we estimate the following specification:

$$prob\left(Y_i = 1\right) = \Phi\left(\beta P_i + \gamma T_i + X_i'\theta\right) \quad (1)$$

where Y_i is respondent *i*'s stated vaccine acceptance. The variable P indicates whether respondent *i* received the prompt about the hypothetical vaccination of the president or the cardinal. Coefficient β is estimated from the model and represents the treatment effect. Variable T measures a respondent's trust in the president or cardinal with respect to COVID-19. Vector X includes a range of control variables that may correlate with vaccine acceptance. At the level of the respondent, we include age, gender, years of education and ethnicity. We further control for respondents' stated opinions regarding the importance, effectiveness, and safety of vaccines as well as their compatibility with respondents' religious beliefs. At the household-level, we control for household size, dependency ratio, log yearly income, construction quality of the home, and the ownership of radio and television.

To analyze the moderating role of trust in the survey experiment, we add an interaction term to equation (1):

$$prob\left(Y_i = 1\right) = \Phi\left(\beta P_i + \gamma T_i + \delta P * T_i + X_i'\theta\right) \quad (2)$$

where variable T measures a respondent's trust in the president or cardinal with respect to COVID-19, and coefficient δ allows to investigate how the effect of the survey experiment differed for respondents with high or low trust.[4]

To investigate the impact of the president's actual vaccination on stated vaccine acceptance, we estimate:

$$prob\left(Y_i = 1\right) = \Phi\left(\beta P_i + \gamma T_i + \lambda V_i + \nu A_i + X_i'\theta\right) \quad (3)$$

where the variable V indicates whether a respondent was interviewed after Tshisekedi's public vaccination. Here we are interested in exploring the role of information transmission. This is captured by variable A, indicating whether a respondent was aware of the president's vaccination. Such awareness may be correlated with other characteristics that can influence vaccine acceptance, e.g., perhaps it captures respondents who are more informed in general, and therefore also about health benefits of vaccination. To control for such possible confounding factors, we augment vector X with variables capturing respondents' knowledge of politics and include measures to capture how often they listened to the radio or watched television in the week prior to the interview.

Although specification (3) controls for a large range of potentially confounding variables, it remains possible that other unobserved characteristics simultaneously influence awareness of the president's vaccination and vaccine acceptance. To formally assess the threat of such omitted variable bias, we turn to the procedures suggested by Altonji et al. (60) and Oster (61). It uses selection on observable variables as a guide to assess the potential bias from unobserved variables. Selection on observable variables is evaluated by looking at movements in the estimated coefficients on the awareness variable while gradually controlling for additional covariates. The relevance of these covariates is assessed by evaluating associated movements in the R-squared. Based on these insights, Oster developed a measure that allows to assess how large selection on unobservable variables has to be, relative to selection on observables, to fully explain away the estimated effect (Supplementary Appendix 4 describes the methodology in detail).

6 Results

6.1 Descriptive statistics

On average, a sample respondent is 44 years old and has 6.8 years of education (Table 1). About one third of respondents are male. The average household counts 6.6 members, with a dependency ratio of 0.53, indicating that about half of members are not in the active age group (15 to 60). The mean annual household income is 947 USD, corresponding to a local purchasing power of 1,894 USD in 2021, thus implying 5.2 USD PPP per day. Almost half of households own a radio, while only 13% owns a television. Most respondents agree that vaccines are important for children (95%), effective (87%), safe (85%) and compatible with their religious beliefs (74%). Consequently, general vaccine acceptance is very high (Figure 3, Panel A). Almost nine out of ten households indicate to have vaccinated their children against tuberculosis, diphtheria, polio, measles, and yellow fever, while 98% of households vaccinated their children against at least one of these diseases. In sharp contrast, only 22% of respondents indicated they would accept the COVID-19 vaccine if it was available to them. This is much lower than the mean stated COVID-19 acceptance rate of 80% found in a sample of 10 low- and middle-income countries in Asia, Africa and South America, but in line with other studies reporting lower COVID-19 vaccine acceptance and confidence in African countries and the DR Congo in particular (2, 9, 62).

Respondents with a stated willingness to take the vaccine ($N = 129$) indicated they would do so to protect themselves (91%), their family and household (78%) and their community (63%). Respondents who did not accept the vaccine ($N = 412$) were asked to motivate their choice in an open question. After categorizing their open answers, six main answer categories emerged (Figure 3, Panel B). The largest group among them (31%) indicated a general lack of trust in the COVID-19 vaccine and its efficacy. About 27% expected that they might get COVID-19 from the vaccine or feared other, potentially mortal, side-effects. Illustrative answers included "To avoid Corona contamination," "This vaccine kills people" and "It's poison." More

4 Results for specification (1) and (2) remain qualitatively unchanged when additionally controlling for (awareness of) the president's vaccination through variables V and A (see Table 2).

TABLE 1 Socio-demographic profile of respondent and household.

	Obs.	Mean	Std. dev.	Min	Max
Respondent's age	600	44	16	18	79
Respondent is male	600	0.31	0.46	0	1
Respondent's years of education	600	6.82	4.41	1	18
Respondent is of dominant ethnicity	600	0.99	0.11	0	1
Household size	600	6.59	2.72	1	22
Household dependency ratio	600	0.53	0.20	0	1
Household yearly income ($)	600	947	1,490	0	9,250
Household owns radio	600	0.49	0.50	0	1
Household owns television	600	0.13	0.33	0	1

The dependency ratio is calculated as the number of people younger than 15 plus the number of people older than 64 divided by the total size of the household.

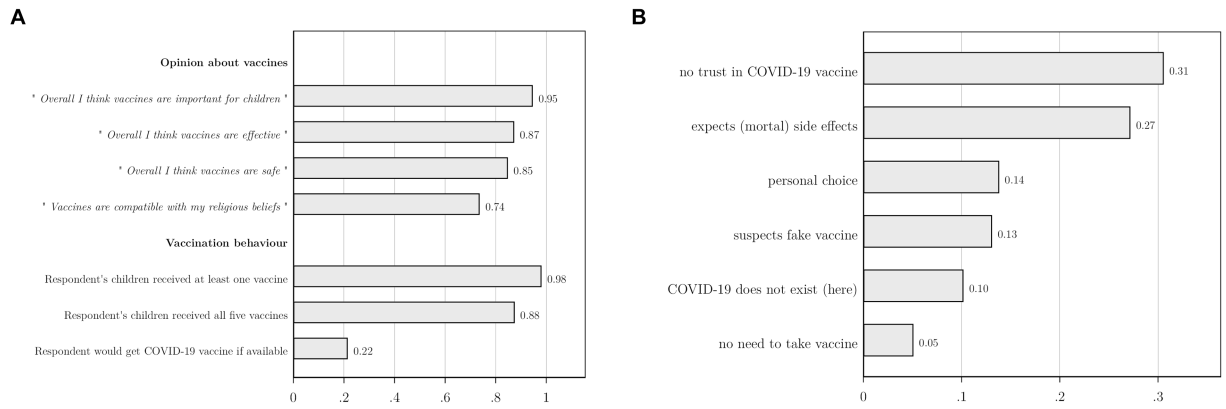

FIGURE 3
We asked respondents with children (97.5%) whether their children were vaccinated against tuberculosis, diphtheria, polio, measles, and yellow fever. In Panel **A**, the first two bars under the heading 'Vaccination behavior' indicate whether children received at least one of these vaccines, or all five vaccines. Panel **B** represents the answer categories that emerged after categorizing open answers to the question "Why would you not take a COVID-19 vaccine?." This question was asked to the 412 respondents who indicated not to accept a COVID-19 vaccine if it would be available to them; 129 respondents indicated they would accept it, while the remaining 59 respondents refused to answer or indicated they were unsure.

than 1 out of 10 (13%) suspected that they would not receive a real vaccine, mentioning, e.g., "It's a fake vaccine," "It's a bad vaccine. White people want to eliminate us," "The vaccine sent to Africa is dubious." Others indicated that it is their personal choice not to take the vaccine (14%), that they doubted the existence of COVID-19 (10%), or they felt no need to take the vaccine as they believed they would not get sick (5%).

We find rather low levels of institutional trust, ranging between a low of 17% for the president with respect to his management of the COVID-19 crisis and a high of 46% for general trust in local authorities (Figure 4). Overall, we find that institutional trust is systematically lower within the COVID-19 context, and systematically lower for institutions higher up in the administration. In line with the opinion poll by the Congo Research Group (57), trust in the cardinal is considerably higher than trust in the president.

6.2 Survey experiment

Figure 5 presents the results of the survey experiment, relying on t-tests to assess differences in means between the control group and the treatment group.[5] On average, the hypothetical vaccination of President Tshisekedi has no effect on vaccine acceptance (Panel A). However, we find trust in the president to be an important moderating variable. Among respondents who trust the president, exposure to his hypothetical vaccination raises vaccine acceptance with 24 percentage points, from 0.32 to 0.56, a sizeable difference that is significant at the 5%-level (Panel B). Among respondents who indicated not to trust the president, vaccine acceptance is seven percentage-points lower among those in the treatment group (0.13 compared to 0.20), but, with a p-value of 0.11, the result is just shy of being statistically significant at the 10%-level (Panel C).

The hypothetical vaccination of the cardinal in the survey experiment failed to boost vaccine acceptance, even among respondents who indicated to trust the cardinal (Panels D–F). Despite the higher perceived trustworthiness of the cardinal, these results suggest that the Cardinal's actions play no role in influencing respondents' vaccine acceptance. This

5 Table A2 in Supplementary Appendix 2 shows that covariates are balanced between the control and treatment group.

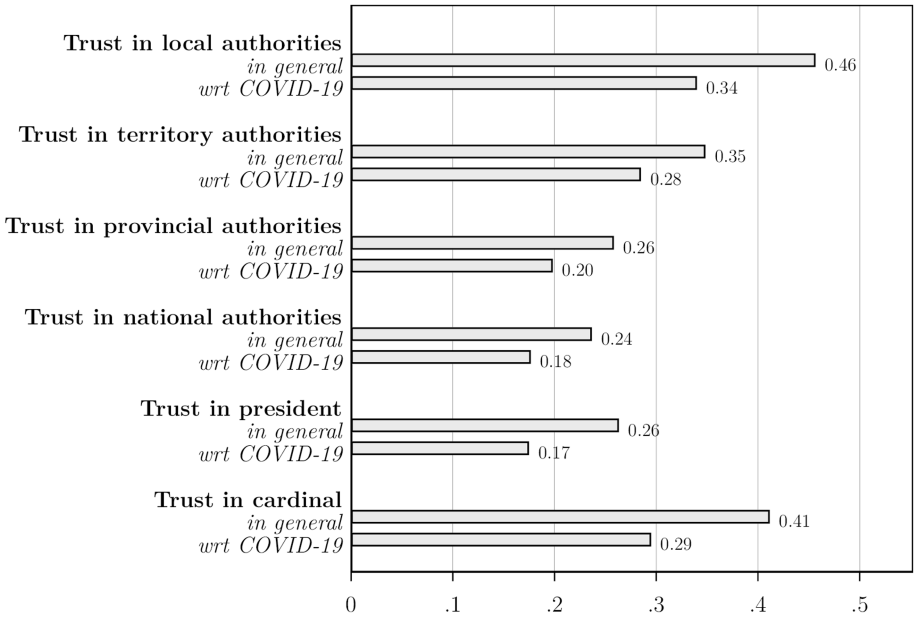

FIGURE 4
For each institutional level, we asked: "In general, to what extent do you believe the following authorities represent the best interests of the Congolese population?." We then asked this question specifically related to these authorities' management of the COVID-19 crisis. $N = 600$.

aligns with the conclusion of Abu-Akel et al. (29) that, in times of health crises, it is health experts and government officials – those in a position to manage the crisis and be held accountable for it – who are likely to exert the greatest influence on public opinion.

These findings are confirmed in a multivariable logistic regression that controls for the respondent- and household level covariates identified above (Table 2). The results in Column (1) relate to equation (1). We find that, on average, neither the president treatment nor the cardinal treatment in the survey experiment significantly affected vaccine acceptance. Our results do confirm the importance of institutional trust; respondents who trust the president when it comes to managing the COVID-19 crisis are twice more likely to indicate that they are willing to get a COVID-19 vaccine ($p < 0.01$). In contrast, trust in the cardinal is not associated with stated vaccine acceptance. In Column 2, we estimate equation (2) and include interaction terms to explore how trust in the president and the cardinal affect the survey experiment treatment effects. We find that public trust strongly reinforces the impact of the president treatment. Specifically, stated vaccine acceptance for respondents who trust the president and were exposed to the president treatment is 4.75 times higher ($p < 0.01$) than that of respondents in the base category (those who do not trust the president and were not exposed to president treatment).[6] The results do not indicate a statistically significant interaction between the cardinal treatment and trust in the cardinal.

6.3 Impact of the president's actual vaccination

Four out of five respondents (486 out of 600) were interviewed *after* the broadcasting of President Felix Tshisekedi's vaccination. However, media access is low in our study area, and the news may not have reached everyone. For instance, Figure 6 shows that the large majority of respondents did not watch television (91%) or listen to the radio (57%) in the week prior to the interview. Hence, it is no surprise that only 89 respondents reported being aware of the President's inoculation.[7] The actual exposure to the president's vaccination is thus much smaller, covering just 18% of the sample interviewed after the president got vaccinated.

6 To help interpret this finding it is useful to explore predictive margins, which we do in Figure 7.

7 Watching television and listening to the radio are positively and significantly correlated with being aware of the President's vaccination and general knowledge about politics (measured through a question asking them to name the president of Uganda). Correlation coefficients range between 0.16 and 0.28 and are all significant at the 1%-level. In addition, 13% of our respondents indicated that their household does not own a mobile phone, and among those that do own one, only half of respondents reported to use it on a daily basis. While we cannot infer from out data whether respondents have access to the internet, national statistics indicate that only 3.6% of women and 11.3% of men aged 15–49 use the internet at least once per week [INS, USAID, and UNICEF (13)]. We did ask respondents to what extent they trusted social media as a source of news on COVID-19. Answer categories included (1) high trust, (2) little trust, (3) no trust at all. Only 5% indicated high trust, while 37% indicated little trust and the majority (59%) indicated not to trust social media at all as a source of news on COVID-19.

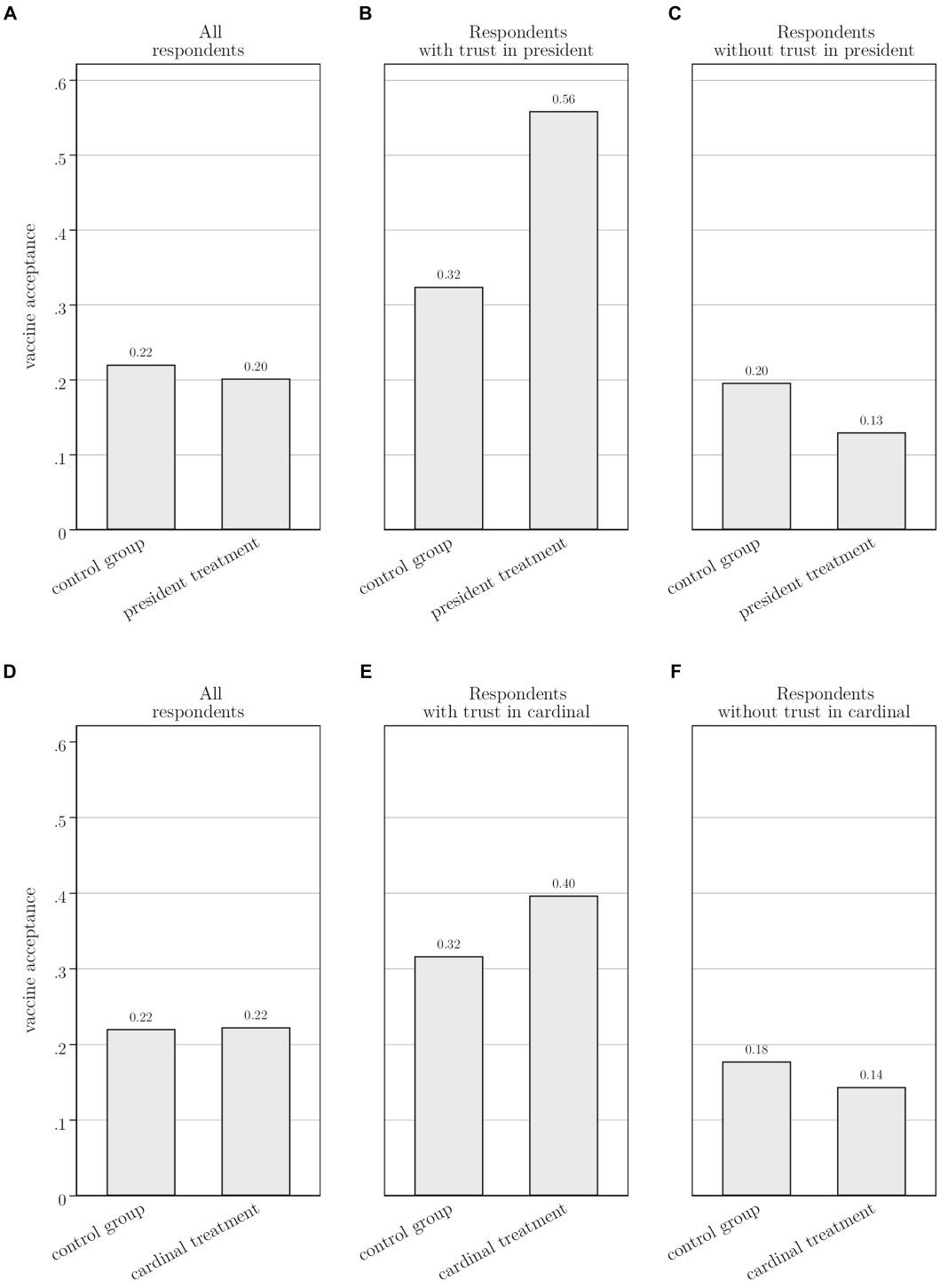

FIGURE 5
Panel **A** compares vaccine acceptance across respondents in the president treatment ($N = 203$) and the control group ($N = 195$). The difference in means is 0.02 (p-value:0.65). Panel **B** only considers respondents who trust the president with respect to COVID-19 ($N = 71$). It compares vaccine acceptance across respondents in the president treatment ($N = 37$) and the control group ($N = 34$). The difference in means is 0.23 (p-value:0.047). Panel **C** only considers respondents who do not trust the president with respect to COVID-19 ($N = 327$). It compares vaccine acceptance across respondents in the president treatment ($N = 158$) and the control group ($N = 169$). The difference in means is 0.07 (p-value:0.11). Average trust in the president is balanced across the control (0.19) and treatment (0.17) group, with a difference in means of 0.02 (p-value:0.56). Panel **D** compares vaccine acceptance across respondents in the cardinal treatment ($N = 202$) and the control group ($N = 195$). The difference in means is 0.002 (p-value:0.96). Panel **E** only considers respondents who trust the cardinal with respect to COVID-19 ($N = 123$). It compares vaccine acceptance across respondents in the cardinal treatment ($N = 63$) and the control group ($N = 60$). The difference in means is 0.08 (p-value:0.36). Panel **F** only considers respondents who do not trust the cardinal with respect to COVID-19 ($N = 274$). It compares vaccine acceptance across respondents in the cardinal treatment ($N = 139$) and the control group ($N = 135$). The difference in means is 0.03 (p-value:0.45). Average trust in the cardinal is balanced across the control (0.31) and treatment (0.31) groups, with a difference in means of 0.004 (p-value:0.93). Differences in means and significance levels are obtained from t-tests.

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TABLE 2 Multivariable logistic regressions.

	Willingness to get COVID-19 vaccine				
	(1)	(2)	(3)	(4)	(5)
	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]	OR [95% CI]
President treatment	0.93	0.60*	0.93	0.91	0.59**
	[0.50,1.74]	[0.36,1.00]	[0.50,1.72]	[0.50,1.67]	[0.35,0.98]
Cardinal treatment	1.06	0.74	1.05	1.04	0.77
	[0.68,1.63]	[0.38,1.44]	[0.69,1.61]	[0.68,1.60]	[0.41,1.45]
Trust in president WRT COVID	3.01***	1.80	3.00***	3.00***	1.77
	[1.61,5.62]	[0.71,4.55]	[1.60,5.65]	[1.60,5.62]	[0.68,4.57]
Trust in cardinal WRT COVID	1.71	1.33	1.72	1.63	1.35
	[0.80,3.67]	[0.68,2.61]	[0.81,3.66]	[0.67,3.97]	[0.65,2.79]
President treatment * trust president WRT COVID		4.75***			5.04**
		[1.64,13.81]			[1.45,17.52]
Cardinal treatment * trust cardinal WRT Covid		2.31			1.97
		[0.80,6.67]			[0.66,5.87]
Interviewed after president's vaccination			1.14	0.88	0.93
			[0.56,2.29]	[0.43,1.78]	[0.45,1.92]
Aware that president got vaccinated				2.97***	2.95***
				[1.74,5.06]	[1.70,5.14]
Socio-demographic controls	Yes	Yes	Yes	Yes	Yes
Vaccine confidence indicators	Yes	Yes	Yes	Yes	Yes
Knowledge of politics	No	No	No	Yes	Yes
Radio & television usage	No	No	No	Yes	Yes
Observations	600	600	600	600	600
Pseudo R^2	0.12	0.14	0.12	0.14	0.16

Data are Odds Ratios from a logistic regression with respondent's willingness to get a COVID-19 vaccine as the outcome variable. Standard errors are clustered at the village-level. Significance is indicated by *** $p<0.01$, ** $p<0.05$, * $p<0.10$. Full regression output is presented in Supplementary Appendix 3.

In Column 3 of Table 2 we add an indicator variable for respondents who were interviewed after President Tshisekedi got vaccinated on 13 September 2021. In Column 4, we further add a variable that captures whether a respondent was aware of the president's vaccination. In addition, we add variables capturing respondents' knowledge of politics and include measures to capture how often they listened to the radio or watched television in the week prior to the interview – thereby estimating equation (3). The results show that being interviewed after the president's vaccination does not by itself affect stated vaccine acceptance. We only find an impact for those who indicated being aware of the president's vaccination; these respondents are 197% more likely to indicate that they are willing to get a COVID-19 vaccine ($p<0.01$).[8]

Being aware of the president's vaccination may be correlated with other characteristics that can influence vaccine acceptance. While we control for a large set of likely confounding covariates, it is possible that other, unobserved, characteristics are driving our findings. Relying on the procedures suggested by Altonji et al. (60) and Oster (61) we formally assess the threat of such omitted variable bias. We find that selection on unobservables would have to be 5.97 times larger than selection on the included variables to fully explain away our estimated effects on awareness of the president's vaccination. Appendix 4 discusses the methodology and results in detail. Taken together, the findings suggest that our qualitative conclusions are not sensitive to omitted variable bias.

6.4 The impact of public trust and media outreach

Our results demonstrate that the impact of the president's vaccine role modelling is moderated by trust and depends on media outreach and access. In Figure 7 we make our findings more concrete by presenting predictive margins based on the most inclusive regression specification presented in Table 2. Panel A presents predictive margins for the survey experiment, by trust in the

8 It is possible that being aware of the president's public vaccination influenced the results of the survey experiment. We check this in Column 5 and find that the results are qualitatively unchanged compared to Column 2. We further explored whether there is a significant interaction between trust in the president and being aware of his vaccination. The results indicate that this is not the case, but this may be due to power issues, given that only 3.3% of the sample indicates to trust the president and be aware of his vaccination.

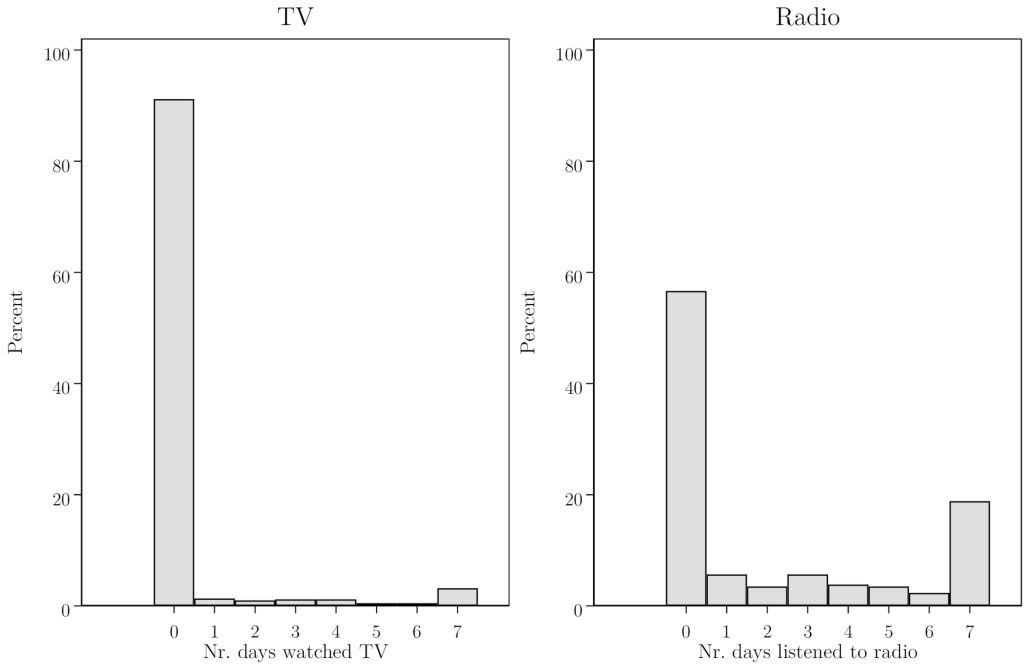

FIGURE 6
We asked respondents to indicate the number of days that they watched TV and listened to the radio in the week prior to the interview. This Figure presents histograms based on the full sample of respondents (N = 600).

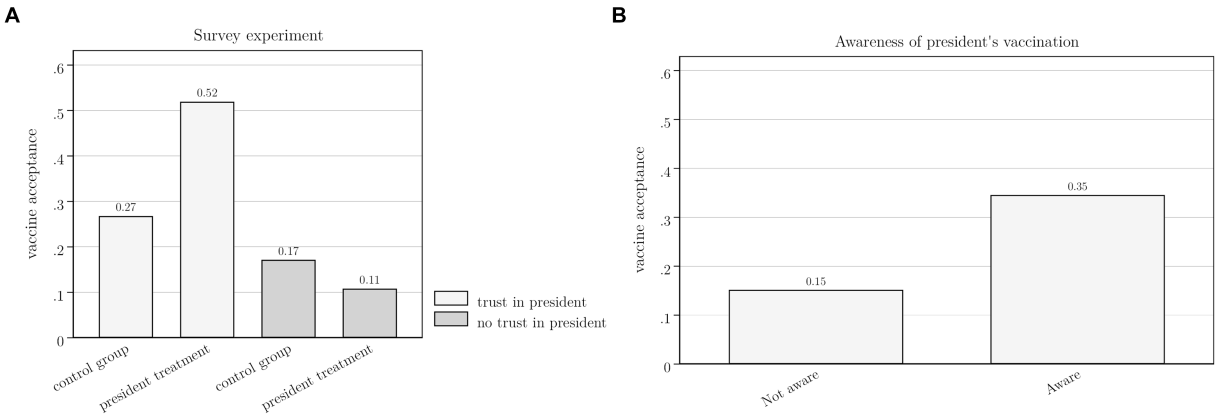

FIGURE 7
This Figure is based on the multivariable logistic regression presented in column 5 of Table 2. Panel A presents predictive margins implying that for Congolese who report trusting the president, the president treatment in the survey experiment boosted vaccine acceptance from 0.27 (95%-CI: 0.18 to 0.35) to 0.52 (95%-CI: 0.21 to 0.83). For those who mistrust the president, it decreased acceptance from 0.17 (95%-CI: 0.08 to 0.27) to 0.11 (95%-CI: 0.02 to 0.19). All other covariates are held at their mean values. The predictive margins in Panel B implies that being aware of the president's vaccination, while holding all other covariates at their mean values, increases vaccine acceptance from 0.15 (95%-CI, 0.08 to 0.23) to 0.35 (95%-CI, 0.14 to 0.55).

president. Holding all other covariates at their mean values, we find that for Congolese who report trusting the president, the experiment strongly boosted vaccine acceptance from 27 to 52%, nearly a doubling. However, for those who mistrust the president, the survey experiment decreased acceptance from 17 to 11%. Panel B focuses on the president's public vaccination. The estimated predictive margins imply that being aware of the president's vaccination, while holding all other covariates at their mean values, increases vaccine acceptance from 15 to 35%.

7 Conclusion

When systematically documenting the attitudes and behavior of heads of state regarding COVID-19 vaccination, the picture that emerges is overwhelmingly pro-vaccine: almost all global leaders endorsed the vaccination rollout, 80% publicly announced their vaccination and 62% did so with a picture or a video. We can thus conclude that most heads of state thought it was important to communicate their vaccination status to the public using more than words.

The cost of a leader getting vaccinated publicly is very low, but its symbolic value may be high, as demonstrated in recent studies from the United States. It is however unclear to what extent these results travel to different settings. In our DR Congo case study, we relied on a survey experiment to empirically verify the impact of such vaccine role modelling. The results indicate that the president's hypothetical inoculation only increases vaccine acceptance among those who trust the president, while it depresses vaccine acceptance among those who do not. When the president got publicly vaccinated during the survey period, we find that it only increased vaccine acceptance among respondents who were aware of this fact.

These results have important policy relevance. They show that public vaccination of heads of state can only effectively serve as a vaccination advocacy tool if two conditions are satisfied. First, the said leader should be perceived as trustworthy by citizens. Second, the live inoculation should be widely communicated, preferably through diverse channels that also reach areas with low media access. These conditions were largely absent in our study area. Only 17% of respondents expressed trust in the president amidst the COVID-19 crisis, and only 18% of those interviewed after the president got vaccinated were aware of his vaccination. In such a context, vaccination of local public figures, for instance village leaders or respected older adult community members, might be more effective to improve vaccine acceptance. Indeed, our data shows that trust in local leaders is almost twice as high as trust in the president. Additionally, despite the remoteness of these territories, local news travels through word of mouth, as communities are tightly knit and easily exchange information. Mind however that our null result regarding the cardinal's hypothetical vaccination suggests that it is not sufficient to pick any well-known and well-trusted person. Future research should delve deeper into identifying suitable 'vaccine ambassadors' across varied contexts.

Data availability statement

The data and replication files for the analyses presented in this article are publicly available at https://doi.org/10.7910/DVN/OAYJCV.

Ethics statement

The studies involving humans were approved by the University of Antwerp Ethical Advice Committee (file SHW_19_03). The studies were conducted in accordance with the local legislation and institutional requirements. The ethics committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because we anticipated that many of our participants would be illiterate. In addition, given the local context, asking them to sign a document may even create suspicion. Hence, we provided participants with a verbal description of the study and its purpose. Verbal consent was sought from the participants and they were informed of their right not to participate or not to answer certain questions. Participants further had the option to discontinue the survey at any given point without consequences.

Author contributions

LC: Formal analysis, Writing – original draft, Writing – review & editing. EL: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. NS: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. MV: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2024.1364927/full#supplementary-material

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"You can push these conversations, but don't push your patient away": healthcare learner perspectives on virtual simulation games as an educational approach to address vaccine hesitancy

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Background: Vaccine hesitancy is a significant threat to public health. Healthcare providers (HCPs) can address hesitancy during routine patient conversations; however, few multidisciplinary education tools exist for HCPs to learn to engage in vaccine discussion especially considering new vaccine technologies such as mRNA vaccines. The objectives of this study were to explore HCP learners' experiences with COVID-19 vaccine communication, and qualitatively evaluate an online learning module composed of virtual simulation games (VSGs) which utilize the PrOTCT Framework for HCP vaccine communication.

Methods: Three virtual focus groups were conducted from December 2022 to January 2023 with Canadian healthcare learners in nursing ($N = 6$), pharmacy ($N = 9$), and medicine ($N = 7$) who participated in a larger study measuring the effectiveness of the VSGs. Using a pragmatic approach, a qualitative thematic analysis was conducted using NVivo to identify themes and subthemes.

Results: A total of 22 HCP learners participated in this study and three key themes were identified. Across all three disciplines, participants expressed that (1) their prior education lacked training on how to hold vaccine conversations, resulting in uncomfortable personal experiences with patients; (2) the VSGs increased their confidence in holding vaccine conversations by providing novel tools and

skills; and (3) participants also provided feedback to improve the VSGs which was implemented and supported the dissemination to all HCP professions.

Conclusion: Although HCPs are a trusted source of vaccine information, participants in this study felt they received little training on how to engage in challenging conversations regarding COVID-19 vaccines. The introduction of the PrOTCT Framework and presumptive statements provided novel strategies for HCP to initiate vaccine conversations, especially considering new vaccine technologies and participants appreciated the emphasis on coping strategies and resilience. It is essential that HCP are provided both opportunities to practice managing these conversations, and tools and skills to succeed at an early point in their careers to prepare them for future roles in vaccine advocacy, delivery, and promotion.

KEYWORDS

virtual simulation, vaccine hesitancy, communication, thematic analysis, focus groups, qualitative research

Introduction

Vaccine hesitancy is defined by the World Health Organization as the delay or refusal to accept vaccines despite availability (1). The emergence of widespread skepticism and mistrust of vaccines among the vaccine-hesitant population, as well as other barriers to immunization, has led to a dangerous global decrease in rates across several vaccination programs (2, 3). The number of Canadian parents who report being "really against" vaccinations for their children has increased dramatically from 4% in 2019 to 17% in 2024 (4). This increase in hesitancy was exacerbated as a result of the COVID-19 pandemic and the rapid development of mRNA vaccines against SARS-CoV-2 (5, 6) resulting in vaccine hesitancy remaining one of the top critical threats to global health and well-being (7). Even those who were historically accepting of other vaccines reported increased concerns regarding mRNA COVID-19 vaccines, as a result of the novelty of the vaccines, changing public health guidelines and recommendations, and online misinformation (5, 8).

Following the pandemic, healthcare providers (HCPs) have reported feeling uncomfortable initiating vaccine discussions for several reasons, including but not limited to time constraints, staffing limitations, competing priorities, individual burnout, lack of organizational support, and the overall erosion of trust in the healthcare system (9–14). As a result, urgent action is needed to develop effective strategies for HCP to use to combat vaccine hesitancy and encourage the acceptance of vaccines (6, 15). Vaccine discussion is a complicated interpersonal interaction that requires verbal and non-verbal communication skills to actively listen, recognize hesitancy, and address denialism, as pro-vaccine messaging alone is unlikely to be effective (16–19). Whereas initially treated as a knowledge deficit phenomenon, more recent work recognizes vaccine hesitancy as a complex by-product of a person's lived and collective experiences with illness, biomedical institutions, injustices, and their relationships with government and the scientific community (20–22). Rather than viewing these individuals as one homogenous category, HCPs need both knowledge and communication tools to respond in a tailored fashion to individual vaccine hesitant archetypes (23) to effectively engage, build trust, and advance vaccination intention.

A recent scoping review conducted by Lip et al. (24) examined whether educational interventions existed for HCPs on how to effectively engage in vaccine discussions. Several gaps were identified, such as limited accessibility of the interventions. Notably, the interventions were more targeted toward medical workers (students, residents, physicians, and physician assistants) and less so to other disciplines such as nursing and pharmacy, despite these providers playing an important role in immunization distribution and uptake. Similarly, a survey of American HCP students identified a lack of knowledge and overall discomfort engaging in vaccine discussion among medical, nursing, pharmacy students (25).

In response to this gap, we developed an online learning module consisting of three virtual simulation games (VSGs) to specifically address the need for more accessible interventions targeting HCPs across disciplines of medicine, nursing, and pharmacy (26, 27). A discipline and knowledge agnostic design was selected for the games to ensure the intervention could be completed regardless of practice setting or vaccine-specific knowledge but also to encourage future vaccine conversations and recommendations across disciplines. Each VSG was objective-based and designed to increase HCPs confidence and self-efficacy in vaccine communication through the use of presumptive statements (17) and the PrOTCT Framework (28), which are effective evidence-based tools developed to help HCPs discuss vaccines with patients. The PrOTCT Framework, based on evidence based principles of presumptive statements as well as motivational interviewing strategies (**P**resume the patient will vaccinate, **O**ffer to share knowledge and personal experiences with vaccines once you have explored their stance using OARS-open questions, affirmation, reflective listening and summarizing reflections, **T**ailor recommendations to address patients' specific health **C**oncerns, and **T**alk through a specific plan for when and where to get vaccinated), was designed by experts and provides HCPs a framework for vaccine communication (28).

VSG1 focused on conversing with patients expressing hesitancy around receiving an mRNA vaccine booster or completing a vaccine series. VSG2 focused on conversing with patients who minimize the risk of diseases such as COVID-19 while maximizing the risk of the vaccine, especially newer mRNA vaccines. VSG3 focused on fostering HCPs' personal resilience, building and maintaining self-efficacy, and provided suggestions to prevent burnout and moral distress when dealing with vaccine refusal. We chose to conduct a pilot evaluation

of the VSGs with HCP learners in nursing, pharmacy, and medicine in an effort to provide learners with effective vaccine communication skills early in their careers. The objectives of this qualitative study were to: (1) explore HCP learners' personal experiences with vaccine education and vaccine discussion, and (2) conduct a qualitative evaluation of the VSGs to identify opportunities for improvement prior to accreditation and dissemination of the VSGs.

Methods

Study design

This was a qualitative evaluation within a larger pilot study in which we conducted three focus groups between December 2022 and January 2023 with students in nursing from the University of Calgary, students in pharmacy from the University of Waterloo, and medical residents in the internal medicine, family medicine, public health, pediatrics, obstetrics and gynecology, and emergency medicine specialties from the University of Calgary who provided informed consent. Focus groups were used to foster valuable discussions to identify the opinions of and recommendations for the VSGs. This study received approval from the University of Calgary Conjoint Health Research Ethics Board (REB22-0012) and a University of Waterloo Research Ethics Board (REB 44487).

Participant recruitment

Participants were recruited for the focus groups from an existing cohort of 72 participants who had completed all 3 VSGs as part of a larger project evaluating the effectiveness of the VSGs at improving learners' confidence in addressing vaccine hesitancy (27). Eligibility was defined as medical residents in the specialties of Internal Medicine (IM), Family Medicine (FM), Obstetrics and Gynecology (OBGYN), pediatrics (Peds), Emergency Medicine (EM), nursing students in the third or fourth year of their program, and pharmacy students in second, third, or fourth year of their program, as they were most likely to have previous clinical experiences discussing vaccines. Participants were offered an electronic gift card for their time spent participating in the focus group for CAD $50.

Focus group guide development

The focus group guide was developed by the project team based on the findings from the scoping review (24) that outlined the gaps in vaccine conversation education. Questions were designed to explore participants' past experiences with vaccine communication, prior education they received on vaccine communication, as well as their experiences with the VSGs specifically exploring the user experience and their perceived confidence with vaccine discussions.

Focus group moderation/data collection

Discipline-specific focus groups were led by two female members of the research team who were approximately the same age as the participants and were experienced in qualitative methodology. The focus groups were conducted online using Zoom (Zoom Video Communications, Inc., San Jose, CA). Focus groups were 1–1.5 h in length and were led by one researcher, while one facilitator observed, took field notes, and provided technical support. Following the focus groups, the moderator and facilitator debriefed and shared field notes with each other.

Qualitative analysis

The focus groups were audio and video recorded, with third-party verbatim transcription to support rigorous data analysis. Two qualitative researchers performed iterative thematic analysis on transcribed data to identify key themes using Braun and Clarke's 6 step framework (familiarize oneself with the data; generate initial codes; search for themes; review themes; define and name themes; produce final report) (29). Analysis was conducted until thematic saturation was reached to support the dependability of our findings. Data organization and analysis were conducted using the qualitative data analysis software, NVivo 12 (30). The coding and thematic analysis was supported by reviewing field notes recorded during each focus group and comparing the emergent findings to ensure no key themes were missed. Regular communication between the researchers ensured that potential biases from their subjective experiences were addressed and changes to the analysis were discussed and agreed upon. In the discussion of themes, quotations from participants are provided along with the participants' discipline and year of program.

Findings

Of the 72 potential participants from the larger pilot study, 22 participated in one of three discipline-specific focus groups; the distribution included 6 nursing students, 9 pharmacy students, and 7 medical residents. Overall, participants were predominantly female (95.4%). Twenty participants (90.9%) reported having a vaccine conversation in the past, while only 13 (59.1%) reported learning about how to have vaccine conversations in their program. There were no differences in the self-evaluation scores between those who participated in the focus groups and those who only participated in the larger pilot study, suggested the focus group sample adequately represented the larger study population. Additional participant characteristics are provided in Table 1. Three broad themes consistent across all three disciplines were identified through thematic analysis. Additional quotations and subthemes are included in Table 2.

Theme 1: HCP learners' prior education lacked practical training on how to have difficult conversations with patients, resulting in uncomfortable personal experiences discussing vaccines

When asked about their prior education about vaccine conversations, participants in all three disciplines reported that their experiences were often didactic and lacked training on integrating

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TABLE 1 Focus group participant demographics.

	Nursing (*N* = 6)	Pharmacy (*N* = 9)	Medicine (*N* = 7)
Age, n (%)			
18–25	4 (66.7)	9 (100.0)	1 (14.3)
26+	2 (33.3)	0 (0.0)	6 (85.7)
Gender, n (%)			
Female	6 (100.0)	9 (100.0)	6 (85.7)
Male	0 (0.0)	0 (0.0)	1 (14.3)
Year of HCP program, n (%)			
1st	0 (0.0)	0 (0.0)	4 (57.1)
2nd	0 (0.0)	1 (11.1)	3 (42.9)
3rd	1 (16.7)	5 (55.6)	0 (0.0)
4th	5 (83.3)	3 (33.3)	0 (0.0)
Medical resident specialty, n (%)			
Pediatrics			2 (28.6)
Public Health and Preventative Medicine (PHPM)			1 (14.3)
Family Medicine			4 (57.1)

communication skills with immunization content. The academic training often included information on how to administer vaccines and address common questions regarding vaccine ingredients and side effects, but rarely explored how to navigate challenging conversations.

> *"The vaccine class, or the whole vaccine program that we did in school just felt more theoretical. It was mainly based on knowledge of vaccines. I do understand that we had other courses which touched upon patient communication and how to use active listening, like those soft skills, but there's really no course that combines the two."* (3rd year pharmacy student)

In addition, participants in all three disciplines frequently reported feeling nervous, uncomfortable, and unprepared to engage in challenging vaccine conversations with patients. These emotions often resulted in them responding passively or dismissively when patients brought up concerns, while others hoped to avoid the conversations entirely by not bringing up the topic of vaccines. Residents expressed their hesitancy to address the topic, because they feared that it would hinder the therapeutic relationship with the patient and lead to burnout or moral distress.

> *"If I'm being totally honest, I've had a lot of negative experiences, so I'm kind of less and less motivated to really push vaccines on patients, which sounds kind of terrible as a new graduate now, … Like how much do I wanna burn myself out trying to sort of almost convince people?"* (2nd year family medicine resident)

Participants from all disciplines felt motivated to complete the VSGs as they recognized their lack of relevant education and self-confidence. They emphasized their desire to become more confident in their vaccine communication skills, as they felt they would be utilized often in their future roles as HCPs.

> *"I think just knowing that this is something that's gonna come up over and over again in residency and in practice, and just wanting those skills, and recognizing that I don't have them or need some help."* (2nd year pediatrics resident)

Theme 2: HCP learners felt the educational intervention increased their confidence and self-efficacy in having challenging vaccine conversations by providing useful tools and novel and transferable skills

Participants in all three disciplines reported finding the VSGs content to be discipline agnostic, with emphasis on the "soft skills" for communication. They felt the VSGs would be a useful educational tool for all HCPs to complete as they provide skills that are applicable to many different patient scenarios (including other vaccines, medication counseling, and nonpharmacologic lifestyle changes). In addition, they felt that widespread training on vaccine conversations would be beneficial as patients may be more comfortable sharing information with certain providers over others.

> *"I think it can be applicable to many other healthcare professionals as well, because at the end of the day, it really depends on who the patients are most comfortable sharing information with. So it might not be their pharmacist. It might not be their nurse. They may be more comfortable with, you know, their doctor or like another social worker... Depends on who they have that really good rapport with, so if that's another healthcare provider that's not in pharmacy or nursing, then they'll still benefit from this module."* (4th year pharmacy student)

The content in the third VSG specifically focused on HCP resilience, coping strategies, and avoiding moral injury when difficult conversations do not go the way the HCP had planned. Learners in all disciplines appreciated the reminder about the importance of self-compassion and felt the VSG content was a unique and often overlooked strategy for HCPs to utilize when dealing with challenging patient conversations.

> *"I'll take away the self-compassion piece and the piece about, you know, you can push these conversations, but do not push your patient away. And knowing when to kind of take that step back to preserve the therapeutic relationship."* (1st year public health resident)

Although participants had not learned about presumptive statements and the PrOTCT Framework before, they were enthusiastic about practicing the techniques and incorporating them into conversations with future patients. Participants in both nursing and medicine expressed their surprise regarding the effectiveness of presumptive statements, as they had been taught not to make assumptions about patients.

> *"So I would say that definitely the presumptive language that the module introduced was something that was also quite surprising*

TABLE 2 Qualitative focus group themes, subthemes, and representative quotes from each HCP learner discipline.

Theme	
Subtheme	Key Quotes
Theme 1: HCP learners' prior education lacked practical training on how to have difficult conversations with patients, resulting in uncomfortable personal experiences discussing vaccines.	
Participants prior education was very didactic and lacked training on soft communication skills and presumptive statements.	*"I honestly do not think we had very much training as far as having those conversations with patients. Like if I think back, way back to my term three, I think maybe there was some, like a little bit of training just as far as like vaccines just like on their own, but not necessarily like the conversations behind them as far as like, this is how you should approach it with a patient and XYZ"* (4th year nursing student) *"The vaccine class, or the whole vaccine program that we did in school just felt more theoretical. It was mainly based on knowledge of vaccines. I do understand that we had other courses which touched upon patient communication and how to use active listening, like those soft skills, but there's really no course that combines the two."* (3rd year pharmacy student) *"We did have just one lecture, I think, that addressed the vaccine hesitancy. And they did kinda give us some of the main reasons that people provide for being hesitant to vaccines and kinda some of the evidence to rebuttal that…"* (1st year family medicine resident)
Participants felt uncomfortable and unprepared to have challenging vaccine conversations with patients, fearing it would hinder the therapeutic relationship.	*"I think when faced with a more difficult individual that's like very passionate about their opposing beliefs or that's just very strong-willed it makes me, I feel like I might get a little nervous 'cause some individuals might get aggressive. I do not know if that's an extreme, but I just know that some people are very passionate about their opinions in specific situations, and I tend to be a more non-confrontational individual in general. So just because of that I tend to be a little bit more hesitant if it was to take that negative, um, turning point."* (4th year nursing student) *"I was being pretty passive in [a] conversation, um, just because I did not really know how to respond and I was trying to provide reasons to that patient, just general reasons, like that everyone should get it, um, you never know. You cannot really protect against it. But I felt as though I could have been more active, but I did not know how I could direct the conversation and better convince them instead of just giving, you know, general things that they probably heard elsewhere."* (3rd year pharmacy student) *"If you open up the record and see like, they have had no vaccines. Then all of a sudden, I'm like kind of a bit nervous (laughs) and thinking like, "Oh, gosh. How do I even have this conversation?"* (2nd year family medicine resident)
Participants were motivated to complete the VSGs due to the importance of vaccine communication skills in their daily practice.	*"I think knowing that this information could be helpful for so many difficult clinical situations we might encounter, just knowing our profession is like what really kind of motivated me to want to do the games you could say … so just establishing that connection and understanding how common it is to see hesitancy, see or just face difficult situations or conversations with patients"* (4th year nursing student) *"For me, working in a community pharmacy, I came across many vaccine hesitant patients and I did not know exactly how to deal with them, so I wanted to better my own skills and be more confident in that area, so that's what motivated me a lot."* (4th year pharmacy student) *"I think just knowing that this is something that's gonna come up over and over again in residency and in practice, and just wanting those skills, and recognizing that I do not have them or need some help"* (2nd year pediatrics resident)
Theme 2: HCP learners felt the educational intervention increased their confidence and self-efficacy in having challenging vaccine conversations by providing useful tools and new and transferable skills.	
The emphasis on HCP resilience and coping strategies present in VSG 3 brought a unique and often overlooked approach for HCPs dealing with challenging conversations.	*"But I also like the part of the games where they are like, "Oh, like when you have difficult conversations with patients, you also have to have compassion for yourself." I really like that part because I feel like we skip over that a lot. But like, going through the games kind of helped me recircle back to that point that you have to be kind with yourself even while having these conversations with patients."* (4th year nursing student) *"…for that last module, there was no real resolution, it did not have a happy ending of the patient ending up with a vaccine, and I think if that happened in real life, I would blame myself. I would say, "If it were someone else who were better at this than me, the patient would've ended up with the vaccine." And I think that made me realize like this is a professional handling it, and it did not go the way that I wanted it to go, or the professional wanted it to go, so maybe it's not my fault that this is happening, maybe the patient just was not ready for it today."* (4th year pharmacy student) *"I'll take away the self-compassion piece and the piece about, you know, you can push these conversations, but do not push your patient away. And knowing when to kind of take that step back to preserve the therapeutic relationship."* (1st year PHPM resident)
Use of novel PrOTCT framework and presumptive statements	*"So I would say that definitely the presumptive language that the module introduced was something that was also quite surprising to me 'cause it's definitely not an approach that I had thought about before. I think initially when I had seen that in the modules, I actually thought it was quite an abrupt way to ask patients about their vaccines. It was something that I have not had much practice in the past before. And I'd say in general, the modules were a really good starting point to develop an approach to having these conversations."* (2nd years pediatrics resident) *"I had also never heard of it before and I had never used it before. And I did not really consider it until I saw it being used, like implemented in the videos. And I was, at first I was taken aback 'cause I thought that you were not supposed to kind of assume, um, but to see how it's laid out and how it's used, um, I think it makes sense more now to me. And I kind of like... I appreciated having the modules because of that, because if I had never done it, then I would've never known and I would've continued on with my mindset of like, "Do not assume" and "do not, you know, do not go in that specific way." So I really, really, appreciated that."* (4th year nursing student)

(Continued)

TABLE 2 (Continued)

Theme	
Subtheme	Key Quotes
The VSGs content was discipline agnostic, making it multidisciplinary and applicable to many different patient scenarios (other vaccines, medications).	*"I think [the VSGs are] applicable to general vaccines and administration, and also medication hesitancy because both of those things are concepts that happen a lot… with people not knowing what it does or like having bad experiences in the past."* (4th year nursing student) *"Two examples I can think of, outside of vaccines, that I can see myself using the skills that I learned from these modules include like for diabetes, patient starting insulin, and even recommending not pharmacologic changes to patient for lifestyle modifications, like smoking cessation. Um, just being personable, kind of like building that rapport with them was something that I took away from the module that we can really apply to any patient scenario, just to, you know, get the ball rolling."* (3rd year pharmacy student) *"I would definitely recommend them to … most, or any other health profession who's seeing the public in a preventative health kind of way. I think that would apply to a lot of different disciplines, even if they are not set up to specifically provide vaccines or discuss them all the time. I think just having that background and being able to navigate some of those conversations that are inevitably going to come up, regardless of the healthcare setting, I think it would be... I think the skills are very transferable amongst health professions."* (1st year family medicine resident).
Theme 3: HCP learners enjoyed the learning modules and provided actionable feedback on the content, suggestions for future games, and endorsed accreditation.	
The VSGs were enjoyable, interactive, patient-oriented, and engaging through real-life scenarios and first-person perspectives.	*"I really like them. I found them very user friendly and there were aspects where I found myself a bit challenged. Overall it was pretty easy to navigate just through common sense. But, there were definitely areas where I would click the wrong response and then through the, explanation, I really appreciated the explanations that were provided for those wrong responses as they allowed me to kinda reflect on my way of thinking.* (4th year nursing student) *"I really liked how in that last simulation game, the questions were embedded within, so you really felt like you were the healthcare provider providing the information to that patient… And I liked how you could see, okay, if I chose this option, let us see what happens and this why it's like not the right option, and then it … with the correct answer, it walks you through it, and then you see how it plays out."* (4th year pharmacy student) *"I enjoyed them actually. I thought the approaches discussed were... Like they were new to me. 'Cause like I had mentioned earlier, I had just not had really any significant formal teaching around it. And I think what was helpful was the videos and then the questions afterwards … I might select X, Y, Z answer, and it turned out to be wrong, um, for a lot of them. But, then watching the videos around it was quite helpful. So honestly, I think it was a pretty good curriculum. I wish it was introduced into medical school earlier for us."* (2nd year family medicine resident)
Knowledge agnostic content complemented existing theoretical knowledge, but learners want additional information to integrate both	*"I kind of have mixed feelings about it. Um, positive and negative. Like positive in the fact that like, it was strengthening the knowledge that we already had about having those conversations. But like, um, I feel like it was really wonderful to get to know more of that stuff. But like, I also thought, like I would've also appreciated a little bit of a knowledge base. I do not know if that was the point of the games. But like, um, I would've also have appreciated maybe just a little bit of like how to integrate, like talking about the theory part of it with the patient as well"* (4th year nursing student) *"I do not think these videos need to cater toward the theoretical knowledge, they do a great way of working on soft skills in an online platform, and I think that's something that's, we do not really get much in school outside of the clinical labs. So these videos are a really great way of learning how to practice on those soft skills without having to do it in person."* (3rd year pharmacy student) *"I think these conversations are really balancing like the art and science of medicine. I think these modules are really good at giving an approach for developing those communication skills for having these difficult conversations with families. But I do think that since a lot of them are coming up with specific facts that they read online, that it is really important to know the facts, and the science, and the evidence behind their specific questions. And I think as a healthcare provider, I think it also can diminish their trust in us, and if we do not like to have the specific details and the evidence behind like their particular question that they are asking us. And so, I think that it's important for us to be able to know, like some of the evidence and the research behind, like some of their questions that they have, uh, with regards to vaccines."* (1st year pediatrics resident)
Accreditation of the VSGs by a governing body/integration into coursework will make the intervention more likely to be completed by more HCPs.	*"If this was like added on into [coursework] in some way ... like the school making us do it. I think like if you ask some students to do it themselves, they might not, but if you throw it into a course and it's enforced ... like they will not see how the benefits play out until they actually do it."* (4th year pharmacy student) *"I think [accreditation] would be nice too, because I'm in the process of interviewing for jobs right now. Um, and something that I've noticed that a lot of people ask is what, like external education, are you doing on top of school. Um, and so I've been bringing this one up."* (4th year nursing student)

> *to me 'cause it's definitely not an approach that I had thought about before. I think initially when I had seen that in the modules, I actually thought it was quite an abrupt way to ask patients about their vaccines. It was something that I haven't had much practice in the past before. And I'd say in general, the modules were a really good starting point to develop an approach to having these conversations."* (2nd year pediatrics resident)

Theme 3: HCP learners enjoyed the learning modules and provided actionable feedback on the content, suggestions for future games, and endorsed accreditation

All participants found the VSGs to be enjoyable, interactive, and engaging due to the use of real-life patient scenarios and first-person filming perspectives. Participants also appreciated the opportunity to

learn from wrong answers as well as correct ones; the VSGs provided learners the opportunity to see how a situation would change when wrong responses were selected, and why it was not the best option at that time.

> *"I just think it was really well-formatted in the way that it was very interactive because I think sometimes... When we are taught therapeutic communication, you can read an entire textbook about it, but until you actually have that opportunity to do it, like in a case study type of situation, or even in like real-life experiences… That's when you really start to understand the types of comebacks people might give to you, um, which makes it a lot more challenging."* (4th year nursing student)

Participants in all three disciplines appreciated the unique knowledge agnostic VSG design that did not center around factual learning. They felt that the content complemented their existing theoretical knowledge, however all students expressed a desire for additional information regarding how to best integrate vaccine-specific knowledge with communication skills.

> *"I think these conversations are really balancing like the art and science of medicine. I think these modules are really good at giving an approach for developing those communication skills for having these difficult conversations with families. But I do think that since a lot of them are coming up with specific facts that they read online, that it is really important to know the facts, and the science, and the evidence behind their specific questions."* (1st year pediatrics resident)

Finally, participants provided feedback and suggestions to improve the VSGs immediately and for future games (Table 3). All participants supported accreditation of the VSGs by a governing body and the integration of the VSGs into healthcare training program curricula to make the intervention more likely to be completed by a larger number of HCPs.

Discussion

Focus groups with learners in medicine, nursing, and pharmacy were conducted to qualitatively evaluate three VSGs, as well as elicit narrative experiences of HCP learners in holding these conversations. Thematic analysis of focus groups transcripts resulted in the identification of three key themes. Overall, HCP learners in medicine, nursing, and pharmacy reported a lack of sufficient training on how to engage in challenging vaccine conversations. However, they felt that the online learning module complemented their prior education on immunizations and increased their confidence holding these conversations by providing novel tools and useful skills. The VSGs were perceived to be a positive and useful learning modality for broader distribution. Our online learning module has the potential to address some of the current gaps in HCP knowledge and education.

Participants from all three disciplines felt the education they received was didactic, generalized, and did not provide training on how to integrate soft communication skills or presumptive statements into vaccine discussions. This is supported by a previous assessment of medical, nursing, and pharmacy school immunization curricula which found that curriculum content focused on immunization practices and principles rather than communication skills (31). Further, the time spent on the topic varied significantly by discipline and school, lacking consistency even within disciplines (31). Concerningly, HCP learners felt uncomfortable or unprepared when vaccine conversations arose, possibly related to the lack of training. It has been shown that the overall preparedness of a HCP is an important factor in their willingness to engage in conversations with patients (32), however even practicing HCP have expressed discomfort when the topic of vaccines is brought up by patients as a result of the pandemic (9–11). Participants recognized their lack of confidence, the importance of these conversations, and the frequency with which they will occur in practice, which was a motivating factor in completing the learning modules.

The VSGs resulted in an increase in participants' reported willingness to engage in vaccine conversations with patients across all three disciplines. The use of gamification and virtual simulation in medical education is increasing in popularity as it has been shown to increase learner interest, motivation, and overall engagement, while reducing fear of failure (33, 34). Highlights of the VSGs were the virtual and gamified format, as participants reported they were engaging, interactive, multidisciplinary, and provided transferable skills, meaning they could be used by any HCP engaging in conversations with patients, both vaccine-related or otherwise. Considering the effect COVID-19 vaccines and mRNA technology mistrust has on public perception of vaccination, enabling HCP with transferable communication tools may positively contribute to trust building in the HCP-patient relationship (4, 8). The introduction of the evidence-based PrOTCT Framework (28) for guiding vaccine conversations was a novel technique across all three disciplines. Nursing and medical learners found presumptive statements contradicted their prior education about avoiding making assumptions about patients. This suggests a need for HCP training programs to integrate the use of presumptive statements in their immunization education, as presumptive statements have been shown to be significantly more effective than participatory statements in decreasing the odds of parental resistance to vaccines (17). All three disciplines found the content of the VSGs useful, supporting the use of the learning module as a multidisciplinary educational tool.

A unique aspect of the VSGs identified and celebrated by all three disciplines was the emphasis on HCP resilience, coping strategies, and strategies to preserve the therapeutic relationship. Participants enjoyed the reminder of the importance of self-compassion in healthcare professions, especially during difficult or adversarial conversations with patients. To our knowledge, no other vaccine communication interventions specifically address the management of HCP emotions (24), despite findings that the emotional state of HCPs significantly impacts their ability to have challenging conversations (35–37). Moral distress is the psychological distress experienced by HCP as a result of morally challenging situations (38–40), such as in instances of vaccine refusal, and has been associated with HCPs leaving their professions. While research exists to measure and address moral distress, including strategies such as specialist consultations, reflective debriefing, and educational interventions, further rigorous research is needed in this area (41). As HCP are at an increased risk of burnout, anxiety, and depression now more than ever, it is essential for institutions to not only provide mental health resources following burnout, but to provide strategies and training to avoid and address moral distress early in HCP education (37, 42, 43).

Participants supported accreditation and inclusion of the modules in HCP training programs to increase awareness and use of the VSGs,

TABLE 3 Suggested improvements for VSGs design and topics of interest for future games.

Suggested improvements for VSGs	1. Table of contents/back button to allow for movement within VSGs 2. Open text responses to provide opportunity to come up with potential answers 3. Video responses to provide participants an opportunity to practice saying their responses out loud i.More information on the PrOTCT Framework
Suggested topics for future games	1. "Selective hesitancy," patients who prefer a certain vaccine brand over another (e.g., Pfizer vs. Moderna) 2. Vaccine hesitancy in diverse patient populations (e.g., pediatrics, pregnancy, seniors) 3. How to answer questions about vaccine ingredients (pharmacy specific)? 4. Vaccine-specific games, e.g., (HPV, flu, shingles) (resident specific)

which will be facilitated alongside open access to the learning modules. We also explored potential areas for improvement. Participants appreciated that the learning modules did not require any specific knowledge of vaccines, but requested additional information about responding to specific vaccine questions which was not included in the games. This provides an opportunity for future VSGs to be added alongside the presently created ones, and for the VSGs to be incorporated into a single resource alongside other useful information for further education.

Limitations

The study has several limitations. First, only three focus groups were conducted as this was part of a pilot evaluation of the VSGs, although thematic saturation was met after completion of the three focus groups. While there is some debate regarding the number of focus groups required, previous work on qualitative methodology has identified that over 80% of all themes are discovered within two to three focus groups (44). Further, the purpose of our study was quite narrow and specifically designed to identify participant experiences with the VSGs rather than understand deeper issues in medical education and vaccinology (45). Ultimately, further research is needed to confirm our findings. Recruitment of HCP learners in each discipline in the larger pilot study was also challenging due to HCP training programs' rigorous academic demands, which resulted in a limited convenience sample of participants. To mitigate the impact, we offered multiple date and time options to participants to increase attendance. Medicine and pharmacy learners in this sample identified as female at a much higher rate than in the Canadian HCP population (46), although the percentage of female nursing learners in this sample was similar to the percentage of female nurses in Canada (47). Further, selection bias likely occurred due to our recruitment strategy and therefore we may have unknowingly missed learners with very high and low levels of self-confidence as they may have been less likely to enroll in a study on improving confidence due to fear of embarrassment or indifference. Lastly, it is important to acknowledge the role of both qualitative researchers and that their personal experiences, assumptions, and beliefs may have influenced the thematic analysis and what they deemed to be key themes.

Conclusion

This qualitative evaluation adds to the growing literature emphasizing the important role HCPs play as a trusted source of vaccine information (32, 48–50), and the effectiveness of VSGs as an additional educational tool for HCP training (51). Our findings suggest that the VSGs have the potential to effectively address the need for a discipline and knowledge agnostic educational tool to increase the confidence of Canadian HCP learners, however further research with a larger number of participants is needed to both confirm and improve the reliability of our findings. The VSGs improved participants confidence by introducing new skills, such as the use of presumptive statements, and through a focus on HCP resiliency that can complement existing immunization and communication training. Ultimately, it is essential that HCP gain exposure to challenging vaccine conversations at an early point in their training to prepare them for their futures involving of mRNA vaccine advocacy, delivery, and promotion.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the University of Calgary Conjoint Health Research Ethics Board (REB22-0012) and a University of Waterloo Research Ethics Board (REB 44487). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

ED: Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing, Conceptualization. MP: Conceptualization, Data curation, Formal analysis, Project administration, Writing – original draft, Writing – review & editing, Investigation, Methodology. MF: Conceptualization, Methodology, Project administration, Writing – review & editing, Investigation. AL: Conceptualization, Investigation, Methodology, Writing – review & editing, Supervision. SH: Conceptualization, Investigation, Methodology, Supervision, Writing – review & editing. JK: Conceptualization, Methodology, Supervision, Writing – review & editing, Investigation. JL: Conceptualization, Methodology, Supervision, Writing – review & editing, Investigation. SM: Conceptualization, Methodology, Supervision, Writing – review & editing, Investigation. DM: Conceptualization, Methodology,

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Conflict of interest

SH has received unrestricted research funding from Sanofi and Valneva, a medical education grant from GSK, a research consulting honorarium from Seqirus, and has been an advisory committee member for AstraZeneca, GSK, Novavax, Pfizer, Sanofi, Seqirus, and Valneva. JK has been an investigator on projects funded by GlaxoSmithKline, Merck, Moderna, and Pfizer, outside the submitted work. All funds have been paid to his institution, and he has not received any personal payments. He has been an unpaid Data Safety Monitoring Board Member for a COVID-19 vaccine clinical trial. He has been an unpaid member of the Canadian COVID-19 Immunity Task Force (Leadership Group member, Field Studies Working Party Co-Chair and Pediatric Network Lead), and of the Alberta Advisory Committee on Immunizations. CC has been an investigator on projects funded by GlaxoSmithKline, Merck and Pfizer. She has also contributed to continuing medical education initiatives (by producing and delivering vaccine related education materials) supported by pharmaceutical companies such as bioMerieux, Moderna, and Pfizer. All funds, including any honoraria have been paid to her institution (University of Calgary), and she has not received any personal payments. She has held an unpaid executive position for the organization 19 to Zero.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Opportunities and challenges to implementing mRNA-based vaccines and medicines: lessons from COVID-19

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The messenger RNA (mRNA) platform emerged at the forefront of vaccine development during the COVID-19 pandemic, with two mRNA COVID-19 vaccines being among the first authorized globally. These vaccines were developed rapidly. Informed by decades of laboratory research, and proved to be safe and efficacious tools for mitigating the global impact of the COVID-19 pandemic. The mRNA platform holds promise for a broader medical application beyond COVID-19. Herein, we provide an overview of this platform and describe lessons learned from the COVID-19 pandemic to help formulate strategies toward enhancing uptake of future mRNA-based interventions. We identify several strategies as vital for acceptance of an expanding array of mRNA-based vaccines and therapeutics, including education, accurate and transparent information sharing, targeted engagement campaigns, continued investment in vaccine safety surveillance, inclusion of diverse participant pools in clinical trials, and addressing deep-rooted inequalities in access to healthcare. We present findings from the Global Listening Project (GLP) initiative, which draws on quantitative and qualitative approaches to capture perceptions and experiences during the COVID-19 pandemic to help design concrete action plans for improving societal preparedness for future emergencies. The GLP survey (>70,000 respondents in 70 countries) revealed tremendous disparities across countries and sociodemographic groups regarding willingness to accept novel mRNA vaccines and medicines. The comfort in innovations in mRNA medicines was generally low (35%) and was marginally lower among women (33%). The GLP survey and lessons learnt from the COVID-19 pandemic provide actionable insights into designing effective strategies to enhance uptake of future mRNA-based medicines.

KEYWORDS

mRNA vaccines and therapeutics, COVID-19, mRNA vaccine development, public trust, vaccine hesitancy, vaccine confidence

1 Introduction

Tailored healthcare campaigns that engage the public and provide resources to address specific health needs are integral to enhancing health and preventing disease (1). The success of vaccination campaigns is predicated on a multitude of factors, including public trust in health authorities and political leadership, access to vaccines, and perceptions of

vaccination (2, 3). These factors vary across countries (2, 4–8) and intersect with more dynamic influences (e.g., rapidly evolving policy recommendations, media coverage) (2, 3, 8, 9). During the COVID-19 pandemic, the relationship between vaccine hesitancy, sociodemographic characteristics, and political leaning became notable (10–12). Social inequalities were associated with disparate access to care and differential health burden (11, 13), influencing vaccine perceptions and potentially shaping future vaccine behavior. Quantitative measures and benchmarking can provide actionable insights on societal preparedness to mitigate the long-term impact of healthcare crises, e.g., by addressing the gaps between public perceptions and evidence-based information, and targeting trust-building interventions to appropriate demographic groups (14).

Messenger RNA-based vaccines (hereafter mRNA vaccines) were among the primary authorized vaccines against SARS-CoV-2 during the COVID-19 pandemic (15). Although mRNA research has been ongoing for several decades (16), the use of the mRNA platform for vaccines came into the limelight only during the COVID-19 pandemic (15, 17). The novelty of this mode of producing vaccines generated concerns in the public regarding perceived lack of adequate testing of side-effects of mRNA vaccines (2). Herein, we provide an overview of how the mRNA platform works and discuss how lessons learned from the pandemic can inform strategies to enhance trust and facilitate uptake of mRNA-based vaccines and therapeutics beyond COVID-19. We present novel data from a Global Listening Project (GLP) survey (18) showcasing nationwide diversity in the pandemic-era experiences of mRNA-based vaccines and medicines. These data reveal a multifactorial basis underlying acceptance of mRNA-based medicines, highlighting the need for improved communication on this topic and equitable access to care in the time of crisis.

2 The mRNA vaccine platform

Messenger RNA is an essential molecule involved in relaying genetic information encoded in DNA to the production of proteins (19–21). Vaccines based on mRNA can be designed to selectively produce key proteins from pathogens that stimulate a specific immune response, thereby protecting from illness (16, 22, 23). mRNA contains a transcript that directs the production of highly immunogenic proteins by the cells that take up the vaccine and stimulate the immune system the same way as a natural infection (16, 24–26). The protein encoded by mRNA represents one component of the pathogen, and therefore is unable to cause disease (20).

The constituents of mRNA vaccines are synthetic, non-replicating mRNA molecules that approximate the size and composition of naturally occurring mRNA (15, 26), encapsulated by lipid nanoparticles (LNPs) that serve to protect the mRNA from degradation and enable targeted cellular delivery (19, 24, 27, 28). Following administration, the mRNA is rapidly degraded by normal physiological processes (20, 29–31), while the naturally occurring lipids in the LNP vehicles are assumed to be biologically degraded similar to their endogenous analogs (27, 31). The synthetic amino lipid constituent of LNP is rapidly cleared from blood in rodent models (27, 31). Notably, mRNAs do not enter the cell nucleus and therefore cannot integrate into the cellular genome (16).

The key advantages of mRNA over other vaccine platforms (Table 1) are the precision in protein design, the flexibility to reconfigure protein formulations toward enhancing immunogenicity or developing combination vaccines to target multiple pathogens, and the speed at which vaccines can be manufactured and updated (e.g., allowing expeditious updates to target evolving or emerging strains) (24, 28). The manufacturing of mRNA involves standardized chemical processes with reagents that can be rapidly repurposed independently of the encoded protein (28) without the need for adjuvants (26). The specificity and flexibility of the platform allow for iterative improvements in protein design and make the mRNA approach intrinsically faster and scalable up to hundreds of millions of doses (28, 32).

Since the discovery of mRNA in 1961, its medical application has been hampered by various factors, including short half-life and inflammatory properties (28, 33, 34). A breakthrough discovery in 2005 showing that replacing uridine with pseudouridine decreased the degree of mRNA-driven inflammation (28, 34, 35), and additional technological advancements in encapsulating mRNA in LNPs were the key milestones underlying the development of mRNA vaccines (16, 31). With the declaration of the COVID-19 pandemic, two mRNA COVID-19 vaccines, mRNA-1273 (Spikevax, Moderna, Inc., Cambridge, MA, United States) and BNT162b2 (Comirnaty; Pfizer, Inc. New York, NY, United States) were among the first vaccines against SARS-CoV-2 authorized for emergency use worldwide (15). These approvals were based on the data from pivotal Phase 3 randomized clinical trials involving >30,000 participants, which demonstrated high efficacy (>90%) and a favorable risk–benefit profile (36, 37). The mRNA platform was applied to the development of variant-adapted vaccines to target SARS-CoV-2 variants as they emerged (38, 39). Extensive post-licensure real-world data attest to the safety and effectiveness of mRNA vaccines in curbing COVID-19–associated morbidity and mortality (40, 41). These data were valuable for expanding the landscape of mRNA vaccines and therapeutics beyond COVID-19; numerous mRNA vaccines have entered clinical development for respiratory syncytial virus, Zika virus, HIV, influenza, cytomegalovirus, varicella-zoster, and rabies virus (42).

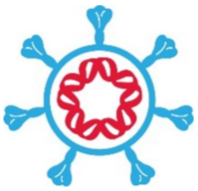
3 Implementation of the mRNA platform: lessons from COVID-19

Several lessons from the COVID-19 pandemic can be leveraged to improve on implementation of mRNA vaccines and medicines.

3.1 Promoting transparent and accurate information-sharing to enhance uptake of novel treatments

Early in the course of pandemic, only 50–60% of the surveyed global population reported willingness to receive a COVID-19 vaccine (43). Concerns about long-term effects, low confidence in efficacy, unprecedented speed of development, and lack of communication from trusted providers were identified as barriers to COVID-19 vaccine uptake (43). Vaccine hesitancy was more prevalent in certain demographic groups, including younger age,

TABLE 1 Summary of key differences between the mRNA platform and other vaccine technologies.

Vaccine type	Advantages	Disadvantages
Live-attenuated A weakened or non-infectious pathogen (82, 83) 	• Mimics natural infection (83) • Simple design (82) • Robust immunogenicity (82) • Long lasting (82)	• Stringent biocontainment (82) • Cold transport requirements (82) • Strong adverse immune reactions in vulnerable populations (82) • Prone to reverse mutations to an infectious strain (82)
Inactivated A fully killed pathogen (82, 83) 	• Broader immune response (82) • Safer than live-attenuated (83) • Stable and scalable (83)	• Potential epitope alteration (83) • Typically requires booster doses (82)
Subunit Purified or recombinant protein/peptide of the target pathogen (82–84) 	• Contain no live components (83) • Favorable safety profile (83) • Flexible, enabling combination vaccines (83) • Stable and scalable (83)	• Low immunogenicity, often requiring an adjuvant or a conjugate (83) • Frequent boosting required (83) • Labor-and time-intensive to manufacture (83)
mRNA Nucleic acid vaccine (83, 84) 	• Precise protein design (28) • Modifiable to target new pathogens (28) • No risk of insertional mutagenesis (80) • Low risk of toxicity (28, 80) • Rapid inexpensive production (28, 80) • Well-tolerated and effective (28)	• Low temperature required for storage and transportation (83)
DNA DNA sequence (82) 	• Adaptable to target new pathogens (83, 85) • Thermostability at refrigerated and ambient temperatures (85)	• Complexity of delivery and increased cost due to a requirement for a device to enhance cellular uptake (85) • Lower antibody responses compared to mRNA and adenoviral vaccines (85) • Risk of genomic integration (82)
Viral vectored Recombinant protein of the target pathogen in the carrier virus vector (84) 	• Flexible; can target multiple pathogens (28) • Rapid manufacturing and scale-up (28) • Potent and stable, supporting single-shot administration (28) • Cost-effective (82) • Thermostability at refrigerated temperatures (82)	• Response dampened by pre-existing immunity against vector (83) • Risk of genomic integration (83) • Rare adverse events of thrombosis and thrombocytopenia associated with COVID-19 vaccines (86)
Toxoid Inactivated toxin of a disease-causing agent (82, 83) 	• Non-virulent (83) • Stable; long-lasting storage (83)	• Local injection-site reactions (83) • Immune responses may not be robust enough, necessitating booster doses (83)

Black race, Hispanic ethnicity, and lower educational attainment (4, 43–45). The degree of vaccine hesitancy among healthcare workers was concerning in some countries, as this population is regarded as a trusted source of information regarding COVID-19 (3, 43). Public uncertainty around non-pharmaceutical interventions (e.g., masking) and frequent revisions to vaccine policy recommendations further fueled mistrust in COVID-19 vaccination (46). For example, at the beginning of vaccination campaigns, the advice was that only one or two doses (depending upon the vaccine brand) would be needed, and no booster (47). Subsequent recognition of the reduced vaccine effectiveness in the context of emerging variants led to the recommendation of booster shots (48). In addition, mixing of vaccine brands, initially discouraged, was ultimately encouraged after finding this improved the immune response (49, 50).

The concerns about the short- and long-term side effects of the COVID-19 vaccine were echoed in parents of children aged 5–11 years following the authorization of COVID-19 vaccines for pediatric

populations (3, 46). Despite the established benefit–risk profile of mRNA COVID-19 vaccines (51), acceptable safety profiles (52, 53), and the rarity of post-vaccination myocarditis in the general population (51, 54), there were parental concerns about reactions to the vaccine, fertility issues, and myocarditis, while confusion around vaccine booster recommendations fueled vaccine hesitancy (46). Motivators among parents that drove vaccine uptake for children included protection from COVID-19 and multifaceted impact of disruptions to schooling (e.g., children missing school or falling behind) (46).

These findings underscore the importance of disseminating transparent, consistent, and evidence-based messaging, to ensure confidence in and enhanced uptake of novel treatments.

3.2 Supporting sectors that emerged as trusted sources of information during the COVID-19 pandemic

3.2.1 Employers

The Edelman Trust Barometer, a globally deployed online survey of the general population that included responses from ~33,000 individuals in 28 countries, revealed key shifts in public trust as the COVID-19 pandemic evolved (55–57). In May 2020, government was the institution most trusted by the public, compared with the media, non-government organizations (NGOs), and businesses, with increases in public trust of 5–24% since January 2020 in 10 of 11 countries surveyed, as determined by the Trust Barometer (55). By January 2021, trust in government had declined by an average of 8% globally; businesses emerged as the only institution trusted as both competent and ethical, with employers (76%) replacing other institutions (NGOs, 57%; government, 53%) as trusted sources of information (55). In 2022, trust in government and the media declined further, with a greater proportion of individuals perceiving these institutions as divisive (48 and 46%, respectively) rather than unifying force in society (36 and 35%); by contrast, businesses and NGOs were more frequently perceived as unifying (45 and 50%, respectively) than divisive (31 and 29%) (56).

A measurable impact of the role of employers during the COVID-19 pandemic was evidenced in a cross-sectional study of nursing and social-care employees in Austria, where employer recommendation affected the decision to vaccinate against COVID-19 in 19% of the 625 participants (58). These findings were echoed in a survey of 400 US-based companies, reporting that employer vaccine-adoption strategies centered on increasing conviction (e.g., sharing scientifically accurate resources), convenience (e.g., setting up onsite vaccination clinics), and reducing the cost (e.g., covering direct costs associated with vaccination) would encourage vaccination in the majority of employees (59). A viable strategy to enhance uptake is therefore to encourage vaccination through employers by disseminating evidence-based information and providing practical support. Notably, while employers appeared hesitant to mandate vaccination as a condition of employment (60), mandated vaccination seemed to have little impact on decision to vaccinate in unvaccinated employees, with 74.3% of participants responding they would rather lose their job than get vaccinated (58).

3.2.2 Healthcare providers

The global response to the COVID-19 pandemic was primarily led by government, who took on the role of recommending and implementing control measures (61). The government response was prone to politicization and divisiveness (56, 62, 63), and, due to the speed of the pandemic, HCPs were not necessarily involved in the traditional way during COVID-19 vaccination campaigns. Trust in HCPs was, however, reported to be greater than in government agencies (63, 64), and was positively associated with COVID-19 vaccine behaviors in multiple studies (46, 63). A qualitative study from the United States found that HCPs were the most trusted sources of information on COVID-19 vaccinations among parents (46). Furthermore, trust in physicians was associated with COVID-19 vaccine uptake among adults in the USA; it was estimated that increasing this trust could induce at least 10% increase in vaccine and booster uptake (63). The HCPs, therefore, seem to be uniquely positioned to educate communities and support uptake of novel vaccines.

3.3 Equitable healthcare requires expansion of health campaigns and clinical trials to be more inclusive

Enhancing inclusion of minority groups in healthcare and representation of historically marginalized communities in clinical trials is vital to ensure trust in the development of new vaccines and therapeutics, and ultimately, equitable healthcare.

Barriers to access COVID-19 vaccines were highlighted by the disproportionate burden of COVID-19 disease on certain ethnic and racial minority groups, arising from deep-rooted structural, social, and healthcare inequalities (65–68). Vaccine hesitancy in the United States was more prevalent in minority groups that were disproportionately affected by the pandemic, including African Americans (41.6%) and Hispanic individuals (30.2%), as compared with the general US population (26.3%) (10, 66). Medical mistrust, lack of information on COVID-19 vaccines, and social disadvantage were among factors associated with increased vaccine hesitancy among these groups (10).

In 2021, 62% of the global population agreed with the statement that the pandemic was amplifying existing inequities worldwide (55). The well-documented disparity between high-and low-income populations on the Edelman Trust Barometer was especially notable in 2022 (62 vs. 47%) (56). Concerted efforts have been made to address some causes of inequity such as racial and ethnic disparities through targeted enrollments in clinical trials, including community outreach initiatives and careful monitoring of enrollment demographics to ensure rapid revision of recruitment strategies (67). Best practices which were built from past experience, with the participation of community and patient advocates in HIV research, were instrumental in driving positive change in the conduct of HIV trials in relation to participant recruitment, study design, and dissemination of findings (69). This highlights the importance of engaging community members in clinical research to raise the profile of novel therapies in the general public.

Targeted campaigns to increase healthcare availability for minority groups and improving diversity in clinical trials are viable strategies for building trust and ensuring equitable access to benefits of novel healthcare interventions, including mRNA vaccines and therapeutics.

4 GLP

The GLP is an initiative dedicated to generating insights into the key dimensions of societal preparedness as a way of building societal cohesion to better prepare society in times of crisis (18). The initiative draws upon quantitative and qualitative research to describe public perceptions and experiences of the COVID-19 pandemic in an effort to establish a foundational metric of public preparedness, a Societal Preparedness Index, for future emergencies (18).

The GLP survey (July 2023–September 2023) involved conducting interviews online, face-to-face, or via computer-assisted telephone in nationally representative samples in 70 countries. To be eligible for inclusion in the survey, respondents were required to be over the age of 18 years and a resident of the country where the survey was administered. To obtain a representative population, probability sampling was used for the face-to-face and computer-assisted telephone interviews. For online interviews, respondents from online panels were invited to participate, with quotas for age, gender, and region set to reflect the demographics of the national population.

The survey revealed stark geographic and demographic disparities in the experience of the COVID-19 pandemic and perceptions of mRNA vaccines and medicines. Among 70,781 participants who were interviewed on the mRNA vaccine acceptance, 66% affirmed that they would accept a newly approved mRNA vaccine to protect themselves; however, wide disparities were observed both by country and gender (Figure 1). In the United States and United Kingdom, the percentage of participants who were willing to accept the new mRNA vaccine was higher than average (73 and 68%, respectively). Countries where less than half of the interviewed population expressed willingness to accept the new mRNA vaccine were South Africa (37%) and central/northeastern European states (41–49%), whereas the highest level of acceptance was observed in Sierra Leone (87%). Globally, more men (70%) than women (63%) were willing to accept the new mRNA vaccine, whereas no stark age disparities were observed (18–34 years, 67%; 35–54 years: 63%; ≥55 years: 69%). Among participants who have heard of vaccines or medicines that use mRNA ($n = 4{,}808$), the majority agreed that mRNA vaccines were important (73%), effective (72%), and safe (68%); however, agreement was more prevalent among men (72–76%) than women (63–69%). Further, among those who reported being aware of mRNA, more than half (60%) reported that they had little knowledge about mRNA, whereas less than one-third (29%) reported they knew a lot, highlighting a discrepancy between the low prevalence of knowledge on mRNA vaccines/medicines and high prevalence of favorable perceptions on safety and efficacy of mRNA vaccines.

Challenges with acceptance of novel therapeutics are not unique to mRNA-vaccines and have been observed globally in non-emergency situations including with stem cell and gene therapy. Since its nascency, public perception of the benefits and risks of stem cell therapy has varied (70); studies have reported varying levels of trust and acceptance between countries (71) and higher levels of trust among older adults (50 years of age or above) regardless of gender (72). Similarly, attitudes toward gene therapy and gene editing also have been met with varying and complex levels of public acceptance with concerns for this therapy found to be linked to a lack of trust, education, and knowledge of risks and benefits (73–75) suggesting that continuous engagement with the public is needed to address concerns with the adoption of new medicines. The Edelman Trust Barometer Global Report for 2024 indicated sex-based differences in the acceptance of gene-based medicine, with 31% of men and 26% of women supporting gene-based medicine (76); these observations are similar to those observed with the GLP survey regarding mRNA-based vaccines. Notably, vaccine hesitancy was a challenge prior to the COVID-19 pandemic with individuals, including HCPs, choosing to delay or refuse various vaccines, possibly influenced by concerns over vaccine safety, and a lack of knowledge and motivation to get vaccinated (77, 78). Existing attitudes of vaccine hesitancy potentially influenced attitudes to COVID-19 vaccines since individuals are more likely to favor information that aligns with their existing beliefs (79). The data patterns emerging from the GLP global survey provide actionable insights to tailor strategies to increase awareness of mRNA-based vaccines and therapeutics for target populations. Among participants who were asked to report comfort with innovations in healthcare ($n = 9{,}651$), fewer women (33%) than men (38%) reported

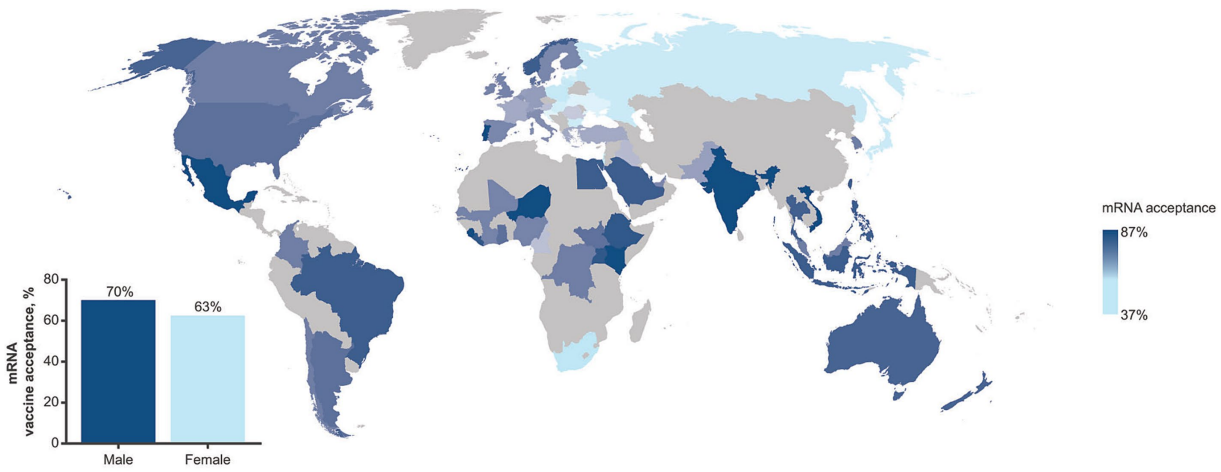


FIGURE 1
Prevalence in mRNA vaccine acceptance as assessed in the GLP survey (July 2023–September 2023) by geographic region. The inset shows prevalence by gender. The GLP survey involved more than 70,000 completed interviews in nationally representative samples from 70 countries.

being comfortable with mRNA-based innovations. The attributes deemed most important for accepting a new vaccine/medicine among interviewed participants ($n = 11,214$) were proven safety (83%) and efficacy (82%), suggesting that campaigns designed to build confidence in those attributes could contribute to improving uptake. In addition, the GLP survey and related interviews revealed that the term "technology" in descriptions of mRNA-based medicines prompted negative perceptions. Public discourse and educational campaigns would therefore benefit from describing mRNA not in terms of a "technology" but as a new science-based approach to developing vaccines and therapeutics.

5 mRNA as a new class of medicine: application to therapeutic areas beyond infectious diseases

In addition to their application to infectious disease prevention, mRNA therapeutic approaches are being developed in oncology to induce immune-targeting responses by encoding proteins that attack and control tumors (42). Numerous mRNA therapeutic candidates against cancer are currently under investigation in clinical trials as monotherapies or combination therapies for a range of disease states, however, no mRNA-based cancer therapeutic has been approved to date (42, 80).

The capacity of mRNA to induce therapeutically relevant expression of proteins that is suitable for substituting malfunctioning or absent proteins has applications in both rare and chronic disease (33, 81). Several mRNA-based protein replacement therapies have entered phase 1 and 2 clinical trials, including LNP-encapsulated mRNA for the treatment of dysmetabolic disorders (Moderna) and cystic fibrosis (Translate Bio), and naked mRNAs for the treatment of ulcers in type 2 diabetes and heart failure (Moderna/AstraZeneca) (81). Application of mRNA vaccines in autoimmune disease is currently at the preclinical stage; however, the experimental data accrued thus far suggest that the mRNA platform is suitable for the delivery of proteins to modulate misguided immune responses in a range of autoimmune and allergic conditions (42).

Taken together, the attributes of mRNA-based products differ from other known approaches in medicine as they utilize innate biology to manufacture a broad range of preventive or therapeutic interventions, with the potential for rapid iteration. There is an urgency to apply the learnings on mRNA uptake from the pandemic and promote a broader level of confidence in this platform.

6 Conclusion

The cardinal feature of mRNA-based medicines is that they use intrinsic cellular mechanisms to generate proteins with therapeutic or prophylactic properties. Many decades of laboratory research in mRNA paved the way for the accelerated development of mRNA vaccines in response to the COVID-19 pandemic. However, despite favorable safety and efficacy profiles of approved mRNA COVID-19 vaccines, vaccine hesitancy was notable in the public, especially among minority and socially disadvantaged groups. As a trusted source of information, HCPs are well placed to take a greater role in building trust and discouraging the spread of misinformation. Employers are also uniquely positioned to support uptake of novel interventions during healthcare crises through transparent communication and provision of practical support to their workforce. Data from the GLP survey presented herein revealed tremendous disparities in willingness to accept new mRNA vaccines and medicines across countries, identifying women as a demographic group that should be prioritized for confidence-building strategies around mRNA vaccines and therapeutics. Concrete plans to enhance public trust and confidence in novel medicines, including the rapidly advancing field of mRNA-based therapeutics, are critical to improve clinical outcomes, reduce disease burden, and enhance the societal capacity to manage future healthcare crises.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: Global Listening Project: http://www.global-listening.org.

Ethics statement

The studies involving humans were approved by the European Society for Opinion and Marketing Research. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin because survey respondents had the opportunity to opt in/out of the survey and to exit the survey whenever they needed to. Respondents were also given the option to refuse to answer or state that they did not know an answer for all questions.

Author contributions

SMI: Writing – original draft, Writing – review & editing, Conceptualization, Data curation, Formal analysis. AMR: Writing – original draft, Writing – review & editing, Conceptualization, Data curation, Formal analysis. DE: Writing – original draft, Writing – review & editing, Conceptualization, Data curation, Formal analysis. AB: Writing – original draft, Writing – review & editing, Data curation, Formal analysis, Conceptualization. HJL: Writing – original draft, Writing – review & editing, Data curation, Formal analysis, Conceptualization. MS: Writing – original draft, Writing – review & editing, Conceptualization, Data curation, Formal analysis. MR: Writing – original draft, Writing – review & editing, Conceptualization, Data curation, Formal analysis. AC: Writing – original draft, Writing – review & editing, Conceptualization. FC: Writing – original draft, Writing – review & editing, Conceptualization, Data curation, Formal analysis.

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Conflict of interest

SMI, AMR, DE, MS, MR, AC, and FC are employees of Moderna, Inc., and hold stock/stock options in the company. HJL received research grants from GSK and Moderna related to the Global Listening Project.

The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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COVID-19 vaccine preferences for pregnant and lactating women in Bangladesh and Kenya: a qualitative study

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COVID-19 was responsible for more than 7 million deaths globally, as well as numerous morbidities and social and economic effects. While COVID-19 vaccines were seen as a marvel of science by the scientific community, much of the public had concerns related to COVID-19 vaccines, with certain groups—such as pregnant and lactating women—having specific concerns related to vaccine effects on their pregnancy and breast milk. In this qualitative study, we interviewed stakeholders in Bangladesh (n = 26) and Kenya (n = 94) who affect the decision-making process related to COVID-19 vaccine acceptance among pregnant and lactating women. These included pregnant and lactating women themselves, community gatekeepers or family members, healthcare workers, and policymakers. Several themes related to confidence and vaccine preference emerged. Stakeholders indicated a lack of confidence related to non-mRNA vaccines due to safety concerns, number of doses, and media coverage; lack of confidence related to mRNA vaccines due to safety concerns; and preference for non-mRNA vaccines due to health system compatibility and availability. While COVID-19 vaccine availability in much of the world—particularly in low- and middle-income countries—affected the public's ability to have a choice in the vaccine they received, there were evident vaccine preferences. As the public health world will continue to face other infectious disease outbreaks, bolstering vaccine confidence broadly and specifically related to new technologies will be paramount to realize the individual-and population-level benefits of life-saving vaccines.

KEYWORDS

vaccine safety, COVID-19, Bangladesh, Kenya, pregnant women, lactating women

1 Introduction

As of April 2024, the COVID-19 pandemic has been responsible for over 7 million deaths worldwide (1). The pandemic has also significantly altered the vaccine landscape, as it spurred cooperation to facilitate new vaccine technologies and regulatory approvals at a pace not previously seen (2). While this expedited timeline was seen as a miracle of science for public health broadly and vaccine scientists specifically, the general public expressed concerns about the speed at which COVID-19 vaccines were made available and the perceived newness of the

mRNA technology (3). These concerns were exacerbated due to the presence of an infodemic alongside the pandemic, with the ubiquity of vaccine misinformation further contributing to an erosion of trust in public health institutions (4).

These COVID-era challenges spotlighted the urgent need to build trust in public perceptions of vaccines, particularly newer vaccines. Compared to pediatric vaccine acceptance, adult vaccine acceptance differs widely, and coverage is suboptimal (5). In addition, particular adult populations—including pregnant and lactating women—have discrete and specific concerns that have not been adequately addressed affecting their vaccine acceptance, even though they are at higher risk for vaccine-preventable disease complications (6). While COVID-19 vaccination is widely recommended for pregnant and lactating women at present, this was not the case earlier in the pandemic, and there has been and continues to be variability in policy recommendations across countries (7). Global data indicate that while COVID-19 vaccines are recognized as generally safe and effective for mothers and their babies, maternal vaccination is an underutilized public health mechanism for mitigating the effects of vaccine-preventable disease (8).

The first approved COVID-19 vaccine, a nucleoside-modified messenger RNA (mRNA) vaccine developed by BioNTech and Pfizer, received emergency use authorization in the United Kingdom on 2 December 2020 (9). The World Health Organization approved the vaccine for emergency use a few weeks later on 31 December 2020 (10). In Bangladesh, the COVID-19 vaccination rollout began in January 2021 with the purchase of 700,000 doses of the Oxford-AstraZeneca (OAZ) vaccine, with the first mRNA vaccines being available in June 2021 (11–13). As of October 2021, pregnant women in Bangladesh were allowed to receive COVID-19 vaccines during pregnancy with qualifications; lactating women were permitted to receive COVID-19 with no qualifications (14). Kenya received its first batch of COVID-19 vaccines, 1.02 million doses of the OAZ vaccine, on 6 March 2021; mRNA vaccines were not available until September 2021 (15, 16). Pregnant and lactating women in Kenya were eligible for COVID-19 vaccination after a risk/benefit consultation with their provider starting in August 2021; in December 2021, this policy was revised to remove the provider consultation requirement (17). Globally, there was stark inequity of vaccine access, with higher-income countries (HICs) hoarding over half of the global supply, their collective doses outnumbering the quantity needed (18). In 2021, HICs had ordered over 70% of five available COVID-19 vaccines, despite comprising only 16% of the global population (3). Since then, HICs have received billions of surplus doses, in contrast with many low-and middle-income countries having inadequate dose numbers for their populations (19). Furthermore, cold chain requirements for OAZ vaccine products were more conducive to the structural systems present in low-and middle-income countries than the newer mRNA technology (20). Given this, perceptions regarding vaccine brand preferences were a critical factor in vaccine confidence.

Given that the COVID-19 vaccines were new vaccines, there was explicit attention given to the effects of the vaccines. Reports of adverse effects from two mRNA vaccines, (21) including the death of 23 older adult patients after receiving an mRNA vaccine (22), likely led to skepticism about the largely unknown technology during the early days of the vaccine rollout. However, studies conducted in the United States and Poland found participants preferred mRNA vaccines over other types (23, 24). A study in the Philippines found that vaccine brand hesitancy was common among adults, with less reported acceptance toward Sinovac-CoronaVac and mRNA vaccines (25). While COVID-19 vaccine preferences existed in many settings globally, supply constraints and inequitable vaccine distribution hindered these preferences. Evidence of global vaccine brand inequity was highlighted as reports of the OAZ COVID-19 vaccine's possible association with blood clots led high-income countries, such as Denmark and Australia, to limit or completely discontinue its use (26). However, Pacific island countries and areas had access to only OAZ vaccines and were unable to adjust their policies and use (26).

During the pandemic, COVID-19 vaccine availability and recommendations differed by country, particularly as related to pregnant and lactating women. We explored the decision-making process among Bangladeshi and Kenyan pregnant and lactating women and other relevant stakeholders related to COVID-19 vaccines. Given that decision-making does not occur in a vacuum, we were interested in understanding the decision-making process among pregnant and lactating women themselves, as well as those that influenced their vaccine decision-making process. We did not explicitly ask about vaccine preferences related to mRNA or non-mRNA vaccines; however, it is within this larger study that preferences related to COVID-19 vaccines emerged. In this study, we seek to summarize COVID-19 vaccine preferences and how they relate to vaccine confidence in Bangladesh and Kenya for pregnant and lactating women during the pandemic.

2 Methods

In Bangladesh, we interviewed 16 healthcare workers (eight who served rural communities and eight who served urban communities) and 10 policymakers from three different levels of the health system—national, divisional, and district—for a total of 26 interviews. Participants were recruited from the capital, Dhaka, and five different communities in the Rangpur Division in northern Bangladesh: Rangpur city (urban), Kanchibari (rural), Gaibandha (urban), Bamandanga (rural), and Ramjiban (rural). In Kenya, we conducted in-depth interviews with a diverse set of audiences that may influence the vaccine decision-making process of pregnant or lactating women: pregnant or lactating women ($n = 29$), male family members of pregnant or lactating women or community gatekeepers ($n = 35$), healthcare workers ($n = 20$), and policymakers ($n = 10$). Participants were recruited from three counties, with two communities in each county: Garissa (rural), Kakamega (rural and urban), and Nairobi (urban); see Table 1 for a list of sampled populations by country.

Data were collected in April–August 2022 in Bangladesh and August–September 2021 in Kenya. Interview instruments were pre-tested in both countries and included questions related to risk perception for the baby and the mother, vaccine efficacy, self-efficacy to get the vaccine, safety concerns, community norms, and vaccine experiences. Data collectors participated in a 3-day training exercise after completing an online human ethics training. Participants were recruited from various health clinics across the nine communities, and policymakers in both countries were identified through ministry contacts. If a participant met the inclusion criteria and agreed to participate, oral consent was obtained. Interviews were conducted in either English, Swahili, Bengali, or other local languages as necessary in a semi-private setting or via Zoom. All interviews were audio recorded. Members of the study team transcribed and translated the transcripts into English. All data were stored on

TABLE 1 Sampled populations across Kenya and Bangladesh.

	Bangladesh			Kenya			
	Rangpur division[1]		Dhaka	Garissa	Kakamega		Nairobi
Target population type	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Pregnant and Lactating Women (PLW)	–	–	–	8	4	6	11
Community members (family members, religious leaders, community leaders)	–	–	–	8	2	10	15
Healthcare providers (HCPs) (midwives, nurses, doctors, immunizers)	7	9	–	6	4	4	6
Policymakers (divisional, district, and national levels)	5	–	5	2	2	–	6
Total	12	9	5	24	12	20	38

[1]Includes districts of Rangpur, Ramjiban, Bamandanga, Kanchibari.

encrypted servers, and only members of the study team had access to the data. Study activities involving in-person interaction, including training and data collection, were conducted following COVID-19 safety protocols per the Ministries of Health in both countries.

A team of seven used a grounded theory approach to analyze the data. The team conducted three rounds of open coding to develop, refine, and finalize a code list. Two members of the team conducted inter-rater reliability with ~10% of the transcripts that neither of them had coded. Reliability was calculated by comparing coding compatibility on each of the transcripts chosen, and the average reliability score was >90%. The team then identified themes and sub-themes. Data were managed using ATLAS.ti. This study received ethics approval from the Johns Hopkins Bloomberg School of Public Health Institutional Review Board, the Bangladesh Medical Research Council, and the Scientific and Ethics Review unit with Kenya Medical Research Institute.

3 Results

Three key themes emerged related to COVID-19 vaccine confidence: (1) lack of confidence related to non-mRNA vaccines due to safety concerns, number of doses, and media coverage; (2) lack of confidence related to mRNA vaccines due to safety concerns; and (3) preference for non-mRNA vaccines due to health system compatibility and availability. The emergent themes were categorized into three levels using the socio-ecological model as a framework. Individual-level factors included perceived vaccine safety and dose number preferences. The health system level included cold chain requirements of mRNA vaccines and the availability of vaccine brands. The environmental level included influence from media reporting on vaccine safety (Figure 1).

3.1 Lack of confidence related to non-mRNA vaccines: safety concerns, number of doses, and media coverage

Stakeholders articulated reasons why communities were hesitant toward non-mRNA vaccines. These included safety concerns related to side effects (fever and blood clots), number of doses, and media coverage related to vaccine safety.

This Bangladeshi healthcare worker informed us that OAZ caused side effects such as fever and was thus not recommended for pregnant and breastfeeding women: "So first, we got the AstraZeneca. Because of AstraZeneca, you have high fever. Then we got the instruction not to give the vaccine to the pregnant and breastfeeding mothers, since a high fever was a side effect of AstraZeneca. Then the people did research and found out that it is okay to give this to pregnant mothers and breastfeeding mothers. But, if you give it to breastfeeding mothers, then maybe the breastfeeding baby might also get the fever (from the AstraZeneca vaccine). But, if the baby will eat something else, other than drinking mother's milk, in those cases, we can give the COVID vaccine, but for 24 h, the baby cannot be breastfed. First, this was the instruction. Then after that, the instruction was 12 h, not 24 h. Then a vaccine came that was called Sinovac or Sinopharm, from China. That vaccine had very little side effect, almost none. So, for that, the instruction was that we can give it to the woman right after delivery, you can give it 2–3 months after delivery, and you can give it to pregnant mothers too since there are no side effects. This is what our supervisors explained to us. But before when we had given AstraZeneca, the instruction was that, since it had side effects, we are better not giving it to pregnant and breastfeeding mothers. Because of its side effects, we were told not to give AstraZeneca to pregnant and lactating women." (*Male healthcare provider, rural, Bamandanga, Bangladesh*). In addition to concerns about getting a fever, this religious leader in Kenya referred to his community's concerns related to blood clots linked to the OAZ vaccine: "Initially they (the community) had mixed reactions and actually most of them are waiting to see the reaction of those people who have been vaccinated. You could hear words from America that this particular vaccine has side effects like blood clots, but now they have faith, now that they have been assured by the government and we have not experienced any case within the community where one received vaccination and died or the person was crippled. And so, with this kind of assurance, and from what they have attested, they are able to say yes to the vaccine." *(Community member 1, urban, Nairobi, Kenya).*

There were several instances related to preferences in dosing. When asked about her family's vaccine intentions, this lactating woman from Kenya informed us that her family preferred the Johnson & Johnson vaccine over the OAZ vaccine: "They are planning to be vaccinated, but they do not want two jabs. They want Johnson & Johnson. My partner has not been vaccinated—he is waiting for Johnson & Johnson. That is what he said, he does not want to be injected twice with AstraZeneca." *(Lactating woman, rural, Kakamega, Kenya).*

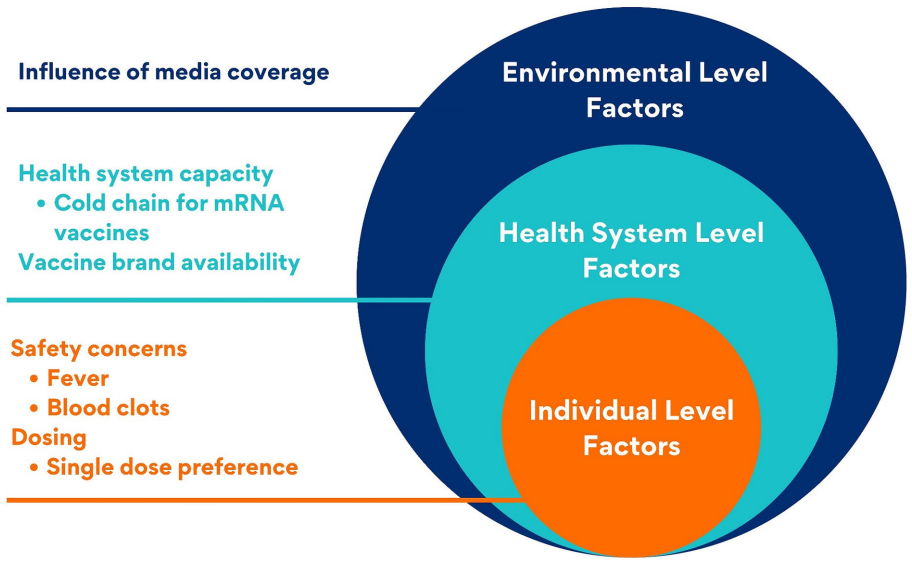

FIGURE 1
Multi-level factors affecting COVID-19 vaccine confidence: an adapted socio-ecological model.

Finally, stakeholders informed us that the media played a role related to vaccine preferences. This Kenyan healthcare worker asserted that the media reported on safety concerns related to the OAZ vaccine: "There is also another issue—the media was reporting that COVID vaccines, especially the AstraZeneca vaccine, is not safe. This led to many questions: will the government take any action to look and see whether that information is true or not? And if that information is true, what action will the government take? Or are there other vaccines that can be substituted for this one? Or has the government put in place mechanisms or measures to know if this vaccine is safe for human uptake or not?" *(Male healthcare provider, rural, Garissa, Kenya).*

3.2 Lack of confidence related to mRNA vaccines: safety concerns

While the mRNA vaccines were eventually adopted for use in Bangladesh for pregnant and breastfeeding women, the government scrutinized the performance of the vaccine in the Bangladeshi population before rolling out a national campaign. This Bangladeshi policymaker asserted that while WHO recommended the Pfizer vaccine, additional observation was employed because it was an mRNA vaccine: "If the immunization committee of WHO gives recommendation, Bangladesh takes up the recommendation immediately. However, they do not suggest using it blindly with the recommendation. They (conduct a) trial for it. At first, they vaccinated 100–200 people. Then they observe those people for 7–10 days. So, after observing, (if there are no issues), approval of each vaccine was given. Pfizer is exceptional because it is used by so many people globally. However, Pfizer is an mRNA vaccine, so doctors suggested to spend time (examining its effect on people). It was given to probably 500 people who were then observed for a week. Then, the country did the national campaign." *(National policymaker, urban, Dhaka, Bangladesh).*

Stakeholders informed us about concerns related to the safety of mRNA vaccines, including blood clots, and this healthcare worker from Kenya discussed the many myths in Kenya related to COVID vaccines, including the mRNA vaccines: "For COVID vaccines, we have so many myths, but when we really go and see the materials and the literature they give out, we have seen it is a very important vaccine. People are saying that (the mRNA vaccines) are going to give you blood clotting, but what I see is that (getting vaccinated) is very important." *(Female healthcare provider 1, rural, Garissa, Kenya).* Similarly, another Kenyan healthcare worker alluded to hesitancy among other healthcare workers related to mRNA vaccines due to perceived safety concerns: "The other thing is that vaccination, they say the priority is the health care workers, right, and I am sure most of the health care workers have not been vaccinated. Even myself, to be honest, I have not been vaccinated because of the issues we have with the vaccine, you know the rumors that it causes the clotting of the blood. Two of my colleagues died after receiving the vaccination—all these have been hearsay that people are hearing and so people are scared. So, nobody came out clearly and told us this vaccine is safe… and then the funny thing is when one is immunized nobody does follow up on the side effects; most of the people are scared of that or about that…So, I have changed my mind set to get the vaccine, but I am going to wait for the Johnson & Johnson. I do not want to get two doses—they said it is one jab and that is it. But I do not know when it is coming." *(Female healthcare provider 2, rural, Garissa, Kenya).*

Given that generally, pregnant women were not included in COVID-19 vaccine clinical trials, stakeholders in both countries changed recommendations over the course of the pandemic related

to which vaccines should be recommended to pregnant women. For example, this policymaker in Bangladesh indicated how the country first recommended OAZ over mRNA vaccines due to safety, but then changed recommendations and recommended OAZ and Pfizer vaccines, only recommending the Moderna vaccine if OAZ was not available. "Several vaccines are given to pregnant and breastfeeding women. We did not encourage them to get the Moderna vaccine, we provided another one namely AstraZeneca—Pfizer was also given. We are giving AstraZeneca now. We did not encourage the Moderna vaccine in the initial stage; later we observed that AstraZeneca, Pfizer all are good. We provided Moderna when those others were unavailable in stock." *(National policymaker, urban, Dhaka, Bangladesh)*. Similarly, this Bangladeshi policymaker commented on the fact that while the Pfizer vaccine was recommended for pregnant and lactating women, there were concerns about its side effects: "At the initial stage, according to the instruction of WHO, when pregnant and lactating women were suggested to have the Pfizer vaccine, we were not getting proper response. Even doctors also had fear about it. Because it was unknown—the long-term effect of the vaccine…Pfizer was given to pregnant and lactating women (based on the) instruction from WHO. It was said that Pfizer is less immunogenic/suitable for lactating mothers as well as pregnant women…We try to give vaccines as soon as possible to pregnant and lactating mother in our vaccine center. And we gave the most prestigious vaccine–Pfizer—to them…. Maybe the vaccines first introduced were not suitable (for pregnant women) according to their research findings. After getting research findings, they decided that Pfizer could be appropriate for pregnant women…If we wish to take Moderna, we are not able to take it!" *(District policymaker, urban, Gaibandha, Bangladesh)*.

3.3 Preference for non-mRNA vaccines: health system compatibility and availability

In both countries, stakeholders alluded to changing recommendations related to vaccines given to pregnant and breastfeeding women. One key issue that drove changing recommendations was health system capacity as this Kenyan policymaker informed us that the country was giving OAZ because of its compatibility with the Kenyan health system: "We have been mainly been giving AstraZeneca; actually, most of the people we are talking of having been vaccinated have received this. It is more friendly to our system because it's using all of the existing cold chain maintenance, but you find other vaccines, which are almost equally good. We seem to have other vaccines in our program, Johnson and Johnson, we have Moderna, we have Pfizer. As we improve our cold chain to handle those–they require temperatures that were not currently in our quoting system—we upgrade our infrastructure. I think a range of vaccines for COVID-19 also improved access because there is a range of vaccines available. People are free to make choices from variety and also improve their access." *(National policymaker, urban, Nairobi, Kenya)*. Availability also dictated preference as this Kenyan community leader alluded that there was a preference for the Johnson & Johnson vaccine due to a number of doses and also alluded that most community members were not aware of the vaccine they were getting: "I asked someone yesterday—someone who received the vaccination at Mama Lucy Hospital—the type of vaccine she received, and she said she never asked. She just went to receive the jab. So many do not ask… Somebody goes and just finds themselves vaccinated but they do not know what type it is…For now, AstraZeneca is what I have been hearing that people are getting." *(Community member 2, urban, Nairobi, Kenya)*.

4 Discussion

Factors leading to lack of confidence in COVID-19 vaccines for pregnant women were identified at the individual, health system, and environmental levels. Themes emerged related to the safety concerns for both mRNA and non-mRNA vaccines. Media reports influenced confidence for non-mRNA vaccines and respondents expressed a preference for a fewer number of doses with a non-mRNA vaccine. Policymakers expressed challenges for including mRNA vaccines within their current health systems that were not designed for their cold chain requirements. The initial unavailability of mRNA vaccines in many LMICs led to changing recommendations.

Both countries had gaps between COVID-19 vaccination policies in pregnancy and interpretations of policies by healthcare workers (14, 17). These results show that there is a lack of clarity among healthcare workers related not only to the overall recommendation itself but also to types of vaccine appropriate for use during pregnancy or while breastfeeding. A lack of information provided to healthcare workers or clear policies about maternal vaccines was found in several other studies in different countries, for both COVID-19 and other maternal vaccines (27, 28). As of 2022, WHO recommends vaccination for pregnant women and lists eight vaccines that can be used during pregnancy (29). These include both mRNA vaccines (Pfizer and Moderna), two viral vector vaccines (OAZ and Janssen/Johnson & Johnson), and two inactivated vaccines (Sinopharm and Sinovac).

At an early stage in the pandemic, acceptance of COVID-19 vaccines in LMICs was variable among the general population. In a systematic review of low-and lower-middle-income countries, Kenya had one of the highest rates of vaccine acceptance, more than 90%, while acceptance in Bangladesh was estimated at approximately 60% in a pooled analysis (30). Globally, COVID-19 vaccine acceptance among pregnant women was low. A systematic review of 15 studies found a pooled acceptance of 49.1% (95% CI, 42.3–56.0) with safety identified as a critical concern (31).

There have been global challenges to vaccine availability and access since early in the pandemic (32). Both Bangladesh and Kenya received only one vaccine product initially, in stark contrast to higher-income countries, which received multiple products for their initial vaccine rollouts. The contrast of initial vaccine product availability includes both monetary and structural factors (3, 20, 32). Policymakers in this study highlighted challenges to introducing mRNA vaccines into health systems; however, several countries, including both Kenya and Bangladesh, were able to adapt cold chain infrastructure to accommodate the lower temperature requirements. In Africa and Asia, the proportion of those vaccinated with mRNA vaccines is 22% (33).

This study found that mRNA technology itself was not a concern. However, unclear policies and recommendations,

especially if there were multiple types of vaccines available, led to a lack of confidence in vaccines, even among healthcare workers and policymakers. A systematic review found mRNA COVID-19 vaccines to be safe and effective in pregnancy (34); these results should be used to improve confidence in mRNA vaccines among key stakeholders in maternal immunization. Including pregnant women in trials can be one way to improve confidence and has been identified by SAGE and regulators as a critical consideration as vaccine trials are planned (35). In addition, the mRNA platform holds promise for future vaccine development as several vaccine candidates across pathogens are leveraging mRNA technology.

There are limitations to this study. We conducted a qualitative study, and it was not designed to be generalizable. Given that we collected data in both countries during the height of the pandemic, participants likely felt pressure to have positive attitudes toward COVID-19 vaccines, and as such, social desirability bias is likely. The findings were heavily dependent on the cross-sectional nature of the study; policies related to COVID-19 vaccine eligibility were in flux in both countries during data collection. We also did not explicitly ask about vaccine preferences related to mRNA or non-mRNA COVID vaccines; data presented in the results are from participants that brought up vaccine preferences organically. Despite these limitations, this study has many strengths. It is one of the first that explored attitudes among a population at higher risk for severe COVID-19-related morbidity and mortality. As we did not ask explicitly about vaccine preferences, what emerged related to vaccine preferences is what organically arose when exploring the decision-making processes among these stakeholders. This study also provides insight related to how the decision-making process changes over time, within the context of changing policy recommendations and during a changing pandemic.

Clear vaccination policies, especially around which vaccines are preferred for use in pregnant women when multiple versions are available, could improve healthcare workers' confidence. Not excluding pregnant women from trials of vaccines underdevelopment can provide the critical safety data that is needed to bolster the public's confidence. mRNA vaccine technology holds promise for new vaccine development, and vaccine coverage will increase if the public's confidence improves, reducing morbidity and mortality from vaccine-preventable diseases. Improving confidence will require increased transparency in clinical development and enhanced engagement of multiple stakeholders.

Data availability statement

The datasets presented in this article are not readily available because of ethical guidelines. Data will be shared upon reasonable request. Requests to access the datasets should be directed to RL, rlimaye@jhu.edu.

Ethics statement

The studies involving humans were approved by Bangladesh Medical Research Council, Kenya Medical Research Institute, Johns Hopkins Bloomberg School of Public Health. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

JS: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing. BF: Formal analysis, Project administration, Visualization, Writing – original draft, Writing – review & editing. EM: Formal analysis, Project administration, Validation, Writing – original draft, Writing – review & editing. PS: Formal analysis, Project administration, Resources, Visualization, Writing – original draft, Writing – review & editing. RL: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Influencing Canadian young adults to receive additional COVID-19 vaccination shots: the efficacy of brief video interventions focusing on altruism and individualism

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Younger adults, aged 18–39 years, exhibit low COVID-19 additional vaccine (i.e., vaccination beyond the original 2-dose series) uptake recommended in Canada. No study has examined how altruistic and individualistic messaging can influence COVID-19 additional dose intentions. The present study aimed to estimate the efficacy of altruism and individualism-based videos on vaccine intentions and to explore the multivariable associations between vaccine related individual psychosocial factors and intention to receive the COVID-19 vaccine. Using a web-based survey in a three-arm, pre-post randomized control trial design, we recruited Canadians aged 18–39 years in both English and French. Participants were randomly allocated in a 1:1:1 ratio to receive the active control (COVID-19 general information), control + altruism or control + altruism + individualism. The video interventions were developed with a media company, based on results of a focus group study conducted previously. The measurement of COVID-19 additional dosage intentions before and after completing the interventions was informed by the multistage Precaution Adoption Process Model. The McNemar Chi-square was used to evaluate within-group changes, and the Pearson Chi-square test was used to evaluate between-group changes post-intervention. The measurement of various psychosocial factors was informed by use of validated scale and self-report questions. We employed a generalized Structural Equation Model to evaluate the associations between COVID-19 vaccine intentions and the psychosocial factors. Analyses were performed on 3,431 participants (control: $n = 1{,}149$, control + altruism: $n = 1{,}142$, control + altruism + individualism: $n = 1{,}140$). Within-group results showed that participants transitioned significantly in all three groups in the direction of higher intentions for receiving additional COVID-19 vaccine doses. The between-group differences in post intervention vaccine intentions were not significant. We found that psychosocial factors that include, collectivism, intellectual humility, intolerance to uncertainty, religiosity, identifying as gender diverse, and being indigenous were associated with higher vaccine intentions, whereas pandemic fatigue was associated with lower vaccine intentions. Our study highlighted that a short video that includes altruism and individualism messaging or general COVID-19 information can

increase intentions to vaccine among young adults. Furthermore, we gained a comprehensive understanding of various psychosocial factors that influence ongoing COVID-19 vaccination. Our findings can be used to influence public health messaging around COVID-19 vaccination.

KEYWORDS

COVID-19, randomized controlled trials, vaccine intentions, mRNA vaccines, altruism, individualism, video intervention, young adults

Introduction

In 2019, the World Health Organization ranked vaccine hesitancy among the top 10 global health threats (1). The COVID-19 pandemic magnified this issue exponentially. COVID-19 vaccination, namely the first mRNA vaccines (Moderna and Pfizer-BioNTech) approved for human use, significantly reduced morbidity and mortality associated with COVID-19 infection and allowed us to return to some degree of 'normalcy'. It is estimated that COVID-19 vaccinations prevented nearly 15 million deaths from COVID-19 in a year (2).

In Canada, the success of the COVID-19 vaccine rollout was evident with over 80% of the population completing the primary series. Most Canadians received mRNA vaccines, with under 1% of Canadians receiving at least one dose of another vaccine type (3). However, by July 2021, vaccination rates had plateaued, and sustaining acceptable COVID-19 vaccination rates even among higher-risk, older adults was challenging (4). In 2022, Canada introduced additional doses (originally referred to as "booster" doses) as waning immunity and new variants' emerged and COVID-19 remained a threat to vulnerable individuals (5). Additional doses provide ongoing protection against severe symptoms that can lead to hospitalization and death (6), and offer some protection against symptomatic infection (7, 8). The Government of Canada states that COVID-19 vaccinations are recommended "if it has been at least 6 months from the previous COVID-19 vaccine dose or known SARS-CoV-2 infection (whichever is later)" (9).

Younger adults have shown higher hesitancy to receive additional COVID-19 vaccines compared to older groups (10), paralleling experiences with the initial COVID-19 vaccinations (before vaccine mandates) and seasonal influenza vaccination (3, 11). By September 2023, 37–45% of Canadian younger adults (aged 18–39) had received three or four doses (3). Since December 2023, only 4–7% of this age group have been vaccinated with five or more (3). This age group's reluctance to follow preventive measures and receive vaccines is associated with lower levels of perceived threat and severity of COVID-19 (12, 13). This may be reflective of vaccine complacency defined by the WHO SAGE Working Group as a key component of vaccine hesitancy in which the perceived risk of vaccine-preventable disease risks is low, and vaccination is therefore not deemed as a necessary preventive behavior (14). While various factors contribute to vaccine hesitancy, addressing complacency in this age group is essential to maintain uptake of recommended COVID-19 vaccination.

A promising and relatively novel method to increase vaccine intentions is through eliciting prosocial motivations (altruism), defined as the act of benefiting others without intentionally benefitting oneself (15). Some studies have found altruism to be positively associated with intentions to receive the first doses COVID-19 vaccine (16, 17) and one found positive associations with additional dose acceptance as well (18). In a randomized controlled trial (RCT) (19), we previously evaluated the impact of a short altruism-based video on COVID-19 vaccine intentions among Canadians aged 20–39. The video significantly increased intentions pre-to-post intervention, and was more effective in increasing vaccine intentions for those in earlier stages of decision making (had not thought about receiving the vaccine, undecided about vaccination) (19). To better understand the findings of the RCT and inform the video development for the present study, we conducted a qualitative study in which we interviewed participants in three focus groups with individuals who had not received any COVID-19 vaccine, who received the primary series without any additional doses, and who received at least one additional dose (20). We found that providing diverse messaging (e.g., including both individualistic and altruistic messages), eliciting feelings of empowerment, and including concrete data, i.e., statistics regarding the COVID-19 pandemic (e.g., mortality rates, vaccine safety and efficacy), could increase COVID-19 additional dose vaccine intentions.

However, other studies have shown that individualistic messaging strongly reduced COVID-19 vaccine hesitancy and increased COVID-19 vaccine intentions (21, 22). To our knowledge, no study has systematically investigated whether combining individualistic messaging with altruistic messaging can amplify COVID-19 vaccine intentions in younger adults (aged 18–39).

Vaccine acceptance varies across cultures. Collectivistic cultures can foster vaccine acceptance because they prioritize social connectedness and the welfare of in-group members (23). In contrast, individualistic cultures emphasize individual autonomy, placing less importance on group welfare and prioritizing personal needs over others (23). This can drive vaccine hesitancy if one believes they are not personally vulnerable to infection or severe symptoms.

In addition of the potential main drivers of COVID-19 vaccine intentions (altruism and individualism), we were interested in exploring other factors (e.g., health behaviors, empathy) that have shown to have a bearing on vaccine intentions in the literature. Empathy involves understanding others' points of view and vicariously experiencing their emotions (24), which can motivate individuals to help others. This is evidenced in research showing that empathy increased prosocial behavior during the COVID-19 pandemic (15). Intellectual humility emphasizes the importance of being open-minded in one's pursuit toward knowledge (25), and can influence vaccine intentions as people are able to recognize their inaccurate beliefs. Intolerance of uncertainty, which entails experiencing negative emotions, thoughts, and actions when faced with uncertainty, can also enhance individuals' inclination to vaccinate, notably, by engaging in health-monitoring behaviors (26). COVID-19 fatigue (pandemic

fatigue) has been characterized as the distress leading to decreased motivation to comply with public health recommendations such as continued recommended vaccination (27). By exploring the complex relationships and pathways among these variables, we can gain a more comprehensive understanding of factors that influence ongoing COVID-19 vaccination.

To inform public health messaging regarding additional COVID-19 vaccination doses and in preparation for vaccine communications with young adults in the event of future outbreaks or pandemics, there is a need to understand the impact of altruism and individualistic messaging and individual factors on intentions for ongoing COVID-19 vaccination. It is essential to determine which public health messages can successfully increase vaccine intentions, particularly among younger adults who significantly contribute to virus transmission. This study aims to achieve two primary objectives:

1 To estimate the efficacy of altruism and individualism-based videos on vaccine intentions.
2 To explore the multivariable associations between vaccine related attitudes and beliefs, health behaviors, sociodemographics and intention to receive the COVID-19 vaccine.

Methods

Study design

We used a 3-arm parallel randomized pre-post design. Participants in a web-based survey were randomly allocated in a 1:1:1 ratio to the control video (informational; Group 1), the control + altruism video (Group 2) or the control + altruism + individualism video (Group 3). We used the Consolidated Standards of Reporting Trials (CONSORT) statement to report the results (28).

Participants and study setting

Participants who met the following eligibility criteria were enrolled in the study: (1) Canadian resident, (2) aged 18–39, and (3) willing to complete the survey in either English or French. Participants were recruited by Dynata, an international online market research company and first-party data and insight platform. Dynata uses a combination of recruitment methods (e.g., on its own website, direct emails, ads on social media). Informed by the Canadian census data from Statistics Canada, to ensure a balanced sample that closely matches the Canadian population, we used quota sampling for primary language spoken at home (80% Anglophones, 20% Francophones); biological sex (50% male, 50% female); household income in 2022 (50% over CAD 75,000, and 50% under CAD 75,000); and population density (80% urban, 20% rural).

During data collection (June 5 to Jul 28, 2023), the National Advisory Committee on Immunization (NACI) recommended additional doses for all individuals who had been previously vaccinated (29). At the time, additional dose uptake was 37–45% in our target age group, and vaccine mandates had been removed.

Study procedures

At the beginning of the survey, we assessed the type of the device that the participants were using to complete the survey (i.e., smartphone, computer, or tablet), and confirmed that they had adequate video and sound capabilities. Upon completing the electronic consent, eligible participants were then randomized into 3 arms. See the randomization section for the full randomization strategy.

After the randomization, participants answered socio-demographic questions and their intentions to receive COVID-19 booster vaccines. Subsequently, depending on their randomly assigned condition, participants were shown an 80 s control (informational) video, a 131 s control + altruism video, or a 180 s control + altruism + individualism video. The video could not be skipped nor muted, and participants could not progress to the next section of the survey until the video was played in its entirety. All participants were prompted that an attention check question will follow the video intervention. For those who responded incorrectly the first time to the attention check question, they were offered the option to either watch the video again or terminate the study. Those who watched the video a second time but still responded incorrectly were terminated.

Immediately following the intervention, participants indicated their intentions to receive a COVID-19 booster vaccine using the Precaution Adoption Process Model (PAPM). The PAPM is a multi-stage theoretical model that explains how individuals make decisions and take actions regarding their health behaviors (30). Although it is a stage theory, it acknowledges that people may skip stages for various reasons and may also regress in intention stages. Participants also reported previous vaccination history (e.g., seasonal influenza, COVID-19), lifestyle factors, self-perceived health status, personal history of SARS-CoV-2 infection, and preferred health-information channels. Validated measures of individualized factors namely empathy, intolerance of uncertainty, individualism and collectivism, COVID-19 pandemic fatigue, Intellectual Humility, and Social Desirability were also completed. Finally, participants were asked whether they perceived any ethnicity and gender bias in the video they viewed.

Randomization

Eligible participants were allocated to 1 of the 16 strata based on the 4 quota sampling criteria (i.e., primary language, biological sex, income, and population density). Within each stratum, a "least-filled" randomization methodology was used to ensure 1:1:1 allocation to each of the three interventions. Using this method, participants were assigned to the intervention group which had the lowest count of participants at the time of randomization. Randomization between groups occurred when there was parity in the lowest participant counts in two or three of the intervention groups within a stratum. Correspondingly, the first participant in a stratum was randomly assigned to any of the three interventions, the second participant to any of the two remaining interventions, and the third allocated to the remaining, unfilled intervention. This would repeat until data collection was completed. Thus, the quota in each stratum was filled and ensured a balanced group allocation throughout the data collection period. If a participant within a stratum did not finish the survey (incomplete data), the next person entering the survey sharing that stratum would either take the subsequently missing position, be assigned to whichever group had the

lowest overall count of participants (least filled) or be randomized between groups with the equivalently lowest participant counts.

Interventions

The videos were developed by Akufen, a Montreal-based media company. Following our first RCT study in the year 2021 (16), we conducted a qualitative study where we conducted three focus groups (divided based on their vaccination status; unvaccinated, completed primary series, and boosted) with adults aged 18–39. They reviewed the video intervention we used in that study and the results of our RCT (16) and provided feedback and recommendations to improve the messaging in the new videos we were planning, particularly as the COVID-19 pandemic had evolved and the focus was now on COVID-19 additional vaccination doses (20).

We elected to use stock videos over animated videos as the focus group participants felt that animations were overly childish. Based on participants' recommendations we included images depicting healthcare professionals as they were perceived as influential in vaccine decision-making. To reduce perceptions of the videos being too emotionally "manipulative" (20), we included more concrete data and statistics. Diversity in gender and ethnicity was appreciated by the focus group participants and was retained in the development of the new videos. We used a video format for all three groups to account for the effect of viewing a video compared to reading text. Group 3 video (available in both English and French) can be found on this link: Group 3 video.

Informational video (Group 1)—80 seconds

Informed by the focus group results of perceiving a return to normalcy, the informational video started by highlighting that although life is returning to normal, COVID-19 remains a concern. As focus group participants requested more concrete data (20), we decided to include estimates of the number of lives the COVID-19 vaccine has saved (31), and reported side effects of the vaccine in Canada (32). This information provided assurance that the vaccine is safe. As well, we added statistics regarding hospitalizations and long-lasting COVID-19 symptoms (32), which also demonstrated a loss of personal freedom, a concern that was raised in the focus group discussions. The video then probed viewers to think about the validity of the information they receive online, addressing the potential of receiving mis- and disinformation from social media. The video ended by reminding viewers the decision to receive COVID-19 vaccines is a personal choice, providing a message of empowerment, and reminded viewers that the vaccine is easily accessible. See Figure 1 for samples from all 3 intervention videos. Group 1 video (available in both English and French) can be found on these links: COVID-19 Booster Video Control EN: https://youtu.be/OR_yLcDz_-Y COVID-19 Booster Video Control FR: https://youtu.be/O7qnZyqttBc.

Informational + altruism video (Group 2)—131 seconds

Adding on to the informational video, the altruism video incorporates the story of Marie, a healthy, 25-year-old woman who uses public transportation to go to school and work. This character was chosen to be more relatable to our target age group, as suggested by the focus group participants. The vignette described that while she feels that she may not be at risk of infection or severe complications of COVID-19 herself, she may be surrounded by vulnerable people in public spaces who would be at risk of severe consequences of infection. Demonstrating prosocial behavior by protecting those who were vulnerable was a message that all three focus groups deemed as important. The vignette also emphasized the need to prevent the healthcare system from being overwhelmed, as over 600,000 surgeries were delayed as a result of the pandemic (33). The video then showed Marie receiving a vaccine, staying up to date with her vaccinations. Finally, the video ended with a group of individuals of diverse ages at a dinner table, highlighting that through vaccination, she was able to protect vulnerable people and allowed them to return to normalcy. Refer back to Figure 1 for samples from the Group 2 video. Group videos in English and French may be found here: COVID-19 Booster Video Altruism EN: https://youtu.be/JugIqS9mBHc COVID-19 Booster Video Altruism FR: https://youtu.be/xRvb1b9vafM.

Informational + altruism + individualism video (Group 3)—180 seconds

We created an individualism-based video, as suggested by the focus group participants who identified ego-centric reasons for vaccination. This video was added to the informational and altruism videos and followed the story of John, a 30-year-old who is healthy, and vaccinated but had not received additional doses. Like Marie, this character was chosen to be relatable to our target age group. John's vignette emphasized the possibility of losing control of his well-balanced life schedule due to a COVID-19 infection which has been associated with increased hospitalization and mortality rates among individuals aged 18–39 who were not up-to-date with their additional vaccine doses (34) and that vaccination is the best way to protect him from these consequences. The video ended with John receiving a vaccine, showing that he is staying up to date with his vaccinations for individualistic reasons. Refer back to Figure 1 for samples from the Group 3 video. Group 3 videos (in English and French) can be found on these links: COVID-19 Booster Video Individualism EN: https://youtu.be/pMpWLxQAY5w COVID-19 Booster Video Individualism FR: https://youtu.be/N80mEXg6Nso.

Hypotheses

The present study's objective was to evaluate the efficacy of videos centered around altruism and individualism on vaccine intentions. We have two hypotheses for our study:

1 The altruism and individualism-based videos will increase pre-to-post vaccine intentions.
2 Post-intervention vaccine intentions will be higher in the intervention arms in comparison to the active control.

Measures

Baseline sociodemographic

Variables included in the analyses were: gender; identifying as a visible minority; identifying as a parent; Language spoken at home included English, French, and Other; higher education (i.e., an apprenticeship or trades certificate/diploma, junior college or CEGEP degree, or university degree); province/territory of residence; household income; number of COVID-19 vaccine doses.

FIGURE 1
Samples from each video intervention group. Reprinted with permission from "COVID-19 Booster Video Control EN" (Informational Video (Group 1)), "COVID-19 Booster Video Control + Alt EN" (Altruism Video (Group 2)), "COVID-19 Booster Video Control + Alt + Ind EN" (Individualism Video (Group 3)) by Akufen licensed under Individual License.

Main outcome

Informed by the PAPM, we assessed participants' intentions to receive additional COVID-19 vaccines with the question, "Which of the following best describes your thoughts about receiving recommended COVID-19 vaccines?" We allowed participants to place themselves in one of four nominal intention stages: (1) *unengaged* (i.e., had not thought about receiving any additional COVID-19 vaccines); (2) *undecided* (i.e., not yet decided about receiving any additional COVID-19 vaccines); (3) *decided not* (i.e., do not want to receive any additional COVID-19 vaccines); and (4) *decided to* (i.e., do want to receive additional COVID-19 vaccines).

Additional measures

Individual factors and health behaviors

Dichotomous (yes/no) variables included: identifying as a caregiver; identifying as a healthcare provider; influence of religion on health decisions; seasonal influenza vaccine uptake in the past 12 months; Ethnicity and gender bias were measured with the questions, "To what extent did you perceive that the video you saw was inclusive of ethnicity?" and "To what extent did you perceive that there was gender bias in the video that you watched?," respectively. Participants were provided Likert scale options 1–5 (1 indicating not at all, 5 indicating entirely).

We measured several psychosocial variables using validated scales that showed very good internal reliability in the original studies. For all scales the mean score (and SD) was calculated.

Toronto Empathy Questionnaire (TEQ)

Empathy was measured using the validated 16-item Toronto Empathy Questionnaire (TEQ); Cronbach's $\alpha = 0.85$ (35). The inclusion of this scale was informed by research showing empathy promotes COVID-19 vaccine intentions (36).

Individualism/collectivism scale

Altruistic motivation was measured using the validated 14-item Individualism/Collectivism Scale Cronbach's $\alpha = 0.66$ for the individualistic orientation and $\alpha = 0.65$ for the collectivistic orientation (23). Previous research has shown that elevated COVID-19 vaccine intentions were found in individuals from collectivist cultures (37).

Intolerance of uncertainty scale – short form (IUS-12)

Intolerance for uncertainty was measured using the validated 12-item Intolerance of Uncertainty Scale – Short Form (IUS-12), Cronbach's $\alpha = 0.89$ (38). Heightened intolerance to uncertainty also emerges as a predictor for engaging in preventive behaviors, such as receiving the flu vaccine (39).

COVID-19 pandemic fatigue

COVID-19 pandemic fatigue was measured using the validated 6-item COVID-19 Pandemic Fatigue Scale Cronbach's $\alpha = 0.74$ (40).

Literature has found COVID-19 fatigue to reduce COVID-19 vaccine intentions (27).

Comprehensive intellectual humility scale

Intellectual humility was measured using the validated 5-item Openness to Revising One's Viewpoint subscale of the Comprehensive Intellectual Humility Scale Cronbach's $\alpha = 0.80$ (41). Intellectual humility has been found to be positively associated with intentions to vaccinate against COVID-19 (42).

Marlowe-Crowne social desirability scale

Social desirability was measured using the short-form, validated 13-item Marlowe-Crowne Social Desirability Scale with Kuder Richardson formula 20 reliability $r_{KR20} = 0.76$ (43).

Sample size calculation

Consistent with the annual uptake of the flu vaccine in our target population, we estimated that the uptake of additional COVID-19 vaccines (boosters) would be 30% (11). The sample calculation for between-group effects assumed a 3% increase (i.e., from 30 to 33%) of intentions in the active control group (Group 1) and a 9% increase (i.e., from 30 to 39%) of intentions in the group who watched the control + altruism + individualism video (Group 3). To detect a 6% difference in vaccine intentions between Group 1 and Group 3 (at a power of 80% and 2-sided significance of 5%) we calculated that the minimum required number of participants per group would be $N = 1{,}005$ (44). Considering a 1:1:1: allocation and an approximate 10% oversample to account for inattentive respondents, the total number of completed questionnaires for this study was approximately $N = 3{,}300$.

Data analysis

Data cleaning

In our strategy, we excluded participants who responded to the survey very quickly. We determined a time threshold that we thought was unreasonable to expect respondents to fully engage with the survey. This threshold was set at less than 5% of the average time taken by participants in each group. Consequently, we removed individuals who completed the survey in less than 382 s in group 1, less than 432 s in group 2, and less than 465 s in group 3.

Statistical analysis

To estimate the pre-to-post intervention change in vaccine intentions, we used a binary outcome (i.e., "intenders" corresponding to *decided to*, and "non-intenders" corresponding to *unengaged, undecided, and decided not.*), and the McNemar Chi-Square test. To estimate pre-to-post changes in PAPM intention stages, we conducted exact tests of symmetry (4 × 4 contingency tables) comprised of pairwise McNemar tests using the *nominalSymmetryTest* function available in the R package *rcompanion* (45). We reported adjusted *p* values for multiple comparisons [Benjamini & Hochberg method (46), odds ratios (OR) and Cohen's g effect size that was interpreted as small (0.05 to <0.15), medium (0.15 to <0.25) or large (≥0.25)]. For each study group we used the significant transitions between vaccine intention stage pairs for calculating the total number of participants that changed toward increased vaccination intentions (e.g., from *undecided* to *decided to*). To estimate the between-group difference in vaccine intentions, we used the Pearson Chi-Square Test on post-intervention vaccine intentions using the binary PAPM outcome.

To evaluate the associations between COVID-19 vaccine intentions and psychosocial factors known in the literature as important determinants of vaccine intentions (see measures section), we employed generalized Structural Equation Modeling (*gsem* command in STATA) (47). Because we used validated scales, the gSEM model contains only observed variables, i.e., for scales we calculated composite scores. As a preliminary step, we constructed a diagram illustrating the hypothetical directional associations between these factors and COVID-19 vaccine intentions. For this analysis, we used a binary COVID-19 vaccine intentions variable, i.e., "Yes" for individuals intending to receive additional COVID vaccines after the intervention and "No" for individuals who selected any other PAPM vaccine intention stage. Other dichotomous variables included in the analyses were: history of influenza vaccination (Yes/No); receipt of more than 2 COVID vaccines (Yes/No); education (Higher/Lower); self-reported influence of religious beliefs on health decisions (Yes/No); self-reported caregiver status (Yes/No); and biological sex (Male/Female). Gender identity included three categories (Man; Woman, and Diverse) while ethnicity comprised five categories (North American, Indigenous People, European; Asian and Other). Additionally, the following scale scores were included as continuous variables: individualism, collectivism, empathy, intellectual humility, COVID-19 fatigue and tolerance to uncertainty. In the subsequent step, we used general SEM to simultaneously evaluate the complex relationships between variables using the theory-informed diagram from step one. Odds ratios (OR) and 95% confidence intervals (CI) were estimated for relationships in which the outcome was categorical, while linear regression beta coefficients and 95% CI were estimated for continuous outcomes. Analyses were conducted using R version 4.3.1 and Stata BE version 18 statistical software.

Ethical considerations

The study was approved by the Research Ethics Board of the Integrated Health and Social Services University Network for West-Central Montreal (CIUSSS West-Central Montreal; Project ID # 2023–3,198).

Results

Participant flow

Recruitment dates

Data collection took place from June 30 to July 31, 2023. Midway through the recruitment, we had relatively low proportion of French speaking participants, accounting for only 12%. In response, we adjusted the provincial quota to ensure a targeted representation of 20% French-speaking participants. By August 1, we successfully attained our anticipated number of participants, concluding the recruitment phase across all established quotas. See Figure 2 for Participant Flow diagram.

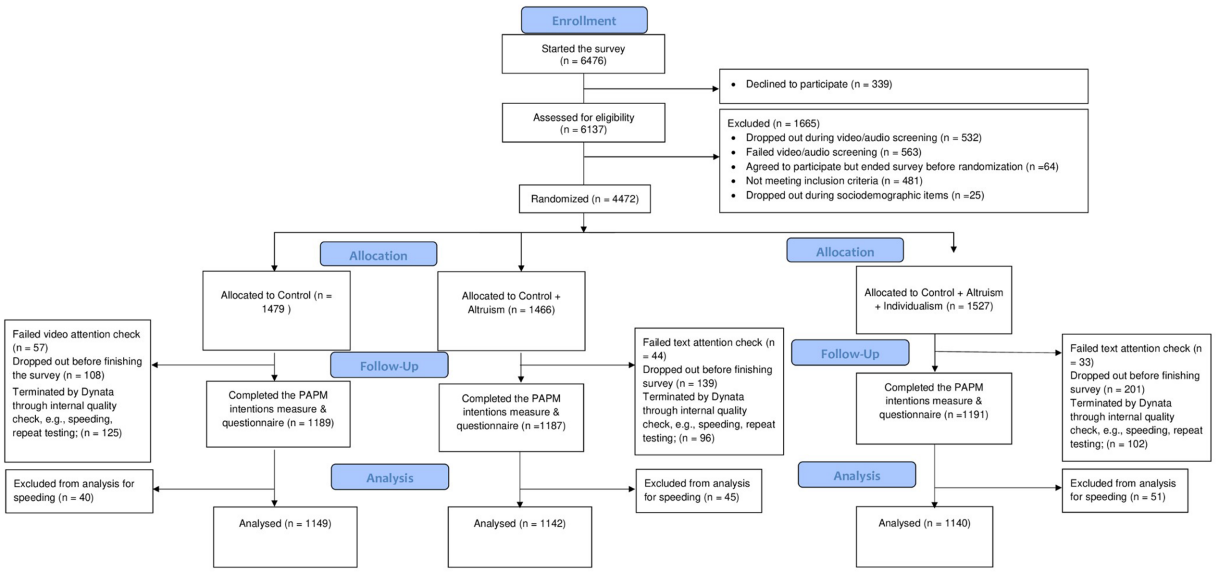

FIGURE 2
CONSORT diagram. CONSORT, Consolidated Standards of Reporting Trials; PAPM, Precaution Adoption Process Model.

Main analyses

In addressing Objective 1, we evaluated the comparative efficacy of the three videos on vaccine intentions by estimating the between group and within-group differences.

Baseline

The sample were equally distributed between males ($n = 1700$, 49.5%) and females ($n = 1731$, 50.5%), the mean age was 30.67 years, the majority used English as the primary language at home ($n = 2{,}514$, 73.3%), and most resided in an urban area ($n = 2{,}774$, 80.9%). None of the sociodemographic characteristics differed significantly between the intervention groups (see Table 1).

In Group 1, PAPM stage distribution was as follows: $n = 390$ (33.9%) were *unengaged*, $n = 230$ (20.0%) were *undecided*, $n = 266$ (23.2%) *decided not*, and $n = 263$ (22.9%) *decided to* receive additional vaccine doses. PAPM stage distribution of participants allocated to Group 2 and Group 3 was similar in vaccine intentions, and the between group difference in vaccine intentions was not significant ($\chi^2_6 = 3.43$, $p = 0.75$) (see Table 1).

Cronbach's α for each of the scales were as follows: TEQ $\alpha = 0.74$; Individualism/Collectivism $\alpha = 0.86$; IUS-12 $\alpha = 0.881$; COVID-19 Pandemic Fatigue $\alpha = 0.86$; Openness to Revising One's Viewpoint $\alpha = 0.89$; Marlowe-Crowne Social Desirability $\alpha = 0.79$.

Main analyses

Objective 1- pre-to post intervention changes in vaccine intentions

We compared all vaccine non-intender participants combined (i.e., *unengaged, undecided, and decided not*) to vaccine intenders (*decided to*). There was a significant transition of participants from vaccine non-intender to vaccine intender (*decided to*) stages in all three intervention groups (Group 1: $\chi^2_1 = 114.3$, $p < 0.001$; Group 2 $\chi^2_1 = 141.1$, $p < 0.001$; Group 3: $\chi^2_1 = 123.6$, $p < 0.001$). These results show that participants transitioned significantly in all three groups in the direction of higher intentions for receiving additional COVID-19 vaccine doses.

Within group changes

To provide a more detailed understanding of within PAPM stage movements, we examined changes in movements from baseline to post intervention for each stage within each group. Specifically, there was a decrease in the number of participants who were *unengaged* post-intervention in all three groups (e.g., the number of *unengaged* participants in Group 1 decreased from 390 to 228 from baseline to post intervention). In all three groups, there was an increase in the number of participants who moved to *undecided* and *decided to* (e.g., in Group 2, the number of participants who were *decided to* increase from 262 at baseline to 427 post-intervention). Meanwhile, there was a decrease in the number of participants who were *decided not* in all groups (e.g., the number of *decided not* participants decreased from 287 to 243 in Group 3). All changes in the number of participants in each intention stage from baseline to post-intervention are provided in Table 2.

To show more precise movements of individuals, we created three figures, one for each group intervention to highlight the movements visually.

Specific movements pre-to-post intervention between stages in Group 1 (control) are provided in Figure 3. As shown, significantly more participants moved from *unengaged* to *undecided* ($n = 87$, $p < 0.001$, OR = 3.8, Cohen's $g = 0.29$); from *unengaged* to *decided to* ($n = 79$, $p < 0.001$, OR = 15.8, Cohen's $g = 0.44$); from *undecided* to *decided to* ($n = 66$, OR = 7.3, Cohen's $g = 0.38$); from *unengaged* to *decided not* ($n = 32$, $p < 0.001$, OR = 4.0, Cohen's $g = 0.30$); from *decided not* to *undecided* ($n = 32$, $p < 0.001$, OR = 6.4, Cohen's $g = 0.37$); and from *decided not* to *decided to* vaccinate ($n = 23$, $p < 0.01$, OR = 3.3, Cohen's $g = 0.27$). For movements corresponding to groups 2 and 3 (see Figures 4, 5).

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TABLE 1 Sample characteristics.

	Full sample (n = 3,431)	Group 1: control (n = 1,149)	Group 2: control + altruism (n = 1,142)	Group 3: control + altruism + individualism (n = 1,140)	p-value[¥]
Age (years), M (SD)	30.67 (5.76)	30.70 (5.71)	30.58 (5.81)	30.74 (5.75)	0.80
Biological sex, n (%)					
Female	1731 (50.5)	578 (50.3)	579 (50.7)	574 (50.4)	0.98
Male	1700 (49.5)	571 (49.7)	563 (49.3)	566 (49.6)	
Region, n (%)					
Western and Territories	999 (29.1)	348 (30.3)	335 (29.3)	316 (27.7)	
Ontario	1,261 (36.8)	414 (36.0)	416 (36.4)	431 (37.8)	0.79
Quebec	943 (27.5)	314 (27.3)	308 (27.0)	321 (28.2)	
Atlantic	228 (6.6)	73 (6.4)	83 (7.3)	72 (6.3)	
Area, n (%)					
Rural	657 (19.1)	222 (19.3)	219 (19.2)	216 (18.9)	0.97
Urban	2,774 (80.9)	927 (80.7)	923 (80.8)	924 (81.1)	
Ethnicity, n (%)					
North American – Indigenous[1]	293 (8.5)	95 (8.3)	108 (9.5)	90 (7.9)	
North American – Other[2]	1,284 (37.4)	424 (36.9)	438 (38.4)	422 (37.0)	0.36
European[3]	718 (20.9)	244 (21.2)	240 (21.0)	234 (20.5)	
Asian[4]	701 (20.4)	236 (20.5)	207 (18.1)	258 (22.6)	
Other[5]	435 (12.7)	150 (13.1)	149 (13.0)	136 (11.9)	
Visible minority, n (%)					
Yes	1,025 (29.9)	344 (29.9)	321 (28.1)	360 (31.6)	0.19
No	2,406 (70.1)	805 (70.1)	821 (71.9)	780 (68.4)	
Primary language, n (%)					
English	2,514 (73.3)	847 (73.7)	853 (74.7)	814 (71.4)	0.27
French	714 (20.8)	230 (20.0)	233 (20.4)	251 (22.0)	
Other	203 (5.9)	72 (6.3)	56 (4.9)	75 (6.6)	
Completed post-secondary education, n (%)					0.07
Yes	2,544 (74.1)	867 (75.5)	819 (71.7)	858 (75.3)	
No	887 (25.9)	282 (24.5)	323 (28.3)	282 (24.7)	
Gender identity, n (%)					
Female/woman	1,690 (49.3)	566 (49.3)	560 (49.0)	564 (49.5)	0.76
Male/man	1,670 (48.7)	564 (49.1)	554 (48.5)	552 (48.4)	
Gender diverse[6]	71 (2.1)	19 (1.7)	28 (2.5)	24 (2.1)	
Household income, n (%)					
≤39,999 CAD[7]	671 (19.6)	217 (18.9)	217 (19.0)	237 (20.8)	
40,000–79,999 CAD	1,230 (35.8)	416 (36.2)	427 (37.4)	387 (33.9)	0.67
≥80,000 CAD	1,457 (42.5)	492 (42.8)	476 (41.7)	489 (42.9)	
Prefer not to answer	73 (2.1)	24 (2.1)	22 (1.9)	27 (2.4)	

[1]i.e., First Nations, Inuit, Metis.
[2]e.g., Canadian, American, Ontarian, Quebecois, Acadian.
[3]e.g., British, French, Western European, Eastern European.
[4]e.g., West Central Asian, South Asian, East and Southeast Asian.
[5]i.e., Caribbean (e.g., Cuban, Haitian, Jamaican), Latin, Central and South American (e.g., Mexican, Argentinian, Brazilian, Chilean), African (e.g., Central and West African, North African, Southern African), Oceania (e.g., Australian, New Zealander, Pacific Islander), and Other.
[6]i.e., gay, lesbian, queer, two spirit and "prefer not to answer".
[7]CAD denotes Canadian Dollar.
[¥]Denotes p value of tests for between intervention group differences, i.e., ANOVA for continuous variables and Chi-square for categorical variables.

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TABLE 2 Number of participants by PAPM vaccine intention stage and intervention group at baseline and post intervention.

Group	Unengaged	Undecided	Decided not	Decided to	Total	Between group difference*
Baseline *n* (%)						
1 (control)	390 (33.9)	230 (20.0)	266 (23.2)	263 (22.9)	1,149 (33.5)	
2 (control + altruism)	375 (32.8)	230 (20.1)	275 (24.1)	262 (22.9)	1,142 (33.3)	$p = 0.75$
3 (control + altruism + individualism)	348 (30.5)	237 (20.8)	287 (25.2)	268 (23.5)	1,140 (33.2)	
Total (%)	1,113 (32.4)	697 (20.3)	828 (24.1)	793 (23.1)	3,431	
Post intervention *n* (%)						
1	228 (19.8)	264 (23.0)	247 (21.5)	410 (35.7)	1,149 (33.5)	
2	209 (18.3)	256 (22.4)	250 (21.9)	427 (37.4)	1,142 (33.3)	$p = 0.78$
3	198 (17.4)	273 (23.9)	243 (21.3)	426 (37.4)	1,140 (33.2)	
Total (%)	635 (18.5)	793 (23.1)	740 (21.6)	1,263 (36.8)	3,431	

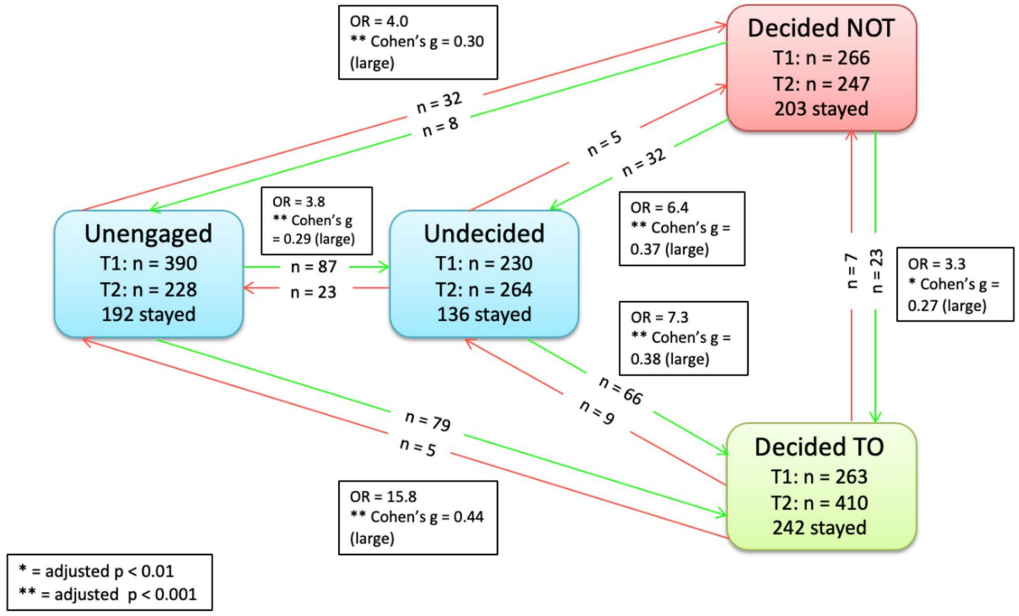

FIGURE 3
Significant transitions pre-to-post intervention Group 1 (control).

Objective 2- between group differences in intentions

Using the binary PAPM intentions variable, we found that post intervention the intentions to receive additional COVID-19 doses was not significantly different between the intervention groups ($\chi^2_6 = 3.21$, $p = 0.78$).

Exploratory analyses

To better understand what influences individuals to move to the *decided to vaccinate* stage, we examined factors known to be associated with vaccine intentions using structural equation modeling (see Figure 6 and Appendix A: Table of gSEM Results).

The gSEM was used to test our hypothesized model: pathways lead from individual and psychosocial factors to intent to receive the COVID-19 vaccine both directly and via these factors. Collectivism was associated with higher intentions to receive the COVID-19 vaccine (OR = 1.14; CI:1.05; 1.23, $p < 0.001$). Collectivism was found to be a mediator between empathy ($\beta = 0.02$; CI:0.01; 0.02, $p < 0.001$) and intentions to receive the COVID-19 vaccine, but empathy was not directly associated with intentions to receive the COVID-19 vaccine. Empathy was also found to be negatively associated with individualism ($\beta = -0.01$; CI:0.01; 0.00, $p < 0.001$). Intellectual humility was associated with higher collectivism ($\beta = 0.05$; CI:0.04; 0.07, $p < 0.001$) and higher individualism ($\beta = 0.03$; CI:0.01; 0.03, $p < 0.001$). Individualism was not directly associated with intentions to receive the COVID-19 vaccine. Intellectual humility (OR = 1.04, CI:1.02; 1.07, $p < 0.001$), and intolerance to uncertainty (OR = 1.02, CI:1.01; 1.03, $p < 0.001$) were associated with higher intentions to receive the COVID-19 vaccine. COVID-19 fatigue was associated with lower intentions to receive the COVID-19 vaccine (OR = 0.90, CI:0.88; 0.91, $p < 0.001$) and higher

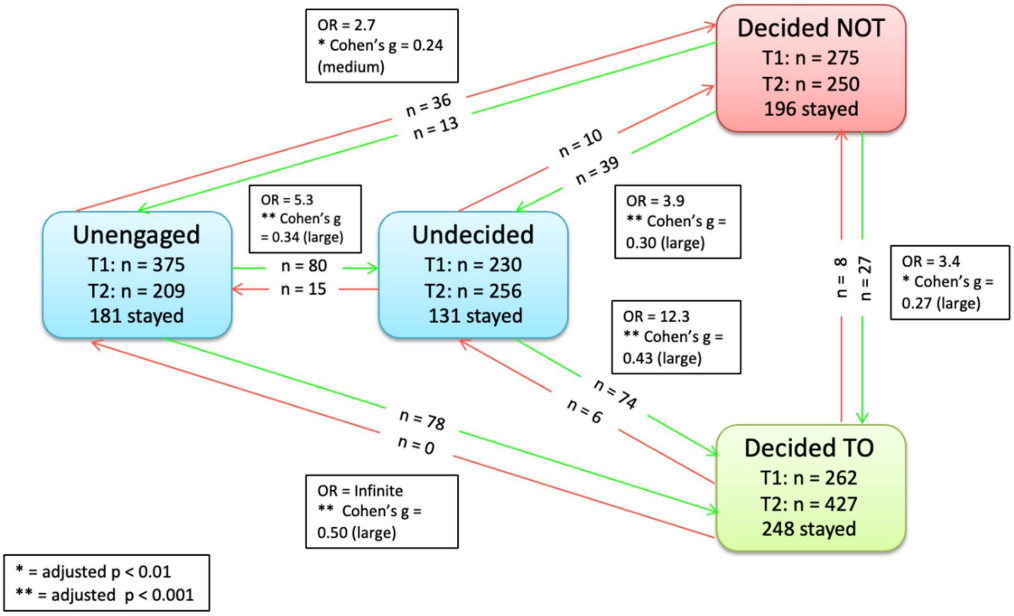

FIGURE 4
Significant transitions pre-to-post intervention Group 2 (control + altruism).

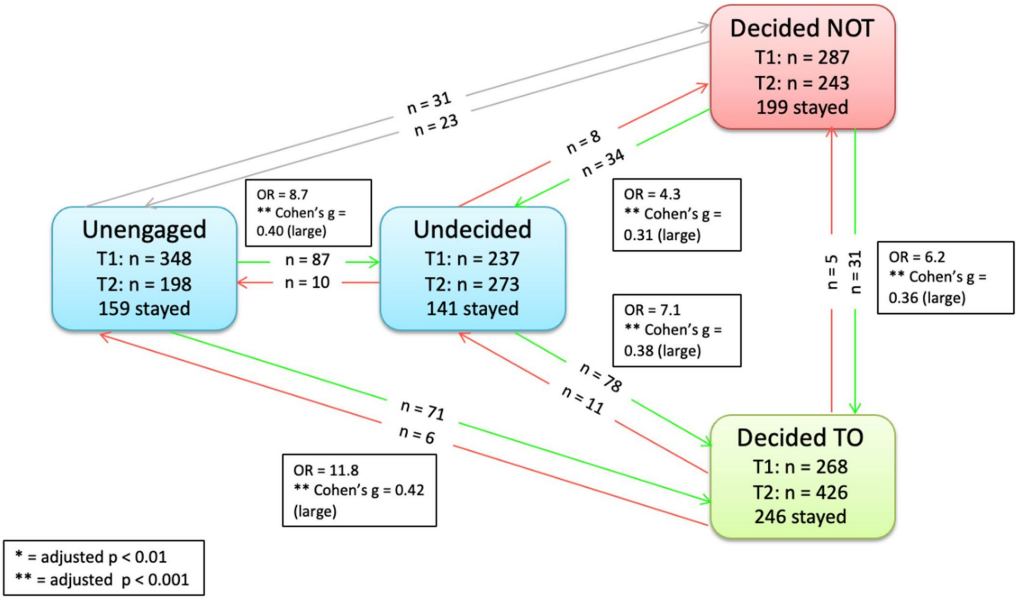

FIGURE 5
Significant transitions pre-to-post intervention Group 2 (control + altruism + individualism).

odds of having received two or more COVID-19 vaccines (OR = 0.90, CI:0.88; 0.91, $p < 0.001$). Intolerance to uncertainty was associated with higher COVID-19 fatigue ($\beta = 0.18$, CI:0.16; 0.20, $p < 0.001$). Intolerance to uncertainty (OR = 1.01, CI:1.00; 1.01, $p < 0.01$) and collectivism (OR:1.25, CI:1.17; 1.33, $p < 0.001$) were associated with higher odds of having received the flu vaccine. Collectivism was also associated with higher odds of having received two or more COVID-19 vaccines (OR = 1.25, CI:1.14; 1.36, $p < 0.001$) whereas individualism was associated with lower odds of having received two or more COVID-19 vaccines (OR = 0.90, CI:0.82;0.98, $p < 0.05$).

Health behaviors and sociodemographics

Having received the flu vaccine (OR: 2.57, CI:2.17; 3.02, $p < 0.001$), being a caregiver (OR = 1.52, CI:1.27; 1.82, $p < 0.001$), Indigenous ethnicity (OR = 1.86, CI:1.39; 2.49, $p < 0.001$), European ethnicity (OR = 1.36, CI:1.11; 1.68, $p < 0.001$), having completed higher education (OR = 1.47, CI:1.22; 1.77, $p < 0.001$), reporting religious

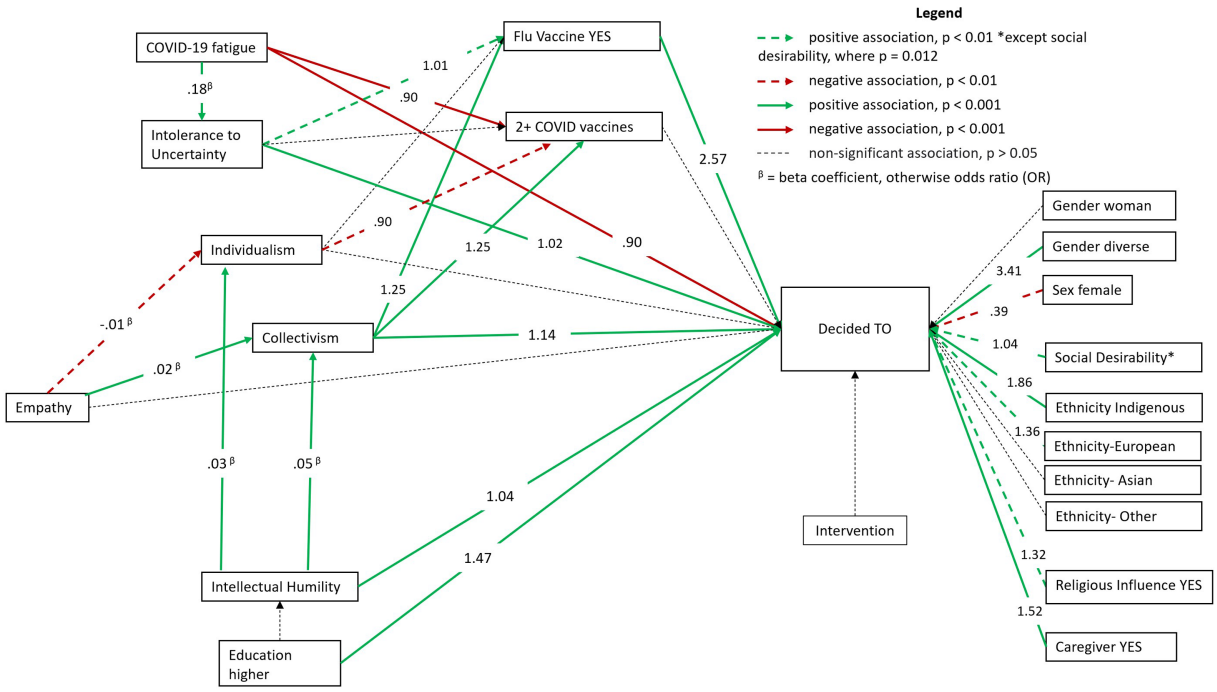

FIGURE 6
General Structural Equation Model demonstrating factors associated with vaccine intentions.

beliefs influencing health decisions (OR = 1.32, CI:1.08; 1.60, $p < 0.001$), and identifying as gender diverse (OR = 3.41, CI:1.70; 6.31, $p < 0.001$) were all associated with higher intentions to receive the COVID-19 vaccine. Identifying as a female was associated with lower intentions to receive the COVID-19 vaccine (OR = 0.39, CI:0.20; 0.72, $p < 0.01$). Social desirability was associated with higher intentions to receive the COVID-19 vaccine (OR = 1.04, CI:1.00; 1.07, $p < 0.05$).

Discussion

This study is part of a multi-phase sequential exploratory and explanatory mixed-methods approach to understand and evaluate the role of altruistic and individualistic motives in increasing vaccine intentions. Building upon our research team's previous study (19), which found that a video intervention based in altruistic messaging significantly increased pre- to post-vaccine uptake intentions and that individuals who were either classified as 'unengaged' or 'undecided' in intention were most amenable to change, we conducted a qualitative study to ask subjects to provide feedback that would guide the development of our present video intervention (20). We integrated these insights into the new video intervention that contained both altruism and individualism messages. In the present study, we used a three-arm RCT and online survey to test the efficacy of the new intervention on COVID-19 vaccine intentions and explored the multivariable associations between psychosocial factors and vaccine intentions.

Our first hypothesis was that the altruism and individualism-based videos would increase the pre-to-post vaccine intentions In line with our previous study, we found that our video intervention was effective in changing pre-to-post vaccine intentions. Our previous RCT showed 43 (6.3%) participants changed from non-intenders at baseline (i.e., *unengaged*, *undecided*, or *decided not*) to vaccine intenders (i.e., *decided to*) post-intervention, and in our current RCT we also found that 180 (6.3%) participants changed from non-intenders to vaccine intenders post-intervention (Group 3). Furthermore, there was significant movement toward an advanced vaccine decision stage across all three video interventions groups (e.g., in Group 2, 80 participants moved from unengaged to undecided), indicating the effectiveness of our video-based intervention in increasing vaccine intentions.

Secondly, we hypothesized that vaccine intentions will be higher in the intervention arm (Group 3) compared to the active control. Contrary to our second hypothesis, our study found no statistical superiority of the intervention video based on altruistic and individualistic messaging in comparison to our active control group video. Previous research has found that vaccine-information based video interventions, such as our active control group video, were effective in increasing willingness to vaccinate against COVID-19. For instance, an RCT found an 8-min animated educational video regarding COVID-19 mRNA vaccines was significantly more likely to increase intentions to vaccinate against COVID-19 compared to a passive control group (48). Therefore, it is possible that including an active control group has created ambiguities in the interpretation of treatment effects because vaccine intentions also increased pre-to-post intervention in the active control group. It is possible that the active control video may be sufficient to motivate movement toward greater vaccine intentions. If we had used a different design that offered the information video (i.e., in the control group) to those interested at the end of the survey, we could have detected a significant difference between the interventions and the control group. This is suggested by our sensitivity analyses, which show that post-intervention vaccine intentions were significantly higher in Groups 2 and 3 compared to baseline intentions (that would assume that participants in the control

group were not allocated to any intervention) in the active control group (Group 1) ($\chi^2_2 = 59.96$, $p < 0.001$).

Our exploratory analysis tested the associations between important sociodemographic and psychosocial factors and COVID-19 vaccine intentions. An important finding was that collectivism was associated with intention to receive the COVID-19 vaccine, aligning with previous research (49). COVID-19 vaccine offers the ability to protect one's social group and the surrounding community by possibly limiting transmission. If this is indeed the case, then the messaging around the prosocial benefits derived from the COVID-19 vaccine align with collectivistic beliefs and potentially contribute toward higher vaccine intention.

Interestingly, while previous studies have found empathy as predictor of COVID-19 vaccine intentions (15), we did not find a direct association between empathy and intentions. We found collectivism to be a possible mediator between empathy and intentions, suggesting a more nuanced understanding of empathy in shaping vaccine intentions. Our findings could be explained by the results of meta-analysis that found that cultural orientation was a moderating factor between empathy and prosocial behavior (50). With COVID-19 vaccination viewed as a pro-social behavior (51), these results shed light on how cultural values reflecting collectivism/individualism traits can influence the pathway between empathy and COVID-19 vaccine intentions. More research is needed in this area.

Our study also included a measure of intellectual humility (defined as openness to revising one's viewpoint based on new information). We found a positive association between intellectual humility and COVID-19 vaccine intentions. Our results align with previous research indicating that individuals with lower levels of intellectual humility tend to harbor greater skepticism toward vaccine-related information, often leaning toward conspiracy theories and misinformation (42). In addition, higher intellectual humility can foster trust in science (52), which could increase vaccine intentions.

Intolerance of uncertainty is the tendency to respond negatively to ambiguous and uncertain situations. The COVID-19 pandemic has brought about several ambiguities in people's daily lives: for example, rapidly changing guidelines regarding vaccination, lockdowns, health safety practices. In line with previous literature, we found that intolerance of uncertainty was positively associated with vaccine intentions, and pandemic fatigue (53). This suggests that the ambiguity of the pandemic evolution, exacerbated by the constantly evolving government recommendations, can heighten the fatigue experienced by individuals with higher intolerance to uncertainty. Similar to a study conducted by Qin et al. (27), we found that individuals who have increased pandemic fatigue are less inclined to receive subsequent COVID-19 vaccine doses. Therefore, it would be important to create tailored messaging aimed to reduce pandemic fatigue. The World Health Organization (WHO) provided several strategies for preventing pandemic fatigue, such as increasing transparency, coordination and consistency in the information provided to public and acknowledging the needs of all individuals and psychological impact of different public health guidelines on them (54). Identifying as a caregiver was also found to be a predictor of higher vaccine intentions in our study, coinciding with increased investments and programs initiated by Government of Canada to support home and community care services (55–57). Caregivers should be targeted in public health messaging to increase COVID-19 vaccine uptake. It is not surprising that social desirability was associated in exploratory analyses (gSEM, $n = 3{,}431$) with higher vaccine intentions because when vaccination is perceived as a social norm and as a socially desirable action, it has been shown in the literature that it positively influences one's decision to get vaccinated (58, 59).

We were pointed in asking participants whether their religious beliefs influenced their health decisions. Our results indicated that higher scores were associated with higher vaccine intentions. These results are consistent with a study that found people in countries reporting higher levels of religiosity (i.e., religion is important to people) also predicted higher level of vaccine confidence (60). Religion and religiosity as an indicator of community affiliation helps us understand the willingness to vaccinate to keep the community safe.

At the end of our survey, participants also answered questions regarding perception of ethnic inclusivity and gender in the video interventions. Participants found no gender bias and perceived the video to be moderately inclusive of ethnicities. With our videos being perceived as gender neutral and ethnically inclusive, we found that Indigenous identity, and gender diverse individuals were more likely to intend to receive the additional COVID-19 vaccine. Furthermore, our study was one of the first to find that identifying oneself as gender diverse (i.e., individuals who do not identify with binary gender) was associated with higher COVID-19 vaccine intentions, underscoring the importance of inclusive messaging that addresses the specific needs of this segment of the population.

Strengths

Our study is unique in that it is one of the first to evaluate the effectiveness of two potentially major drivers of intentions: individualism and altruism, both individually and in combination. It also assesses the impact of these variables on individuals' willingness to receive additional COVID vaccine doses. Given the perpetual emergence of new variants of COVID-19, the potential for future pandemic waves (and the development of variant-specific vaccines) remains a concern.

One of the notable strengths is that the designing of our videos included using qualitative methods to elucidate opinions of young adults related to COVID-19 vaccination and including these ideas in our new videos, consideration of diverse themes and ideas, ensuring gender and ethnic representation, homing in on messages that matter to this population and a thorough empirical evaluation. It remains unclear whether the videos, commercials, radio advertisements and messages we hear from different organizations use such extensive approaches in designing and importantly evaluating such as messages, as to date, the evaluation of the efficacy of these interventions are not available in the public domain.

Our results align with our first RCT showing that altruistic messages can increase vaccine intentions. Our study is one of the first to offer guidance on how to select and implement various vaccine intervention for a particular population (e.g., in the present study young adults), suggesting that more than one message can increase vaccine intentions. Factors to consider beyond video efficacy include accessibility, cost, length, modality, environment, culture, and place of the messaging.

Limitations

While we were developing this study, the pandemic was evolving rapidly, with the emergence of new variants and changing policies across the country. Moreover, it is important to note that

the COVID-19 vaccines were the first Government approved mRNA vaccine (Pfizer and Moderna) that were administered to the public. Specific concerns around the mRNA vaccine development such as the speed of development, approval, and efficacy of the vaccine, were not addressed in our videos which could have potentially helped in increasing trust in mRNA technology for vaccine development. It is important to note that our video did address concerns regarding vaccine efficacy and safety more generally.

It is important to note that our study was conducted to evaluate the efficacy of our video interventions using an experimental design. Further research is required to ascertain real-word effectiveness of altruistic and individualistic based messaging in increasing vaccine intentions.

Lastly, our study measured the intent to vaccinate. Hence, we cannot conclude that the intervention would also increase vaccine uptake. The Theory of Planned behavior suggests that intentions are predictors of health behaviors (61), and studies have demonstrated that intention to vaccinate have predicted subsequent uptake of vaccines as well (62). Furthermore, social desirability was found to be associated with higher vaccine intentions. Self-reported data is prone to social-desirability bias which could influence one's reported vaccine intentions. We recommend further studies measuring intentions to control for social desirability.

Future directions

Our study highlighted that a short video that includes altruistic and individualistic messages did impact intentions to vaccine among young adults. Since the active control video also impacted intentions, more research is needed to understand the mechanisms underlying this effect. Currently we are embarking on a study using qualitative methodologies to better understand why the altruistic video did not have more significant effect on vaccine intentions compared to the individualism video and identify methods to disseminate these videos widely (e.g., to hard-to-reach audiences, social media platforms). This is a crucial step in implementation science to continuously refine the work and disseminate accordingly to have population-wide impact.

Data availability statement

The data sets used for this study will not be published in a publicly available repository in accordance with the ethics proposal approved by the overseeing research ethics board. They will be available from the senior author (ZR) upon reasonable request and upon agreement of confidentiality and data use policies provisioned by the primary institution.

Ethics statement

The studies involving humans were approved by the Research Ethics Board of the Integrated Health and Social Services University Network for West-Central Montreal (CIUSSS West-Central Montreal; Project ID # 2023-3198). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

RB: Data curation, Formal analysis, Methodology, Project administration, Writing – original draft, Writing – review & editing, Validation, Visualization. OT: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. PZ: Writing – original draft, Writing – review & editing, Conceptualization, Data curation, Investigation, Methodology, Project administration, Visualization. SP: Writing – original draft, Writing – review & editing, Conceptualization, Funding acquisition, Investigation, Methodology. BH: Writing – original draft, Writing – review & editing, Conceptualization, Funding acquisition, Methodology, Project administration. GZ: Writing – original draft, Writing – review & editing. ZR: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2024.1414345/full#supplementary-material

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A global survey to understand general vaccine trust, COVID-19 and influenza vaccine confidence

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Introduction: The COVID-19 pandemic has greatly impacted the way that the world views vaccines. While safe and effective, COVID-19 vaccines were, and continue to be met with hesitancy and misinformation. We aimed to understand public perceptions and trust in COVID-19 vaccinations and how the pandemic has impacted perceptions of non-COVID-19 vaccines.

Methods: Survey data were collected between August 7, 2023–August 16, 2023, from 7,000 respondents aged 18 years and older from the United States ($n = 1{,}000$); Nigeria ($n = 1{,}000$); United Kingdom ($n = 1{,}000$); France ($n = 1{,}000$); Canada ($n = 1{,}000$); Brazil ($n = 1{,}000$); and India ($n = 1{,}000$).

Results: Trust in COVID-19 vaccines was highest in Brazil (84.6%) and India (80.4%) and lowest in the United States (63.5%) and France (55.0%). 47.5% of respondents agreed that they trust traditional protein-based vaccines more than mRNA vaccines, 13.5% disagree and 39.0% are neutral about their trust in protein-based versus mRNA vaccines. Overall, 53.9% of respondents reported that the COVID-19 pandemic impacted their perceptions of vaccines with half of these respondents (51.7%) reporting that the pandemic made them think that other vaccines are more important as they understand how critical vaccines can be at preventing serious illnesses.

Discussion: These data can be used by health system decision makers, public health and researchers to understand how vaccine trust impacts perceptions of COVID-19 and influenza vaccines globally and develop tailored interventions that address local concerns.

KEYWORDS

vaccine trust, COVID-19, vaccine confidence, immunization, mRNA

1 Introduction

Public trust in the safety and efficacy of vaccines is essential to the success of immunization programs globally (1). Trust is often described as the key influence on vaccine acceptance (2) and it impacts not only personal health outcomes, but also the broader landscape of public health (2, 3). Vaccine trust extends beyond individual confidence in the safety and efficacy of a vaccine; rather it includes trust in the institutions that oversee its development, regulation, and administration. The interplay between perceived vaccine quality and safety, coupled with the credibility of the institutions endorsing the vaccine, significantly impact an individual's likelihood of receiving a vaccine (2). A strong foundation of trust can bolster vaccine uptake, contributing to the achievement of herd immunity and the prevention of widespread infectious

diseases. Interpersonal trust refers to the confidence an individual has in those directly responsible for communicating about and administering the vaccine. Personal characteristics including race, socioeconomic status, level of education, and religion profoundly affect interpersonal trust. These attributes influence who an individual interacts with to obtain information regarding vaccines and further shapes their views. This often results in increased interaction with those who validate their own perspectives (2). Trust in health care providers and trust in government confidence are strong drivers of vaccine acceptance across multiple countries and regions (4).

The global landscape of vaccine trust is characterized by a myriad of factors, including cultural, socioeconomic, political, and historical influences (5). Each country presents a unique set of circumstances that can either foster or challenge public confidence in vaccination efforts. Understanding these nuances can help tailor public health communication. Previous COVID-19 global surveys have shown large variation in vaccine acceptance across countries ranging from 47.9% in South Africa to 98.3% in India (6). Despite the disproportionate challenges in vaccine availability and distribution faced by low- and middle-income countries (LMICs), these countries tend to exhibit lower levels of vaccine hesitancy and higher acceptance rates than higher-income countries (7). Previous research shows that perceived susceptibility to COVID-19 infection, severity of complications, and believed benefit are associated with a higher intention to vaccinate (8). Meanwhile, people with concerns about the efficacy and side effects of COVID-19 vaccines are less likely to have a positive vaccination intent (8). As the world grapples with the challenges posed by COVID-19, understanding the dynamics of vaccine trust becomes paramount, not only for this virus but also in shaping broader attitudes toward other respiratory vaccinations, such as influenza vaccines. A recent review indicated that COVID-19 has increased intention to get influenza vaccinations (9). However, there are also reports of decreased influenza vaccination in healthcare personnel throughout the COVID-19 pandemic which is hypothesized to be due to COVID-19 vaccination campaigns leading to less emphasis on influenza vaccination or vaccine fatigue (10). Investigating the interconnectedness of vaccine trust and its repercussions on broader immunization initiatives can shed light on the potential ripple effects of building or eroding public trust.

Various research indicates that trust is integral to vaccine confidence; however, what type of trust has been up for debate. Trust in experts, scientists, medical authorities and medical professionals appears to have a small to moderate effect (11–13). Trust in government shows variation in the effect with a 25-sample study finding non-significant effects on vaccine confidence (13). Interestingly, a 19-country study (14) and an 8-country study (12) found significant effects of trust in government on vaccine acceptance. Finally, Rozek et al.'s (15) 17 country survey, found that trust in health institutions is significant but no effect for trust in political leaders.

The Vaccine Trust Gauge was developed from a previous scoping review (5) to create a standardized approach to measuring trust in vaccines (4). This validated and reliable tool includes perception of vaccine safety, efficacy, and importance, while also inquiring about trust in information sources (16). This paper uses the vaccine trust gauge to delve into the intricate interplay of vaccine trust on a global scale, with a specific focus on COVID-19 and influenza vaccines. By examining patterns of trust across different countries, including Canada, Brazil, France, India, the United States, the United Kingdom, and Nigeria, we aim to unravel the factors influencing public perception.

2 Methods

We conducted an observational cross-sectional survey to explore how vaccine trust differs across countries and the relationship between overall vaccine trust and perceptions of COVID-19 and influenza vaccines.

2.1 Survey instruments

The survey instrument contained 4 parts: (1) demographic questions; (2) the Vaccine Trust Gauge (4); (3) COVID-19 vaccine related questions and (4) Influenza vaccines-related questions. Demographic questions included sex, age, education, and average yearly income. The Vaccine Trust Gauge is a series of questions that measure overall vaccine trust levels and has a high internal reliability (Cronbach's alpha =0.947) (16). Additional questions related to perceptions about COVID-19 and influenza vaccines were also included in the survey instrument based on the recommendations of public health and infectious disease physicians. These questions were adapted from previous studies and focused on the knowledge, perceived safety and efficacy and intention to receive COVID-19 and influenza vaccinations (6, 14, 17). The full survey instrument can be found in the Supplementary material.

2.2 Recruitment and data collection

Survey data were collected between 7 August - 16 August 2023 from $N = 7{,}000$ respondents aged 18 years and older from the United States ($n = 1{,}000$); Nigeria ($n = 1{,}000$); United Kingdom ($n = 1{,}000$); France ($n = 1{,}000$); Canada ($n = 1{,}000$); Brazil ($n = 1{,}000$); and India ($n = 1{,}000$). An online opt-in panel of participants was provided by Consensus Strategies and participants were recruited by telephone contact, social media outreach and direct email solicitation. Social media outreach was complete by posting recruitment materials on social media platforms (X and Instagram) where participants were directed toward the online survey. The online survey was available in English, French, Portuguese and Hindi based on the predominant languages in each country. A stratum-based sample design was implemented based on age, gender, statistical regions, median income, and levels of education for each country; a minimum of 50 participants was set for each stratum, with target enrollment calculated to reflect the distribution of each subgroup in the general population of each country. This survey was administered by Emerson College, located in Boston, U.S.A. No personally identifiable information was collected or stored. This approach has been utilized in previous literature to recruit a random sample of the population (6).This project was reviewed and deemed exempt from research by Emerson College's Institutional Review Board (protocol number 22-019-F-X).

2.3 Analysis

Descriptive statistics were calculated for all variables. Similar to previous papers using the Vaccine Trust Gauge (4), scores from the Vaccine Trust Gauge survey questions were aggregated and then converted to a 0.0–1.0 scale with 0.0 representing no trust at all and 1.0 representing complete trust. The Vaccine Trust Gauge scores

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were then categorized into high, medium and low trust levels using 0.33 intervals. Multinomial logistic regressions were conducted to explore the association between demographic characteristics, COVID-19 vaccine perspectives and influenza vaccine perspectives and vaccine trust levels. Responses for COVID-19 and influenza vaccine perspectives were categorized as agree (strongly agree and somewhat agree), neutral, and disagree (strongly disagree and somewhat disagree). All analyses were conducted in SAS version 9.4 software.

3 Results

3.1 Demographics

A total of 7,000 people responded to the survey including 1,000 people from Brazil, Canada, France, India, Nigeria, the United Kingdom, and the United States. Women comprised 50.1% of the study population, and 50.0% of all participants earned less than the average median income while 50% earned above the median income. One in five participants had a university degree. Respondent characteristics by country are listed in Table 1.

Multinomial logistic regression showed the association between demographic characteristics and vaccine trust levels. The odds of having high vaccine trust decrease by 1.4% for every one-year increase in age ($p < 0.001$). Having no college education significantly decreases the odds of having high vaccine trust by 49.5% ($p < 0.001$). Having below-average yearly income significantly decreases the odds of having high vaccine trust by 49.5% ($p < 0.001$). The odds ratios (OR) and 95% confidence intervals (CI) for each predictor variable are presented in Table 2.

3.2 Vaccine trust levels by country

Brazil (78.8%), India (66.7%), Nigeria (61.8%) and the UK (60.8%) had the highest proportion of participants with high vaccine trust. The United States (12.8%), France (10.7%), Canada (10.2%) and the UK (8.8%) had the highest proportion of participants with low vaccine trust (Figure 1).

TABLE 1 Participant demographics by country.

	Total	Brazil	Canada	France	India	Nigeria	U.K.	U.S.
	n = 7,000	*n* = 1,000	*n* = 1,000	*n* = 1,000	*n* = 1,000	*n* = 1,000	*n* = 1,000	n = 1,000
Sex								
Female	50.1%	50.5%	50.0%	51.0%	49.5%	49.5%	50.0%	50.2%
Male	49.4%	49.4%	49.0%	48.5%	50.5%	50.5%	49.3%	48.9%
Non-binary	0.5%	0.1%	1.0%	0.5%	0.0%	0.0%	0.7%	0.9%
Age								
18–24	15.3%	17.8%	9.7%	10.5%	17.6%	28.4%	11.2%	11.7%
25–34	19.7%	22.4%	18.0%	15.2%	23.0%	23.4%	17.5%	18.1%
35–44	18.4%	17.4%	16.9%	16.5%	24.0%	21.5%	15.8%	16.8%
45–54	14.8%	16.2%	15.1%	14.7%	14.8%	13.1%	14.5%	15.5%
55–64	14.1%	13.5%	17.1%	16.4%	11.1%	7.5%	16.7%	16.7%
65 or older	17.6%	12.6%	23.1%	26.8%	9.4%	6.2%	24.3%	21.1%
Education								
No college degree	78.7%	83.0%	73.6%	82.1%	91.0%	91.4%	66.1%	64.0%
College degree or more	21.3%	17.0%	26.4%	17.9%	9.0%	8.6%	33.9%	36.0%
Average yearly income								
Below average	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Above average	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
Healthcare worker?								
Yes	6.8%	3.9%	6.9%	8.5%	6.6%	8.8%	7.3%	5.9%
No	93.2%	96.1%	93.1%	91.5%	93.4%	91.2%	92.7%	94.1%

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TABLE 2 Participant demographics associated with vaccine trust levels.

	Total	Brazil	Canada	India	Nigeria	UK
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Medium vaccine trust						
Age	0.981 (0.975–0.986) ***	0.989 (0.966–1.012)	0.983 (0.970–0.997)	1.019 (0.977–1.063)	0.996 (0.962–1.031)	0.971 (0.957–0.985)***
Gender: female *vs* male	1.111 (0.904–1.366)	1.637 (0.772–3.470)	1.631 (1.009–2.636)	2.065 (0.505–3.625)	0.534 (0.128–2.237)	0.946 (0.563–1.591)
Education: no college *vs* college	0.743 (0.545–1.013)	0.501 (0.120–2.090)	0.633 (0.321 1.249)	2.412(0.140–4.684)	0.937 (0.058–1.820)	0.575 (0.292–1.129)
Yearly income: below average *vs* above average	0.684 (0.551–0.849) ***	0.401 (0.177–0.909)	0.900 (0.549–1.475)	0.03 (0.001–0.978)*	0.037 (0.001–1.295)	1.636 (0.965–2.774)
High vaccine trust						
Age	0.986 (0.981–0.991)***	0.997 (0.975–1.018)	1.005 (0.992–1.018)	1.026 (0.983–1.070)	0.9670.9341.002	0.995 (0.982–1.009)
Gender: female *vs* male	0.959 (0.787–1.169)	2.347 (1.164–4.732)*	1.202 (0.761–1.897)	3.188 (0.787–5.589)	0.3320.081.385	0.695 (0.426–1.134)
Education: no college *vs* college	0.505 (0.375–0.679)***	0.359 (0.091–1.412)	0.378 (0.198–0.721)**	1.630 (0.096–3.164)	0.2750.0174.415	0.272 (0.144–0.514)***
Yearly income: Below average *vs* above average	0.505 (0.411–0.622)***	0.301 (0.140–0.651)**	0.609 (0.382–0.972)	0.027 (0.001–0.869)*	0.0290.0011.008	1.218 (0.741–2.003)

*$p < 0.01$; **$p < 0.005$; ***$p < 0.001$.

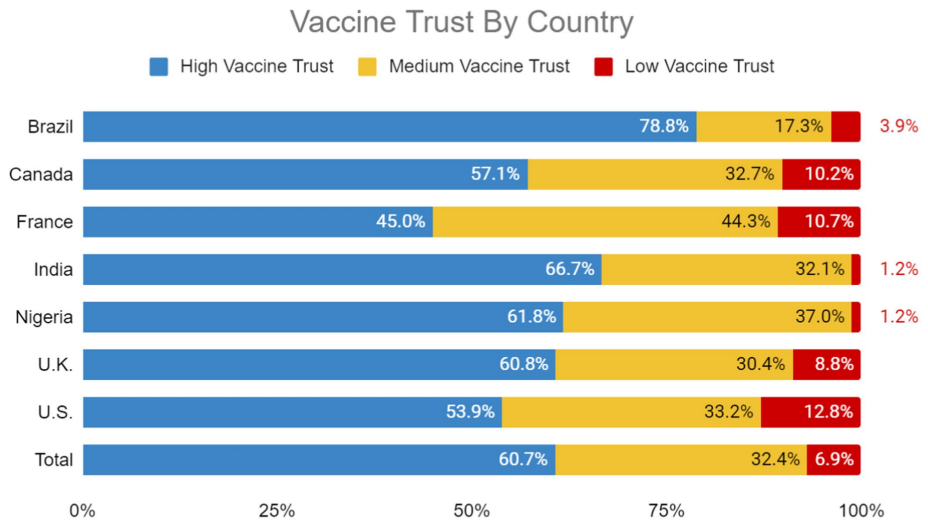

FIGURE 1
Vaccine trust by country.

3.3 COVID-19 vaccine perceptions

Overall, Brazil (82.9%), Nigeria (68.6%) and India (56.8%) were the countries most concerned about illnesses caused by COVID-19. They were also the countries with the most trust in the safety, efficacy and science behind COVID-19 vaccines. Brazil and India had the highest proportion of people who would continue to receive additional booster vaccines and reported the importance of ensuring the booster matches the current strain of COVID-19. 47.5% of respondents agreed that they trust traditional protein-based vaccines more than mRNA vaccines, 13.5% disagree and 39.0% are neutral about their trust in protein-based versus mRNA vaccines (Figure 2).

India (80.2%), Brazil (71.6%) and Nigeria (67.8%) were the countries that most reported that the pandemic and their knowledge

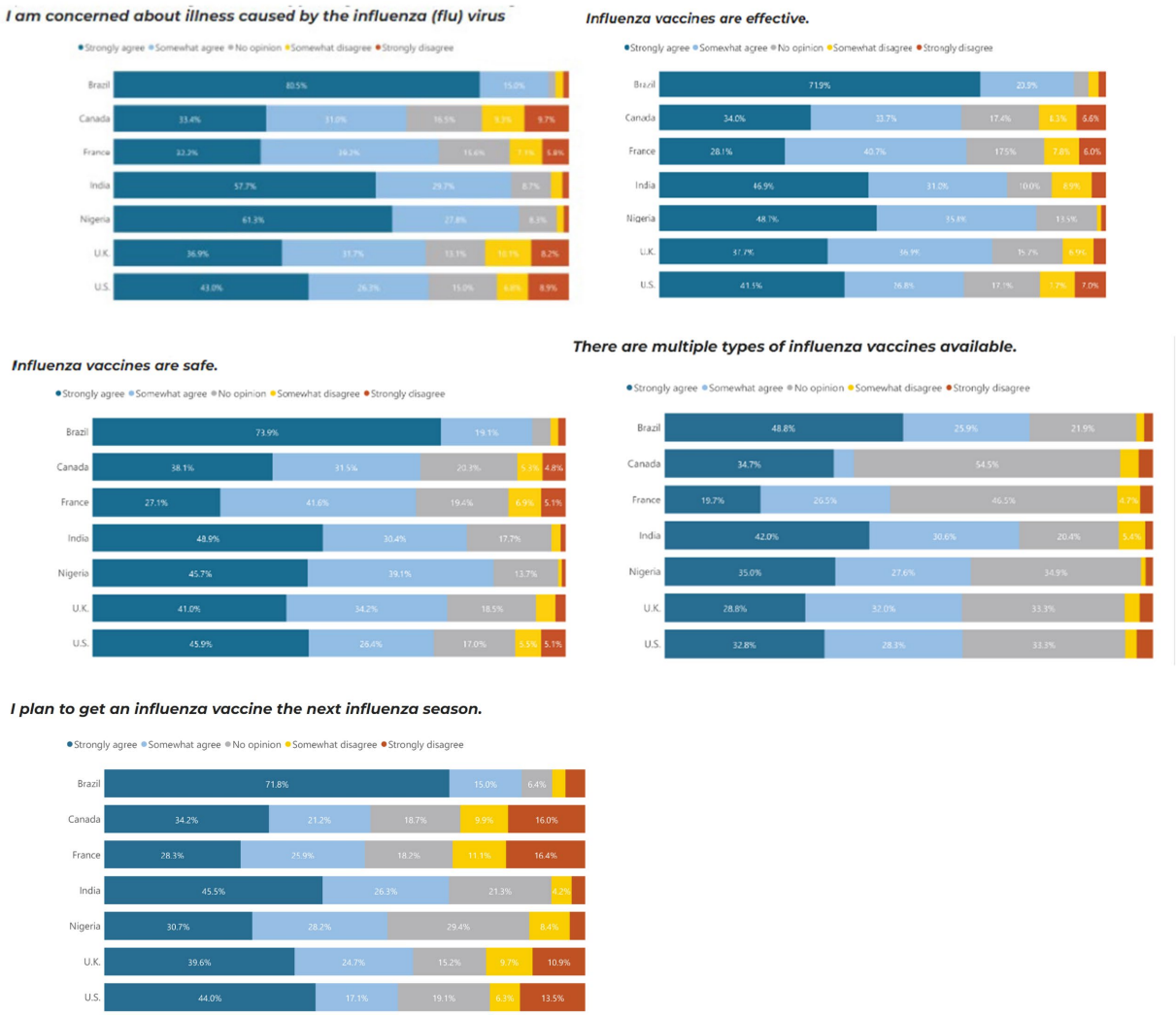

FIGURE 2
COVID-19 vaccine perceptions by country.

of COVID-19 vaccines changed their perspectives on other vaccines. Of those that said the pandemic impacted their perception of vaccines, increased concerns about the efficacy (72.7%) and safety (68.2%) of vaccines were the main impact of the pandemic on vaccine perceptions.

Table 3 shows the association between vaccine trust levels and COVID-19 perspectives. Those with high vaccine trust were more likely to agree with COVID-19 vaccine confidence sentiments regardless of country. Participants who were concerned about illness caused by COVID-19 had 2.5 times higher odds of having high vaccine trust compared to those who disagreed ($p < 0.001$). Participants who believe that COVID-19 vaccines are effective had 7.4 times higher odds of having high vaccine trust compared to those who disagreed ($p < 0.001$). Participants who agreed that COVID-19 vaccines are safe had 5.2 times higher odds of having high vaccine trust compared to those who disagreed ($p < 0.001$). Participants who agreed that they trust the science behind COVID-19 vaccines had 5.2 times higher odds of having high vaccine trust compared to those who disagreed ($p < 0.001$). Participants who agreed that they trust traditional vaccines more than mRNA vaccines had 17.2 times higher odds of having high vaccine trust compared to those who disagreed ($p < 0.001$).

3.4 Influenza vaccine perceptions

Similar to COVID-19, Brazil (80.5%), Nigeria (61.3%) and India (57.5%) were the countries most concerned about illnesses caused by influenza, and they were also the countries with the most trust in the safety, efficacy and science behind COVID-19 vaccines. In comparison, Brazil and Nigeria, the UK and the US were marginally more concerned about COVID-19 than influenza. Brazil and India had the highest proportion of people who would continue to receive additional booster vaccines and reported the importance of ensuring the booster matches the current strain of COVID-19 (Figure 3).

Those with high vaccine trust were more likely to agree with influenza vaccine confidence sentiments regardless of country. Individuals with a high level of concern about illness caused by the influenza virus have 1.9 times higher odds of having high vaccine trust

TABLE 3 Association between vaccine trust levels and COVID-19 perspectives.

	Total	Brazil	Canada	France	India	Nigeria	UK	US
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
High vaccine trust								
I am concerned about illness caused by COVID-19: agree *vs* disagree	2.456 (1.696–3.557)***		0.685 (0.274–1.713)	2.874 (1.085–7.612)	0.246 (0.005–1.569)	2.336 (0.313–11.424)	1.034 (0.391–2.734)	5.89 (2.556–13.569)***
I am concerned about illness caused by COVID-19: neutral *vs* disagree	1.111 (0.667–1.852)		0.578 (0.131–2.546)	0.688 (0.207–2.291)	0.935 (0.008–1.003)	0.986 (0.035–2.994)	1.245 (0.306–5.069)	1.738 (0.563–5.368)
COVID-19 vaccines are effective: agree *vs* disagree	7.361 (3.599–11.123)***	7.536 (1.236–13.936)	8.500 (1.355–15.531)	9.340 (1.589–15.904)	7.536 (1.236–13.936)	3.934 (0.130–6.307)	0.986 (0.035–2.994)***	1.790 (0.387–8.291)
COVID-19 vaccines are effective: neutral *vs* disagree	1.249 (0.732–2.13)	0.437 (0.0610–3.140)	2.026 (0.473–8.679)	2.416 (0.715–8.165)	4.253 (0.0161–9.210)	0.102 (0.013–0.790)	6.47 (1.562–6.831)*	0.387 (0.098–1.535)
COVID-19 vaccines are safe: agree *vs* disagree	5.221 (2.112–8.330)***	5.065 (0.740–10.069)	1.441 (0.213–9.769)	2.066 (1.821–2.519)	1.361 (0.007–3.770)	4.892 (0.149–8.946)	4.653 (0.527–9.101)	8.825 (1.688–19.775)
COVID-19 vaccines are safe: neutral *vs* disagree	0.931 (0.538–1.612)	2.567 (0.325–4.809)	1.466 (0.338–6.355)	0.716 (0.179–2.859)	1.771 (0.003–3.175)	6.851 (0.436–12.696)	0.901 (0.206–3.933)	0.643 (0.159–2.601)
I trust the science behind the COVID-19 vaccines: agree *vs* disagree	17.275 (6.846–27.704)***	1.409 (0.298–6.657)	1.834 (0.733–2.965)	3.561 (1.729–7.042)	0.563 (0.003–1.838)	0.199 (0.005–1.249)	6.239 (2.735–12.420)**	3.635 (1.162–7.288)
I trust the science behind the COVID-19 vaccines: neutral *vs* disagree	2.703 (1.548–4.72)***	0.874 (0.158–4.843)	4.261 (0.969–9.736)	2.616 (0.718–9.525)	0.886 (0.007–1.242)	0.821 (0.076–1.933)	4.341 (0.820–8.557)	2.675 (0.645–11.097)
I will continue to get boosted for COVID-19 vaccine if it is recommended to me: agree *vs* disagree	4.232 (1.946–9.207)***	8.433 (1.596–15.270)	1.137 (0.937–2.389)	1.253 (0.289–5.433)	1.253 (0.289–5.433)	2.221 (0.574–4.682)	1.518 (0.231–3 0.951)	4.313 (2.464–9.931)*
I will continue to get boosted for COVID-19 vaccine if it is recommended to me: neutral *vs* disagree	1.163 (0.674–2.007)	0.189 (0.034–1.051)	1.249 (0.331–4.720)	4.988 (1.223–8.337)	4.988 (1.223–8.337)	1.919 (0.653–2.869)	0.273 (0.05–1.488)	2.238 (0.677–7.394)
It is important that any booster vaccine I get matches the current circulating variant(s): agree *vs* disagree	4.758 (2.825–8.012)***	0.265 (0.031–2.301)	2.276 (0.602–8.608)	7.105 (1.603–14.485)*	7.426 (0.057–14.957)	1.354 (0.201–9.100)	2.678 (0.618–5.612)	9.957 (2.183–16.407)**

(Continued)

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TABLE 3 (Continued)

	Total	Brazil	Canada	France	India	Nigeria	UK	US
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
It is important that any booster vaccine I get matches the current circulating variant(s): neutral *vs* disagree	1.468 (0.909–2.371)	0.177 (0.017–1.795)	1.021 (0.320–3.260)	6.591 (1.646–12.391)*	10.347 (0.293–19.443)	0.244 (0.031–1.897)	0.946 (0.244–3.664)	2.032 (0.523–7.899)
I trust traditional vaccines (e g, protein-based vaccines) more than mRNA vaccines: agree *vs* disagree	5.206 (3.503–7.739)***	3.471 (0.973–5.969)	1.401 (0.528–3.718)	5.12 (1.984–13.211)***	6.591 (1.646–12.391)*	5.960 (0.683–11.044)	2.912 (0.8421–0.075)	6.249 (2.242–12.417)***
I trust traditional vaccines (e g, protein-based vaccines) more than mRNA vaccines: neutral *vs* disagree	2.544 (1.736–3.73)***	3.203 (0.825–5.581)	1.068 (0.388–2.937)	2.364 (0.991–5.643)	2.364 (0.991–5.643)	7.980 (0.876–15.694)	1.023 (0.310–3.373)	9.471 (3.496–17.655)***
Medium vaccine trust								
I am concerned about illness caused by COVID-19: agree *vs* disagree	2.319 (1.714–3.137)***	2.331 (1.458–3.118)***	1.667 (0.809–3.436)	2.462 (1.177–5.149)	0.145 (0.003–7.007)	2.392 (0.384–4.910)	1.512 (0.666–3.433)	2.627 (1.38–5.001)**
I am concerned about illness caused by COVID-19: neutral *vs* disagree	1.735 (1.148–2.621)*	1.735 (1.148–2.621)	2.793 (0.767–5.173)	0.898 (0.357–2.259)	3.474 (0.035–6.518)	0.506 (0.022–1.897)	1.876 (0.556–6.332)	1.186 (0.510–2.759)
COVID-19 vaccines are effective: agree *vs* disagree	3.729 (1.938–7.176)***	1.970 (0.479–8.102)	6.076 (1.212–11.455)	11.136 (2.155–19.556)**	2.462 (1.177–5.149)	2.093 (0.077–5.138)	3.912 (2.157–5.075)	0.950 (0.270–3.344)
COVID-19 vaccines are effective: neutral *vs* disagree	1.265 (0.838–1.910)	0.767 (0.177–3.315)	2.477 (0.843–7.281)	2.860 (1.040–7.861)	6.690 (0.028–12.475)	0.084 (0.014–0.504)*	2.443 (0.843–7.079)	0.769 (0.296–1.998)
COVID-19 vaccines are safe: agree *vs* disagree	3.875 (1.651–9.09)**	2.502 (0.481–3.048)	0.375 (0.069–2.020)	2.477 (0.843–7.281)	6.892 (0.041–17.669)	5.760 (0.189–11.623)	5.783 (0.776–11.084)	2.398 (1.763–3.731)
COVID-19 vaccines are safe: neutral *vs* disagree	1.674 (1.097–2.557)	2.780 (0.565–4.995)	1.428 (0.479–4.256)	0.674 (0.203–2.235)	1.428 (0.479–4.256)	2.112 (1.103–3.083)	1.778 (0.56–5.651)	1.318 (0.552–3.147)
I trust the science behind the COVID-19 vaccines: agree *vs* disagree	5.016 (2.063–7.969)***	1.057 (0.273–4.100)	0.375 (0.069–2.020)	7.921 (0.614–10.113)	0.202 (0.001–0.362)	0.069 (0.002–2.688)	4.234 (0.831–8.562)	3.041 (0.391–6.624)
I trust the science behind the COVID-19 vaccines: neutral *vs* disagree	2.37 (1.495–3.755)***	1.106 (0.318–3.845)	2.7140 (0.882–8.349)	3.302 (1.095–9.963)	1.138 (0.011–2.446)	0.294 (0.03–2.843)	8.255 (1.926–15.386)**	1.531 (0.530–4.419)

(Continued)

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TABLE 3 (Continued)

	Total	Brazil	Canada	France	India	Nigeria	UK	US
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
I will continue to get boosted for COVID-19 vaccine if it is recommended to me: agree *vs* disagree	1.657 (0.785–3.497)	1.665 (0.405–6.850)	4.743 (0.423–6.196)	0.399 (0.104–1.535)	3.302 (1.095–9.963)	0.442 (0.172–1.098)	0.272 (0.046–1.61)	6.253 (0.677–12.784)
I will continue to get boosted for COVID-19 vaccine if it is recommended to me: neutral *vs* disagree	1.458 (0.908–2.341)	0.742 (0.219–2.509)	1.542 (0.487–4.883)	3.098 (0.883–6.861)	0.399 (0.104–1.535)	5.220 (0.666–10.847)	0.233 (0.051–1.058)	1.477 (0.549–3.975)
It is important that any booster vaccine I get matches the current circulating variant(s): agree *vs* disagree	2.378 (1.555–3.636)***	0.127 (0.027–0.591)**	1.950 (0.663–5.733)	1.800 (0.0.684–4.733)	0.932 (0.008–1.374)	0.768 (0.128–4.613)	4.496 (1.394–8.505)	2.108 (0.71–6.256)
It is important that any booster vaccine I get matches the current circulating variant(s): neutral *vs* disagree	1.393 (0.988–1.966)	0.128 (0.026–0.639)	0.921 (0.409–2.077)	1.099 (0.482–2.505)	1.467 (0.048–2.450)	0.719 (0.107–4.812)	2.201 (0.829–5.846)	0.828 (0.394–1.74)
I trust traditional vaccines (e g, protein-based vaccines) more than mRNA vaccines: agree *vs* disagree	3.670 (2.602–5.177)***	4.141 (1.085–7.197)	2.680 (1.238–5.803)	8.147 (3.582–18.526)***	0.921 (0.409–2.077)	2.763 (0.327–4.323)	3.705 (1.379–9.955)*	4.233 (1.960–9.144)***
I trust traditional vaccines (e g, protein-based vaccines) more than mRNA vaccines: neutral *vs* disagree	2.267 (1.638–3.139)***	3.507 (0.848–6.166)	2.28 (1.001–5.190)	4.406 (2.109–9.205)***	2.680 (1.238–5.803)	5.575 (0.631–10.235)	1.807 (0.721–4.526)	4.53 (2.208–9.293)***

*$p < 0.01$; **$p < 0.005$; ***$p < 0.001$.

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compared to those with low vaccine trust ($p = 0.002$). Individuals who agree that influenza vaccines are effective have 3.5 times higher odds of having high vaccine trust compared to those with low vaccine trust ($p < 0.001$). Individuals who agree that influenza vaccines are safe have 18.7 times higher odds of having high vaccine trust compared to those with low vaccine trust ($p < 0.001$). Individuals who agree that they plan to get an influenza vaccine in the next season have significantly higher odds of having high vaccine trust compared to those who disagree ($p < 0.001$) (Table 4).

4 Discussion

We found a wide range of variation in vaccine trust across Brazil, Canada, France, India, Nigeria, the United Kingdom, and the United States. Like previous global surveys on vaccine confidence (14), lower- and middle-income countries like India, Nigeria and Brazil tended to have high vaccine trust which was strongly associated with positive perspectives of COVID-19 and influenza vaccines. We found variations in the strength of these associations between countries. A country's income level often correlates with vaccine uptake since perceptions of vaccine efficacy can vary significantly depending on the country's economic context. Within high-income countries, elevated distrust in vaccine efficacy may be attributed to the belief in conspiracy theories, institutional distrust in vaccine administration, distribution, and marketing (7).

Our results parallel other research that shows that demographic characteristics like older age, people with no college education and those with lower incomes were less likely to have high vaccine trust (6, 18). These intersecting personal attributes that shape an individual's perceptions are a main driving force in vaccine acceptability and likelihood of opting to get vaccinated (2). Our findings align with previous research, showcasing that individuals with greater levels of education, minimal financial hardship, and firsthand experience with COVID-19 demonstrate greater inclination to trust science, which is associated with a higher likelihood of vaccine uptake (19). Understanding these associations can aid in tailoring immunization campaigns to specific population characteristics and needs For example, understanding vaccine trust in older age groups may help to better tailor immunization programs to older adult populations who may be at higher risk of being hospitalized if they contracted COVID-19, influenza or other respiratory illnesses (20). Given that populations exhibit varying levels of trust in vaccines, when factoring in dimensions such as race, ethnicity, political affiliation, and religion, it is essential to recognize the heterogeneity within these groups (21). The diverse intersections of identities within these subpopulation can result in a variety of perspectives on vaccination, further underscoring the importance for tailored interventions that address the specific nuances of these communities.

Data suggests that intent to get a COVID-19 booster vaccine decreased from 87.9 to 71.6% in 2023 which is a cause for concern across the globe (17). However, the same study also showed that about 60% of people are more willing to get vaccinated for other non-COVID-19 vaccines due to their experiences throughout the pandemic (17). Our study showed that a higher level of concern about influenza, a strong belief in the effectiveness and safety of influenza vaccines, awareness of multiple vaccine types, and intention to get vaccinated are all associated with significantly higher odds of having high vaccine trust. A low-risk perception of COVID-19 was seen within underserved communities. It's hypothesized that navigating the COVID-19 infodemic has led to misconceptions, and negative attitudes toward vaccination which have impacted underserved communities (22). A lack of access to trustworthy information coupled with socio-economic challenges present within underserved communities may hinder health literacy and reduce trust in public health efforts. As a result, underserved communities are disproportionately susceptible to misinformation and less inclined to recognize the advantages associated with vaccination (23, 24).

Almost half of all respondents agreed that they trust traditional protein-based vaccines more than mRNA vaccines, and around 40% are neutral. While both mRNA and traditional vaccines have been found to be safe and efficacious for COVID-19 (25), there is still a public preference for protein-based vaccines or no preference at all. Leveraging people's concerns about COVID-19 and influenza instead of focusing on vaccine technology has been suggested as more beneficial (26). Differences in vaccine preferences can be attributed to overall availability in vaccines within an individual's respective country. These protein-based vaccines are more prevalent in LMICs due to mRNA vaccines requiring specific infrastructure to adhere to cold-chain protocols (27). This poses a challenge to rural areas as they may not have the capacity to utilize mRNA vaccines on a widespread scale (27). Further expanding on the educational efforts to provide supplemental information regarding mRNA vaccines to individuals residing in lower-income countries is vital in increasing overall vaccine uptake when available (28).

Our results raise crucial questions about the determinants and potential implications for public health strategies. Increasing overall vaccine trust may be the key to improving respiratory vaccine uptake (17). Instead of focusing on marketing individual respiratory vaccines, efforts spent promoting overall vaccine trust may have positive implications for improving COVID-19 and influenza vaccine trust. Utilizing community-based interventions to build mutualistic relationships between vaccine providers and their associated community can provide trust building opportunities, and result in greater rates of vaccine uptake (29). Identifying specific concerns, building trust in healthcare systems, and improving communication strategies may also contribute to fostering a positive perception of vaccines. Furthermore, lessons can be learned from countries with high vaccine trust to inform best practices and potential strategies for enhancing public confidence in vaccinations.

Our study has limitations given that the survey was taken at one point in time in August 2023, after the World Health Organization officially declared the COVID-19 pandemic "over" and does not reflect the changing landscape of vaccinations. However, the survey was conducted in all seven countries at the same time, which allows us to compare the different perspectives at the same point in time. A strength of the project was using a stratum-based sample design which resulted in a sample that best represents the entire population of each country.

5 Conclusion

These findings show that there are differences in vaccine trust across the world. Therefore, tailoring information to the individual context may be valuable for public health immunization programs. Additionally, we found that overall vaccine trust levels are associated with confidence in COVID-19 and influenza vaccines. By understanding variations across

TABLE 4 Influenza vaccine perceptions by country.

	Total	Brazil	Canada	France	India	Nigeria	UK	US
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
High vaccine trust								
I am concerned about illness caused by influenza: agree *vs* disagree	1.858 (1.264–2.73)**	5.545 (0.649–9.388)	0.644 (0.257–1.618)	1.537 (0.598–3.953)	1.537 (0.598–3.953)	1.728 (0.201–2.861)	2.86 (1.238–6.607)	1.924 (0.816–4.534)
I am concerned about illness caused by influenza: neutral *vs* disagree	0.858 (0.552–1.334)	2.307 (0.099–4.518)	1.56 (0.526–4.626)	0.721 (0.273–1.903)	0.721 (0.273–1.903)	25.441 (0.365–38.826)	2.139 (0.804–5.692)	0.388 (0.133–1.136)
Influenza vaccines are effective: agree *vs* disagree	3.483 (2.141–5.665)***	5.211 (0.446–10.904)	1.617 (0.468–5.583)	2.428 (0.762–7.732)	2.428 (0.762–7.732)	1.339 (0.04–2.457)	4.066 (1.276–8.958)	9.27 (2.097–16.984)**
Influenza vaccines are effective: neutral *vs* disagree	1.637 (1.041–2.573)	1.085 (0.109–1.788)	1.1 (0.388–3.119)	1.079 (0.384–3.026)	1.079 (0.384–3.026)	0.484 (0.014–2.216)	2.356 (0.754–7.358)	3.612 (0.817–6.964)
Influenza vaccines are safe: agree *vs* disagree	18.714 (10.605–26.026)***	1.531 (0.051–3.57)	3.84 (0.1795–6.857)***	6.529 (3.872–9.551)***	4.529 (1.872–7.551)***	4.009 (0.043–7.351)	3.84 (0.1795–6.857)***	8.391 (2.861–12.605)***
Influenza vaccines are safe: neutral *vs* disagree	2.842 (1.688–4.785)***	1.23 (0.049–5.946)	3.849 (1.022–6.489)	3.543 (1.176–10.677)	3.543 (1.176–6.677)	2.089 (0.029–4.56)	1.861 (0.498–6.953)	3.214 (0.559–6.466)
There are multiple types of influenza vaccines available: agree *vs* disagree	5.996 (3.798–9.467)***	19.341 (2.936–27.39)	9.966 (5.714–15.929)***	10.462 (3.764–17.076)***	10.462 (3.764–17.076)***	0.86 (0.017–1.028)	2.312 (0.924–5.783)	5.463 (1.307–7.826)
There are multiple types of influenza vaccines available: neutral *vs* disagree	3.141 (1.941–5.083)***	2.666 (0.177–5.136)	8.404 (2.45–16.826)***	4.623 (1.572–13.6)*	4.623 (1.572–7.6)*	1.306 (0.023–2.558)	1.547 (0.522–4.59)	1.898 (0.397–4.078)
I plan to get an influenza vaccine the next influenza season: agree *vs* disagree	8.21(5.361–12.574)***	9.542(6.637–12.742)	9.318(2.96–17.336)***	1.47(0.5483.944)	1.47(0.548–3.944)	6.488(5.921–7.118)***	8.391(2.861–12.605)***	6.837(2.569–11.196)***
I plan to get an influenza vaccine the next influenza season: neutral *vs* disagree	1.941 (1.349–2.794)***	4.021 (0.629–8.688)	5.757 (2.051–10.163)***	0.952 (0.39–2.32)	0.952 (0.39–2.32)	10.171* (2.051–18.442)	1.259 (0.526–3.011)	2.171 (0.896–5.256)

(Continued)

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TABLE 4 (Continued)

	Total	Brazil	Canada	France	India	Nigeria	UK	US
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Medium vaccine trust								
I am concerned about illness caused by influenza: agree *vs* disagree	2.031 (1.444–2.857)***	7.617 (1.564–14.103)	0.86 (0.384–1.928)	2.218 (0.962–5.115)	2.218 (0.962–5.115)	2.299 (0.274–4.285)	2.517 (1.162–5.452)	1.091 (0.512–2.322)
I am concerned about illness caused by influenza: neutral *vs* disagree	1.076 (0.738–1.568)	0.582 (0.045–7.491)	1.79 (0.683–4.694)	1.436 (0.643–3.208)	1.436 (0.643–3.208)	6.859 (0.526–12,251)	2.176 (0.922–5.134)	0.414 (0.169–1.017)
Influenza vaccines are effective: agree *vs* disagree	1.023 (0.669–1.566)	1.599 (0.17–3.055)	1.222 (0.4–3.729)	1.94 (0.688–5.468)	1.94 (0.688–5.468)	7.917 (0.21–14.52)	0.938 (0.353–2.491)	0.332 (0.125–0.887)
Influenza vaccines are effective: neutral *vs* disagree	0.94 (0.654–1.352)	1.379 (0.216–8.795)	1.301 (0.557–3.039)	1.015 (0.434–2.375)	1.015 (0.434–2.375)	3.378 (0.09–6.775)	1.215 (0.51–2.895)	0.592 (0.25–1.4)
Influenza vaccines are safe: agree *vs* disagree	5.672 (3.64–8.838)***	0.228 (0.018–2.855)	7.086 (2.274–13.08)***	6.582 (2.26–10.172)***	6.582 (2.26–10.172)***	0.685 (0.008–1.365)	9.53 (2.992–18.352)***	5.513 (2.272–8.377)***
Influenza vaccines are safe: neutral *vs* disagree	2.062 (1.447–2.939)***	0.146 (0.016–1.288)	1.043 (0.471–2.314)	1.926 (0.849–4.368)	1.926 (0.849–4.368)	0.524 (0.008–1.475)	2.96 (1.183–4.407)	1.687 (0.722–3.942)
There are multiple types of influenza vaccines available: agree *vs* disagree	4.277 (2.941–6.222)***	7.818 (1.552–24.388)	9.68 (3.659–14.606)***	8.045 (3.377–13.165)***	8.045 (3.377–14.165)***	0.401 (0.009–1.394)	2.038 (0.891–4.662)	5.796 (2.317–8.499)***
There are multiple types of influenza vaccines available: neutral *vs* disagree	2.327 (1.605–3.374)***	8.178 (0.955–27.067)	3.411 (1.489–7.816)**	4.877 (2.082–7.423)***	4.877 (2.082–6.423)***	0.854 (0.016–1.539)	1.624 (0.663–3.978)	1.288 (0.512–3.239)
I plan to get an influenza vaccine the next influenza season: agree *vs* disagree	2.255 (1.492–3.408)***	6.529 (1.488–12.649)	1.841 (0.609–5.562)	0.664 (0.258–1.708)	0.664 (0.258–1.708)	12.332 (1.826–21.269)	3.695 (1.29–5.581)	3.818 (1.513–9.634)*
I plan to get an influenza vaccine the next influenza season: neutral *vs* disagree	1.918 (1.384–2.658)***	7.209 (1.174–14.28)	3.115 (1.202–8.074)	0.741 (0.33–1.665)	0.741 (0.33–1.665)	9.684 (1.984–17.265)	1.181 (0.551–2.533)	3.134 (1.511–6.499)**

*$p < 0.01$; **$p < 0.005$; ***$p < 0.001$.

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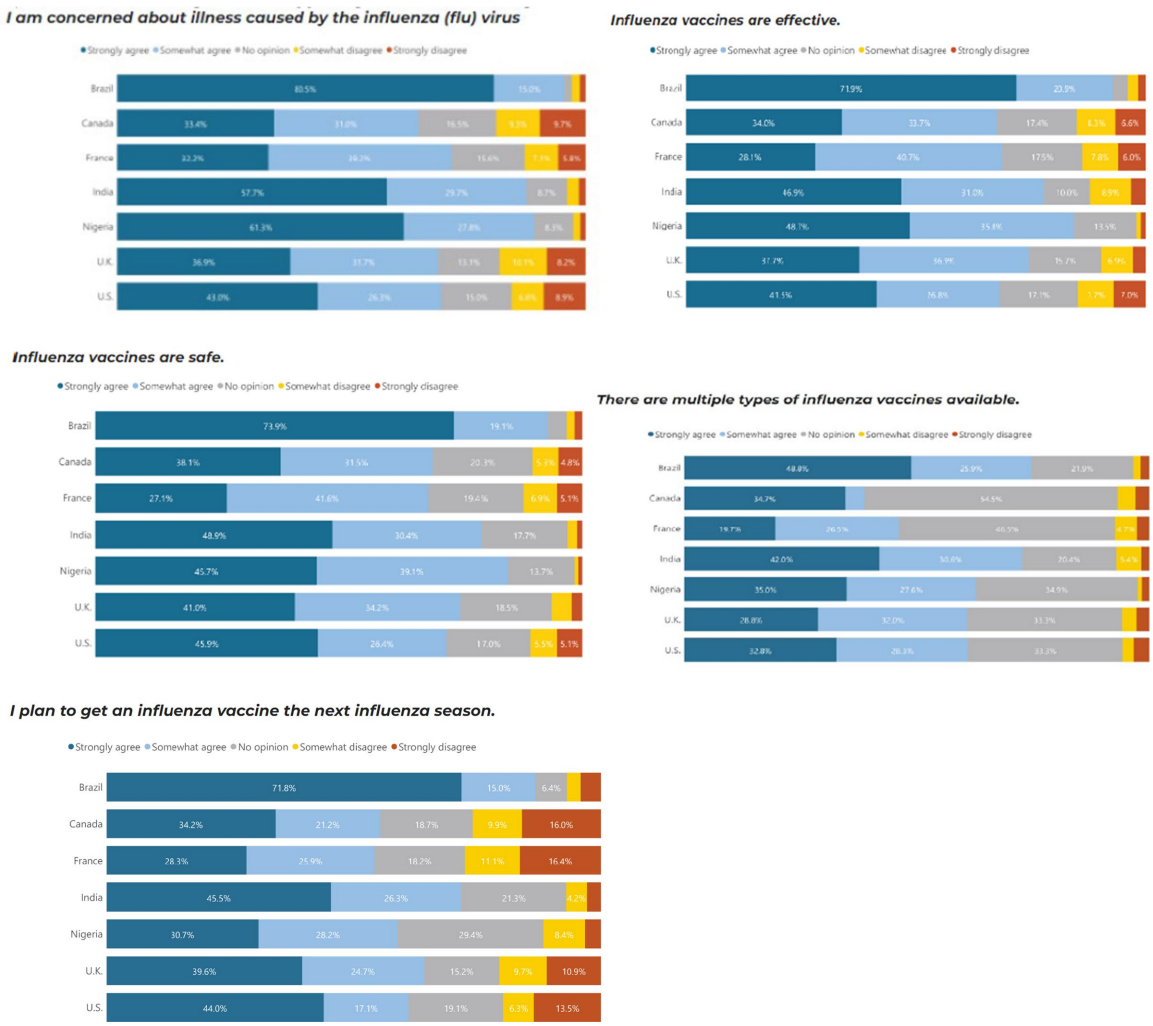

FIGURE 3
Influenza vaccine perceptions by country.

countries, public health officials can develop targeted and culturally sensitive messaging that enhances the likelihood of successful vaccine uptake within specific communities. These differences highlight the importance of context-specific considerations and the need for comprehensive cross-cultural analysis to refine public health strategies and interventions tailored to each country's unique circumstances. Tailoring interventions can ultimately contribute to achieving higher vaccination rates and fostering a more resilient and responsive global health landscape.

Data availability statement

All relevant data are presented in the article/Supplementary material. Further inquiries can be directed to the corresponding author.

Ethics statement

The requirement of ethical approval was waived by Emerson College Human Research Subjects Committee/Institutional Review Board (IRB) for the studies involving humans because this project was reviewed and deemed exempt from research by Emerson College's Institutional Review Board (protocol number 22-019-F-X). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin because this project was reviewed and deemed exempt from research by Emerson College's Institutional Review Board (protocol number 22-019-F-X).

Author contributions

CD: Data curation, Formal analysis, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. MF: Conceptualization, Writing – original draft, Writing – review & editing. JH: Conceptualization, Funding acquisition, Methodology, Supervision, Writing – original draft, Writing – review & editing. KR: Writing – original draft, Writing – review & editing. SR: Conceptualization, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing.

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Conflict of interest

CD, MF, and JH are employed by 19 to Zero Inc., the sponsors of this special topic.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2024.1406861/full#supplementary-material

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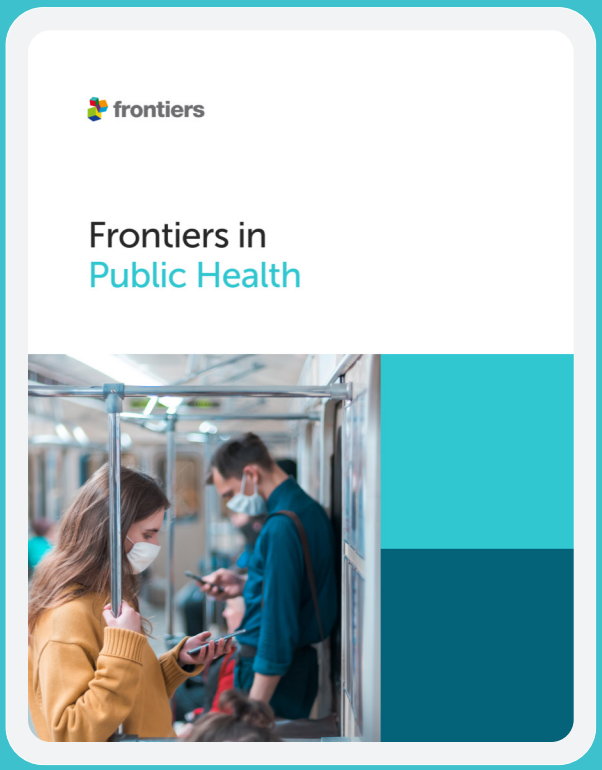

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