Impact of Media on Vaccine Literacy and Vaccine Hesitancy: A Systematic Review

Francesco Leonforte, Vito Nicosia, Paola Comite, Giustino Morlino, Antonio Mistretta

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Abstract

Background: Effective communication regarding vaccination is a critical public health priority nowadays. Challenges such as vaccine hesitancy and infodemic, exacerbated by the COVID-19 pandemic, complicate this task. Despite new communication tools present numerous opportunities, they also risk the spread of misinformation and mistrust.

Objective: We aim to provide a deeper understanding of communication means’ effectiveness in promoting vaccine literacy and countering vaccine hesitancy.

Methods: We conducted a rigorous systematic review following PRISMA guidelines, beginning with 5.124 articles (from PubMed, Scopus, and Web of Science). After initial screening and duplicates removal, pre-established inclusion and exclusion criteria were applied, resulting in a total of 77 articles.

Results: Upon full-text screening, 34 articles were ultimately included and appropriately categorized. Traditional media appear more effective in enhancing vaccine attitudes and acceptance than online and social media. Vaccine adherence is also significantly influenced by various sociodemographic determinants, including gender, age, ethnicity, education level, socioeconomic status, and political orientation.

Conclusions: Communication strategies need to be re-evaluated and enhanced considering rapid social changes and technological advancements to implement tailored approaches and improve the effectiveness of vaccination campaigns. Clinical Trial: PROSPERO ID: CRD42025637441

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Original Manuscript

Review

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Keywords

Vaccine literacy; Vaccine hesitancy; Vaccine adherence; Communication; Traditional media; Digital media; Chatbots; Sociodemographic factors; Systematic review

Introduction

Scientific communication in the vaccination context is a significant global priority, essential for the success of vaccination campaigns and the safeguarding of public health [1]. Despite vaccines being a key tool for the prevention of infectious diseases, challenges such as “vaccine hesitancy” have significantly hindered efforts, jeopardizing vaccination coverage and protection of vulnerable communities [2–4]. The SARS-CoV-2 pandemic has exacerbated these issues and highlighted the importance of targeted and effective communication strategies to improve trust in vaccines and promote their acceptance [5].

The WHO defines vaccine hesitancy as behaviour that delays or opposes vaccination, driven by factors like distrust, safety concerns, lack of accurate information, and sociocultural influences [6]. Vaccine fatigue also refers to the phenomenon where individuals exhibit inertia or inaction towards vaccine information or instructions due to perceived burden and burnout [7].

Vaccine literacy is the ability to acquire, understand, and apply information about vaccines [8]. It is shaped by the quality and accessibility of information, coupled with empathetic, transparent, and participatory communication [9]. This approach is particularly effective with undecided or misinformed individuals [10].

The term "infodemic” describes the massive spread of information, often unverified or misleading, that has characterized the COVID-19 pandemic [11]. Particularly, due to the abuse of new communication tools such as the internet, social media, and artificial intelligence fake news and conspiracy theories about vaccines spread at a faster rate than accurate scientific information, making stricter regulation and implementation of targeted educational campaigns necessary [12].

Vaccine communication is a widely debated and highly interesting topic in contemporary literature [13]. Over the past five years, numerous academic works have detailed the impact of various communication interventions and strategies on vaccine literacy and the fight against vaccine hesitancy [14,15]. These studies have also explored the role of sociodemographic factors to design strategies suitable for specific populations (e.g. developing countries), and offered an overview of the most recent evidence, outlining future directions for scientific research [16,17]. Attention has been focused on identification of the most impactful communication interventions, as well as the development of strategies aimed at engaging undecided individuals, who do not categorically refuse the vaccine, but may adhere if adequately informed [18–21]. Despite the progress made, it remains crucial to address the lack of consolidated evidence and systematic reviews in this field.

This systematic review of the literature aims to provide a deeper understanding of communication means’ effectiveness in promoting vaccine literacy and countering vaccine hesitancy. The specific purposes are:

1. Evaluate and compare the impact of several communication means on vaccine literacy, hesitancy, and adherence.
2. Investigate the moderating role of sociodemographic factors.
3. Identify gaps in literature and future perspectives.

Methods

This systematic review was designed to analyse communication strategies aimed at improving trust in vaccines, increasing adherence to vaccination campaigns, and reducing the impact of misinformation. A rigorous approach based on PRISMA guidelines was adopted (see flowchart in Fig. 1), ensuring transparency and reproducibility of the results [22]. The screening process was

conducted in a double-blind manner in groups of two, and in case of conflicting opinions, a fifth person was designated to make the final decision. The protocol for this systematic review has been officially registered in the international PROSPERO database (ID: CRD42025637441).

Identification of Articles

The search was conducted in three main databases (PubMed, Scopus, and Web of Science) using structured queries. The key terms included:

- "vaccin*", "communication", "literacy", "hesitancy", "acceptance".
- References to tools and platforms such as "social media", "chatbot", "television".

The use of Boolean operators ("AND", "OR", "NOT") allowed the combination of terms to maximize sensitivity and specificity.

The identified articles have been downloaded and imported into the Rayyan© software for screening (see Table 1). The search produced an initial total of 5.124 articles, distributed as follows:

Table 1. Identification of Articles

Database	*Identified papers*
PubMed	1.995
Scopus	114
Web of Science	3.015
Total	5.124

Application of Restrictions

Several restrictions were progressively applied to refine the selection (see Table 2):

1. *Temporal restriction (2014-2024):* The selection focused on the last ten years, including recent developments in technology and vaccination, especially after the COVID-19 pandemic.
2. *Language restriction (English):* Only articles published in English were included to ensure comparability and minimize interpretative ambiguities.
3. *Exclusion of irrelevant types:* Reviews, letters, editorials, commentaries and non-peer-reviewed articles were excluded.
4. *Elimination of duplicates.*

Table 2. Application of Restrictions

Step	*Number of papers*
Initial number	5.124
Temporal restriction	4.851
Language restriction	4.781
Type restriction	3.598
Duplicate elimination	2.585

Application of Inclusion/Exclusion Criteria

The inclusion criteria were defined based on four main elements according to the PICO framework:

- *Population:* Studies on adult subjects (≥18 years).
- *Intervention:* Strategies designed to improve vaccine literacy, increase vaccination adherence,

and reduce hesitancy.
- *Comparison:* Studies comparing different communication strategies or using control groups.
- *Outcome:* Indicators such as vaccine literacy, vaccination adherence, and reduction in hesitancy.

Only peer-reviewed studies (surveys, ecological, case-control, cross-sectional, cohort, prevalence, quasi-experimental, and RCT) were considered.
The exclusion criteria were defined as follows:

- Studies not conducted on humans or conducted exclusively on the paediatric population or healthcare professionals.
- Reviews, abstracts, editorials, letters, preprints, and other types of articles not covered by the inclusion criteria.
- Articles not in English.
- Articles that do not concern vaccines or interventions/means aimed at improving adherence or communication in the vaccination context.

These criteria reduced the total to 250 articles, further filtered to include only studies with samples larger than 1.000 subjects, leading to a final selection of 77 articles. This first review process was carried out based on the title and the abstract (see Table 3).

Table 3. Application of inclusion/exclusion criteria

Step	*Number of papers*
Initial number	2.585
Application of criteria	250
Sample>1000	77

For the aforementioned 77 articles, a rigorous full-text review process was subsequently carried out to confirm full compliance with the inclusion and exclusion criteria and, if confirmed, to proceed with the extraction of relevant information and the compilation of an expressly prepared Microsoft® Excel spreadsheet. The review and data extraction process were performed by two reviewers and, subsequently, checked by the others. The information acquired included:

a. Title
b. Authors
c. Year of publication
d. Country/context setting
e. Methodology
f. Objectives/purpose of the study
g. Study population and sample size
h. Vaccine
i. Intervention (communication method) and details
j. Duration
k. Main results
l. Public health implications

m. Limitations

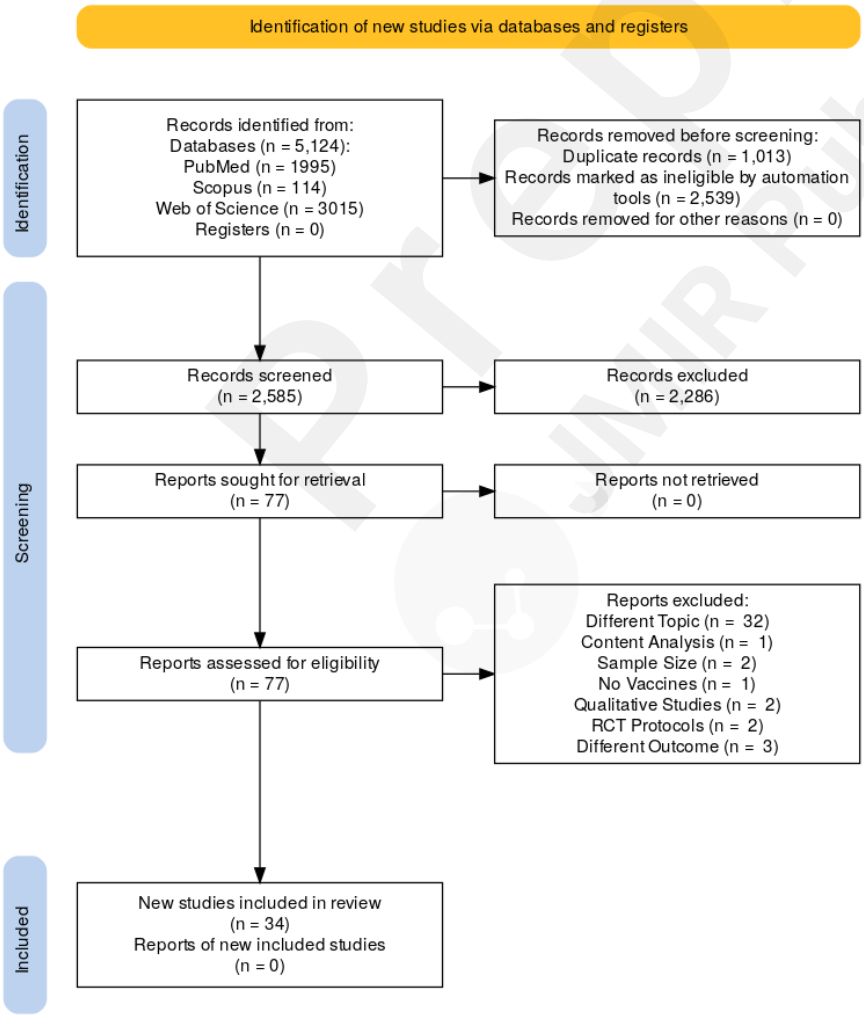
Risk of bias assessment

The evaluation of bias utilized the ROBIS tool, which is specifically designed to assess the risk of bias in systematic reviews across four pivotal healthcare domains: interventions, diagnosis, prognosis, and aetiology. The assessment follows a structured three-phase process: an optional evaluation of the research question's relevance, identification of potential concerns within four review process domains (study eligibility criteria; identification and selection of studies; data collection and study appraisal; and synthesis and findings), and a final judgment on the overall risk of bias. Each domain incorporates a series of key questions to guide the reviewer in forming their judgment, with possible responses being "Yes," "Probably Yes," "No," "Probably No," or "No Information." The ultimate overall assessment categorizes the risk of bias as "High," "Low," or "Unclear." [23]

Quality assessment

Eligible studies were subject to a rigorous evaluation of their methodological quality utilizing the Modified Medical Education Research Study Quality Instrument (M-MERSQI) tool, a quantitative assessment which comprises 12 items across 7 domains, with a total possible score of 100 [24]. Studies were categorized into three quality levels: low quality (scores ranging from 0 to 35), medium quality (scores ranging from 36 to 65), and high quality (scores ranging from 66 to 100).

Fig. 1. PRISMA flowchart



Results

At the culmination of the refined review work on the full text, a total of 34 scientific articles were included, all of which demonstrated perfect compatibility with the inclusion and exclusion criteria (see Table 4). Notably, among them are two Randomized Controlled Trials, two cohort studies, and one case-control study, while most of the remaining articles are cross-sectional studies and surveys. Conversely, 43 articles were excluded based on the following reasons: thirty-two articles were only marginally related to communication means and/or interventions, one was not related to the topic of vaccines, one performed content analysis of digital or social media platforms without specifically considering a study population, two employed qualitative methodology, two did not meet the sample size criterion, two were protocols for Randomized Controlled Trials without reporting any results and, lastly, three had different outcomes. The included studies were categorized into based on intervention in traditional media, social media and community interventions.

Table 4. Included studies

Author	*Publication year*	*No. Participants*	*Country of study*	*Quality score (M-MERSQI)*	*Vaccine discussed*	*Communication intervention*
Daley et al.	2018	1.093	USA	67	Vaccines in general	Website with vaccine information and social media components (VSM arm); website with vaccine information only (VI arm)
De Giorgio et al.	2022	1.003	Croatia	61	COVID-19	Multiple communication tools
DeMora et al.	2024	1.768	USA	71	COVID-19 and influenza	Social media
Evans et al.	2023	1.100 treatment, 833 comparison	Nigeria	69	COVID-19	Social media
Garg et al.	2024	6.252	USA	67	HPV	Health-related videos
Garrett et al.	2024	1.043	USA	61	COVID-19	Social media
Geniole et al.	2022	1.584	UK	61	COVID-19	Internet memes
Hwang et al.	2018	4.174	USA	72	Vaccines in general	Multiple communication tools
Jin et al.	2022	2.160	Pakistan	76	Polio	Public service advertisements and digital media platforms
Jung et al.	2015	151.209	13 countries of Sub-Saharan Africa	75	Childhood vaccines in general	Traditional Media (radio, television, newspaper)
Jung et al.	2018	1.571	South corea, China, Japan	75	BCG, DPT, polio, and measles	Television, radio, book, newspaper
Khanijahani et al.	2021	220.570	USA	72	Influenza	Internet use for health information and communication
Kim J. et al.	2017	1.367	South Korea	72	Vaccines in general	General mass media (radio, newspaper, smartphone, internet)
Kim S. et al.	2024	5.804	Tanzania	58	COVID-19	"The One by One: Target COVID-19 campaign". High-profile and high-impact influencers and viral content on social media platforms
Kim Y. et al.	2023	9.584	USA	72	COVID-19	Informal sources of information (social media, Internet, and friends/family) and formal source (traditional news, government guidance, and health care providers)

Kobayashi et al.	2022	10.192	Japan	61	COVID-19	Corowa-kun chatbot
Lee KY. et al.	2023	2.045	Thailand, Hong Kong, and Singapore	63	COVID-19	COVID-19 chatbots
Lv et al.	2016	1.673	China	72	Influenza	TV, community message boards, doctors
Melovic et al.	2020	1.593	Montenegro, Serbia, and Bosnia and Herzegovina	68	Vaccines in general	Online media
Nah et al.	2023	1.000	Cameroon	65	COVID-19	Social media use and medical mistrust
Nah et al.	2023	1.136	USA	65	COVID-19	Social media use and medical mistrust
Piltch-LoebI et al.	2021	2.957	USA	72	COVID-19	Traditional media (TV, newspapers, radio) and social media (Facebook, Instagram, YouTube, Twitter, TikTok)
Recio-Román et al.	2023	27.524	UE	79	Vaccines in general	Traditional media (TV, radio, newspaper, magazine, social networks, internet sites, ecc...) and institution (political parties, regional or local public authorities, national government or parliament, UE, ecc...)
Sakamoto et al.	2022	14.425	Japan	58	COVID-19	Multiple communication tools. Specifically evaluated a 14-minute-long educational movie to provide information about the COVID-19 vaccine.
Schmid et al.	2022	2.444 at baseline and 817 at follow-up	Germany	60	COVID-19	1. Text-based refutations (debunking) 2. Prebunking hypothesis
Schuh et al.	2023	14.235	USA	63	COVID-19	Informational animated videos
Sunohara et al.	2023	3.348	Japan	72	COVID-19	Multiple communication tools
Teoh et al.	2019	1.037	USA	61	HPV	Graphic messages: 8 Instagram graphic mockups promoting HPV vaccination to prevent cancer. 4 categories: infographics; disease photos; young adult cancer patient photos; humorous graphics
Thompson et al.	2022	1.192	USA	61	HPV	Social media, trust in providers, internet verification skills, and demographics

Wada et al.	2015	3.140	Japan	61	Vaccines in general	Healthcare providers, national or local government, family, friends, TV, newspapers, Internet, books.
Wamba et al.	2023	2.001 from France and 1.107 from South Africa	France and South Africa	75	COVID-19	Traditional media, specialized health sources, family or friends, social media, web-based sources
Wilson et al.	2020	3.000	Worldwide	64	Vaccines in general	Social media
Yoneoka et al.	2022	30.053	Japan	61	COVID-19	Multiple media channel (i.e. medical professionals, TV, Newspapers, The Novel Coronavirus Expert Meeting and Local government)
Zahrani et al.	2024	7.159	Saudi Arabia	61	Vaccines in general	Promotion by healthcare leaders

Discussion

Traditional media and social media

In recent decades the vaccine communication landscape has profoundly changed, transitioning from traditional campaigns on television, radio, and newspapers to digital strategies that leverage social media, chatbots, and mobile apps [25]. Traditional media allow us to reach uniformly a wide and diverse audience with official, verified, and authoritative messages [26]. Television and radio are employed to broadcast public service announcements, informative spots and educational programs, particularly benefiting communities with limited internet access [27,28]. Newspapers and magazines offer in-depth analyses that help contextualize complex data, provide scientific and technical insights and facilitate health professionals to build trust and credibility [29,30]. Print media are particularly useful for reaching more educated readers or professionals [29].

The advent of digital media has opened new opportunities for disseminating accurate and up-to-date information about vaccines and amplifying the message using visual and interactive content, but has also brought unique challenges, such as combating online misinformation [31,32]. Social media campaigns can leverage emotional appeals and engaging narratives to establish a personal connection with the audience [33]. Artificial intelligence and chatbots offer a personalized experience, responding in real-time to frequently asked questions about vaccines, reducing doubts, and providing immediate reassurance [34,35]. Lastly, integrated campaigns combine various communication channels to reach a heterogeneous audience. These initiatives include community awareness activities, collaborations with local organizations, schools or other institutions, and the involvement of influencers or well-known testimonials, such as religious leaders or respected public figures, to promote trust in vaccines [36].

A comparison between among these communication modes highlights advantages and limitations, offering insights for optimizing future vaccination campaigns [37].

Recio-Román et al.'s study on 27.524 European citizens underscored the pronounced positive impact of traditional media in mitigating vaccine hesitancy, compared to new media. Television (β = −0.094; $P < .001$; 95% CI: −0.132 to −0.056), radio (β = −0.066; $P < .001$; 95% CI: −0.092 to −0.041), and newspapers/magazines (β = −0.194; $P < .001$; 95% CI: −0.229 to −0.162) exerted considerable influence. The effect on vaccine adherence was mainly mediated by the reduction of hesitancy, except for television, which didn't show significant effect on increasing vaccine uptake, potentially due to the context and sociodemographic factors of the recipients. Conversely, online media demonstrated less influence on reducing hesitancy (β = −0.041, $P < .001$; 95% CI: −0.068 to −0.014) and indirectly on increasing adherence (β = 0.021; $P < .05$; 95% CI: 0.003 to 0.038), and other internet sources had no significant impact. Not being informed increased vaccine hesitancy (β = 0.049; $P < .001$; 95% CI: 0.008 to 0.089) and decreased vaccine adherence (β = −0.063; $P < .001$; 95% CI: −0.090 to 0.037), highlighting the detrimental effects of unreliable communication and information [38]. Sakamoto et al. reported a positive attitude towards COVID-19 vaccination among university students in Japan, with the majority utilizing television and radio as their primary information sources. However, among those displaying negative attitudes and concerns, a significantly higher percentage relied on YouTube and Instagram for information [39].

Jung et al. (2015) confirmed the strategic importance of traditional media in raising awareness among families, even in the digital age, through a study involving 151.209 women from sub-Saharan African countries. The daily consumption of television and radio was associated with a higher likelihood of vaccinating children against BCG, DPT, polio, and measles [40]. Similar results emerged from a study by Jung et al. (2018) on Chinese and South Korean mothers. Use of internet corresponded to lower likelihood of vaccinating children [41]. Hwang et al.'s research demonstrated that the value attributed to magazines by U.S. parents was positively associated with their perception of vaccination benefits. Additionally, the value attributed to television was positively correlated with the maintenance of vaccination programs. In contrast, social media usage was negatively associated with the perception of vaccination benefits [42].

De Giorgio et al. demonstrated that participants who sought information from TV, radio (OR = 2.35; 95% CI: 1.71–3.23; $P < .001$), or from family doctors (OR = 2.53; 95% CI: 1.78–3.61; $P < .001$) were more likely to be vaccinated. Conversely, participants who relied on social networks (OR = 0.36; 95% CI: 0.27–0.49; $P < .001$), general Internet forums/blogs (OR = 0.34; 95% CI: 0.22–0.52; $P < .001$) or friends/acquaintances (OR = 0.66; 95% CI: 0.48–0.91; $P = .011$) were less inclined to receive vaccination [43]. Lastly, in a study on 1.673 elderly individuals Lv et al. found that those who had received information through television (OR = 1.403; 95% CI: 1.124–1.752; $P < .010$) and community bulletin boards (OR = 1.812; 95% CI: 1.446–2.270; $P < .010$) were more likely to be vaccinated against influenza [44]. These results emphasize how traditional media and direct contact with healthcare providers are fundamental tools for increasing trust and adherence to vaccinations, while social media and online informal sources can often contribute to greater hesitancy [45]. Indeed, according to Kim Y. et al. adults who relied on informal sources of information were less likely to receive the COVID-19 vaccine (OR = 0.65; 95% CI: 0.56–0.75), undergo COVID-19 testing (OR = 0.85; 95% CI: 0.74–0.98), and engage in preventive behaviours (OR = 0.61; 95% CI: 0.50–0.74). In reverse, reliance on diversified information sources increased the odds of all three outcomes [46].

About the deleterious role of social media, Garrett et al. determined lower knowledge of COVID-19 guidelines among TikTok users [47]. According to Nah et al. among Cameroonians and Black Americans social media use along with medical mistrust were positively associated with beliefs in misinformation about the COVID-19 vaccine and, inferentially, to vaccine hesitancy [48,49].

Piltch-Loeb et al. supported the reliability of traditional media during the COVID-19 pandemic. Television was the most frequently employed communication channel, with both national and local TV contributing to increased vaccine acceptance, as well as newspapers. High trust in information had a major impact. Acceptance significantly decreased among individuals relying solely on social media or on a combination of social and traditional media [50]. These results are further supported by Sunohara et al., which evidenced significantly lower odds for the incompleteness of the second vaccinations among TV (OR = 0.31; 95% CI: 0.21–0.44) and newspapers (OR = 0.32; 95% CI: 0.20–0.50) users and, contrarily, higher odds for those who informed themselves through books (OR = 3.34; 95% CI: 1.58–7.06), commercial video sites (OR = 2.22; 95% CI: 1.44–3.43), Facebook (OR = 2.36; 95% CI: 1.24–4.48), and personal blogs or electronic bulletin boards (OR = 4.81; 95% CI: 2.72–8.48). Books may often contain too much

technical, misleading, and out-of-date information or reflect excessively the authors' thinking [51].

In the same vein Yoneoka et al. observed that individuals unsure of the vaccination tend not to obtain information from authoritative media such as medical professional, government and TV, while the authoritative ones such as novel coronavirus expert meeting and local government were associated with unwillingness, probably because of an oppressive perception [52]. Here, the importance of conducting large-scale communication campaigns becomes evident, as emphasized by Jin et al. (2022) on 2.160 Pakistanis parents. They showed that public service advertisements significantly and positively influenced polio vaccine acceptance for their offspring, effectively counteracting the adverse impacts of misinformation, fake news, and religious fatalism [53].

However, the positive and responsible use of Internet and social media can be a valuable strategy for disseminating high-quality information and increasing trust in vaccines. According to Khanijahani et al., adults using the Internet for health-related information were more likely to receive influenza vaccinations compared to non-health information seekers (OR = 1.52; 95% CI: 1.45–1.59) and non-Internet users. Customised interventions for different internet use habits can help increase immunisation efforts [54]. Equally, a cohort study by Evans et al. in Nigeria revealed that participants exposed to a public health campaign on Facebook and Instagram exhibited higher vaccination rates compared to those without such intervention [55]. Also, Melovic et al. in Montenegro, Serbia, and Bosnia-Herzegovina found that online media play a substantial role in shaping parents' attitudes toward child vaccination and correlate with the degree of trust in vaccines [56]. Lastly, in a RCT by Daley et al. 1.093 women were randomized to the following: a website with vaccine information and social media components arm; a website with vaccine information only arm; or usual care arm. When comparing baseline with Timepoint 1 among vaccine-hesitant parents, both interventions were associated with significant improvements in vaccination attitudes, relative to the usual care group. Similarly, when comparing baseline with Timepoint 2, both arms were linked to significant reductions in parental concerns about vaccination [57].

All these findings encourage the implementation of modern forms of online communication and social marketing for improvement of public health, avoiding any harmful impacts through accurate content analysis and appropriate use of them [58].

Role of Sociodemographic factors

The effectiveness of vaccination communication strategies is influenced by a multitude of sociodemographic factors, such as age, gender, education level, social class, and ethnic background [59]. These variables not only modulate the perception of risk and trust in vaccines but also the receptivity to public health messages: understanding them is crucial to enhance effectiveness, inclusivity and the ability to overcome cognitive, emotional, and sociocultural barriers [16,60]. Particularly, some minority groups tend to be more vulnerable to misinformation and may require specific and tailored communication approaches [61]. This is supported by Lee KY. et al., who by testing the effectiveness of a COVID-19 chatbot among unvaccinated or retardants individuals found the greatest effects in improving acceptance and trust in the vaccine among groups of people belonging to minorities and with lower levels of education [62].

First, Recio-Román et al. examined a range of socio-demographic variables that may affect vaccine uptake. After adjusting for age, older age brackets exhibited lower odds of vaccination relative to the youngest participants, while no statistically significant differences were observed after adjusting for occupation. Higher educational attainment, good economic circumstances, and higher social classes were associated with increased vaccination odds. Having children was associated with higher vaccination odds for families with one child, while no statistically significant results were found for families with more than one child correlate with higher odds of being vaccinated. Political orientation also played a role in vaccine uptake, with left-leaning individuals showing 8.7% higher odds of vaccination compared to centrists [38].

Garg et al. demonstrated that increase of health-related videos' consumption on social media by U.S. adults leads to a greater awareness regarding HPV vaccine, with higher effects among young and better educated adults (18–40 years) [63]. These results reflect the importance of education in accessing and understanding informational content, in connection with the "digital health literacy models", which indicate that skills in interpreting and evaluating digital health information are crucial factors in combating misinformation [64]. In this sense, also De Giorgio et al. underscored a significant association between instruction level and willingness to receive COVID-19 vaccine: individuals with a bachelor's degree (OR = 2.25; 95% CI: 1.14–4.46; *P* = .020) and a PhD (OR =1.97; 95% CI: 1.01–3.52; *P* = .021) were more likely to be vaccinated compared to those with only a high school diploma [43].

Another key element significantly moderating effectiveness of communication is religiosity. Indeed, a prospective study conducted by Schmid et al. highlighted its role as a powerful moderator of individual credibility judgment on a false myth debunking message regarding vaccines in the long term, but not in the short term. Instead, a false myth pre-bunking message appeared not influenced by spirituality [65]. This could be explained through the lens of "worldview backfire effect" models, according to which deeply rooted religious, and cultural beliefs tend to prevail even in the face of contrary information, requiring long-term interventions and an approach that integrates cultural sensitivity and respect for beliefs [66]. In regard, Jin et al. (2022) highlighted the moderating influence of religious fatalism on the effectiveness of communication strategies in addressing vaccine hesitancy [53]. This highlights the need to construct messages that emphasize the sense of community and collective responsibility, which could be more consistent with religious value systems [67].

Age also emerges as a relevant factor, particularly affecting the individual choice of a reliable source of information [68]. Yoneoka et al. demonstrated that individuals under the age of 50 who expressed uncertainty about vaccination typically sought information from authoritative sources, including healthcare professionals, expert meetings, and both local and central government agencies. In contrast, individuals over the age of 50 were more inclined to rely on social media as their primary source of information [52]. In this regard, research conducted by Kim S. et al., which assessed a social media campaign aimed at boosting confidence in COVID-19 vaccination in Tanzania, found no statistically significant changes among young adults aged 18 to 24 years. However, the campaign led to a notable increase in vaccination adherence among individuals aged 25 to 34 years. In contrast, a statistically significant reduction in vaccine hesitancy was observed among individuals aged 35 and older [69]. Such data reflects a generational

shift in the perception of authority of sources, linked to the phenomenon of the "digital divide," which makes some groups more vulnerable to misleading content [70]. However, Kobayashi et al., developing and evaluating a chatbot that provides information about the COVID-19 vaccine, found that factors most correlated with an increase in vaccine hesitancy included being aged between 16 and 34 years (OR = 3.7; 95% CI: 3.0–4.6) and female gender (OR = 2.4; 95% CI: 2.1–2.8), emphasizing how effects of new digital communication tools, although promising, require further clarification [71]. In line with these findings Sunohara et al. documented that the use of social media among older individuals and males was associated with lower levels of vaccine acceptance [51]. Indeed, for some population categories social media may not be an effective source for promoting vaccination adherence, likely due to the presence of low trust in online sources and misinformation [72].

About gender, a cross-sectional study published by Teoh et al. assessed statistically significant differences, albeit modest in effect size, in response to a social media graphic communication campaign based on the demographic characteristics, such as gender, ethnicity and level of digital health literacy. For instance, women rated patient photos more favourably [73]. Sakamoto et al. also highlighted how female gender was associated with a positive attitude towards the vaccine [39]. Likewise, Wada et al. illustrated significant differences between men and women, particularly related to trust in government recommendation and likelihood of considering various sources of information as reliable. Specifically, women tended to consider information from family (OR = 1.60; 95% CI: 1.23–1.99), newspapers (OR = 1.56; 95% CI: 1.03–2.15), internet (OR = 2.19; 95% CI: 1.58–2.73), and books (OR = 2.99; 95% CI: 2.19–3.40) more reliable, while men tended to place more trust in information from friends (OR = 1.96; 95% CI: 1.24–2.60) [74]. Otherwise, a cross-sectional study by Zahrani et al. explored the role of health leadership in promoting vaccine acceptance, highlighting that men were significantly more inclined than women to accept the influence of healthcare workers in promoting vaccination [75]. Thompson et al. examined parents' perceptions and decision-making processes about the HPV vaccination and proved that fathers had a significantly lower likelihood of accepting the vaccine compared to mothers (aOR = 0.42; 95% CI: 0.27–0.64; $P < .001$) [76]. These results can be interpreted considering theories on gender differences in decision-making processes, which suggest that women tend to be more influenced by information emphasizing familial or social protection, likely due to a greater relational orientation [77].

The issue of geographical location, distinguishing between rural and urban areas, is a significant factor in vaccine acceptance [78]. Lv et al. found that vaccination coverage among the elderly population in Beijing was significantly higher in rural areas (OR = 2.57; 95% CI: 1.801–3.655; $P < .010$) compared to urban areas [44]. This suggests that the availability, access, and perceptions of vaccines can vary considerably based on location, with potential barriers in urban areas that could influence the decision to vaccinate [79].

In terms of political orientation, research by DeMora et al. revealed that increased engagement with social media is linked to higher vaccination rates, with this relationship being influenced by political orientation in distinct ways. Among Democrats, the connection is primarily driven by exposure to information about emerging pathogens, while among Republicans, it is largely influenced by the belief that individuals within

their social circle are receiving the recommended vaccines [80].
Social and contextual factors, along with beliefs and opinions, play a critical role in influencing vaccine acceptance. In Wamba et al's study, participants were classified into four opinion profiles: enthusiasts, sceptics, followers, and conspiracy theorists. The results indicated that enthusiasts, followers, and sceptics generally placed greater trust in traditional media, friends and family, online resources, and specialized health sources, whereas conspiracy theorists demonstrated low trust in all these sources. Social media usage showed no significant differences across sociodemographic profiles, suggesting that it is not the primary channel of influence [81]. A meaningful example of how adapting messages to the ethnic and cultural identification can be effective is provided by Schuh et al., exploring the effectiveness of educational videos about COVID-19 vaccine. It was reported that an ethnic congruence between the video protagonist and the viewer increased the likelihood of full watching of the video (OR = 1.89; $P < .01$) [82]. The importance of cultural and ethnic identification in strengthening the effectiveness of public health messages fits within the framework of social identification theories, which highlight that messages are perceived as more credible when conveyed by individuals perceived as "similar" by the target audience [83].
Kim J. et al. in South Korea highlighted that a higher socioeconomic background was positively correlated with vaccination adherence, likely because of an advantage in terms of access to reliable information channels and resources [84]. It is possible analyse this outcome through the lens of the socioeconomic gradient theory, which suggests that people with lower incomes and less education tend to have less access to reliable healthcare resources and quality information [85].
Finally, a crucial point is that sociodemographic factors do not always serve as effect modifiers, indicating that they are unlikely to independently undermine the effectiveness of a well-structured communication strategy. Supporting this view, Geniole et al. demonstrated that the impact of online memes on the intention to vaccinate against COVID-19 was so strong that it was not significantly influenced by factors such as gender, age, or political orientation [86]. Therefore, implementing innovative and creative communication strategies can hopefully bypass some sociodemographic barriers [87]. Anyway, sociodemographic factors provide valuable insights for designing effective and inclusive communication strategies, ensuring a greater impact of public health campaigns. Looking ahead, the integration of predictive models based on artificial intelligence and big data could represent a breakthrough for increasingly targeted communication, capable of accounting for individual and collective complexities [59].

Strength and Limitations

To the best of our knowledge, this review represents one of the first comprehensive examinations of vaccine communication strategies and tools aimed to enhance vaccine adherence and mitigate vaccine hesitancy. A notable strength focuses on studies of more than 1.000 participants, ensuring relevant implications for public health policies. Remarkably, several studies involve even more than 10.000 participants. All the analysed articles were published within the last five years, and only studies employing quantitative methodologies were considered, thereby enhancing the generalizability of the evidence presented.
One significant limitation in many analysed studies is the decision to measure vaccination

intentions rather than actual vaccination behaviours. While intentions can provide insights into behavioural trends, they often fail to materialize into concrete actions due to various personal, cultural, or logistical factors. Furthermore, many studies overlook booster doses, which are crucial for the success of immunization strategies. The reliance on self-reported data also introduces issues concerning their reliability. Recall bias, leading to inaccurate recollections of past events, and social desirability bias, where participants provide more socially acceptable responses, compromise the quality of the data collected. To enhance accuracy, it is advisable to integrate self-reported data with objective monitoring tools, such as health records or actual vaccination data covering the entire vaccination cycle.

Many studies rely on samples that are not representative of the general population, restricting the generalizability of the results and hindering their application to large-scale public policies. To address these issues, it is essential to adopt more inclusive sampling strategies.

The studies considered are predominantly observational and cross-sectional, limiting the ability to establish causal links between the variables studied. It is challenging to determine whether the intervention caused the effect or if external factors intervened. Longitudinal designs, which follow participants over time, would be more suitable for understanding the long-term impact of campaigns and identifying any behavioural changes.

Collecting data from specific platforms, such as Facebook or YouTube, introduces selection bias due to the distinct demographic audiences and unique interaction dynamics of each platform, limiting the generalizability of the results to broader contexts or other communication modes.

Moreover, during the COVID-19 pandemic risk perceptions and attitudes towards vaccines changed rapidly, influenced by factors such as infection progression, new restrictions, and news related to vaccine side effects. This instability complicates the comparison of studies conducted at different times, reducing the consistency of the results.

The use of online surveys in many studies introduces sampling bias, as more technologically proficient and already informed users tend to be overrepresented, while potentially more hesitant groups are excluded.

Lastly, despite our approach led to the inclusion of a larger number of relevant studies, it is possible that some pertinent papers may have been missed.

Conclusions

This review highlights the urgency of rethinking and improving vaccination communication strategies, adapting them to the increasing complexity of the sociodemographic and cultural context. There is no universal approach: the design of campaigns must consider the specific characteristics of the target populations, aiming for a diversified and personalized implementation and ensuring equitable access. The most relevant evidence focusses on the combination of multimedia contents and interactive tools with traditional media. This work provides a framework for tackling future challenges, emphasizing the importance of evidence-based strategies that are dynamic and adaptable to rapid social and technological changes.

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Formal analysis: FL (lead), VN (equal)
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Methodology: AM (lead), FL (equal), VN (equal)
Project administration: AM
Resources: AM (lead), VN (supporting), PC (supporting)
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Writing – review & editing: FL (lead), AM (equal), VN (equal), PC (equal), GM (equal)

Conflicts of Interest

None declared.

Abbreviations

aOR: Adjusted Odds Ratio
BCG: Bacillus Calmette-Guérin
CDC: Centre for Disease Control
DPT: Diphtheria, pertussis, and tetanus
OR: Odds Ratio
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCT: Randomized Controlled Trial
RRR: Relative Risk Reduction
TV: Television
WHO: World Health Organization

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Supplementary Files

Figures

PRISMA flowchart.