Prepared under the Digital Results Improve Vaccine Equity and Demand (DRIVE Demand) Project

Barriers and Enablers: Behavioral Dynamics of COVID-19 Vaccinations in Low- and Middle- Income Countries

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Authors: Janeth Amwoma, Julia Hammann, Rowan Harrity, Jonathan Karl, Justin Kinyera, Samuel Oyegunle, Anna Yalouris
Co - Authors: Heidi Good and Claudia Harner-Jay
Reviewers: Abby Minor and Kenzy Tynuv
Copy editor: Mara Lavery

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Acronyms

CBO	community-based organization
CHW	community health worker
COM-B	Capability, Opportunity, and Motivation Behavior (model)
COVAX	COVID-19 Vaccines Global Access
COVID-19	coronavirus disease 2019
DRIVE Demand	Digital Results Improve Vaccine Equity and Demand
HBM	Health Belief Model
HCW	health care worker
LMIC	low- and middle-income countries
MOH	ministry of health
SCT	Social Cognitive Theory
TPB	Theory of Planned Behavior
UNICEF	United Nations Children's Fund
Vax Up	Vaccine Acceptance and Uptake Programme
WHO	World Health Organization

Introduction

Busara's literature review for DRIVE Demand

The Digital Results Improve Vaccine Equity and Demand (DRIVE Demand) project is a two-year, US$5 million partnership implemented by PATH's Digital Square initiative with social research support from Busara Center for Behavioral Economics to deploy and expand the use of digital health tools in Honduras, Mali, Tanzania, Thailand, Uganda, and Zambia. Through DRIVE Demand, the partners are aiming to help ministries of health (MOHs) use digital technologies to understand, track, and influence demand for immunizations. Ultimately, it will support target countries' effort to reach national COVID-19 and routine immunization targets, while strengthening data-driven health systems in Asia, the Caribbean, and sub-Saharan Africa.

To understand the essential behavioral dynamics impacting COVID-19 vaccine uptake in low- and middle-income countries (LMIC), this literature review examined key barriers and levers influencing vaccine demand. Specific emphasis in this review has been placed on literature from the project's four African exemplars: Mali, Tanzania, Uganda, and Zambia. This review included peer-reviewed, white, and gray literature but excluded blogs, opinion pieces, and news articles. In all, Busara reviewed 179 sources, scanning for key words and phrases (e.g., digital health, COVID-19, vaccine, hesitancy, acceptance, determinants, attitudes, Africa, infodemic, risk communication, community engagement, social and behavior change communication, public health preparedness and response, motivation, opportunity, capability, consistency, trust, and the like).

Guided by the operational footprint of DRIVE Demand, this literature review studied the behavioral and structural determinants of COVID-19 immunization in LMIC, referring to countries classified by the World Bank as low- or middle-income that are in Africa, Asia, Oceania, Latin America, and the Caribbean. Our work first prioritized examination of the four African DRIVE Demand countries (Mali, Tanzania, Uganda, and Zambia) before turning to broader research findings applicable to LMIC. Our emphasis on literature from LMIC recognized the unique cultural, social, and environmental determinants of COVID-19 immunizations that define LMIC's experience.

The review team framed our analysis of the literature around the **Capability**, **Opportunity**, and **Motivation of Behavior (COM-B) model** for a systematic approach to understanding influence, behavior, and behavior change:[1]

- **Capability**: Capability refers to an individual's psychological and physical capacity to engage in a particular behavior, such as knowledge and cognitive abilities, as well as mobility.
- **Opportunity**: Opportunity refers to the external factors that enable or hinder the occurrence of a behavior. This includes the physical, social, and economic environment in which the desired behavior occurs. There are three sub-components of opportunity:
    - **Physical opportunity** refers to availability of the resources, time, and physical spaces required to perform the behavior.
    - **Social opportunity** relates to social and cultural factors such as social norms, social support, and the social impact of others who influence the desired behavior.
    - **Economic opportunity** encapsulates financial and economic factors such as the cost, affordability, and accessibility of the resources required to engage in the desired behavior.
- **Motivation**: Motivation refers to **reflective** and **automatic** brain processes that drive behavior and decision-making. Reflective motivation involves conscious decision-making processes and beliefs about the behavior, such as attitudes, beliefs, intentions, and goal setting. Automatic motivation includes the unconscious or automatic processes influencing behavior, such as habits, impulses, emotions, and automatic responses. In our literature review, we have examined reflective and automatic processes through a discussion of risk perception, trust and credibility,

agency, social influence, beliefs, and attitudes, all of which determine reflective and automatic decision-making processes.

Applying the COM-B model, we defined specific sub-components influencing each of the COM-B nodes (Capability, Opportunity, and Motivation). During our initial review of the literature, the findings were mapped to each sub-component of COM-B before conducting a synthesis of the literature under each. Studies that were reviewed and selected explore the psychological and physical capabilities for vaccine acceptance, the environmental opportunities that enable or hinder vaccination behavior, and the motivational factors influencing vaccine decision-making, as well as the effects of trusted messengers, digital delivery channels, and community-based pathways for vaccine promotion and uptake. By synthesizing findings within the COM-B framework, the literature review produced insights into viable strategies to enhance vaccine demand in the focus countries based on available evidence.

To this end, this literature review was intended to establish a foundational knowledge base describing the behavioral barriers and levers of immunization uptake, vaccine-seeking behavior, and vaccine hesitancy to serve as a pivotal thought leadership document providing a synthesis of currently available global research. It includes major global- and country-based research, synthesized findings on the effectiveness of sharing social and behavior change messaging through digital channels, and findings on COVID-19 vaccine hesitancy and acceptance.

This literature review is built upon previous work completed by Busara in the space of COVID-19 vaccine uptake and acceptance in LMIC. In particular, it is enabled by research conducted by Busara and its partners such as that per the linked page: Vaccine Acceptance and Uptake Programme (Vax Up). Collecting insights on behavioral levers and barriers facilitating or impeding COVID-19 vaccinations globally, Vax Up has explored the factors influencing individuals' perceptions of and decisions to seek vaccination. By drawing on psychology, anthropology, economics, and sociology, the Vax Up initiative provides insights into the contextual, cultural, environmental, and behavioral dynamics influencing vaccine hesitancy and vaccine-seeking behaviors.

With these insights, the Vax Up partners—Busara, Common Thread, and Save the Children—have produced tailored, context-specific guidance for public health agencies to address vaccine hesitancy, foster trust, and bridge the intention-action gap. To date, Vax Up has produced such influential documents as The Little Jab Book: 18 Behavioral Science Strategies for Increasing Vaccination Uptake; The Little Jab Aid: 5 Ideas to Increase COVID-19 Vaccination for Teachers in Middle East and North Africa (MENA); The Little Jab Aid: 5 Ideas to Increase COVID-19 Vaccination for Women in Middle East and North Africa (MENA); and country-specific guidance for Nepal, Kenya, Papua New Guinea, and the Philippines.

This review is also built upon the foundational actions of global vaccine initiatives working to increase demand for COVID-19 vaccines and accelerate global vaccine equity while driving understanding, synthesis, and insights generation around vaccine demand considerations to improve vaccination rates in under-immunized communities. This literature review likewise builds from global research supported by Gavi, the Vaccine Alliance through the COVID-19 Vaccines Global Access (COVAX) initiative, a multilateral effort that is co-led by the Coalition for Epidemic Preparedness Innovations, Gavi, and the World Health Organization (WHO) and that began in April 2020 at the start of the pandemic to support equitable development, procurement, and delivery of COVID-19 vaccines globally.

These initiatives underscore the importance of diagnosing the contextual, social, cultural, and environmental dimensions that influence vaccine acceptance and uptake and demonstrate the need for public health agencies to conduct primary and secondary research and analysis to inform interventions promoting vaccination. Through this literature review, Busara sought to add to the work of Vax Up, the Global Vaccination Initiative, and broader immunization uptake initiatives, including Gavi's Phase 5 strategy (Gavi 5.0), to strengthen the leadership and contributions toward vaccine equity made by the DRIVE Demand project.

Context of the global COVID-19 pandemic

The global COVID-19 pandemic has underscored the importance of equitable vaccine distribution, particularly in LMIC. Despite considerable efforts to enhance access to COVID-19 vaccines, global vaccine uptake remains insufficient. The global health community, including the COVAX initiative, has taken steps to expand availability of COVID-19 diagnostics, treatments, and vaccines. Collaborative initiatives between organizations like Gavi and vaccine manufacturers such as Pfizer, Moderna, and AstraZeneca have yielded agreements to supply COVID-19 vaccine doses to lower-income countries.

Despite these initiatives, gains in the promotion and uptake of COVID-19 vaccines are limited. According to The Rockefeller Foundation, "only 15% of people in low-income countries have received at least one dose of a COVID-19 vaccine,"[2] and the reviewed literature highlights the demographic, structural, and psychological factors contributing to muted uptake, which are further detailed below.

Indeed, research has identified that a major contributing factor to the challenges associated with the promotion and uptake of COVID-19 vaccines is vaccine hesitancy, as vaccine hesitancy has been strongly linked with an overall decline of routine immunizations and COVID-19 vaccination coverage. For example, a study in India found that even a 1 percent increase in vaccine hesitancy can lead to a decline in vaccination coverage of 30 percent.[3] While this study focused primarily on COVID-19 vaccination hesitancy, the authors draw a strong linkage between the dynamics of the pandemic and broader losses in routine immunization coverage. This finding correlates with a report from WHO which notes that routine child immunizations have dropped to their lowest rates in 30 years, with an estimated 25 million children missing out on lifesaving vaccines.[4]

To address these issues, it is necessary to develop a stronger understanding of the landscape of vaccine hesitancy. Moreover, there is a need to understand the behavioral, cultural, and environmental dimensions that drive vaccine hesitancy and suppress vaccine uptake. To this end, Busara, through the DRIVE Demand project, intends to provide a thorough investigation of the literature using a behavioral lens to highlight best practices, identify broad trends and essential questions, and preview potential enablers of vaccine uptake for public health practitioners in LMIC.

Literature review summary using the COM-B model

Capability

Our review of the literature highlights the influence of demographic characteristics in acceptance of, as well as attitudes and behaviors toward, COVID-19 immunizations and their uptake. Many studies reviewed reveal that women in LMIC often exhibit lower vaccine acceptance, and as a result, interventions that develop gender-specific communication strategies are vital for enhancing vaccine access and coverage,[5–8] as well as mitigating gender-based disparities.[9,10]

Similarly, the reviewed literature highlights the role of age in outcomes of vaccine uptake and hesitancy, though these findings are not necessarily consistent across countries and contexts. For example, a portion of the reviewed literature, specifically in Uganda and Tanzania, indicates that older adults (65 years old and older) demonstrate a higher inclination to receive the vaccine.[11,12] However, a study conducted in West Africa found the opposite, that traditional beliefs and cultural factors inspired higher rates of vaccine hesitancy and distrust among older populations.[13] Interestingly, findings from South Africa highlight that young people are more likely to change their attitudes toward COVID-19 vaccinations than older populations, underscoring that public health agencies may do well to focus communication campaigns and outreach activities on youth.[14] The takeaway here is that age is certainly an important influencing factor, but its influence on vaccine hesitancy and uptake is not consistent, and context-specific research should be done by public health agencies and researchers to better understand how to address age-related differences in target populations.

Educational attainment was also found to be strongly associated with lower rates of vaccine hesitancy. Individuals with higher education levels tend to exhibit greater willingness to be vaccinated, driven by their privileged access to reliable information about COVID-19 and vaccines, which in turn instills trust in health care professionals.[15] Correspondingly, surveys in Uganda underscored the

positive association between higher education and vaccine uptake, as informed individuals proactively safeguard themselves and their communities.[11] These studies indicate that individuals with higher education levels are more likely to have received, or be willing to receive, COVID-19 vaccination. This may be attributed to their access to accurate information, awareness of vaccination benefits, trust in health care professionals, and better understanding of the importance of vaccination.

Finally, the reviewed literature demonstrates the important role that digital tools play in the capability of individuals to access and make decisions related to COVID-19 vaccines. Existing literature unveiled the significance of digital tools in vaccine acceptance and the challenges posed by limited access. Studies explored the relationship between digital tools and COVID-19 vaccine acceptance, revealing their potential to empower informed decision-making and address barriers. Global mobile device subscriptions and social media usage have facilitated information dissemination and countered hesitancy.[16] However, social media's dual impact was evident, with platforms both countering and promoting hesitancy.[17] Digital tools are observed to enhance agency for vaccine decisions while also perpetuating misinformation.[18,19] Notably, gender disparities in digital technology adoption were found to be persistent, impacting women's access to vaccination-related resources and information. Policies fostering digital literacy and skills training are essential to empower women in COVID-19 vaccination efforts.[20]

Opportunity

The literature considered in this review emphasizes the importance of convenience in the opportunity of individuals to access COVID-19 vaccinations. Logistical challenges—including but not limited to long distances, unfavorable operating hours, vaccine availability, confusion on where or how to access vaccines, appointment availability, and transportation challenges—were found to contribute significantly to COVID-19 vaccine hesitancy and challenges to uptake. Geographical barriers to accessing health centers negatively impacted women’s COVID-19 vaccination numbers in particular.[21–24] Furthermore, there were digital obstacles observed in accessing online COVID-19 vaccination registration platforms due to poor online access and literacy.[22,25]

The literature review also highlights the opportunity cost associated with health seeking that many must balance to access COVID-19 vaccinations. The financial burden faced by many included but was not limited to purchase expenses, delivery and administration costs, and indirect outlays, such as transportation and potential income loss.[26–28] This extended beyond mere vaccine pricing to include clinic fees, time away from work, and other financial considerations.[27,28] Particularly impactful in LMIC, studies revealed that these financial constraints hinder vaccine accessibility, with marginalized communities facing significant challenges due to out-of-pocket vaccine expenses.[29]

Likewise, the reviewed literature describes how vaccine hesitancy and acceptance are heavily impacted by the dimensions of governing entities within the health care system. These dynamics are influenced by capacity challenges among health care providers, as well as limitations such as time constraints, workload pressure, along with compromised mental health due to exposure to distressing media content and societal pressures.[30,31] Health care workers (HCWs) also grappled with ways to disseminate accurate information about vaccine safety and efficacy to citizens amid conflicting data.[32]

Moreover, findings demonstrate that competing demands and cultural influences shape the intricate interplay of prioritization and alternatives in the pursuit of robust COVID-19 vaccine uptake.[33,34] These multifaceted barriers, more pronounced in LMIC, involve navigating health needs, cultural beliefs, and occupational commitments.[35–37] Research underscores the impact of vaccine prioritization and the sway of alternative health practices, highlighting the need for culturally sensitive communication to counter misconceptions.[34] Women, who often juggle various roles, face challenges in prioritizing vaccination, spurring flexible schedules as a potential solution.[38–40]

Motivation

In the dynamic landscape of COVID-19 vaccination, the intertwined concepts of agency and confidence stand as pivotal determinants for an individual’s motivation to seek vaccination. The literature has described agency as rooted in the capacity for autonomous decision-making, intersecting with confidence and trust.[41] A person's motivation to seek vaccinations, therefore, is

influenced by a number of converging and context-specific factors, including demographic factors described in the "**Capability**" section, as well as social influence and knowledge, the effects of misinformation, and a person's convictions.

Reviewed literature highlights that social influence exerts a powerful role in shaping individual attitudes and behaviors, driving decisions and actions in vaccine acceptance and uptake. Some governments have employed informational social influence by revealing vaccination rates, although this may be less effective due to distrust in governments and misinformation.[42–44] Religious leaders have been found to significantly impact their followers' attitudes and health-seeking behaviors, either endorsing or discouraging vaccination, as observed in anti-vaccine campaigns within religious gatherings.[45,46] Peer influence also has been observed to play a pivotal role, where friends, neighbors, and media affect individuals' vaccine attitudes.[22] Stigma and misinformation from peers and caregivers also influenced vaccine hesitancy, similar to challenges seen in human papillomavirus vaccine uptake.[47] Leveraging community networks and leaders is suggested to effectively improve immunization uptake, necessitating stakeholder collaboration and prioritizing community health workers (CHWs) as vital vaccine advocates.

Studies reviewed by Busara revealed that mental models, influenced by experiences and perceptions, exert immense influence on the shape of attitudes toward vaccination.[48,49] Moreover, reviewed literature underscores the role of misinformation, social networks, and political influences in shaping hesitancy.[6,50] Effective interventions involved encouraging community-based organizations (CBOs) to engage empathetically with their communities, having trusted messengers present vaccine information, addressing misconceptions, and employing the Health Belief Model (HBM) to enhance vaccine acceptance.[6,15,49,51]

Behavior: Factors to consider in the promotion of COVID-19 vaccination

Through Busara's review of the literature, it was clear that a complex nexus of structural, contextual, environmental, and behavioral factors influenced vaccine hesitancy and uptake in LMIC. The literature strongly highlights that public health agencies must consider the structural barriers which impeded vaccine uptake—such as availability, affordability, and adequately trained CHWs—before developing the behavioral features that impact vaccine hesitancy and uptake. Thus, it was suggested through this literature review that public health donors and implementing partners supporting local MOHs in program implementation for the uptake of vaccines should consider layered interventions: structural interventions that address core access, availability, and management challenges and behavioral interventions that respond to cultural, contextual, and environmental factors that dissuade the uptake of immunizations.

Moreover, the literature review indicates that public health agencies aiming to support MOHs should consider commissioning context-specific research that includes the following five key behavioral features:

- Exploring behavioral barriers and levers associated with vaccine hesitancy among key influencers, such as HCWs and traditional leaders, as well as among more marginalized groups, such as women and young people, where social behavior change for the promotion of vaccine acceptance and uptake may have lasting effects.
- Defining the dynamics of digital health tools in target populations in terms of access, ease of use, and any gendered divides.
- Elucidating relationships of trust and confidence between target populations and public health agencies.
- Understanding the interface between structural barriers and behavioral dynamics affecting vaccine hesitancy and uptake.

Capability: Demographic Criteria

Gender

Definition

Gender is an important social factor that influences an individual's behavior and attitude, including acceptance of COVID-19 vaccines. Understanding gender-related patterns in vaccine acceptance can help public health authorities and policymakers design targeted interventions to improve vaccine uptake rates among specific populations.

Research questions

The following questions regarding gender were considered in the review:

- What is the relationship between gender and COVID-19 vaccine acceptance?
- How does gender sway an individual's decision about and attitude toward vaccination?
- How does gender influence attitudes or behaviors vis-à-vis COVID-19 vaccination across age groups?

Findings from the literature

Throughout LMIC, vaccine hesitancy and health-seeking behaviors were strongly related to gender identity. Across relevant studies reviewed by Busara, women were less likely to hold positive attitudes toward COVID-19 vaccination.[5,6,7,8] The gendered determinacy gap of vaccine hesitancy stands out strongly among other determinants, as these findings were largely homogeneous across LMIC, while other factors such as age, education, and religious affiliation displayed heterogenous relationships with vaccine hesitancy.[6] Moreover, the gendered gap of vaccine hesitancy in LMIC literature was observed to be consistent with findings globally.[52]

Several studies reviewed by Busara suggested potential drivers of the gendered vaccine hesitancy divide. Patriarchal social norms were observed to inhibit the agency of women to access information on COVID-19 vaccines and immunization drivers.[9,53] Women's education, literacy levels, and work and care obligations were all observed to be associated with their agency to access immunizations,[9] and women's lack of autonomy over their health decisions hindered their access to health care services.[24,54] A study conducted with women in Ghana identified lack of proximity to hospitals and vaccination centers as one of the primary barriers to COVID-19 vaccination.[21] This finding is consistent with a study conducted in India, which found that older age groups and women were dissuaded from getting vaccinated due to the confusion and complexity surrounding access to vaccination sites.[22] In Uganda, women reported that access to health facilities is constrained by transport challenges, fear of contracting COVID-19 at the facility, delays at the facility which result in missed clinic appointments, the need to borrow money to access private facilities, and feelings of distress.[23,24]

There are also several cultural barriers to women's use of health facilities that were observed in the literature. In a study done in Egypt, a lack of female physicians was listed as a factor that hinders most women from seeking basic health services.[24,55] A similar study considered in a scoping review in LMIC found that women who are nomadic pastoralists are reluctant to be examined by male health personnel due to their cultural beliefs and practices.[54] A study done in Tanzania highlights gender dynamics as a challenge in vaccine acceptance, finding that patriarchal norms inhibited the agency and capability of women to access vaccinations.[53]

The pandemic compounded these barriers with concerns about side effects, misinformation, and a decline in health-seeking behavior. Msuya et al. surveyed Tanzania and found that gender negatively influenced vaccine uptake and that women were less likely than men to have received a COVID-19 vaccination.[8] This difference was particularly pronounced among younger women, with only 12 percent of women 18 to 24 years old having been vaccinated compared to 24 percent of men in

the same age group. Specific reasons for the age group disparity were not provided in the study; however, we outline the dynamics of age on vaccine hesitancy and uptake in the “Age” section below.

This review also provided hints pointing to the role that the caregiver’s gender plays in the vaccination uptake of children. According to several studies, fathers were found to be more likely to vaccinate their children as compared to mothers, possibly explained by the difference in the social roles of mothers and fathers.[56,57] Strategies such as using community-based approaches and addressing the gendered digital divide could improve women's vaccine access and coverage,[9] and collecting sex-disaggregated data and involving women-led groups are crucial for evidence-informed change.

These studies collectively have highlighted the influence of gender-related factors on COVID-19 vaccine acceptance and hesitancy. To address gender disparities in vaccination rates, it has been crucial to develop targeted interventions that address gender-specific concerns and employ effective communication strategies tailored mainly to women's perspectives and needs.[10]

Age

Definition

By understanding the role of age in vaccine acceptance, this section has explored the ways in which age influences vaccine acceptance and hesitancy, identifying trends in the literature that can be leveraged to inform research and intervention designs that can respond to age-specific factors that contribute to vaccine acceptance among young adults / youths.

Research questions

The following questions regarding age were considered in the review:

- What is the association between age and COVID-19 vaccination uptake?
- Why are older adults more likely to be vaccinated than younger adults?
- How can we use age as a demographic indicator to improve COVID-19 vaccination rates?

Findings from the literature

Several studies conducted in Uganda, Tanzania, Mali, and Zambia examined the role of age as a demographic indicator in influencing COVID-19 vaccination uptake. In these countries it was observed that older adults (65 years old and older) have a higher likelihood of receiving the COVID-19 vaccine compared to younger adults.[11] This indicates that age plays a significant role in determining vaccine uptake, with older individuals being more proactive in getting vaccinated. Moreover, studies have highlighted that older health care professionals in these countries are more likely to be vaccinated compared to their younger counterparts.[12] This suggests that age-related factors may contribute to health care professionals' decision to get vaccinated. In contrast, a study by Abrazado and Coronel in Zambia found that younger age groups are more receptive to vaccines, partly attributed to targeted vaccination campaigns in schools and universities.[58] Similarly, a study by Limaye et al. found that vaccine uptake among adolescents and young adults is higher compared to older age groups, reflecting tailored outreach strategies for younger populations.[59]

In addition to vaccine uptake, studies examined age-related factors influencing vaccine acceptance, with findings that demonstrated that younger age groups were more likely to be hesitant than older groups. Echoru et al. conducted a cross-sectional study in Uganda and reported that older adults display greater interest in participating in COVID-19 vaccine clinical trials compared to younger adults.[60] Similarly, Kanyike et al. investigated medical students in Uganda and found that older students are more likely to accept the COVID-19 vaccine.[61] In a web-based, cross-sectional study conducted in Zambia, Mudenda et al. found that individuals older than 41 years were more likely to accept the vaccine compared to those between 18 and 23 years old.[62] These findings were also observed in a similar study conducted in Libya.[63] Findings for age groups between younger and older demographics were more mixed.[11, 63]

These studies suggest that age influences both vaccine uptake and acceptance and that, overall, older individuals may have a higher inclination toward receiving the COVID-19 vaccine compared to younger individuals given that the majority of the literature surveyed found that younger population groups tend to be vaccine hesitant. Several key factors were found to play into this dynamic: First, older demographic groups are more likely to consider contracting COVID-19 to be a serious risk than younger ones (18 to 24 years old) and therefore more likely to favor vaccinations https://www.mdpi.com/2076-393X/11/2/465.[8,58] Second, younger demographic groups are more likely to view vaccines as unsafe or rushed than older groups.[14] Finally, younger demographic groups are more likely to be influenced by misinformation through social media.[17] However, while this trend was observed throughout a large portion of the study, these findings were not ubiquitous. For example, individuals 18 to 20 years old in Western Uganda were more accepting of the vaccine than those who were 61 to 70 years old.[60] Additionally, a study in Mali found that vaccine hesitancy was more prevalent among older individuals, with cultural beliefs and lack of trust in the health care system being identified as significant barriers to vaccine acceptance.[13]

The culmination of these studies indicates that, while younger people were more likely to view the vaccination unfavorably, older individuals were more likely to be influenced by traditional health methods and alternatives for vaccinations.

Despite the overall tendency to be hesitant of the COVID-19 vaccine, longitudinal data in South Africa demonstrate that youths between 18 and 24 years old are 5.6 percent more likely to change their beliefs and become willing to receive a COVID-19 vaccine.[14] This same study also found that there is generally a significant increase in willingness to receive the COVID-19 vaccine over time, highlighting a positive trend in vaccine acceptance. However, it also was observed that younger adults are 8.5 percent more likely to exhibit vaccine hesitancy, confirming other studies that suggest potential reservations or concerns within this age group.

These studies have underscored the need for targeted vaccination promotion campaigns that address the specific concerns and barriers faced by younger adults, with an aim to increase vaccine acceptance and uptake within this demographic. The literature also underscores the importance of considering that stated intent may not always translate into actual behavior, and further efforts are required to bridge the intention-action gap.

Education level

Definition

Education refers to an individual's level of formal education attainment, such as primary, secondary, or tertiary education. Education plays a crucial role in shaping perceptions, beliefs, and behaviors toward vaccines. People with higher education levels often have greater access to information from reliable sources, enabling them to make informed decisions regarding vaccination. They may possess a better understanding of the scientific concepts behind vaccines, including their safety, efficacy, and importance for public health. Additionally, higher education levels are often associated with improved health literacy, which encompasses the ability to access, understand, and use health-related information effectively.

Research questions

The following questions regarding education level were considered in the review:

- Is there a difference in the willingness to be vaccinated between people with different levels of education?
- Is there a difference in the uptake of COVID-19 vaccination between people with different levels of education?
- What factors explain any association between education and COVID-19 vaccination?

Findings from the literature

According to the literature, understanding the factors that influence COVID-19 vaccination uptake is crucial in designing effective public health strategies. Education was highlighted as a demographic indicator in several studies that investigated its association with vaccine acceptance: In a multicountry study by Hawlader et al.,[15] it was revealed that individuals with higher education levels demonstrate a greater willingness to be vaccinated. This inclination could be attributed to their privileged access to accurate and reliable information about COVID-19 and vaccines, which in turn instills a sense of trust in health care professionals. Echoing these findings, Ndejjo et al. observed through a survey in Uganda a higher vaccine uptake among individuals with higher education levels. The authors reasoned that this group's awareness of the benefits of vaccination and their trust in health care professionals contributed to their proactive approach in protecting themselves and their communities.[11]

Similarly, in a study in western Uganda, individuals with higher education levels were more likely to express willingness to accept the COVID-19 vaccine.[60] Additionally, Msuya et al. conducted a community-based survey in Tanzania and found that individuals with higher education levels were more likely to have received a COVID-19 vaccine.[8] This could be attributed to their awareness of vaccination benefits and their trust in health care professionals.

Similarly, when considering the immunization of children, literature reviewed from the Middle East strongly supports the claim that children’s immunization is correlated with the age, education level, occupation, degree of informed COVID-19 awareness, and vaccination status of their parents.[57] Parents who were vaccinated were five times more likely to vaccinate their children than unvaccinated parents, and older parents (40 to 50 years old) showed higher readiness to vaccinate their children as compared to younger parents.

These findings suggested that higher education levels may contribute to a better understanding of the risks associated with COVID-19 and a higher motivation to protect oneself from infection. This may be attributed to greater access to accurate information, deeper trust in health care professionals, and better understanding of the importance and benefits of vaccination.

Access to digital tools

Definition

The section highlights the significance of access to digital tools in ensuring effective communication of vaccine-related information to the public. It emphasizes the use of online platforms, social media, mobile apps, and other digital technologies to facilitate the dissemination of vaccine safety, efficacy, and schedule updates, as well as to address vaccine hesitancy and counteract misinformation among the general population.

The existing literature has provided valuable insights into the relationship between access to digital tools and COVID-19 vaccine acceptance or hesitancy. Multiple studies have highlighted the significance of digital tools in promoting vaccine acceptance and addressing barriers. Limited access to digital tools, however, poses challenges in reaching certain populations.

Research questions

The following questions regarding access to digital tools were considered in the review:

- Does having Internet access significantly influence the acceptance of the COVID-19 vaccine among medical students in Uganda?
- Can access to or ownership of digital tools such as mobile phones influence COVID-19 vaccine behavior and intentions among youths?

Findings from the literature

Digital technologies, including smartphones, social media, and online datasets, have played a crucial role in the public health response to COVID-19.[16] The global prevalence of mobile device

subscriptions and social media usage has facilitated access to digital tools, enabling the dissemination of accurate information and supporting communication campaigns to counter vaccine hesitancy. On the other hand, studies have demonstrated that social media plays a significant role in influencing behavior intentions and vaccine hesitancy among specific populations, such as youth https://link.springer.com/article/10.1186/s13690-022-00904-4.[17] Social media platforms, such as Facebook and WhatsApp, have been instrumental in spreading misinformation and promoting vaccine hesitancy.[64] The presence of vaccine-resistant communities on these platforms, as well as the clout of celebrities and online influencers, has contributed to the proliferation of hesitancy. Busara did not find literature explaining the causal dynamics of social media usage on vaccine hesitancy in LMIC specifically; however, studies in the Global North have noted that social media posts with vaccine-hesitant content received more engagement than social media posts that promoted vaccination.[65,66] Even among those studies in the Global North examining the influence of social media on vaccine hesitancy, it is not readily evident why social media is so disproportionately successful in promoting vaccine hesitancy as opposed to uptake.[67]

Digital tools can have both positive and negative impacts on agency for vaccine decision-making. On one hand, digital tools can provide accurate and timely information about vaccine availability, safety, and efficacy, as well as facilitate registration and appointment systems.[18] Digital tools can also empower women and gender-diverse groups to voice their concerns, share their experiences, and access support networks.[68] On the other hand, digital tools also can spread misinformation, rumors, and stigma about vaccines, as well as expose users to online harassment, surveillance, and discrimination.[19] Finally, digital tools can exclude those who lack access to technology or the Internet or lack digital literacy skills.

In response to the role of social media on vaccine hesitancy, public health agencies across LMIC have developed tools, approaches, and platforms that leverage social media platforms and other such digital tools to combat misinformation. Research has shown that digital tools play a crucial role in disseminating COVID-19 vaccine awareness and acceptance information.[62] These tools have been used for data collection and online engagement to enhance vaccine acceptance efforts.

In Mali the MaliKaKeneya app, a digital health tool operating on mobile phones and tablets, has been employed to enhance access to health care. This digital tool, powered by the Community Health Toolkit platform, enables CHWs to identify symptoms related to COVID-19, facilitate patient referrals for testing and treatment, and conduct screenings for other diseases. The use of digital tools such as this in Mali has been lauded for improving the accessibility of health care services and bolstering the involvement of CHWs in the response to the COVID-19 pandemic, though Busara has not found any strong evidence detailing its impact.

U-Report is a social platform created by UNICEF that allows young people to express their opinions and contribute to positive change in their communities. It gathers opinions and information from young people on various topics, including COVID-19. U-Report developed a chatbot to provide accurate information about the virus, report rumors, and assess the impact of COVID-19 on children and communities. The COVID-19 vaccine chatbot has been accessed by over 6 million people in 52 countries.[69] U-Report is a valuable tool for UNICEF, governments, and civil society partners to inform youth-friendly policies and programs.[69] Busara has not found any evidence of U-Report's impact on vaccine hesitancy; however, UNICEF maintains the platform's efficacy through case studies on its website.

Beyond these discrete examples, the literature adds depth to our understanding of how digital tools determine gendered outcomes of vaccination hesitancy and uptake. For instance, in India research has found that gender plays a significant role in determining how access to digital technologies such as the Internet impacts vaccine coverage and hesitancy. Dhalaria et al. observed a strongly correlated association between an increase in males' access to the Internet and an increase in vaccination coverage.[3] However, their research found the opposite for women: as females' access to the Internet increases, vaccination coverage decreases. In the context of India, the authors speculated that this dynamic may be attributed to higher vaccine hesitancy and lower utilization of health services among women.

The comprehensive integration of digital strategies was crucial in navigating the psychological landscape and achieving widespread acceptance of COVID-19 vaccines. Studies consistently highlighted significant gaps in digital technology adoption and usage between men and women. For instance, a Global Systems for Mobile communications Association report found that women in several LMIC have lower rates of Internet access and smartphone ownership compared to men.[68] Socioeconomic constraints, cultural norms, and limited educational opportunities often contributed to this disparity. These barriers prevented women from accessing life-enhancing services such as education, health care, COVID-19 information, and financial inclusion, especially during the COVID-19 pandemic when many activities had to go online. Moreover, deep-rooted stereotypes and biases perpetuate the notion that certain digital tools or skills are more suitable for men, discouraging women from using technology-related tools.[70]

Consequently, women have faced challenges like language barriers, time constraints, and lack of digital literacy when seeking education and training in digital skills, hampering their ability to fully participate in the vaccination process.[71] This digital exclusion has had far-reaching consequences, limiting women's access to online platforms that provide vaccination registration or scheduling, social networks that disseminate vaccine-related updates, e-commerce platforms that offer vaccine-related resources, and reliable health-related information sources.[72] To address this disparity and empower women in the digital age, comprehensive strategies are needed, including policies promoting digital literacy and skills training targeted at women in the context of COVID-19 vaccination.[20]

Opportunity: Structural Barriers

Convenience

Definition

An individual's vaccine acceptance decision represents a complex sum of the degree of vaccine confidence, disease complacency (or fear), and convenience in accessing vaccination.[73] Among these, access to health care services is a critical factor in enabling COVID-19 vaccine uptake. Access to health centers may be affected by certain logistical barriers such as geographical inaccessibility, unfavorable operating hours, appointment availability, and transportation challenges. Additionally, access to health centers may be affected by social and cultural factors, such as perceived insecurities for women in accessing health facilities.

Research question

The following question regarding convenience was considered in the review:

- What are key inconveniences that prohibit (or limit) vaccine uptake?

Findings from the literature

Distance from home to public health facilities is particularly salient in the context of sub-Saharan Africa, where findings from Falchetta et al. have indicated that one-sixth of the population lives more than two hours away from a public hospital, and one in eight individuals resides at least an hour away from the nearest health center.[74] These findings highlight the substantial geographical barriers faced by communities in sub-Saharan Africa, making it challenging for them to access essential health care services, including COVID-19 vaccinations.

The literature also outlined significant challenges encountered by women in LMIC regarding convenience. A study conducted with women in Ghana identified that lack of proximity to hospitals and vaccination centers was one of the primary barriers to COVID-19 vaccination.[21] This finding is consistent with the results of a study conducted in India which found that older age groups and women are dissuaded from getting vaccinated due to the confusion and complexity surrounding access to vaccination sites.[22] In Uganda women reported that access to health facilities was constrained by transport challenges, fear of contracting COVID-19 at the facility, delays at the facility that resulted in missed clinic appointments, the need to borrow money to access private facilities, and feelings of distress.[23,24]

Beyond barriers to accessing physical vaccine locations, digital barriers were also noted in the literature. In South Africa, Katoto et al. discovered that challenges in accessing the government's online COVID-19 vaccination registration platform were associated negatively with vaccine uptake.[25] Tamysetty et al. in India also found that technological barriers (e.g., lack of good network connectivity and low digital literacy) hampered online vaccination registration.[22]

These findings emphasize the pivotal role of access to health centers in shaping COVID-19 vaccine uptake and addressing vaccine hesitancy. To promote COVID-19 vaccination uptake, it is essential to make vaccines easily accessible in safe, familiar, and convenient locations. "Drop-in" clinics at or near market squares located near where patients frequently visit can encourage individuals to get vaccinated.[45] By establishing vaccination centers in such accessible settings, the barriers of prohibitive distance, appointment unavailability, and transportation challenges could be mitigated, leading to improved access to health care services and increased vaccine acceptance rates.[45]

Public health providers

Definition

Public health care providers in the context of COVID-19 include a range of professionals and organizations involved in providing medical care, support, and services related to the prevention, diagnosis, treatment, and management of the disease. They play a crucial role in vaccine uptake, as they serve as the primary source of information on, recommendations for, and administration of vaccines.

Research question

The following question regarding governing entities was considered in the review:

- What structural barriers impeded public health care providers from delivering optimal immunization uptake rates?

Findings from the literature

The monumental logistical task of mass COVID-19 vaccination in Africa, as in most of the world, has relied heavily on the "public service workers who interact directly with citizens in the course of their jobs."[53] HCWs have been particularly influential in the pandemic response. Bolsewicz et al. explored the perceptions of health and aged care workers in Australia, noting the importance of trust, confidence, and responsibility in promoting vaccination acceptance.[49]

In a scoping review conducted by Chemali et al., HCWs were found to face challenges related to their well-being, professional and personal identity, and daily work-life routine during the pandemic.[30] HCWs reported negative impacts on their physical health, such as tiredness, discomfort, skin damage, and sleep disorders, as well as compromised mental health. The reduced well-being of HCWs was attributed to work-related factors, including new requirements, the burden of personal protective equipment, increased workload, lack of expertise, ethical dilemmas, and media pressure.[30] Additionally, their compromised psychological well-being was triggered by extensive exposure to concerning information via the media and the pressure from having society and the media assign HCWs to hero status.[30,31] The proliferation of diverse and sometimes conflicting information regarding the safety and efficacy of different vaccines posed a challenge for health care providers in supplying accurate and comprehensive information to promote the benefits of COVID-19 vaccination to their patients.[32]

The dynamic nature of the COVID-19 pandemic has necessitated capacity development for health care providers in training, education, and improved communication to effectively manage infectious disease outbreaks.[75] HCWs have had to undergo training on how to administer the vaccine that included a mixed variety of online modules and videos, written procedures/protocols, and hands-on training at the vaccine center in order to meet mass vaccination objectives.[76] The knowledge and attitudes of health care providers regarding vaccines have played a crucial role in shaping their personal vaccine uptake and their inclination to recommend vaccinations to their patients.[77]

Successful public health interventions have required a robust data management system to efficiently collect, analyze, and interpret data for planning and administration.[78] However, many countries in Africa have faced challenges in accessing updated basic medical information about their citizens, including sociodemographic characteristics and medical conditions in public health hospitals.[32] Furthermore, the resources necessary to obtain this crucial information for the immunization campaign within a limited time frame was often insufficient, resulting in a delay in COVID-19 vaccination, particularly during the first phase.[32] Additionally, poor recordkeeping, which is evident in many countries, can make tasks such as tracking specific vaccine types used for different individuals challenging.[32]

In conclusion, strategies should focus on addressing the logistical challenges associated with mass vaccination campaigns and prioritizing the well-being of HCWs by providing support and resources to mitigate work-related factors that impact their physical and mental health. Capacity-development programs should be implemented to enhance the knowledge and skills of health care providers in managing infectious disease outbreaks and effectively communicating the benefits of vaccination. Furthermore, strategies should aim to improve data management systems to ensure accurate and timely information for planning and administration of vaccination campaigns.

Vaccine availability

Definition

Although studies have identified the different factors associated with people's intention to get vaccinated for COVID-19, to date none has studied the implication of vaccine availability for the public acceptance of the COVID-19 vaccine.[79,80] Several studies have shown how vaccine availability has been a crucial factor affecting vaccination efforts, particularly in LMIC in Africa. In this context, vaccine availability refers to the accessibility and sufficient supply of vaccines to meet the population's immunization needs.[81]

Research questions

Exploring the literature on vaccine availability in the four DRIVE Demand focus countries (Mali, Tanzania, Uganda, and Zambia) and other African countries has raised several key research questions:

- What are the underlying factors contributing to inadequate vaccine availability in these countries?
- How do logistical challenges and weaknesses in the health care infrastructure impact the distribution and accessibility of vaccines?
- Are there disparities in vaccine allocation and access among different regions or population groups within these countries?

Findings from the literature

The significance of vaccine availability has been observed to lie in its impact on achieving high vaccination coverage and controlling the spread of infectious diseases.[82] Several studies emphasized the salience of structural barriers that can impede vaccine availability, thereby limiting the reach and impact of immunization programs. Limited funding by governing bodies in public health agencies has consequently resulted in issues such as inadequate storage systems and challenges in maintaining a structured vaccine distribution network, leading to expiration and inactivation of vaccines, particularly in rural areas with poor infrastructure and limited access to basic amenities.[32] For example, the Oxford/AstraZeneca vaccine, distributed through COVAX, requires standard refrigeration temperatures, but some countries faced difficulties in meeting these requirements.[32] Challenges faced by LMICs include conflict and security issues, the inaccessibility of groups that are more vulnerable to low vaccination rates, the limited shelf life of COVID-19 vaccines, funding constraints faced by Ministries of Health and by public health donors and implementing partners , and logistical challenges with vaccines that require a two-dose regimen with specific time gaps between doses that are inappropriate for mass usage in low-resource contexts.[32]

Research findings suggest that a limited supply of vaccines, rather than inadequate demand, is likely the key bottleneck to reaching high COVID-19 vaccine coverage in sub-Saharan Africa.[83] These barriers encompassed challenges such as inadequate vaccine supply, logistical constraints in distribution, and disparities in vaccine allocation among different regions or population groups.[84,85] Additionally, research indicated that the accessibility of necessary resources and equipment is another critical factor to consider. These studies shed light on how the availability of supplies, as well as trained HCWs and other health care professionals to administer the vaccines once available, poses a significant challenge. As such, understanding and addressing these structural barriers have been crucial for improving vaccine availability and increasing vaccination rates.

Insufficient vaccine supply has emerged as a significant barrier to vaccination in various African countries, including the project's four focus countries. Studies have repeatedly highlighted the impact of limited vaccine availability on immunization efforts. For instance, a systematic review conducted by Sallam found that inadequate vaccine supply posed a significant challenge, particularly in rural areas.[86] This scarcity often resulted in delays and missed opportunities for vaccination. Furthermore, the literature noted disparities in vaccine distribution, with some regions experiencing shortages while others had excess supply.[79] Similar findings were observed in Tanzania and Kenya, where a study emphasized the importance of addressing vaccine supply challenges, especially in remote and underserved areas.[87] The limited availability of vaccines in certain regions contributed to low vaccination rates and increased vaccine hesitancy among the population.[87]

Disparities in vaccine allocation among different regions or population groups can impede vaccine availability. Populations that are more vulnerable to those disparities, including those in rural areas and marginalized communities, often face greater challenges in accessing vaccines, exacerbating health inequities.[83] The availability of necessary supplies and trained HCWs / health care providers is crucial for administering vaccines. Limited availability of health care resources can further hinder vaccine availability and use.[88]

These findings underscore the importance of addressing structural barriers to vaccine availability to improve vaccination rates and mitigate vaccine hesitancy in low resource settings. Strategies should focus on strengthening vaccine supply chains, ensuring equitable distribution, and addressing regional disparities to enhance vaccine accessibility for all populations.

Cost and affordability

Definition

Cost and affordability in the context of routine vaccinations and COVID-19 vaccines encompass the financial burden imposed on individuals and households throughout the vaccination process.[26] They include various components such as the purchase cost of vaccines and expenses related to vaccine delivery and administration, as well as indirect costs associated with accessing vaccination services.[27,28] The concept of cost and affordability extends beyond the actual vaccine price and encompasses additional financial considerations that individuals may encounter while seeking vaccination, such as transportation costs, clinic fees, and potential income loss due to time spent away from work or other daily activities.[27,28]

Research questions

The following questions regarding cost and affordability were considered in the review:

- What are the specific cost-related barriers faced by different populations?
- How do these barriers differ across countries and regions?
- What strategies can be implemented to mitigate the financial burden of vaccination and improve affordability?

Findings from the literature

Numerous studies have consistently demonstrated the impact of cost and affordability on vaccination efforts, especially in LMIC. Research has revealed that financial constraints significantly hinder

vaccine uptake and accessibility. For instance, some researchers have highlighted the substantial challenge posed by out-of-pocket expenses for vaccines, particularly among marginalized communities with limited resources.[29] The high costs of vaccines, along with transportation expenses and indirect costs, have further impeded access to vaccines, resulting in reduced immunization rates.[29] This relationship between cost/affordability and vaccine accessibility is multifaceted, as high vaccine costs create barriers for individuals from low-income backgrounds or economically disadvantaged communities. Consequently, these challenges not only contribute to lower vaccination rates but also exacerbate existing health disparities.[89]

Further, perception of affordability has continued to play a critical role in individuals' decision-making process regarding vaccination. Despite the vaccine being technically available, individuals may perceive it as unaffordable due to various factors, such as income level, health insurance coverage, and out-of-pocket expenses.[49,90] This perception could significantly impact vaccine acceptance and uptake rates, as individuals may prioritize other essential needs over vaccination if they perceive the cost as prohibitive. This work has highlighted the importance of addressing both actual costs and individuals' perceived affordability to improve vaccine accessibility and ensure equitable distribution.

Understanding the interplay between cost, affordability, and vaccine accessibility has been essential for devising effective strategies to overcome these structural barriers. By addressing cost-related challenges and improving affordability through measures such as subsidies or waivers for populations who are more vulnerable to those structural barriers, it could become possible to enhance vaccine accessibility and promote equitable distribution.[91] Such efforts would be crucial in ensuring that all individuals, regardless of their socioeconomic status, have equal opportunities to protect themselves and their communities against COVID-19.[92]

Prioritization of and alternatives to vaccines

Definition

To increase rates of COVID-19 vaccine uptake, it is imperative to address the factors of prioritization and alternatives as significant structural barriers. These factors encompass the challenges individuals or communities encounter when confronted with competing demands that may impede their inclination or capacity to prioritize vaccination. Such competing demands can manifest in various forms, including concurrent health needs, occupational commitments, cultural beliefs, and reliance on alternative health care practices.[33,34,93]

Research questions

The following questions regarding prioritization and alternatives were considered in the review:

- What are the factors that influence the prioritization of vaccines among different populations?
- How do alternative health practices and cultural beliefs impact vaccine acceptance and use?
- What strategies can be employed to address competing demands and enhance vaccine prioritization?

Findings from the literature

Extensive research has provided valuable insights into the impact of prioritization of and alternatives to vaccines on immunization rates and acceptance among diverse populations. Notably, several studies delved into the underlying factors contributing to low vaccine uptake, identifying factors such as competing health needs (specifically, the prevention and treatment of diseases like malaria), as well as challenges associated with limited access to health care services.[35–37] These factors have emerged as significant barriers to vaccination efforts.

A systematic review investigated the impact of cultural beliefs and alternative health practices on vaccine acceptance. The researchers found that traditional healers and herbal remedies were often preferred over vaccines in some communities.[34] Cultural beliefs surrounding illness causation, such as attributing diseases to supernatural causes, also influenced vaccine hesitancy.[34] The study

suggests the importance of implementing culturally sensitive communication strategies and engaging community leaders to address misconceptions and promote vaccine acceptance.

Moreover, research findings underscore the significance of household and work obligations as barriers to vaccination. Studies observed a prevalent trend in which individuals, particularly women, prioritize employment or income-generating activities over accessing vaccination services.[38,39,94] Women are found to often juggle multiple roles and responsibilities, including caregiving, domestic chores, and informal labor, which could make it challenging for them to prioritize their own health and seek timely vaccination.[95] Research has shown that women may face additional barriers, such as limited autonomy in decision-making regarding their health and the health of their children, which can impact their ability to access vaccines.[96]

In the light of these findings, researchers emphasize the pressing need for flexible vaccination schedules, suggesting that offering evening or weekend clinics can effectively accommodate the work-related demands of individuals, thereby enhancing accessibility to vaccination services.[38,40,97] Addressing the challenges faced by women in prioritizing vaccination requires targeted interventions that consider their unique circumstances. Alongside offering flexible vaccination schedules to accommodate work and caregiving responsibilities, it is important to ensure convenient locations for vaccination centers and implement outreach strategies that specifically target women. By recognizing and addressing these challenges, health care systems can improve vaccination rates among women and contribute to overall vaccination coverage in communities.[98,99]

Additionally, to address the structural barriers to prioritization of and alternatives to vaccines, targeted strategies can be implemented. These include engaging community leaders and influencers to promote the importance of vaccination, integrating vaccination services with other health care interventions, and incorporating traditional healers and alternative health practitioners into immunization programs.[100]

Motivation: Psychological Barriers

Misinformation

Definition

Misinformation refers to false or inaccurate information that is shared or spread, often unintentionally, through various channels. It can take different forms, such as rumors, conspiracy theories, fabricated news stories, misleading claims, or deceptive content. Misinformation can be generated and shared by individuals, groups, or even automated systems. It often thrives in contexts where there is a lack of reliable information or during times when people are more susceptible to confirmation biases, cognitive shortcuts, or emotional responses. Misinformation can have significant consequences, as it can mislead individuals, shape public opinion, erode trust in institutions, and impact decision-making processes.

Research questions

The following questions regarding misinformation were considered in the review:

- To what extent does misinformation pose a barrier to vaccine demand?
- How can misinformation around vaccines be alleviated?

Findings from the literature

Social media has become a central avenue for the anti-vaccine community to spread misinformation, bypassing traditional sources of information and making it easier to reach susceptible populations to spread rumors (e.g., the pandemic is a government-made fabrication to obtain funds), foreign conspiracies targeting Africans, and concerns about the safety and efficacy of vaccines.[101] Several studies attribute vaccine hesitancy to misinformation.[102–106] Particularly in less developed countries, misinformation is a major driver of vaccine hesitancy.[12,53,106–108] Key misbeliefs and misinformation revolve around questions of efficacy, safety, and side effects, which are often associated with reduced

trust in institutions disseminating the vaccine and the vaccine itself. A plethora of myths are circulating around COVID-19 and the vaccine, despite the absence of scientific evidence.[109] These have included, for instance, the idea that the COVID-19 vaccine enters your cells and changes your DNA or that the vaccine causes dangerous side effects like blood clots or even COVID-19.[110]

A large body of research has investigated the efficacy of interventions to alleviate misinformation. Examples include warnings about false information to social media users and alternative causal explanations for the piece of misinformation.[111,112] Current studies continue to reference findings from these older studies. This work rests on the theory of the continued influence effect, outlining that despite correcting falsehoods, belief in misinformation is likely to persist.[113–115]

Another body of work has shown that "inoculating" people against misinformation can be an effective measure to elevate resilience against and prevent beliefs in false information.[116] The theory of psychological inoculation suggests that cognitive resistance can be cultivated against future misinformation by forewarning people that they may be misled by misinformation.[117] This, coupled with pre-bunking of misinformation by exposing people to weakened forms of misinformation and providing them with relevant counters and refutations, has been proven to effectively inoculate people against future misinformation.[118] Gamified inoculation interventions have used these principles and have initially been proven to be effective in enabling people to identify misinformation, increase truth-discerning abilities, and reduce their sharing of misinformation.[119–121] A recent meta-review of this evidence, however, has called the efficacy of gamified inoculation interventions into question.[122]

Beyond the actual messaging's driving an intervention to alleviate the belief in myths and increase populations' resilience toward misinformation, the perceived credibility of the source of the messaging plays a significant role. Voices trusted within the community carry significant potential to actually reach target populations and change their minds. Several other works confirm this finding: to disseminate information effectively throughout a social network, the position of the agent disseminating information is critical.[123–,124,125,126,127,128,129,130] In their seminal article, "The Diffusion of Microfinance," (as well as their later paper on gossip) Banerjee et al. propose a method to help drive the uptake of microfinance services by strategically injecting information into a community, training socially central individuals on the benefits of said services, and motivating them to spread the message throughout their community.[129,131]

A key gap in research on misinformation interventions is the geographical imbalance of published work. Most studies in the behavioral sciences on alleviating myths and misinformation have been conducted within W.E.I.R.D. (western, educated, industrialized, rich, and democratic) societies.[132] To develop strategies to tackle the misbeliefs and the spread of misinformation in LMIC, replication and contextualization of these strategies need to take place.

In sum, misinformation poses a significant challenge to vaccine demand globally. Behaviorally informed interventions delivered through trusted messengers can help alleviate misbeliefs and help inoculate populations against further conspiracy theories and misinformation. To ensure interventions and messaging strategies are effective in a specific context, foundational research should be conducted to identify key misinformation circulating around the vaccine, as well as trusted messengers to counteract that misinformation.

Risk perception

Definition

Risk perception refers to an individual's subjective assessment of the potential dangers or negative consequences associated with a particular behavior or decision.[41] In the context of vaccination, risk perception encompasses how individuals perceive the risks and benefits of immunization, which can influence their willingness to get vaccinated.

Research questions

The following questions regarding risk perception were considered in the review:

- How do individuals perceive the risks and benefits associated with COVID-19 vaccines?

- What factors influence individuals' risk perception of COVID-19 vaccination?
- How does risk perception impact vaccine acceptance and hesitancy?

Findings from the literature

Numerous studies have shed light on the complex nature of risk perception as a psychological barrier to COVID-19 vaccine acceptance. These investigations have revealed important insights into how individuals perceive the risks and benefits associated with vaccination. One key finding is that individuals' risk perception of the COVID-19 vaccine is influenced by various factors, including prior experiences with vaccines, trust in health care systems, and exposure to vaccine-related information.[133–135] For instance, Saied et al. found that individuals who had previously experienced adverse effects from vaccines were more likely to perceive higher risks associated with the COVID-19 vaccine.[136]

Importantly, risk perception influences vaccine acceptance and immunization rates. A study by Wang et al. demonstrates that individuals with greater perceived risks of adverse effects are less likely to accept the COVID-19 vaccine and are more likely to exhibit vaccine hesitancy or refusal, highlighting the pivotal role of risk perception in shaping vaccine uptake.[137] Notably, studies also have shown how gender dynamics can influence risk perception and vaccine hesitancy.[99,138,139] For instance, women may have different concerns related to vaccine safety and potential side effects due to their reproductive roles and experiences.[10,140] Women's risk perceptions also can be shaped by their roles as caregivers and their responsibility for the health and well-being of their families,[141] and women's risk perceptions have been found to be strongly influenced by those of their immediate families and their husbands' extended families.[22]

Interestingly, evidence from Brazil found that even among hesitant respondents, caregivers were likely to seek COVID-19 immunization for themselves and their children. The study observed that this dynamic is attributed to perceptions of the severe effects of the COVID-19 pandemic on the lives of children, higher risk perception of contracting COVID-19 as compared to other infections, and the understanding that children are more susceptible to contracting the virus and transmitting it to the rest of the family, especially the elderly.[142]

Understanding the dynamics of risk perception is crucial for developing effective strategies to address psychological barriers and promote vaccine acceptance. Tailored communication campaigns that address individuals' specific concerns, provide accurate information, and enhance trust in health care systems can help mitigate the impact of risk perception on vaccine hesitancy.[143] By fostering a comprehensive understanding of risk perception and its implications, health care providers and policymakers can better navigate the psychological landscape and facilitate widespread acceptance of the COVID-19 vaccine.[143]

Trust and credibility

Definition

Trust within the context of COVID-19 vaccination refers to individuals' confidence in the credibility, competence, and integrity of the COVID-19 vaccine, as well as the governments, manufacturers, health care systems, and science involved in vaccine development and distribution. Trust influences individuals' beliefs, perceptions, and decision-making processes regarding vaccination in the pandemic. A low level of trust toward health care institutions can induce citizens to engage in a number of uncooperative behaviors, which can severely undermine the efforts that governments exert to stop COVID-19, especially in LMIC.[144] Trust and credibility, therefore, are critical areas to explore in identifying behavioral barriers to vaccine uptake.

Research question

The following question regarding trust and credibility was considered in the review:

- What do existing studies reveal about the relationship between trust and vaccine uptake?
- What dynamics of credibility exist in the provision of health care that influence vaccine uptake?

Findings from the literature

The safety and efficacy of the COVID-19 vaccines emerged as the primary concern among vaccine-hesitant individuals, as highlighted by multiple studies. Some of the COVID-19 vaccine hesitancy was shown to stem from concerns about the rapid development and approval process, raising doubts about safety and the possibility of shortcuts taken by pharmaceutical companies.[145] Studies in Uganda with adults and medical students corroborated the finding that hesitancy is attributed to concerns around vaccine safety and efficacy.[61,146] This finding was also corroborated in Zambia by Matenga et al. and was consistent with a study done with health care professionals in Western Tanzania, which found that participants' hesitancy behavior toward COVID-19 vaccine uptake was due to concerns about the safety of the vaccine and its trustworthiness.[12,53,108,147] Similar concerns around vaccine safety and side effects have been reported in Mali as key reasons for vaccine hesitancy.[83,148] Finally, in a scoping review by the Africa CDC, respondents in most of the African countries surveyed tended to view new COVID-19 vaccines as less safe than vaccinations in general, further fueling COVID-19 vaccine hesitancy.[107]

A majority of the distrust in vaccines across countries was found to stem from lack of confidence in the health care system and the government.[106,149] In a study among the sub-Saharan countries of Burkina Faso, Ethiopia, Ghana, Nigeria, and Tanzania, adolescents' distrust of the health care system was listed as a barrier to vaccine uptake.[6] Similar studies on HCWs in rural Uganda confirmed that vaccine hesitancy was at least partly fueled by distrust in health authorities.[146] This is consistent with findings in Mali by Fournier-Tombs et al., who mention general mistrust in the public health system as a contributor to vaccine hesitancy.[148] These findings are echoed throughout other contexts in LMIC, such as Nepal, where Paul et al. found that lack of mutual trust between service seekers and service providers is a significant component of a cycle of service bias. It is therefore imperative to build trust in governments, as vaccination uptake in Africa is associated with the level of trust communities have for their governments.[25,150]

Distrust in modern medicine also emerged as a barrier to vaccine uptake. Evidence from Zambia pointed out that vaccine-hesitant individuals were particularly skeptical toward modern medicine and past personal and community experiences with vaccines and adverse events. Additionally, modern medicine, which is still perceived as “white” or “western,” is rooted in a colonial history of exploitation and appropriation.[151] Similar findings on mistrust in western medicine and lack of belief in conventional medicine versus belief in God were found in Zambia to increase vaccine hesitancy.[108] Trust in government, medical authorities, and one’s own health care providers was found to influence vaccine acceptance.[151,152]

There is also mistrust about the vaccine ingredients that is rooted in religious belief. A study by Khoo et al. found that parents in Malaysia were concerned about the halal status of the ingredients in vaccines, as they believe that vaccines might be contaminated with porcine DNA, thus making the vaccines haram since the consumption of porcine-sourced products, including medicines, is generally not permissible for Muslims.[153] Likewise, in an online survey in Somalia, respondents (who were mainly from the Islamic community) mentioned that their reason for vaccine hesitancy was due to the fear that some COVID-19 vaccines may contain substances derived from pigs.[154]

In summary, lack of trust in the safety and efficacy of the vaccine, in the credibility of the government and health system, and in modern medicine in general was found to be among the top reasons for vaccine hesitancy. Therefore, efforts to address vaccine hesitancy should prioritize initiatives that foster trust in the government, health care providers, and modern medicine as a whole.

Agency and confidence

Definition

Agency and confidence are vital factors influencing an individual's decisions regarding COVID-19 vaccination. Agency refers to an individual’s capacity to make autonomous decisions and act based on personal beliefs and values, including the ability to make choices about vaccination. Confidence, on the other hand, refers to the trust and belief individuals have in the safety and efficacy of COVID-19 vaccines. Empowering individuals with a sense of control over their health decisions, addressing

concerns about safety and efficacy, and providing accurate and tailored information are key to building confidence and promoting vaccination uptake.

Research question

The following question regarding agency and confidence was considered in the review:

- How can we address concerns about the safety and effectiveness of vaccines in a way that builds trust and confidence?

Findings from the literature

The race to develop and distribute COVID-19 vaccines relies on the agency of various stakeholders, including scientists, pharmaceutical companies, governments, and international organizations.[155] Their collective agency has been instrumental in rapidly developing and distributing safe and effective vaccines. In parallel, confidence plays a crucial role in COVID-19 vaccination uptake among the elderly.[156] Vaccine hesitancy among the elderly in Jakarta was driven by concerns about factors such as education, knowledge, perception of COVID-19 severity and vaccine safety, government policies, HCW recommendations, and family support and influence around confidence. However, youths in South Africa (between 18 and 24 years old) were more likely to change their beliefs and become confident enough to receive a COVID-19 vaccine,[14] influenced by increased awareness of the benefits of vaccination, increased trust in the safety and efficacy of vaccines, increased exposure to government and public health messaging promoting vaccination, and reduced concerns about the potential side effects of vaccination.

The interplay of gender and agency was also found to play a crucial role in determining who gets vaccinated, who makes the decision whether to do so, and what factors influence those choices. According to a WHO 2021 report on gender barriers in the COVID-19 vaccine rollout, women and gender-diverse groups faced more barriers than men in accessing and demanding COVID-19 vaccines due to limited mobility, restricted decision-making power, limited access to information and resources, and risk of gender-based violence.[157] These barriers reduced their agency and ability to protect themselves and their communities from the virus.[158]

Digital tools also were found to have a profound impact on vaccine decision-making, empowering individuals with readily accessible information and resources to make informed choices. Through various online platforms and social media, people could access a plethora of vaccine-related data, scientific research, and public health recommendations. These digital resources played a significant role in shaping individual attitudes and beliefs about vaccination.[3] Online forums and community groups foster discussions around vaccines, allowing individuals to voice concerns and ask questions, which can influence vaccine acceptance and uptake.[62] However, it is essential to be mindful of the potential risks of misinformation on digital platforms, as false or misleading information can negatively impact decision-making.[159] Overall, digital tools offer an unprecedented level of agency to individuals by arming them with information, connecting them with like-minded peers, and facilitating discussions that shape their perspectives on vaccination.[160]

Confidence played a pivotal role in shaping vaccine acceptance and uptake. Studies consistently showed that individuals with higher levels of confidence in the safety and effectiveness of vaccines are more likely to be willing to receive them.[107] The most common reason for low vaccine confidence was uncertainty about receiving the vaccine.[22] Factors influencing confidence include trust in institutions, perceptions of the risk posed by COVID-19, and exposure to misinformation.[152] Trust in institutions, such as the government and public health agencies, was associated with increased confidence in vaccines. Furthermore, perceiving COVID-19 as a significant threat enhanced confidence, while exposure to misinformation undermined it.[152] It was therefore crucial to focus on building confidence by providing accurate information, engaging trusted messengers, and addressing misinformation.[107,152] Finally, effective strategies for vaccine demand creation involved factors such as supply-side confidence, branding, marketing, and information dissemination.[64] These strategies played a significant role in instilling confidence in the vaccine supply, providing reliable information, and empowering individuals to exercise agency in their decision-making.

Interventions targeting confidence showed promise in promoting vaccine acceptance and addressing hesitancy. CBOs have emerged as influential actors in this regard.[51] By engaging with communities, building trust, and acting as trusted messengers, CBOs positively impacted vaccine decision-making.[51] Community engagement interventions, such as those implemented in Kenya, have successfully increased knowledge about vaccines and reduced hesitancy.[107] Additionally, using trusted messengers, as demonstrated in Nigeria, where traditional healers were trained to provide accurate information about vaccines, increases trust and improves vaccine uptake.[51,107]

In the effort to combat misinformation surrounding COVID-19 vaccines, South Africa implemented a range of interventions. These strategic measures involve disseminating accurate vaccine information through various channels, including government websites, social media platforms, and traditional media outlets. Additionally, collaboration with community and religious leaders has been pivotal in dispelling rumors and countering misinformation.[51,107]

Findings demonstrate a need to enhance the effectiveness of campaigns and improve the accessibility and convenience of vaccination, particularly among groups who are particularly vulnerable to issues of confidence, to increase vaccine uptake.[22] Confidence, influenced by trust, risk perception, and exposure to misinformation, shapes individual choices. CBOs act as trusted messengers, promoting trust and acceptance. The collective agency of scientists, companies, governments, and organizations has enabled rapid progress. By fostering confidence, empowering individuals, and maintaining collective agency, we can advance vaccine acceptance effectively.

Social influence

Definition

Social influence describes how our thoughts, feelings, and behaviors respond to our social world, including our tendencies to conform to others, follow social rules, and obey authority figures.[161] Why do people choose to conform? Researchers have categorized the motivation to conform into two types: normative social influence and informational social influence.[162] In normative social influence, people conform to the group norm to fit in, to feel good, and to be accepted by the group. However, with informational social influence, people conform because they believe the group is competent and has the correct information, particularly when the task or situation is ambiguous. In the context of vaccine intention and uptake, this analysis explores the role of social influence in COVID-19 uptake.

Research question

The following question regarding social influence was considered in the review:

- How does social influence affect COVID-19 vaccination intention among the unvaccinated?

Findings from the literature

A series of studies highlight several strategies used by governments to increase vaccine uptake. First, governments have leveraged informational social influence by revealing how many people in the population have received the vaccine in a bid to encourage everyone to follow suit. An online experiment in Turkey with unvaccinated individuals found that this did not predict COVID-19 vaccine intention.[42] This could be explained by the distrust held among unvaccinated citizens toward the government, coupled with the misinformation and negative perceptions of the government's mitigation strategy.[43] In Tanzania, inconsistencies in messaging by political and community leaders further led to increased doubts and hesitancy among study participants toward the COVID-19 vaccine.[44]

Social influence has been identified as one of the key factors influencing vaccine uptake and acceptance.[27] Religious leaders hold significant influence over their followers, shaping their attitudes toward public health interventions and playing a crucial role in guiding their health-seeking behaviors, ultimately impacting the acceptance and uptake of vaccines.[45,46] In a study in sub-Saharan Africa, it was found that in countries such as Ghana, Kenya, South Africa, Tanzania, and Zimbabwe, some religious leaders have used religious gatherings to advance anti-vaccine campaigns, a form of informational social influence.[163] Community religious leaders were also reported to have actively

discouraged the take-up of the human papillomavirus vaccine,[164] which is a pattern being observed for the COVID-19 vaccine, as well.[154]

The social influence of HCWs was found to be an important factor in vaccine hesitancy and uptake. Agyekum et al. found that this may be attributed to HCWs' low levels of trust in government and health agencies.[165] Furthermore, normative social influence from close family members has been shown to influence vaccine acceptance by HCWs.[166] Lastly, HCWs' decision to be vaccinated was influenced by their trust in how the hospital manages the pandemic.[167]

Examining normative social influence on people's intention to receive COVID-19 vaccines, Husain et al. found a strong positive relationship between subjective norms and vaccine intention.[168] This finding further emphasized the impact of peer influences from friends, relatives, and health care professionals in endorsing the vaccines and promoting vaccine uptake behavior. In a study done in India by Tamysetty et al., peer influence played a major role in shaping peoples' opinions, with some community members reporting hesitancy to get vaccinated due to caution by a family member or the death of a popular media personality perceived to be attributed to vaccination, while others were motivated by friends, neighbors, community volunteers, employers, colleagues, and the media.[22] In Tanzania, a lack of acceptance of the COVID-19 vaccine and negative beliefs held by several people in the community appeared to encourage vaccine hesitancy in others.[44]

Leveraging community social networks and leaders to disseminate correct information and build support for immunization can be effective in improving immunization uptake in some contexts.[46,51] Specific portions of the literature support a stakeholder consensus-building approach, wherein public health actors engage community and religious leaders to endorse the immunization program and build trust).[169] CHWs must be treated as essential focal points for promoting vaccine acceptance and uptake, and public health agencies and stakeholders should consider exploring the contextual dynamics influencing the vaccine perceptions of community HCWs in order to promote wider uptake.

Beliefs and attitudes

Definition

This section explores the role of beliefs and attitudes as indicators in understanding COVID-19 vaccine acceptance and hesitancy. Belief refers to individuals' perceptions, convictions, and trust in the safety and effectiveness of vaccines, while attitude refers to their overall disposition, opinions around vaccination, and willingness to be vaccinated. We examine these factors through a mental models framework, detailing how these factors shape vaccine-related decision-making and can significantly impact vaccination rates within communities.

Research questions

The following questions regarding beliefs and attitudes were considered in the review:

- What is the role of religious organizations and CBOs in shaping beliefs and attitudes that promote COVID-19 and routine immunizations?
- What are the beliefs and attitudes that contribute to COVID-19 vaccine hesitancy among adolescents in sub-Saharan Africa?

Findings from the literature

Mental models serve as the foundation for reasoning and decision-making processes that drive both individual and systemic behaviors, and they are shaped by an individual's experiences, perceptions, and comprehension of the world. As such, studies found that individual and communal perceptions of public health institutions, information sources, communication channels, and the like are composed of components of a vaccination mental model that significantly shapes individual and communal attitudes toward COVID-19 vaccination.[48,49] Understanding the origin and transmission of the virus influences vaccination attitudes, with beliefs about transmission playing a greater role than beliefs about origin.[48] Trust, confidence, and responsibility influenced acceptance of vaccination among health and aged care workers, while concerns about safety, effectiveness, and limited understanding

of herd immunity contributed to hesitancy.[49] Addressing these perceptions through targeted communication strategies was vital to promote vaccination acceptance,[48,49] highlighting the impact of mental models on vaccination attitudes.

Health models such as HBM, Theory of Planned Behavior (TPB), and Social Cognitive Theory (SCT) have stood as widely recognized frameworks for understanding health behavior.[170] These models offer valuable insights into how people form their beliefs, attitudes, intentions, and behaviors toward vaccination. HBM emphasizes the role of perceived susceptibility, benefits, barriers, and self-efficacy, while TPB focuses on attitudes, subjective norms, and perceived behavioral control. On the other hand, SCT highlights the dynamic interplay between personal factors, environmental influences, and behavior. By employing these models, interventions could be designed to effectively promote vaccine acceptance and reduce hesitancy by addressing information gaps, communication strategies, social norms, incentives, barriers, and self-efficacy factors.[171]

Several studies have shed light on the relationship between belief, attitude, and COVID-19 vaccination. Latkin et al. found that trust in specific information sources positively influenced vaccination uptake, while distrust in certain institutions was associated with lower vaccine acceptance.[172] Wang et al. (2022) identified concerns about vaccine safety and effectiveness as primary reasons for hesitancy among sub-Saharan adolescents.[6] Carcelen et al. observed that hesitancy among parents in Zambia was due to beliefs about COVID-19 severity, risk, and vaccine safety.[173] Echoru et al. highlighted sociodemographic factors influencing vaccine acceptance in Uganda, emphasizing the need to address fears and misconceptions within communities.[60] Hawlader et al. used HBM to identify predictors of vaccine acceptance in South Asia, including perceived severity, susceptibility, benefits, and barriers.[15] Onyeaghala et al. called for clinical development and interventions that address beliefs surrounding herbal supplements for COVID-19.[34] Biswas et al. conducted a scoping review that highlighted a range of beliefs and attitudes contributing to vaccine hesitancy worldwide.[90]

In the Philippines, general hesitations around vaccines were shaped by individual perceptions of the vaccine. Literature indicates that these perceptions “are shaped by exposure to (mis)information amplified by the media, the community, and the health system.”[50] The identified factors associated with vaccine hesitation include social networks, political influences, and trust in authority. Social networks could both positively and negatively impact the vaccination uptake based on an individual’s own views on the vaccine. Political influences could contribute to hesitation about the brand of vaccine, as well as delays in their sales or refusals in the region. Any perception of inefficiency or inflexibility of the system can be a barrier to vaccine rollout, especially for marginalized communities, whose hesitations are further exacerbated by low health literacy—particularly when it comes to the COVID-19 vaccines and their uptake and reach.[50] One paper highlights the role of addressing the social traumas of the people of the Philippines in counteracting vaccine hesitancy. The traumas act as a barrier to acknowledging the safety of vaccines provided by the health facilities and entering into trusting relationships with authorities.[174]

Interventions aimed at addressing vaccine hesitancy and promoting COVID-19 vaccination targeted specific beliefs, attitudes, and concerns identified in the research. For instance, CBOs played a pivotal role by engaging empathetically with communities and creating safe spaces for vaccine-related discussions.[51] Trusted health messengers and other sources of information were crucial in effectively reaching communities, regardless of the messenger’s origin, by presenting health information respectfully and understandably.[51] It is important to address concerns and misconceptions about vaccine safety and effectiveness, particularly among sub-Saharan adolescents and other specific populations, to increase vaccine acceptance.[6] Tailored communication strategies, such as providing clear and accurate information about vaccine development, safety, and importance, are essential, especially for HCWs.[49] Use of the HBM helped in understanding and modifying individuals' beliefs and attitudes toward COVID-19 vaccination.[15] Additionally, building trust and ensuring the credibility of information sources were vital for positively influencing vaccine acceptance.[172] By implementing these interventions, public health efforts could effectively tackle vaccine hesitancy, modify beliefs and attitudes, and ultimately enhance COVID-19 vaccine acceptance rates.

In summary, beliefs and attitudes were key factors influencing individuals' willingness to be vaccinated against COVID-19 according to the literature. Belief in the effectiveness of the vaccine and positive attitudes toward vaccination, combined with trust in reliable information sources, were associated with higher vaccine acceptance. Conversely, exposure to misinformation had a negative impact on belief and attitude, leading to decreased willingness to be vaccinated. These findings underscore the importance of disseminating accurate information, fostering positive attitudes toward vaccines, and promoting trust in reliable sources to enhance vaccine acceptance.

Behavior: Factors to Consider in the Promotion of COVID-19 Vaccination

Busara's review of the literature highlights essential trends that public health agencies should keep in mind when developing an understanding of and designing responses to COVID-19 vaccine hesitancy. Before behavioral solutions are developed and implemented, public health actors must consider the structural barriers that impede vaccine uptake. Literature reviewed by Busara suggests that limited supply of vaccines, rather than inadequate demand, is likely the key bottleneck in attempting to achieve high COVID-19 vaccine coverage in sub-Saharan Africa.[83] Proximity to health facilities, accessibility of digital health tools, functionality of public health systems, the presence of adequate logistics, and availability and reliability of immunization supplies are all core essentials of an ecosystem that is appropriate for extensive behavioral design and solutions.

If structural barriers are to be remedied, we must consider which key demographic groups public health interventions should target in promoting vaccination. Understanding the unique barriers and levers affecting groups who have been traditionally marginalized, who have less agency and autonomy, and who live in low-resource settings is critical for consideration. In particular, the barriers and enabling factors for women should be explored in each cultural context and setting where COVID-19 vaccinations are rolled out. Our literature review found that women are less likely to hold positive attitudes toward COVID-19 vaccines than men.[5–8] Social norms, patriarchal constructs, other cultural barriers, and safe, appropriate messaging around COVID-19 vaccines must all be considered and understood to promote the uptake of COVID-19 immunizations. Men also must be subject to research, as the research reviewed indicates that they are key players in the agency and health-seeking behaviors of women in LMIC.

Moreover, our review of the literature has highlighted the unique dynamics of age on vaccine hesitancy and uptake. In general, older populations are more likely to have positive associations with COVID-19 vaccines.[11] However, this is not always the case: a study in Mali found that vaccine hesitancy is more prevalent among older individuals due to cultural beliefs and a lack of trust in the health care system.[13] Similar findings were observed in Zambia.[58] Interestingly, our review of the literature revealed that young people are more likely to change their attitudes toward COVID-19 vaccinations over time,[14] highlighting that successful social behavior change programs should target this demographic.

Public health practitioners should consider points of influence revealed in Busara's research. The literature indicates that HCWs, CBOs, social networks, and local leaders and community influencers, such as religious leaders, should be involved in the promotion of COVID-19 immunization.[46,51] Findings that show how core behavioral barriers affect motivation, capability, trust, attitudes, and risk perception highlight the importance of anchoring public health programming among key influencers in the local context, including the demonstrated importance of social networks as essential to combating misinformation.[123–130] Leveraging community social networks and leaders to disseminate information and build support for immunization can be effective in improving immunization uptake in some contexts .

Another point of influence leverages digital tools, including social media platforms, mobile phones, and visualization tools, which act as essential points of dissemination and decision-making. At the individual level, digital tools can be powerful carriers of misinformation and vaccine hesitancy, but the literature also indicates that they are useful in the empowerment of women and marginalized groups,

allowing them to voice their concerns, share their experiences, and access support.[68] At the level of public health agencies, digital tools such as data dashboards have strengthened the capacity to understand and respond to pandemics and other pressing public health challenges.[16] Moreover, digital health tools can serve as a convening point between public health agencies and individuals seeking care. Public health agencies should commission research that thoughtfully probes the accessibility of digital health tools and platforms to ensure that public health campaigns use them effectively.

Public health practitioners may find use in established behavioral science models, such as HBM, TPB, and SCT. These models are commonly used to understand health behavior and offer valuable insight into how people form their beliefs, attitudes, intentions, and behaviors toward health-seeking behaviors and, in the context of the literature review, how health behaviors affect vaccine uptake.[170]

While access to correct information is important in debunking myths and increasing vaccination uptake, Betsch suggests that the unfolding COVID-19 pandemic can be brought under control only by massive and rapid behavior change among individuals.[175] Looking at vaccination uptake from a zoomed-out policy perspective, Volpp et al. found that a national COVID-19 vaccine promotion program needs behavioral science and social marketing to increase confidence and acceptance.[176]

Vaccine coverage can be affected by the education of the caregiver, as educated individuals often process information more effectively and are thus typically less sensitive to stigma; resources available to health providers, school, and families; prevailing cultural norms; the level of interaction and trust with state and health authorities; and resources available to the caregivers.[177] The implication is that a one-size-fits-all vaccination program may not be successful unless it carefully considers regional variation (e.g. between urban and rural settings) in access, prevailing norms, and levels of trust in social service providers.[178]

The literature review produces several considerations for public health implementing organizations supporting MOHs in working on COVID-19. Specifically, they should:

- Explore the behavioral barriers and levers associated with vaccine hesitancy among key influencers, such as HCWs and traditional leaders, as well as among more marginalized groups, such as women and young people, where social behavior change for the promotion of vaccine acceptance and uptake may have lasting effects. The literature suggests that were these groups to be more intimately understood and involved in the creation of vaccine promotion and uptake interventions, the impact would be felt throughout broader social networks.

- Understand the dynamics of digital health tools in their target populations. Key divides in terms of accessibility must be understood to improve and optimize public health messaging for social behavior change, and on the institutional side, bottlenecks in the comprehension of public health digital infrastructure should be identified and rectified to make public health systems more responsive and accessible.

- Define the relationships between target populations and public health agencies. Throughout much of the literature reviewed, trust in the public health system—and in “western” medicine in general—is a critical component of a person’s decision to seek vaccination against COVID-19 and perceive it positively.[151] A lack of trust in the health care or information provider can exacerbate fears,[179] and a significant portion of the distrust in vaccine efficacy across LMIC stems from lack of confidence in the health care system and the government.[106,149]

- Seek to understand the structural barriers affecting vaccine hesitancy and uptake. Long distances, security threats, and capacity gaps among clinic staff may all influence the capability of target populations to successfully seek, access, and complete their schedule of COVID-19 immunizations. Diagnosing behavioral barriers and levers is useful only once the implementation context is better understood so that behavioral interventions are better tailored to fit the context.

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contact@busara.global
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