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Review

The role of misinformation in COVID-19 vaccine hesitancy in low- & middle-income countries

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ABSTRACT

Background: During the COVID-19 pandemic, timely vaccination was crucial in acquiring herd immunity. While high-income countries typically had better access to vaccines, interventions were implemented to improve accessibility for low and middle-income countries (LMICs). Vaccine uptake presented major barriers to achieving herd immunity globally and was more significant in LMICs. Vaccine hesitancy was amplified by misinformation, including but not limited to social media misinformation. This scoping review aims to: (1) explore the role of misinformation in COVID-19 vaccine hesitancy in LMICs and (2) identify primary sources, key themes, and dissemination channels of this misinformation, encompassing all relevant sources but with an emphasis on social media, given the infodemic context which proved to be particularly significant during the COVID-19 pandemic. Methods: This scoping review was conducted using the Arksey and O'Malley framework and PRISMA-ScR guidelines. Five databases (Scopus, Embase, PubMed, CINAHL, and PsycINFO) were searched using predefined search terms. All identified articles underwent a rigorous screening process, and if eligible, proceeded to data extraction. Results: In total, 119 studies were included in this review. Primary dissemination platforms included Facebook, WhatsApp, X, YouTube, Instagram, TikTok, Telegram, Pinterest, LinkedIn, and Zalo. Key themes of misinformation identified included (1) malicious intent, (2) fear of side effects, (3) concerns about vaccine development and safety, (4) religious and cultural beliefs, and (5) natural immunity. Conclusion: Overall, this scoping review addresses the literature gap in the role of misinformation pertaining to COVID-19 vaccine hesitancy and suggests investing in misinformation-mitigation interventions to reduce public harms and disruptions.

1. Introduction

In late 2019, SARS-CoV-2, a novel coronavirus, emerged and rapidly escalated into a global public health emergency. On March 11, 2020, the World Health Organization (WHO) declared COVID-19 as a global pandemic, reflecting sustained worldwide transmission and the urgent need for coordinated action across countries and sectors [1]. The pandemic's health, social, and economic disruptions accelerated major scientific efforts, resulting in the rapid development and deployment of multiple COVID-19 vaccines [2]. Despite these efforts, the benefits of vaccination have not been equitably realized globally due to differences in access and uptake worldwide [3]. To address inequitable access, global initiatives such as COVID-19 Vaccines Global Access (COVAX) were launched as part of a collaborative effort by various organizations (e.g., WHO, UNICEF, and several others) to promote fair vaccine distribution, particularly in countries facing constrained supply and delivery capacity such as low and middle-income countries (LMICs) [4].

Long before the COVID-19 pandemic, vaccine hesitancy has been

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recognized as a significant public health concern. Vaccine hesitancy is commonly defined as a delay or refusal in the acceptance of a vaccine despite adequate supply, and it is often shaped by factors like insufficient knowledge, low risk perception, as well as socio-demographic and cultural backgrounds [5]. In 2019, the WHO identified vaccine hesitancy as one of the ten threats to global health, highlighting that vaccine refusal or delays in vaccine acceptance can undermine efforts to mitigate the spread of vaccine-preventable disease [5]. During the COVID-19 pandemic, vaccine hesitancy emerged across diverse populations, ranging from the general public to healthcare workers, and became particularly consequential given the need for high coverage to reduce severe disease and protect health systems. In response, the WHO articulated global vaccination targets as part of its strategy to increase population level immunity, underscoring the urgency to improve vaccine coverage across all regions [6].

Much of the research surrounding high-income countries (HICs) has examined COVID-19 vaccine hesitancy and the information environments that shape it, including the relationship between misinformation exposure and vaccination intentions [7]. Misinformation is commonly defined as false or inaccurate information shared inadvertently, without the intent to cause harm [8]. In addition, an infodemic refers to an excessive volume of information including misleading or false information that can spread during public health crises like disease outbreaks, one result of which can be prolonged outbreaks [9]. Studies have also highlighted the influence of social media on shaping vaccination attitudes, both by facilitating the rapid dissemination of misleading claims and by influencing perceived social norms surrounding vaccination [10]. Although insights from HIC settings are informative, they may not translate directly to LMICs, where health system constraints, historical inequities, political instability, and local trust dynamics can interact differently with vaccine decision making and information credibility. In many LMICs, limited access to healthcare providers and trusted institutional communication channels may increase reliance on social media as a primary source of health information, potentially increasing the impact of vaccine-related misinformation.

In this scoping review, we focus on misinformation as a core concept contributing to COVID-19 vaccine hesitancy. During the COVID-19 pandemic, misinformation circulated widely as part of the broader "infodemic," described by the WHO as an overabundance of information, including false or misleading content occurring in both digital and physical environments, capable of undermining public health responses [11]. Vaccine-related misinformation has included false claims regarding safety, effectiveness, ingredients, fertility, and long-term health effects, alongside conspiracy narratives that frame vaccination as harmful or politically motivated. These narratives are not limited to a single medium: they can spread through interpersonal communication, community networks, and traditional media [9]. Notably, the COVID-19 pandemic has been described as the first pandemic in which technology and social media were used at massive scales to communicate and connect, while also enabling the rapid amplification of misinformation [11]. Given this context, a more explicit focus on misinformation sources, including but not limited to social media-based misinformation, is warranted.

The structural features of social media platforms facilitate the rapid diffusion, repeated exposure, and social reinforcement of misleading claims, which may increase the perceived credibility of misinformation even when it conflicts with information from trusted institutions [10]. Existing literature focuses on the broader role of misinformation arising from multiple information outlets, with their specific influences on shaping vaccine hesitancy, particularly in LMIC settings, remaining understudied. Preliminary literature searches suggest that relevant evidence exists but remains fragmented across disciplines and geographic settings. To date, no scoping review has comprehensively mapped this body of literature. Therefore, a scoping review is warranted focusing on the role of misinformation as it relates to vaccine hesitancy in LMICs. We considered various misinformation outlets in our study and given the context of the broader infodemic during the COVID-19 pandemic as defined by the WHO, included an emphasis on social media-based misinformation sources. This review seeks to (1) explore how misinformation contributes to COVID-19 vaccine hesitancy in LMICs, and (2) identify the key misinformation themes, sources and dissemination channels that shape vaccine-related attitudes and behaviors in these settings.

2. Methods

This scoping review was conducted in accordance with the Arksey and O'Malley framework for scoping reviews and Preferred Reporting Items for Systematic Reviews and Meta-Analyses - extension for Scoping Reviews (PRISMA-ScR) guidelines [12,13].

2.1. Search strategy

A comprehensive literature search was conducted on June 15, 2025, across various databases, including Scopus, Embase, PubMed, CINAHL, and PsycINFO. Detailed search strings encompassing study criteria were created for each database, and keywords relating to the study such as "LMIC", "COVID-19", "vaccine", "hesitancy", "misinformation", and "social media" were used. Search strings can be found in Appendix A.

2.2. Article screening

Upon the comprehensive literature search, articles were imported into Covidence, a systematic review tool, Veritas Health Innovation, Melbourne, Australia (available at https://www.covidence.org/) [14]. Covidence was used to conduct title/abstract (stage one) and full-text (stage two) screening. All articles were screened by two independent reviewers (AYS, ZUK, TR, ZK, AM, MH, LP, MAI, AA, JZ, LI, DLT, NB, NN, ED). Conflicts were resolved by a third reviewer to minimize bias in the screening process. Routine team meetings were held to discuss any conflicts that arose during this process and were evaluated to maintain reviewer consistency.

2.3. Inclusion and exclusion criteria

A rigorous set of inclusion and exclusion criteria was applied to effectively classify articles as relevant or irrelevant to the study. Studies were included if they focused on populations in LMICs, as classified by the World Bank [15], regardless of age group. Articles also had to examine COVID-19 vaccine-related misinformation as a central topic, investigate its association with vaccine hesitancy, refusal, or low vaccine uptake, and be conducted within the context of the COVID-19 pandemic (i.e., from November 2019 onwards). Empirical studies (quantitative, qualitative, or mixed methods), reviews, commentaries, peer-reviewed journal articles, or pre-prints were included article types.

Articles were excluded if they exclusively focused on HICs without any reference to LMIC populations or comparisons did not address misinformation as a central theme or failed to connect it to COVID-19 vaccine hesitancy; or if they focused exclusively on vaccine efficacy, logistics/supply chains, clinical trials, or public health campaigns, without linking to public perception or misinformation narratives. Editorials or news articles without empirical data or substantive analysis were also excluded. Additionally, the study was restricted to English-language publications only.

2.4. Data acquisition and analysis

Data extraction was conducted using Microsoft Excel. A standardized data extraction spreadsheet was developed to note key variables relevant to the study. Included articles were imported and systematically distributed among team members (AYS, ZUK, TR, LP, JZ, NB, AM, ZK, LI, MDI, MH, DLT). Extracted variables included: Covidence study #, name

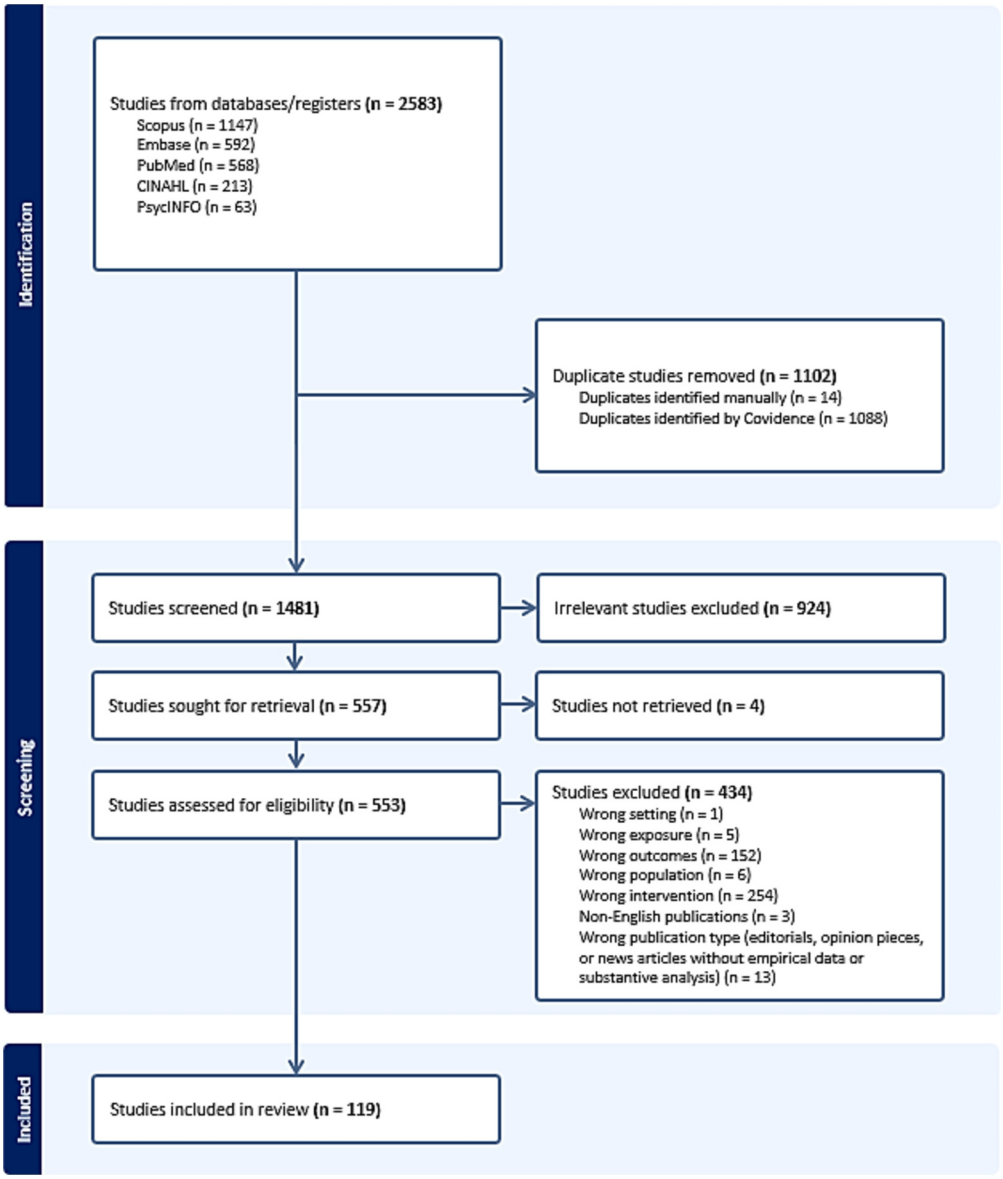

Fig. 1. PRISMA-ScR flow diagram of systematic article inclusion.

of study, country, type of study, study population, demographic factors (if applicable), prevalence/incidence of vaccination, primary sources of misinformation, institutional trust, conspiracy/alternative beliefs, religious/cultural beliefs, social media use/trust, beliefs on vaccine efficacy/post-vaccination symptoms, and perception of COVID-19 health risks. Following data extraction, thematic data analysis was conducted to identify and summarize key themes across the included studies.

While study characteristics are presented and discussed throughout the paper, additional details and syntheses have been provided in the form of supplementary tables. Supplementary Table 1 provides the complete data extraction format used for this scoping review, consisting of all included studies and extracted variables. Supplementary Table 2 provides a concise overview of key variables like the countries that a study applied to, major misinformation types, media sources, and whether the study showed a negative relation with vaccine uptake. This was divided into three categories: Yes, No, and Not Applicable (N/A). "Negative relation with vaccine uptake" was coded as "Yes" when a study reported that misinformation, misinformation-related beliefs, or identified misinformation source(s) were associated with lower vaccine uptake, lower vaccination intention, greater hesitancy, or refusal; "No" when such a negative relation was not supported or when findings were neutral/positive; and "N/A" when the study did not permit this determination.

3. Results

In total, 2583 articles were identified across all relevant databases, including Scopus (1147), Embase (592), PubMed (568), CINAHL (213), and PsycINFO (63). 1102 automatic duplicates were removed, and 1481 title/abstracts were screened, of which 553 full-text articles remained and were screened for eligibility in stage two. Ultimately, 119 articles met the inclusion criteria and were included in the review (Fig. 1). With the exception of geographical location and study type, not all categories of our results are mutually exclusive, and individual studies could be classified into multiple categories. Given the diverse nature of the studies included in this review, restricting the classification of studies into a single category would have misrepresented the complexity of the data. As such, total study counts may exceed the total number of studies due to overlap across categories.

3.1. Study characteristics

A total of 119 studies were included in the final analysis, representing diverse geographic and population contexts across LMICs (Supplementary Table 1). The largest number of studies were conducted in Nigeria (18) [16–33], Pakistan (13) [34–46], India (11) [47–57], and Ethiopia (6) [58–63], with additional representation across Sub-Saharan Africa, South Asia, the Middle East, and Southeast Asia. Notably, over 15/119 (12.61%) of studies [64–78] were conducted across multiple countries, reflecting a growing interest in cross-national perspectives on COVID-19 vaccine misinformation.

Cross-sectional studies were the most common study design among the included articles (69/119; 57.98%) [18,20–23,25–28,33,38,39,41,42,44,47–51,53,54,56–61,63–66,68,69,72,75,77,79–110], followed by qualitative and descriptive studies (28/119; 23.53%) [16,17,19,29,31,32,35–37,43,46,52,55,67,78,111–123], mixed-methods studies (12/119; 10.08%) [24,40,62,124–132], reviews and commentaries (7/119; 5.88%) [34,45,70,71,73,74,76], as well as content analysis studies (3/119; 2.52%) [30,133,134].

Supplementary Table 1: Study Characteristics A.

Supplementary Table 2: Study Characteristics B.

The study population included in this review represents a diverse sample of LMICs. The most commonly observed population was the general public, represented in 95 of 119 studies (79.83%) [16–18,20–24,26,27,29–38,40–43,45–48,50–52,54–57,60,62,64–73,75,77–85,89,91–95,97–100,102,104–124,127,128,130,131,133,134], including non-healthcare students, social media users, and individuals employed in education or business sectors. Healthcare workers and healthcare students constituted the second-most common study population (31/119; 26.05%) [19,25,28,32,42–45,52,53,55,58,61,63,71,73,86,87,89,90,96,103,106,108,112,115,123,125,128,129,132]. Additionally, 10/119 studies (8.40%) [32,39,49,55,59,88,101,104,115,126] mentioned patients as part of the study population, while 2/119 studies (1.68%) [74,76] did not report relevant data regarding a study population.

Demographic characteristics were reported in most of the included studies (106/119; 89.08%) [16–25,27–29,31–44,46–68,71,72,75–92,94–118,120,121,124,125,127–133], which were classified as follows: (1) age and sex/gender composition, (2) education level, socioeconomic indicators, and employment/occupation, (3) participants' residential environment, geographic setting, and/or marital status, as well as (4) religion or ethnicity. Most commonly reported was age and sex/gender composition (96/119; 80.67%) [16–22,24,25,27–29,32–36,38–42,44,46–64,66–68,71,72,75,77–90,93–116,118,121,124–127,129–132], followed by education level, socioeconomic indicators, and employment/occupation (87/119; 73.11%) [16–20,22,24,27–29,31,33,35–44,46–53,55,56,58–63,65–68,71,72,75–85,87,89–92,95–102,104–113,116,120,121,125,127,129–132]. Many studies also reported participants' residential environment, geographic setting, and/or marital status (50/119; 42.02%) [22,28,29,32,34,35,38–44,48,50,54,56,57,61–65,67,68,71,76,81,82,84,85,91,92,98,99,101–104,107,109,115,117,118,120,127,128,130,131,133]. Lastly, fewer studies reported demographic characteristics regarding religion or ethnicity (31/119; 26.05%) [17,19,24,25,28,33,46,48,56,58–61,65,66,76,77,82,91,92,96,97,101,103,108,109,111,117,118,120,131], while some studies did not report any demographic data [26,30,69,70,73,74,119,122,123,134].

3.2. COVID-19 vaccine uptake and intention

Vaccination prevalence and incidence, such as current vaccination status, uptake/coverage, willingness/intention, and hesitancy/refusal were reported in 78/119 included studies (65.55%) [16,17,19,21,22,24,27,28,30,33–35,39,44,46,47,49–53,56,58–66,68,71–76,78,79,81,82,84–91,95–99,101–104,106–113,118,123–125,127–133]. Measures of willingness/intention/hesitancy/refusal were the most commonly reported vaccination outcomes (59/119; 49.58%) [17,21–24,27,28,33–35,46,47,51,53,56,58–66,68,71,72,75,76,78,79,81,82,84,86–91,95,96,98,101–104,106,109–113,118,124,125,127,131,133]. Fewer studies reported current vaccination status/-uptake/acceptance/coverage (39/119; 32.77%) [16,17,19,24,33,39,44,47,49–51,53,64,71–74,76,88–90,96,97,99,101–104,106–108,118,123,125,127–130,132].

3.3. Institutional trust in information sources

Institutional trust was discussed in the majority of included studies (96/119; 80.67%) [18–21,23–26,28–32,34,36–39,41–48,50–53,55–59,61,62,64,65,67,68,70,71,73–80,82–85,88–93,95,96,98–101,104–124,126–130,132–134]. Trust related to government/health authorities was the most referenced institutional domain (30/119; 25.21%) [20,32,39,41,43,44,48,50,51,53,58,59,64,75,77,82,98,104,105,109,110,115–117,120,121,123,128,132,134]. Across the included literature, distrust/low trust in one or more institutions was also frequently reported (54/119; 45.38%) [19,21,25,26,29,30,34,36–38,45,46,48,55,56,61,62,67,71,73–76,78–80,82,84,85,88,91–93,95,96,100,101,106–108,111–115,118,119,121,123,124,127,130,131,133] and several studies specifically described healthcare professionals, health systems, and the scientific community as trusted sources of vaccine information (16/119; 13.45%) [28,42,48,52,64,73,75,79,81,99,100,111,115,116,126,131].

3.4. Primary sources of misinformation

Social media was identified as the most common source of COVID-19 vaccine-related misinformation in 97 of 119 studies (81.51%) [16,18–22,25–43,45,46,51–54,56–58,60,61,63–71,74–78,83–87,89–91,93–98,100–127,130–134]. Particularly, social media platforms included Facebook (41/119; 34.45%) [16,19,20,31,35,37,40,43,51,63,64,66,71,76,78,84,87,89,91,94,95,97,98,100,102,108–113,115,116,118,121,124–127,130,134], WhatsApp (28/119; 23.53%) [16,19,20,31,37,40,43,51,52,64,71,76,84,87,89,94,97,98,100,112,113,115,117–119,121,125,127], X (21/119; 17.65%) [16,20,31,37,40,41,43,51,57,64,66,69,76,78,87,89,97,108,115,124,130], YouTube (11/119; 9.24%) [30,40,41,54,71,89,109–111,114,118], Instagram (9/119; 7.56%) [16,19,31,41,51,89,98,125,130], TikTok (3/119; 2.52%) [16,40,133], Telegram (2/119; 1.68%) [31,63], Pinterest (1/119; <1%) [89], LinkedIn (1/119; <1%) [89], and Zalo (1/119; <1%) [109]. Other misinformation sources, such as mainstream media, television (TV), radio, the internet, family relatives, word-of-mouth, healthcare workers, Google, or friends, were mentioned by 37 of 119 studies (31.09%) [18,21–23,25,26,32,33,38–40,42,45,46,51,53,54,67,73,76,85,88–91,97,99,103,104,114,116,118,119,127–129,131]. Contrastingly, 22 studies (18.49%) [17,23,24,44,47–50,55,59,62,72,73,79–82,88,92,99,128,129] did not identify social media to be a major source of misinformation or did not report relevant data.

Social media use and trust was a key data element in exploring the role of misinformation in COVID-19 vaccine hesitancy. While the vast majority of studies (107/119; 89.92%) [16,17,19–23,25–47,49–71,73–85,87,89–94,96–103,105–119,121–123,127–134] reported social media usage among their respective study populations, findings differed with respect to the influence of social media on vaccination outcomes. Furthermore, 73 studies (73/119; 61.34%) [16,17,19,20,23,26–30,33–40,42,43,45,46,52,53,55–58,60–62,64–67,70,71,74–76,78–80,83–85,87,89,90,93,96,100,101,103,105,108,111–114,116–118,121–123,127,128,130–134] reported a high degree of negative influence of social media-induced misinformation on vaccine-related outcomes, whereas 14 studies (14/119; 11.76%) [31,32,41,47,50,51,59,81,82,94,98,99,106,110] reported a minimal negative influence. Notably, 27 studies (27/119; 22.69%) [21,22,25,28,40,44,49,52,54,57,63,67–69,73,77,91,92,97,99,102,107,109,111,115,119,129] reported a neutral or positive influence of social media on vaccination outcomes and

specified instances where misinformation did not directly lead to vaccine hesitancy. Lastly, 12 studies (12/119; 10.08%) [18,24,48,72,86,88,95,104,120,124–126] did not report specific data in this regard.

3.5. Key themes of misinformation

Several prominent themes of misinformation were identified, with many studies reporting multiple themes: (1) malicious intentions, (2) fear of side effects, (3) concerns about vaccine development and safety, (4) religious and cultural beliefs, and (5) natural immunity. Few studies (9/119; 7.56%) did not explicitly report themes of misinformation [16,20,48,69,72,94,110,115,125].

(1) "Fear of side effects" was the most prominent theme, reported in 80/119 studies (67.23%). This included beliefs such as vaccination causing illness, COVID-19, autism, infertility, death, DNA changes, blood clots, or that humans turn into zombies [22,24,26–30,32,34–37,41–44,46,47,49–53,55–57,60–64,67,68,70,71,73–77,79,80,83–86,88–92,96–98,100–104,106–108,111–114,116–120,122–124,126–130,132,133].

(2) "Concerns about vaccine development and safety" was another common theme, reported in 77/119 studies (64.71%). This included skepticism surrounding vaccine safety, the short development period, the idea that vaccine ingredients are dangerous, or that vaccines are saline water. Furthermore, this also included beliefs regarding the quality, efficacy, and degree of protection from vaccines [17–19,21,22,24–26,29,30,32–39,41,42,44–46,49,51–55,57–60,62–64,66,68,70,71,73,74,76,78,80,81,83,85–88,90–92,95,96,98,100,103,104,108,109,111,112,114,116,118–121,123,124,127,130–134].

(3) "Malicious intentions" was a theme reported in 57/119 studies (47.90%). This included beliefs such as capitalist industries controlling the vaccines, vaccine developed to achieve commercial, financial, and economic aims, or deployed as part of broader conspiratorial efforts, including population reduction schemes, the establishment of a "new world order", or covert research initiatives. Additional narratives within this theme included claims that COVID-19 is a man-made virus, that vaccines functioned as weapons of war, or enabled 5G microchipping [21–26,29,31,32,34,35,37,40,41,45–47,56,62,64,66–68,71,74–76,78,80,82–84,86,88,90–93,100,102,106–109,112,113,116–123,127,129,130].

(4) "Religious and cultural beliefs" were reported in 50/119 studies (42.02%). This includes faith or cultural-based objections, moral/religious symbolism (such as the "mark of the beast") and concerns about vaccine permissibility [17–19,26,28,29,32,34,35,40,42,45–47,49,50,55,56,60,62,64–67,70,71,73,74,76,78,79,82,88,91,93,99–101,103,108,117,118,120,122,123,127,128,130,132,134].

(5) "Natural immunity" was the least common theme, reported in 15/119 studies (12.61%). Beliefs revolved around a preference for natural remedies, trust in natural immunity, and an overall false sense of being immune to COVID-19 [28,46,47,51,67,70,85,95,101,103,105,108,119,120,128].

4. Discussion

Across the analyzed literature, misinformation related to COVID-19 vaccination in LMICs consistently appeared to operate within a broader information ecosystem, where the channel through which vaccine narratives spread often mattered just as much as the content itself. Many studies positioned social media and messaging platforms as central pathways for encountering and sharing vaccine-related claims, including both misinformation and debate about vaccine credibility [16,18–22,25–43,45,46,51–54,56–58,60,61,63–71,74–78,83–87,89–91,93–98,100–127,130–134]. Additionally, the findings of this review suggest that non-social media information sources including (but not limited to) TV, radio, the internet, family relatives, word of mouth, and friends were found to spread misinformation in far less instances [18,21–23,25,26,32,33,38–40,42,45,46,51,53,54,67,73,76,85,88–91,97,99,103,104,114,116,118,119,127–129,131]. This underscores the influential role of social media misinformation on public attitudes towards COVID-19 and COVID-19 vaccine hesitancy, and more broadly towards public health crises.

In terms of the content of misinformation and related beliefs, the included studies most frequently emphasized narratives that directly lower confidence in vaccines by reframing them as harmful, unsafe, or not worthwhile [17–19,21,22,24–30,32–39,41–47,49–64,66–68,70,71,73–81,83–92,95–97,100–104,106–109,111–114,116–124,126–134]. While many sentiments in the included studies found that many individuals had concerns regarding the overall effectiveness of vaccine benefits (often including perceptions that vaccines do not work or are unnecessary), one prominent pattern involved concerns of side effects, post-vaccination symptoms, and safety (often due to skepticism surrounding vaccine development). This included believing that the vaccine may cause severe harm or even death.

These concerns often coexisted with conspiracy-oriented frames that offered an "explanation" for why vaccines might be dangerous, such as narratives involving malicious intent, profiteering, population control, or politically motivated vaccine campaigns. Technological or biomedical-related frames are examples of these themes (such as microchips, 5G, or DNA-related narratives), which can further intensify safety fears by adding a sense of hidden, irreversible risk [17–19,21,22,24–30,32–39,41–47,49–64,66–68,70,71,73–81,83–92,95–97,100–104,106–109,111–114,116–124,126–134]. In addition, some studies highlighted "alternatives to vaccination" framing, including natural immunity or traditional remedies, which can reduce the perceived need for vaccination even when safety concerns are not the main driver [28,46,47,51,67,70,85,95,101,103,105,108,119,120,128].

Many of the included studies repeatedly pointed to institutional trust, such as trust in governments, health authorities, healthcare professionals, and the scientific community [20,28,32,39,41–44,48,50–53,58,59,64,73,75,77,79,81,82,98–100,104,105,109–111,115–117,120,121,123,126,128,131,132,134]. These themes pointed to the influences that shape how people interpret competing messages. In addition, several studies documented distrust in official institutions [19,21,25,26,29,30,34,36–38,45,46,48,55,56,61,62,67,71,73–76,78–80,82,84,85,88,91–93,95,96,100,101,106–108,111–115,118,119,121,123,124,127,130,131,133]. Religious and cultural framing appeared less consistently than safety or conspiracy themes, but when present, it sometimes shaped vaccine interpretation through leader influence, perceived religious permissibility, or religiously framed narratives about vaccines [17–19,26,28,29,32,34,35,40,42,45–47,49,50,55,56,60,62,64–67,70,71,73,74,76,78,79,82,88,91,93,99–101,103,108,117,118,120,122,123,127,128,130,132,134]. Taken together, these findings suggest that misinformation in LMIC contexts is not simply a random set of incorrect claims, but rather a pattern of claims that compound into larger narratives within the infodemic.

It is important to note that a small subset of the included studies reported a minimally negative, neutral or positive influence of social media on vaccination outcomes. This can be attributed to a few different factors. First, the study populations examined by these studies held varying degrees of medical knowledge or digital literacy. For instance, studies that focused on healthcare workers as their target population were less likely to believe circulating misinformation regarding vaccines than chronic disease patients. Second, varying degrees of religious or cultural beliefs may have also played a role in determining the influence of social media on vaccination outcomes, especially due to messages propagated by religious leaders. Similarly, these factors also apply to the positive outcomes observed, as study populations who did not believe misinformation were more likely to recognize vaccination campaigns. In

addition, varying levels of government/institutional trust were observed across the included studies, and contexts where institutional trust was higher may help explain more positive outcomes.

4.1. Future implications

Important lessons can be learned from the role of misinformation in COVID-19 vaccine hesitancy and applied to future pandemics. The rampant impact of misinformation, especially the type found circulating on social media platforms during the COVID-19 pandemic, influenced the trends of poor vaccine uptake in LMICs. The idea of misinformation serving an influential role in driving populations to vaccine hesitancy is not unique to COVID-19 and can therefore affect numerous infectious diseases that can be controlled by vaccination. One example is measles, a highly contagious disease caused by the measles virus, which requires herd immunity to control spread [135]. In 2025, the rise of measles in HICs like the United States and Canada resulted from a poor uptake of vaccines caused by vaccine hesitancy, similar to COVID-19 in the sense that herd immunity is a key concept in controlling spread [136,137]. Similar to COVID-19, themes of misinformation regarding the measles vaccine are prevalent and not exempt from affecting LMICs in a similar or even more significant manner. Lessons from social media misinformation and COVID-19 vaccine hesitancy in LMICs should be utilized in developing interventions to combat the circulation of inaccurate health information to the public [138]. If left unaddressed, the battlefield remains open for misinformation to circulate regarding infectious diseases in LMICs, and vaccine-hesitant outcomes may be observed similarly to during the COVID-19 pandemic, resulting in major public health repercussions. Therefore, it is strongly suggested that LMICs and governing influential authorities consider the potential impact of misinformation on vaccination outcomes within the population and implement appropriate measures to combat its widespread dissemination. Additionally, it is especially crucial to consider heterogeneity in the forms of misinformation as they pertain to vaccine hesitancy. While misinformation sources may include mainstream media, public outlets, and social media, the findings of this review highlight the overwhelmingly unfavorable influence of social media misinformation on COVID-19 vaccine hesitancy in LMICs, underscoring the need for targeted misinformation-specific interventions to counter infodemics. The lessons learnt from the COVID-19 pandemic in relation to misinformation and vaccine hesitancy, both as highlighted in this review and in the vast literature, are pivotal in ensuring that LMICs are better prepared for future pandemics by implementing robust misinformation countermeasures [139,140]. As seen from the developments post-pandemic in various HICs, lessons from the COVID-19 pandemic are crucial in preparing for future pandemics. Various studies have noted system-level factors like healthcare delivery strain, funding, and workforce constraints as major inhibitors which, although historically always present, were brought to light during the COVID-19 pandemic [141,142]. As such, it is paramount to invest in the development of robust pandemic preparedness frameworks as part of key systemic reforms to the public health sector. HICs lead the way in incorporating these changes, allowing LMICs to use them as exemplars in their own advances.

As such, future research should focus on addressing specific literature gaps to help formulate a cohesive plan-of-action that can be applicable to future infectious diseases or pandemics. Based upon the results of this review, there are several evident research gaps. First, a disproportionately high number of studies were conducted in a small subset of countries, which resulted in some LMICs being overrepresented. Notably, Nigeria, Pakistan, and India accounted for a disproportionate share among the overall number of included studies, with several other countries accounting for a much lower proportion of the included studies. Countries with particularly low representation (i.e., only one study per country) included Zambia, Sierra Leone, Nepal, Papua New Guinea, Palestine, Egypt, Togo, and Yemen. This discrepancy in the overrepresentation of certain countries and underrepresentation of others, can be attributed to various factors, but most importantly their differing socio-political and media contexts. This can considerably influence overall narratives towards vaccination, access to media, and social media literacy. As such, this inconsistency may lead to gaps in information pertaining to these underrepresented countries, preventing the development of appropriate interventions. The findings of this review indicate that the adequacy of formal research studies across all LMICs is not equal, and is an important literature gap worth addressing. This also suggests that our findings, based off the overrepresentation of some countries over others, may not be truly generalizable to all LMICs. This issue warrants future research to focus on minimizing the disproportionate representation among LMICs in relation to misinformation and vaccine hesitancy, to ultimately more homogenously represent the various LMICs. Moreover, our review found that not all social media use is harmful and that, in some cases, social media use can have a beneficial or neutral impact on vaccine uptake [49,52,67,73,77,91,92,102,107,111]. While several social media platforms were examined in our dataset, there was a lack of evidence on which platforms led to better vaccine uptake outcomes, if any. Therefore, future research in this direction is essential to more adequately understand the misinformation infodemic in LMICs, allowing for more effective interventions to sustain future diseases and pandemics.

4.2. Strengths & limitations

Several measures were taken into consideration during the completion of our scoping review. First, a comprehensive mapping of the literature regarding the role of misinformation in COVID-19 vaccine hesitancy in LMICs has not previously been conducted, making it an essential literature gap worth addressing. Second, this scoping review was conducted in accordance with frameworks like Arksey and O'Malley and PRISMA-ScR, allowing for enhanced transparency and reproducibility. Furthermore, search strategies were created for multiple databases, enabling broad identification of relevant studies. Moreover, several independent reviewers were involved in the screening stages, ensuring minimal selection bias at all stages. Finally, an exhaustive data extraction template was curated, resulting in a rich dataset allowing for the identification of key themes, which can be used to effectively highlight further literature gaps.

Despite these strengths, our study is not exempt from limitations and should thus be interpreted with caution. While this review examines the role of misinformation in COVID-19 vaccine hesitancy, it is important to note that many included studies were cross-sectional and therefore cannot establish causal relationships. As a result, the findings should be interpreted as demonstrating associations between misinformation exposure and hesitancy, rather than definitive causal effects. Nonetheless, the consistency of these associations across studies suggests that misinformation may play an important contributory role. First, only articles published in the English language were included in our review. Importantly, English is not the primary language in the vast majority of the LMICs included in this study, and excluding non-English publications may mean that locally published health communication and research were excluded from our analysis. Therefore, this may reflect a language bias from the studies included and could result in decreased generalizability of the results across different LMIC contexts. Second, given the scope of this review and the large volume of published literature identified, a grey literature search was not conducted for this study, which may cause the results to overwhelmingly represent data present in peer-reviewed literature only. Organizations like the WHO, UNICEF, and government health agencies have produced substantive reports on vaccine misinformation in LMICs. Excluding this may represent a publication bias and have potentially caused us to miss unpublished data or data with null or negative results, affecting the comprehensiveness of this review. Third, as this is a scoping review, the quality appraisal stage is optional and was not conducted. Given the heterogeneity of the studies included in this review, no single quality

appraisal tool exists that can apply to all the included study types, further limiting our ability to formally conduct a quality appraisal of the included articles. Therefore, the methodological rigour and risk of bias of the studies included in this review cannot be determined. As a result, the conclusions drawn reflect the breadth of literature rather than the strength of the evidence and should thus be interpreted with caution. Fourth, as this study included a small number of review articles, there is a possibility of minimal overlap with primary studies. However, overlap was limited and did not meaningfully affect the breadth or conclusions of the review. Lastly, this review included a small number of pre-print articles ($n = 5$), which are identified explicitly in the supplementary files. Despite their non-peer-reviewed status, the small number of pre-prints relative to the total study count (5/119) is unlikely to substantially affect the overall confidence in the findings of this review.

5. Conclusion

Our review suggests that misinformation relating to COVID-19 and COVID-19 vaccines is most frequently encountered and disseminated through social media and messaging platforms, which were identified as a major source of misinformation in most included articles. Likewise, these were also commonly associated with negative vaccination-related outcomes. Misinformation themes most often centered on malicious intentions, conspiratorial motives, fear of side effects, and concerns about vaccine development and safety, while religious and cultural narratives and natural immunity beliefs appeared less frequently. Consistent with these patterns, beliefs concerning vaccine efficacy and safety, including post-vaccination symptoms and side effects, were reported in nearly all included studies, reinforcing the central role of safety and effectiveness concerns as key drivers of vaccine doubt in LMIC contexts. Finally, institutional trust was discussed in most studies, with findings spanning both high trust in official sources and distrust in institutions such as governments, healthcare systems, and vaccine manufacturers, highlighting that misinformation related to vaccine decision-making occurs within a broader trust landscape. From a public health standpoint, it is crucial to apply the lessons from misinformation and vaccine hesitancy during the COVID-19 pandemic, towards interventions aimed at combating the social media misinformation infodemic in LMICs. Moving forward, engaging in research aimed at filling existing research gaps is important in developing resilient pandemic preparedness strategies for LMICs, ultimately resulting in more optimal population health outcomes.

CRediT authorship contribution statement

Aryan Yogesh Sarnaik: Writing – review & editing, Writing – original draft, Visualization, Project administration, Formal analysis, Data curation, Conceptualization. **Ziyad Uddin Khan:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Formal analysis, Data curation, Conceptualization. **Thenugaa Rajeswaran:** Writing – review & editing, Data curation, Conceptualization. **Aditi Majoe:** Writing – review & editing, Data curation, Conceptualization. **Joy Zeng:** Writing – review & editing, Data curation. **Lakshna Ponrajah:** Writing – review & editing, Data curation, Conceptualization. **Zaara Kastura:** Writing – review & editing, Data curation, Conceptualization. **Labiqah Iftikhar:** Writing – review & editing, Data curation, Conceptualization. **Md. Akhtarul Islam:** Writing – review & editing, Data curation, Conceptualization. **Naumana Basharat:** Writing – review & editing, Data curation. **Mariam Hassan:** Writing – review & editing, Data curation. **Jasleen Kaur:** Writing – review & editing, Conceptualization. **Daliana Lobo Torres:** Writing – review & editing, Data curation. **Dipika Shankar Bhattacharyya:** Conceptualization, Writing – review & editing. **Bara' Abdallah AlShurman:** Project administration, Conceptualization. **Nuzhat Namiha:** Project administration. **Zahid Ahmad Butt:** Writing – review & editing, Validation, Supervision, Project administration, Data curation, Conceptualization.

Ethics approval

As this is a scoping review comprising of published literature, no ethics approval was required.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2026.128595.

Data availability

No data was used for the research described in the article.

References

[1] Coronavirus disease (COVID-19) pandemic. Retrieved December 16, 2025, from, https://www.who.int/europe/emergencies/situations/covid-19; 2025.
[2] Bok K, Sitar S, Graham BS, Mascola JR. Accelerated COVID-19 vaccine development: milestones, lessons, and prospects. Immunity 2021;54(8):1636–51. https://doi.org/10.1016/j.immuni.2021.07.017.
[3] Md Khairi LNH, Fahrni ML, Lazzarino AI. The race for global equitable access to COVID-19 vaccines. Vaccines 2022;10(8):1306. https://doi.org/10.3390/vaccines10081306.
[4] COVAX: ensuring global equitable access to COVID-19 vaccines | UNICEF Supply Division. Retrieved December 16, 2025, from, https://www.unicef.org/supply/covax-ensuring-global-equitable-access-covid-19-vaccines; 2025.
[5] Ten health issues WHO will tackle this year. Retrieved December 16, 2025, from, https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019; 2026.
[6] Strategy to Achieve Global Covid-19 Vaccination by mid-2022. Retrieved December 16, 2025, from, https://www.who.int/publications/m/item/strategy-to-achieve-global-covid-19-vaccination-by-mid-2022; 2026.
[7] Loomba S, de Figueiredo A, Piatek SJ, de Graaf K, Larson HJ. Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. Nat Hum Behav 2021;5(3):337–48. https://doi.org/10.1038/s41562-021-01056-1.
[8] Lazer DMJ, Baum MA, Benkler Y, Berinsky AJ, Greenhill KM, Menczer F, et al. The science of fake news *Science (American Association for the Advancement of Science)* 2018;359(6380):1094–6. https://doi.org/10.1126/science.aao2998.
[9] Infodemic. 2025, https://www.who.int/health-topics/infodemic#tab=tab_1.
[10] Cascini F, Pantovic A, Al-Ajlouni YA, Failla G, Puleo V, Melnyk A, et al. Social media and attitudes towards a COVID-19 vaccination: A systematic review of the literature. eClinicalMedicine 2022;48:101454. https://doi.org/10.1016/j.eclinm.2022.101454.
[11] Managing the COVID-19 infodemic: Promoting healthy behaviours and mitigating the harm from misinformation and disinformation. Retrieved December 16, 2025, from, https://www.who.int/news/item/23-09-2020-managing-the-covid-19-infodemic-promoting-healthy-behaviours-and-mitigating-the-harm-from-misinformation-and-disinformation; 2026.
[12] Arksey H, O'Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol 2005;8(1):19–32. https://doi.org/10.1080/1364557032000119616.
[13] Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. Ann Intern Med 2018;169(7):467–73. https://doi.org/10.7326/M18-0850.
[14] Covidence—Better systematic review management. Covidence; 2025. Retrieved December 16, 2025, from, https://www.covidence.org/.

[15] World Bank country classifications by income level for 2024-2025. World Bank Blogs; 2026. Retrieved May 9, 2025, from, https://blogs.worldbank.org/en/opendata/world-bank-country-classifications-by-income-level-for-2024-2025.

[16] Adesina E, Salawu A, Adeyeye B. Preferred information sources and COVID-19 vaccine acceptance: a comparative analysis of television vs. social media. Pak J Life Soc Sci 2024;22(2):9203–13. https://doi.org/10.57239/PJLSS-2024-22.2.00696.

[17] Adetayo AJ, Williams-Ilemobola OB, Asiru MA. Religious sources of COVID-19 vaccine information, authentication and vaccination acceptance among students in selected universities in Nigeria. J Consum Health Internet 2022;26(2):157–70. https://doi.org/10.1080/15398285.2022.2053830.

[18] Anorue LI, Ugwu AC, Ugboaja SU, Nwabunze UO, Ugwulor-Onyinyechi CC, Njoku C. Communicating covid-19 vaccine safety: knowledge and attitude among residents of south east, Nigeria. Infection and Drug Resistance 2021;14:3785–94. https://doi.org/10.2147/IDR.S329183.

[19] Bakare AA, Olojede OE, King C, Graham H, Uchendu O, Colbourn T, et al. Care seeking for under-five children and vaccine perceptions during the first two waves of the COVID-19 pandemic in Lagos state, Nigeria: a qualitative exploratory study. BMJ Open 2023;13(3). https://doi.org/10.1136/bmjopen-2022-069294.

[20] Ekezie W, Bosah G. Demographic representation of COVID-19 social media and information engagement in Nigeria. Population Medicine 2021;3. https://doi.org/10.18332/popmed/137087.

[21] Esan AO, Ushie JA. City residents' awareness and perception of covid 19 vaccination. Record and Library Journal 2022;8(2):216–27. https://doi.org/10.20473/rlj.V8-I2.2022.216-227.

[22] Eze SU. Exploring the knowledge, attitude and practice of COVID-19 vaccination and associated factors in relation to COVID-19 vaccine uptake among residents of Abakaliki metropolis in Ebonyi state, Nigeria. TEXILA INTERNATIONAL JOURNAL OF PUBLIC HEALTH 2024;12(2). https://doi.org/10.21522/TIJPH.2013.12.02.Art006.

[23] Goldstein JA, Grossman S, Startz M. Belief in COVID-19 misinformation in Nigeria. J Polit 2024;86(2):810–4. https://doi.org/10.1086/727605.

[24] Iliyasu Z, Umar AA, Abdullahi HM, Kwaku AA, Amole TG, Tsiga-Ahmed FI, et al. They have produced a vaccine, but we doubt if COVID-19 exists: correlates of COVID-19 vaccine acceptability among adults in Kano, Nigeria. Hum Vaccin Immunother 2021;17(11):4057–64. https://doi.org/10.1080/21645515.2021.1974796.

[25] Iwu CA, Ositadinma P, Chibiko V, Madubueze U, Uwakwe K, Oluoha U. Prevalence and predictors of COVID-19 vaccine hesitancy among health care workers in tertiary health care institutions in a developing country: A cross-sectional analytical study. Advances in Public Health 2022;2022. https://doi.org/10.1155/2022/7299092.

[26] Njoku CC, Ani JI, Batisai K. Perception of COVID-19 vaccination and uptake willingness in northern Nigeria: understanding strategies to optimize coverage. Int J Environ Res Public Health 2025;22(2). https://doi.org/10.3390/ijerph22020153.

[27] Nomhwange T, Wariri O, Nkereuwem E, Olanrewaju S, Nwosu N, Adamu U, et al. COVID-19 vaccine hesitancy amongst healthcare workers: an assessment of its magnitude and determinants during the initial phase of national vaccine deployment in Nigeria. eClinicalMedicine 2022;50. https://doi.org/10.1016/j.eclinm.2022.101499.

[28] Ogunyinka IA, Yusuff KB, Erah PO, Mohammed Y, Wada YH. Coronavirus disease 2019 knowledge, its vaccine uptake intentions, and the influence of personality traits among undergraduate pharmacy students in a university setting: findings and implications. Ann Afr Med 2024;23(3):271–84. https://doi.org/10.4103/aam.aam_201_23.

[29] Omale UI, Adeke AS, Oka OU, Ikegwuonu CO, Iyare O, Nnachi OO, et al. Determinants of COVID-19 vaccination acceptance based on the novel omale INDEPT FORCIS framework and recommendations for subsequent pandemics: A qualitative study among community members in Ebonyi state, Nigeria. Int J Equity Health 2024;23(1). https://doi.org/10.1186/s12939-024-02284-3.

[30] Sadiq M, Croucher S, Dutta D. COVID-19 vaccine hesitancy: A content analysis of nigerian YouTube videos. Vaccines 2023;11(6). https://doi.org/10.3390/vaccines11061057.

[31] Usman B, Eric Msughter A, Olaitan Ridwanullah A. Social media literacy: fake news consumption and perception of COVID-19 in Nigeria. Cogent Arts Humanit 2022;9(1). https://doi.org/10.1080/23311983.2022.2138011.

[32] Wonodi C, Obi-Jeff C, Adewumi F, Keluo-Udeke SC, Gur-Arie R, Krubiner C, et al. Conspiracy theories and misinformation about COVID-19 in Nigeria: implications for vaccine demand generation communications. Vaccine 2022;40(13):2114–21. https://doi.org/10.1016/j.vaccine.2022.02.005.

[33] Zakari S, Ogbu CO, Zakari H, Chioma ES, Ijimbili SB, Idoko JE, et al. Acceptance and hesitancy of COVID-19 vaccine among university community members of Otukpo, Nigeria: a cross-sectional study. Discover Glob Soc 2023;1(1). https://doi.org/10.1007/s44282-023-00013-9.

[34] Akhtar N, Nawaz F, Idnan M, Hayee S. COVID-19 vaccine hesitancy in Pakistan: an analysis of challenges and mitigations. Microbes and Infectious Diseases 2021;2(3):403–6. https://doi.org/10.21608/MID.2021.77185.1159.

[35] Akram S, Aftab R, Baloch QB, Ullah F, Alonazi WB, Baloch VQ, et al. The conditionality of COVID-19 vaccine acceptance: A qualitative study in Pakistan. Afr J Reprod Health 2025;29(3):143–59. https://doi.org/10.29063/ajrh2025/v29i3.17.

[36] Ali S, Pasha SA, Khalid A. COVID-19, vaccination, and conspiracies: A Micro-level qualitative study in Islamabad, Pakistan. Yale J Biol Med 2022;95(2):177–90.

[37] Arif H, Bakare N. Health security, vaccine hesitancy and post-truth: A case of COVID-19 in Pakistan. J Asian Afr Stud 2024;59(4):1135–53. https://doi.org/10.1177/00219096221130344.

[38] Arshad MS, Hussain I, Mahmood T, Hayat K, Majeed A, Imran I, et al. A national survey to assess the COVID-19 vaccine-related conspiracy beliefs, acceptability, preference, and willingness to pay among the general population of Pakistan. Vaccines 2021;9(7). https://doi.org/10.3390/vaccines9070720.

[39] Baraka MA, Manzoor MN, Ayoub U, Aljowaie RM, Mustafa ZU, Zaidi STR, et al. Vaccine acceptance and hesitancy among hospitalized COVID-19 patients in Punjab, Pakistan. Vaccines 2022;10(10). https://doi.org/10.3390/vaccines10101640.

[40] Gao J, Raza SH, Yousaf M, Shah AA, Hussain I, Malik A. How does digital media search for COVID-19 influence vaccine hesitancy? Exploring the trade-off between google trends, infodemics, Conspiracy Beliefs and Religious Fatalism. Vaccines 2023;11(1). https://doi.org/10.3390/vaccines11010114.

[41] Jin Q, Raza SH, Yousaf M, Zaman U, Siang JMLD. Can communication strategies combat covid-19 vaccine hesitancy with trade-off between public service messages and public skepticism? Experimental evidence from Pakistan. Vaccines 2021;9(7). https://doi.org/10.3390/vaccines9070757.

[42] Kashif M, Fatima I, Ahmed AM, Arshad Ali S, Memon RS, Afzal M, et al. Perception, willingness, barriers, and hesitancy towards COVID-19 vaccine in Pakistan: comparison between healthcare workers and general population. Cureus 2021;13(10):e19106. https://doi.org/10.7759/cureus.19106.

[43] Kazi AM, Ahsan N, Jabeen R, Allana R, Jamal S, Mughal MAK, et al. Effects of COVID-19 illness and vaccination infodemic through mobile health, social media, and electronic media on the attitudes of caregivers and health care providers in Pakistan: qualitative exploratory study. JMIR Infodemiology 2024;4. https://doi.org/10.2196/49366.

[44] Minhas S, Sajjad A, Manzoor I, Masood A, Suhail A, Shaikh GM, et al. Knowledge, attitude, and practices of front line health workers after receiving a COVID-19 vaccine: A cross-sectional study in Pakistan. PeerJ 2023;11. https://doi.org/10.7717/peerj.14727.

[45] Mubarak N, Khan AM, Tariq S, Kanwal S. The perils of vaccine hesitancy based on conspiracy theories and misinformation: implications and way forward for Pakistan. Journal of University Medical and Dental College 2021;12(2):vii–xiv. https://doi.org/10.37723/jumdc.v12i2.624.

[46] Qasim R, Shah H, Sultan A, Yaqoob M, Haroon R, Mistry SK, et al. Exploring the beliefs and experiences with regard to COVID-19 vaccine hesitancy and acceptance in a slum of Karachi, Pakistan. Health Promot Int 2022;37(6). https://doi.org/10.1093/heapro/daac140.

[47] Agarwal AK, Kumar N, Kushwaha P, Mahore R, Thamman A. A cross-sectional study assessing the factors causing COVID-19 vaccine hesitancy and WAYS to mitigate it. International Journal of Academic Medicine and Pharmacy 2023;5(1). https://doi.org/10.47009/jamp.2023.5.1.35. 163EP – 170.

[48] Alam F, Tao M, Rastogi R, Mendiratta A, Attri R. Do social media influencers influence the vaccination drive? An application of source credibility theory and uses and gratification theory. Technol Forecast Soc Chang 2024;198. https://doi.org/10.1016/j.techfore.2023.122973.

[49] B R, Rajagopal J, Ramaraju K. A survey on population perceived factors influencing COVID-19 vaccination in south Indian districts. Cureus 2024;16(8):e67696. https://doi.org/10.7759/cureus.67696.

[50] Faraz A, Hina M, Atif A, Sumbul D, Mahmood SE, Riaz F, et al. Knowledge, acceptance, motivators and barriers of booster dose of COVID-19 vaccination among dental patients: A cross-sectional study. Medicine (United States) 2023;102(45):E35747. https://doi.org/10.1097/MD.0000000000035747.

[51] George M, Manoharan K, Jinson J, Priyadharshini ICCSRBG, Anan DAKDNK, Jayamani SVP. COVID-19 vaccine hesitancy: what have we learnt? - a cross sectional survey among adults in Tamil Nadu, India. Namık Kemal Tıp Dergisi 2024;12(4):280–315. https://doi.org/10.4274/nkmj.galenos.2024.50490.

[52] Godbole S, Diwan V, Das S, Reddy MM, Kalyanasundaram M, Rajendran D, et al. Facilitators and barriers to the uptake of COVID-19 vaccine precaution dose among adult population: qualitative analysis across six different states of India. Front Public Health 2023;11. https://doi.org/10.3389/fpubh.2023.1293600.

[53] Jain J, Saurabh S, Kumar P, Verma MK, Goel AD, Gupta MK, et al. COVID-19 vaccine hesitancy among medical students in India. Epidemiol Infect 2021;149. https://doi.org/10.1017/S0950268821001205.

[54] Kumar Verma M, Khan D, Yuvaraj M. COVID-19 vaccine hesitancy among library professionals: A case study of indian health science librarians. J Hosp Librariansh 2022;22(3):204–16. https://doi.org/10.1080/15323269.2022.2088203.

[55] Makwana MN, Shekhda HJ, Rupani MP. Acceptance and expectations of healthcare workers and community during the COVID-19 vaccine rollout in Bhavnagar city, western India: A qualitative exploration. BMC Health Serv Res 2024;24(1). https://doi.org/10.1186/s12913-024-10885-5.

[56] Mundackal R, Agarwal T, Murali K, Isaac NV, Hu P, Dhayal V, et al. Prevalence & correlates of COVID-19 vaccine hesitancy in a rural community of bengaluru district, southern India: A preliminary cross-sectional study. Indian J Med Res 2022;155(5–6):485–90. https://doi.org/10.4103/ijmr.ijmr_3593_21.

[57] Vishwakarma A, Chugh M. COVID-19 vaccination perception and outcome: society sentiment analysis on twitter data in India. Soc Netw Anal Min 2023;13(1). https://doi.org/10.1007/s13278-023-01088-7.

[58] Abay ES, Belew MD, Ketsela BS, Mengistu EE, Getachew LS, Teferi YA, et al. Assessment of attitude towards COVID-19 vaccine and associated factors among clinical practitioners in Ethiopia: a cross-sectional study. PLoS One 2022;17(6). https://doi.org/10.1371/journal.pone.0269923.

[59] Abetu Mehari E, Mekonen TG, Tesfahun Adugnaw M, Abubeker Abdela O. Prevalence of COVID-19 vaccine hesitancy and its associated factors among

chronic disease patients in a resource limited setting in Ethiopia: A cross-sectional study. Advances in Public Health 2023;2023. https://doi.org/10.1155/2023/1776205.
[60] Alemu D, Diribsa T, Debelew GT. COVID-19 vaccine hesitancy and its associated factors among adolescents. Patient Prefer Adherence 2023;17:1271–80. https://doi.org/10.2147/PPA.S400972.
[61] Bereda G. Explore the reasons for SARS-CoV-2 vaccine hesitancy among healthcare workers: A cross-sectional study. Ann Med Surg 2023;85(6). https://doi.org/10.1097/MS9.0000000000000628. 2443EP – 2450.
[62] Dereje N, Tesfaye A, Tamene B, Alemeshet D, Abe H, Tesfa N, et al. COVID-19 vaccine hesitancy in Addis Ababa, Ethiopia: a mixed-method study. BMJ Open 2022;12(5). https://doi.org/10.1136/bmjopen-2021-052432.
[63] Mose A, Haile K, Timerga A. COVID-19 vaccine hesitancy among medical and health science students attending Wolkite university in Ethiopia. PLoS One 2022;17(11). https://doi.org/10.1371/journal.pone.0263081.
[64] Abubakari SW, Workneh F, Asante KP, Hemler EC, Madzorera I, Wang D, et al. Determinants of COVID-19 vaccine readiness and hesitancy among adults in sub-Saharan Africa. PLOS Glob Public Health 2023;3(7). https://doi.org/10.1371/journal.pgph.0000713.
[65] Brackstone K, Marzo RR, Bahari R, Head MG, Patalinghug ME, Su TT. COVID-19 vaccine hesitancy and confidence in the Philippines and Malaysia: a cross-sectional study of sociodemographic factors and information-seeking. medRxiv 2022. https://doi.org/10.1101/2022.06.15.22276457 (Brackstone, Head) Clinical Informatics Research Unit, Faculty of Medicine, University of Southampton, Southampton, United Kingdom(Marzo) Department of Community Medicine, International Medical School, Management and Science University, Shah Alam, Malaysi.
[66] Eberhardt J, Al-Qerem W, Ling J. Comparing COVID-19 booster vaccine acceptance in the United Kingdom, Germany, Austria, and Jordan: the role of protection motivation theory, conspiracy beliefs, social media use and religiosity. Vaccine 2024;42(26). https://doi.org/10.1016/j.vaccine.2024.126474.
[67] Elbarazi I, Yacoub M, Reyad OA, Abdou MS, Elhadi YAM, Kheirallah KA, et al. Exploring enablers and barriers toward COVID-19 vaccine acceptance among arabs: A qualitative study. International Journal of Disaster Risk Reduction 2022;82. https://doi.org/10.1016/j.ijdrr.2022.103304.
[68] Ghazy RM, Abdou MS, Awaidy S, Sallam M, Elbarazi I, Youssef N, et al. Acceptance of COVID-19 vaccine booster doses using the health belief model: A cross-sectional study in low-middle- and high-income countries of the east mediterranean region. Int J Environ Res Public Health 2022;19(19). https://doi.org/10.3390/ijerph191912136.
[69] Jun J, Zain A, Chen Y, Kim S-H. Adverse mentions, negative sentiment, and emotions in COVID-19 vaccine tweets and their association with vaccination uptake: global comparison of 192 countries. Vaccines 2022;10(5). https://doi.org/10.3390/vaccines10050735.
[70] Kabakama S, Konje ET, Dinga JN, Kishamawe C, Morhason-Bello I, Hayombe P, et al. Commentary on COVID-19 vaccine hesitancy in sub-Saharan africa. Tropical Medicine and Infectious Disease 2022;7(7). https://doi.org/10.3390/tropicalmed7070130.
[71] Kanozia R, Arya R. "Fake news", religion, and COVID-19 vaccine hesitancy in India, Pakistan, and Bangladesh. Media Asia 2021;48(4):313–21. https://doi.org/10.1080/01296612.2021.1921963.
[72] Lazarus JV, Wyka K, White TM, Picchio CA, Gostin LO, Larson HJ, et al. A survey of COVID-19 vaccine acceptance across 23 countries in 2022. Nat Med 2023;29(2):366–75. https://doi.org/10.1038/s41591-022-02185-4.
[73] Moola S, Gudi N, Nambiar D, Dumka N, Ahmed T, Sonawane IR, et al. A rapid review of evidence on the determinants of and strategies for COVID-19 vaccine acceptance in low- and middle-income countries. J Glob Health 2021;11. https://doi.org/10.7189/JOGH.11.05027.
[74] Njoga EO, Awoyomi OJ, Onwumere-Idolor OS, Awoyomi PO, Ugochukwu ICI, Ozioko SN. Persisting vaccine hesitancy in africa: the whys, global public health consequences and Ways-out—COVID-19 vaccination acceptance rates as case-in-point. Vaccines 2022;10(11). https://doi.org/10.3390/vaccines10111934.
[75] Sallam M, Dababseh D, Eid H, Al-Mahzoum K, Al-Haidar A, Taim D, et al. High rates of covid-19 vaccine hesitancy and its association with conspiracy beliefs: A study in Jordan and Kuwait among other Arab countries. Vaccines 2021;9(1):1–16. https://doi.org/10.3390/vaccines9010042.
[76] Ullah I, Khan KS, Tahir MJ, Ahmed A, Harapan H. Myths and conspiracy theories on vaccines and COVID-19: potential effect on global vaccine refusals. Vacunas 2021;22(2):93–7. https://doi.org/10.1016/j.vacun.2021.01.001.
[77] Unfried K, Priebe J. Who shares fake news on social media? Evidence from vaccines and infertility claims in sub-Saharan africa. PLoS One 2024;19(4). https://doi.org/10.1371/journal.pone.0301818.
[78] Wang C-W, de Jong EP, Faure JA, Ellington JL, Chen C-HS, Chan C-C. A matter of trust: A qualitative comparison of the determinants of COVID-19 vaccine hesitancy in Taiwan, the United States, the Netherlands, and Haiti. Hum Vaccin Immunother 2022;18(5). https://doi.org/10.1080/21645515.2022.2050121.
[79] Abu Farha RK, Alzoubi KH, Khabour OF, Alfaqih MA. Exploring perception and hesitancy toward COVID-19 vaccine: A study from Jordan. Hum Vaccin Immunother 2021;17(8):2415–20. https://doi.org/10.1080/21645515.2021.1888633.
[80] Abu Ghaboush R, Olimat HS, Hammour SA, Al Buniaian NA, Anabtawi MF, Alqdah TA, et al. Factors associated with vaccination refusal among a sample of the jordanian population. SAGE Open 2024;14(3). https://doi.org/10.1177/21582440241260543.
[81] Acheampong T, Akorsikumah EA, Osae-Kwapong J, Khalid M, Appiah A, Amuasi JH. Examining vaccine hesitancy in sub-saharan africa: A survey of the knowledge and attitudes among adults to receive covid-19 vaccines in Ghana. Vaccines 2021;9(8). https://doi.org/10.3390/vaccines9080814.
[82] Akinocho H, Brackstone K, Eastment N, Fantognon J-P, Head MG. COVID-19 vaccine hesitancy and conspiracy beliefs in Togo: findings from two cross-sectional surveys. medRxiv 2023. https://doi.org/10.1101/2023.08.24.23294554 (Akinocho) Center for Research and Opinion Polls, Lome, Togo(Brackstone, Eastment, Head) clinical informatics research unit, Faculty of Medicine, University of Southampton, Southampton, United Kingdom (Fantognon) Ministry of Health, of Public Hygiene, Univ.
[83] Akther T, Nur T. A model of factors influencing COVID-19 vaccine acceptance: a synthesis of the theory of reasoned action, conspiracy theory belief, awareness, perceived usefulness, and perceived ease of use. PLoS One 2022;17(1 january). https://doi.org/10.1371/journal.pone.0261869.
[84] Alhassan RK, Aberese-Ako M, Doegah PT, Immurana M, Dalaba MA, Manyeh AK, et al. COVID-19 vaccine hesitancy among the adult population in Ghana: evidence from a pre-vaccination rollout survey. Trop Med Health 2021;49(1). https://doi.org/10.1186/s41182-021-00357-5.
[85] Al-kafarna M, Matar SG, Almadhoon HW, Almaghary BK, Zaazouee MS, Elrashedy AA, et al. Public knowledge, attitude, and acceptance toward COVID-19 vaccines in Palestine: a cross-sectional study. BMC Public Health 2022;22(1):1–9. https://doi.org/10.1186/s12889-022-12932-4.
[86] Aloweidi A, Bsisu I, Suleiman A, Abu-Halaweh S, Almustafa M, Aqel M, et al. Hesitancy towards COVID-19 vaccines: an analytical cross–sectional study. Int J Environ Res Public Health 2021;18(10). https://doi.org/10.3390/ijerph18105111.
[87] Anino CO, Sanga P. Usage of social media and COVID 19 vaccine hesitancy among medical students in Kericho county. PLoS Glob Public Health 2024;4(8). https://doi.org/10.1371/journal.pgph.0003529.
[88] Aron MB, Connolly E, Vrkljan K, Zaniku HR, Nyirongo R, Mailosi B, et al. Attitudes toward COVID-19 vaccines among patients with complex non-communicable disease and their caregivers in rural Malawi. Vaccines 2022;10(5). https://doi.org/10.3390/vaccines10050792.
[89] Atuheirwe M, Otim R, Male KJ, Ahimbisibwe S, Sackey JD, Sande OJ. Misinformation, knowledge and COVID-19 vaccine acceptance: A cross-sectional study among health care workers and the general population in Kampala, Uganda. BMC Public Health 2024;24(1). https://doi.org/10.1186/s12889-024-17678-9.
[90] Azimi M, Yadgari MY, Atiq MA. Acceptance and hesitancy toward the covid-19 vaccine among medical students in Kabul, Afghanistan. Infection and Drug Resistance 2023;16:457–61. https://doi.org/10.2147/IDR.S389582.
[91] Brackstone K, Atengble K, Head M, Boateng L. COVID-19 vaccine hesitancy trends in Ghana: A cross-sectional study exploring the roles of political allegiance, misinformation beliefs, and sociodemographic factors. Pan Afr Med J 2022;43:165. https://doi.org/10.11604/pamj.2022.43.165.37314.
[92] Brackstone K, Atengble K, Head MG, Boateng LA. COVID-19 vaccine hesitancy in Ghana: the roles of political allegiance, misinformation beliefs, and sociodemographic factors. medRxiv 2022. https://doi.org/10.1101/2022.03.16.22272463 (brackstone, atengble, head, boateng) clinical informatics research unit, faculty of medicine, university of Southampton, Southampton, United Kingdom(Atengble) PACKS africa, Greater Accra, Accra, Ghana.
[93] Chiweshe MK, Dandah G. Social media, fake news and covid-19 vaccine hesitancy in Zimbabwe. Africa Review 2024;16(1):14–31. https://doi.org/10.1163/09744061-bja10103.
[94] Demuyakor J, Nyatuame IN, Obiri S. Unmasking covid-19 vaccine "infodemic" in the social media. Online Journal of Communication and Media Technologies 2021;11(4). https://doi.org/10.30935/OJCMT/11200.
[95] Dinga JN, Sinda LK, Titanji VPK. Assessment of vaccine hesitancy to a covid-19 vaccine in cameroonian adults and its global implication. Vaccines 2021;9(2):1–14. https://doi.org/10.3390/vaccines9020175.
[96] Elbadawi MH, Altayib LS, Birier ABG, Ali LE, Hasabo EA, Esmaeel MAM, et al. Beliefs and barriers of COVID-19 vaccination hesitancy among Sudanese healthcare workers in Sudan: a cross sectional study. Hum Vaccin Immunother 2022;18(6). https://doi.org/10.1080/21645515.2022.2132082.
[97] Folotiya M, Ngoma C. Social media influence on COVID-19 vaccine perceptions among university students: A Malawi case study. BMC Public Health 2024;24(1). https://doi.org/10.1186/s12889-024-18764-8.
[98] Ghaddar A, Khandaqji S, Awad Z, Kansoun R. Conspiracy beliefs and vaccination intent for COVID-19 in an infodemic. PLoS One 2022;17(1 january). https://doi.org/10.1371/journal.pone.0261559.
[99] Greenleaf AR, Croker-Benn A, Aibo D, Biraro S, Mugisha V, Kwizera MH, et al. Social media use and COVID-19 vaccine status among a nationally representative population sample in Uganda. Digital Health 2023;9. https://doi.org/10.1177/20552076231180733.
[100] Juwayeyi MM, Ntaba J. Public perceptions of the media channels and human sources of information about the COVID-19 vaccine in Malawi. African Journalism Studies 2024;45(4):363–82. https://doi.org/10.1080/23743670.2024.2361640.
[101] Kabanga RL, Chambo VJ, Mokeha R. Knowledge, attitudes and acceptance of COVID-19 vaccine among pregnant women in Mbeya region. medRxiv 2025. https://doi.org/10.1101/2025.02.26.25322935 (Kabanga, Chambo, Mokeha) Department of Obstetrics&Gynecology, Mbeya Zonal Referral Hospital, Mbeya, Tanzania(Mokeha) Department of Obstetrics&Gynecology, University of Dar es salaam-Mbeya College of Health and Allied Sciences, Mbeya, Tanzania(Chambo).
[102] Kahwaji A, Alaryan T, Alhelwani H, Salem M, Alsuliman T. Understanding the influence of social media on COVID-19 vaccine acceptance in a war-torn Syria: A

cross-sectional study. Medicine (United States) 2024;103(32):e38956. https://doi.org/10.1097/MD.0000000000038956.
[103] Kanyike AM, Olum R, Kajjimu J, Ojilong D, Akech GM, Nassozi DR, et al. Acceptance of the coronavirus disease-2019 vaccine among medical students in Uganda. Trop Med Health 2021;49(1). https://doi.org/10.1186/s41182-021-00331-1.
[104] Klib M, Ghandour M, Alazki O, Nabhan AI, Idres FA, Alolabi H, et al. Fears and misconceptions toward COVID-19 vaccination among Syrian population: a cross-sectional study. Health Sci Rep 2023;6(7). https://doi.org/10.1002/hsr2.1426.
[105] Melki J, Tamim H, Hadid D, Makki M, El Amine J, Hitti E. Mitigating infodemics: the relationship between news exposure and trust and belief in COVID-19 fake news and social media spreading. PLoS One 2021;16(6 june). https://doi.org/10.1371/journal.pone.0252830.
[106] Mohmmed HA, Alawad RA, Awad AK, Alobied AA. Knowledge, attitude, and acceptance regarding COVID-19 vaccines in Sudan. Front Public Health 2022;10. https://doi.org/10.3389/fpubh.2022.954810.
[107] Nah S, Williamson LD, Kahlor LA, Atkinson L, Ntang-Beb J-L, Upshaw SJ. COVID-19 vaccine hesitancy in Cameroon: the role of medical mistrust and social media use. J Health Commun 2023;28(9):619–32. https://doi.org/10.1080/10810730.2023.2250287.
[108] Orangi S, Mbuthia D, Chondo E, Ngunu C, Kabia E, Ojal J, et al. A qualitative inquiry on drivers of COVID-19 vaccine hesitancy among adults in Kenya. PLoS Glob Public Health 2024;4(3). https://doi.org/10.1371/journal.pgph.0002986.
[109] Tran BT, Nguyen TDT, Duc VNH, Dang CK, Tran TTN, Nguyen DD, et al. COVID-19 vaccine hesitancy and social media use: a lesson learnt from pandemic. Asia Pac J Health Manag 2024;19(1). https://doi.org/10.24083/apjhm.v19i1.3133.
[110] Vu VT. Media literacy, trust in government and vaccine readiness: A study among vietnams youngsters. Journal of Media Literacy Education 2024;16(3):120–32. https://doi.org/10.23860/JMLE-2024-16-3-9.
[111] Alam W, Farnaz N, Manzoor F, Theobald S, Rashid SF. Perceptions of and attitudes toward COVID-19 vaccination among urban slum dwellers in Dhaka, Bangladesh. Soc Sci 2023;12(4). https://doi.org/10.3390/socsci12040230.
[112] Alhaffar M, Douedari Y, Howard N. "In general people arent excited about the vaccine.." : frontline perspectives on COVID-19 vaccine hesitancy across Syria. Hum Vaccin Immunother 2023;19(2). https://doi.org/10.1080/21645515.2023.2235239.
[113] Al-Jalabneh AA. Health misinformation on social media and its impact on COVID-19 vaccine inoculation in Jordan. Commun Soc 2023;36(1):185–200. https://doi.org/10.15581/003.36.1.185-200.
[114] Amit AML, Pepito VCF, Sumpaico-Tanchanco L, Dayrit MM. COVID-19 vaccine brand hesitancy and other challenges to vaccination in the Philippines. PLoS Glob Public Health 2022;2(1). https://doi.org/10.1371/journal.pgph.0000165.
[115] Fesshaye B, Lee C, Paul AM, Zavala E, Singh P, Karron RA, et al. A qualitative inquiry in understanding trusted media sources to reduce vaccine hesitancy among kenyans. Frontiers in Communication 2023;8. https://doi.org/10.3389/fcomm.2023.995538.
[116] Hakim MS, Mansoor GF, Walizada AW, Saeed KMI, Naeemi S, Fazil FA. General publics perception toward COVID-19 vaccines in Afghanistan, 2021. Hum Vaccin Immunother 2023;19(2). https://doi.org/10.1080/21645515.2023.2228164.
[117] Jaravaza DC, Risiro J, Mukucha P, Jaravaza N. Public health promotion of COVID-19 vaccination to rural consumers: Synthesising the role of social media and religious belief systems. Int J Pharm Healthc Mark 2024;18(1):67–85. https://doi.org/10.1108/IJPHM-02-2023-0016.
[118] Kainja J, Makhumula C, Twabi HS, Gunde AM, Ndasauka Y. Cultural determinants of COVID-19 vaccines misinformation in Malawi. Hum Soc Sci Commun 2024;11(1). https://doi.org/10.1057/s41599-024-03743-6.
[119] Kuatewo M, Ebelin W, Doegah PT, Aberese-Ako M, Lissah S, Kpordorlor AG, et al. Fake news, misinformation, vaccine hesitancy and the role of community engagement in COVID-19 vaccine acceptance in southern Ghana. PLoS One 2025;20(6):e0316969. https://doi.org/10.1371/journal.pone.0316969.
[120] Mahato P, Adhikari B, Marahatta SB, Bhusal S, Kunwar K, Yadav RK, et al. Perceptions around COVID-19 and vaccine hesitancy: a qualitative study in kaski district, western Nepal. PLoS Glob Public Health 2023;3(2). https://doi.org/10.1371/journal.pgph.0000564.
[121] Malcolm LJ, McLean KE. COVID-19 vaccine anxieties: exploring social and political drivers of vaccine attitudes in kono district, Sierra Leone. J Biosoc Sci 2025. https://doi.org/10.1017/S0021932024000373.
[122] Mbulayi SP, Makuyana A, Zindi B, Kangethe SM. Dilemmas associated with COVID-19 vaccine hesitancy in Zimbabwe. Perspectives on Global Development and Technology 2023;21(3–4):286–303. https://doi.org/10.1163/15691497-12341632.
[123] Slivesteri S, Ssali A, Bahemuka UM, Nsubuga D, Muwanga M, Nsereko C, et al. Structural, social, and contextual factors influencing COVID-19 vaccine uptake: a qualitative methods study among healthcare workers and older people in Uganda. medRxiv 2023. https://doi.org/10.1101/2023.07.10.23292213 (Slivesteri, Ssali, Bahemuka, Nsubuga, Seeley, Elliott, Ruzagira) MRC/UVRI&LSHTM Uganda Research Unit, Wakiso, Uganda(Muwanga, Nsereko) Entebbe Regional Referral Hospital, Wakiso, Uganda(Ssemwanga) Villa Maria Hospital, Kalungu, Uganda (Robert) Our Lady.
[124] Ahmed A, Al-Aghbari AA, Hassan OE-H, McGowan M, Al-Qadasi Y, Dureab F. The COVID-19 infodemic as a major driver for vaccine hesitancy in conflict settings: A mixed-method study. Discov Health Sys 2024;3(1):1–12. https://doi.org/10.1007/s44250-024-00127-0.
[125] Amour MA, Mboya IB, Ndumwa HP, Kengia JT, Metta E, Njiro BJ, et al. Determinants of COVID-19 vaccine uptake and hesitancy among healthcare workers in Tanzania: a mixed-methods study. COVID 2023;3(5):777–91. https://doi.org/10.3390/covid3050058.
[126] Cagayan MSFS, Mendoza LG, Viana JNM. BAKUNANAYS guidelines for communicating COVID-19 vaccination information to pregnant women in the Philippines and other developing countries. Frontiers in Communication 2022;7. https://doi.org/10.3389/fcomm.2022.916468.
[127] Flanagan B, Nevill K, Sabok C, Zilliacus M, Sward J. Barriers to the success of COVID-19 immunisation programs in New Ireland province, Papua New Guinea. Rural Remote Health 2023;23(3). https://doi.org/10.22605/RRH7883.
[128] Kessy AT, Onuekwe CE, Mwengee WM, Tumaini H. The role of media and community engagement in COVID-19 vaccinations in tanzania. Journal of Public Health in Africa 2025;16(3):a705. https://doi.org/10.4102/jphia.v16i3.705.
[129] Ayikoru Maureen, Cole J, Dodds K, Atcero M, Bada JK, Petrikova I, et al. Addressing vaccine concerns through the spectrum of vaccine acceptance. Soc Sci Med 2023;333:116146. https://doi.org/10.1016/j.socscimed.2023.116146.
[130] Mgongo MB, Manongi RN, Mboya IB, Ngocho JS, Amour C, Mtei M, et al. A qualitative study on barriers to COVID-19 vaccine uptake among community members in tanzania. Vaccines 2023;11(8). https://doi.org/10.3390/vaccines11081366.
[131] Osur JO, Chengo R, Muinga E, Kemboi J, Sidibe M, Rarieya M. Determinants of COVID-19 vaccine behaviour intentions among the youth in Kenya: A cross-sectional study. Arch Public Health 2022;80(1). https://doi.org/10.1186/s13690-022-00904-4.
[132] Taruvinga T, Chingono RS, Marambire E, Larsson L, Olaru ID, Sibanda S, et al. Exploring COVID-19 vaccine uptake among healthcare workers in Zimbabwe: a mixed methods study. PLoS Glob Public Health 2023;3(12). https://doi.org/10.1371/journal.pgph.0002256.
[133] Berdida DJE, Franco FMC, Santos XAG, Dacol CB, Dimaano M, Rosario ESD, et al. Filipinos' COVID-19 vaccine hesitancy comments in TikTok videos: A manifest content analysis. Public Health Nurs 2023;40(1):135–43. https://doi.org/10.1111/phn.13143.
[134] Matenga TFL, Zulu JM, Moonzwe Davis L, Chavula MP. Motivating factors for and barriers to the COVID-19 vaccine uptake: A review of social media data in Zambia. Cogent Public Health 2022;9(1):2059201. https://doi.org/10.1080/27707571.2022.2059201.
[135] Gastañaduy PA, Banerjee E, DeBolt C, Bravo-Alcántara P, Samad SA, Pastor D, et al. Public health responses during measles outbreaks in elimination settings: strategies and challenges. Hum Vaccin Immunother 2018;14(9):2222–38. https://doi.org/10.1080/21645515.2018.1474310.
[136] Taylor L. Canada sees surge in measles as cases rise across north america. BMJ British Medical Journal (Clinical Research Ed) 2025;390:r1653. https://doi.org/10.1136/bmj.r1653.
[137] Taylor L. US measles cases at highest number in 30 years. BMJ British Medical Journal (Clinical Research Ed) 2026;392:s29. https://doi.org/10.1136/bmj.s29.
[138] Islam MS, Kamal A-HM, Kabir A, Southern DL, Khan SH, Hasan SMM, et al. COVID-19 vaccine rumors and conspiracy theories: the need for cognitive inoculation against misinformation to improve vaccine adherence. PLoS One 2021;16(5):e0251605. https://doi.org/10.1371/journal.pone.0251605.
[139] Cardwell K, Clyne B, Broderick N, Tyner B, Masukume G, Larkin L, et al. Lessons learnt from the COVID-19 pandemic in selected countries to inform strengthening of public health systems: A qualitative study. Public Health 2023;225:343–52. https://doi.org/10.1016/j.puhe.2023.10.024.
[140] Khoo EJ, Lantos JD. Lessons learned from the COVID-19 pandemic. Acta Paediatr 2020;109(7):1323–5. https://doi.org/10.1111/apa.15307.
[141] Dikid T, Chaudhary S, Goel K, Padda P, Sahu R, Kumar T, et al. Responding to COVID-19 pandemic: why a strong health system is required. Indian J Med Res 2025;151(2–3):140–5. https://doi.org/10.4103/ijmr.IJMR_761_20.
[142] Okeke CC, Uguru NP, Uzochukwu B, Onwujekwe O. How can health systems better prepare for the next pandemic? A qualitative study of lessons learned from the COVID-19 response in Nigeria. SSM - Health Systems 2025;4:100052. https://doi.org/10.1016/j.ssmhs.2025.100052.

Glossary

LMICs: Low and middle-income countries as classified by the World Bank.
Vaccine hesitancy: Delay or refusal in vaccine acceptance despite abundant supply due to concerns or beliefs.
Misinformation: False or inaccurate information.
Infodemic: Excessive amounts of information which may include false or misleading information during disease outbreaks.