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Review Article

Vaccine Misinformation in the Digital Age: A Narrative Review

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Abstract: Confidence in immunization has weakened across several regions over the past decade, and the circulation of inaccurate or misleading content about vaccines has accompanied, though not necessarily caused, the resurgence of vaccine-preventable infections. Adequate analysis cuts across immunology, behavioral science, communication research, and public-health practice. This narrative review draws on literature retrieved from PubMed, Scopus, Web of Science, and Embase, complemented by reports from the World Health Organization, the United States CDC, the European Centre for Disease Prevention and Control, and Africa CDC. Search strings combined vaccine-related, misinformation-related, and methodological terms using Boolean operators; the primary window was 2000–2026, with priority placed on work published since 2018 and particular attention to scholarship produced after the COVID-19 pandemic. Article selection followed the Scale for the Assessment of Narrative Review Articles (SANRA). Hesitancy is not a single condition; it varies with political alignment, income, geography, religious context, education, and historical experience with health institutions. Algorithmic curation, engagement-optimized feeds, and the recent emergence of generative-AI tools have altered how vaccine-related claims circulate, although causal estimates linking platform features to behavior remain modest and contested. Mitigation evidence is uneven: Debunking, motivational interviewing, and consistent provider recommendation carry the firmest support, whereas the often-cited backfire effect has not survived recent replication. Sustaining vaccine confidence depends on interdisciplinary work that respects this heterogeneity, acknowledges what the evidence cannot yet settle, and engages honestly with the rapidly shifting digital environment.

Keywords Vaccine Hesitancy, Vaccine Misinformation, Health Communication, Behavioral Science, Platform Governance, Generative Artificial Intelligence, Vaccine-Preventable Disease

Introduction

Few interventions in public health have produced returns on a scale comparable to vaccination. The disappearance of smallpox in 1980, the near-total retreat of poliomyelitis from most regions of the world, and the long decline in measles, diphtheria, and pertussis mortality belong to a body of evidence that is difficult to dispute (Fenner et al., 1988; Orenstein et al., 2017). What has changed in recent decades is not the underlying immunological case for vaccination but the social, informational, and political context in which vaccination decisions are made. The introduction of mRNA technology during the COVID-19 pandemic, the rapid spread of vaccine-related claims through digital platforms, and the visible erosion of public trust in several health systems have produced an environment in which scientific consensus and population behavior can diverge sharply (Krammer, 2020; Lazarus et al., 2022).

Hesitancy itself is not new. Resistance to smallpox vaccination in Victorian Britain, controversy over early polio trials, and the now-retracted Wakefield publication on measles-mumps-rubella and autism each demonstrate that doubt has accompanied immunization programs for as long as such programs have existed (Wolfe and Sharp, 2002; Larson et al., 2014). What is distinctive about the present moment is the speed at which a claim circulates, the porousness of the line between fringe and mainstream media, and the role of automated curation in shaping which messages reach which audiences. A reader in 1998 might have heard about the Wakefield report through a print newspaper days after publication. A comparable claim today can reach a global audience within hours and persist in encrypted group chats for years.

That said, treating hesitancy as a uniform phenomenon obscures more than it explains. Literature consistently reports that hesitancy varies along multiple axes: Partisan identification, income, geography, healthcare access, religious affiliation, education, and the historical experience of communities with medical institutions, and that these axes interact in ways that resist easy categorization (Larson et al., 2018; de Figueiredo et al., 2020). For some communities in the United States, refusal of COVID-19 vaccination drew partly on documented historical injustices, including the Public Health Service Syphilis Study at Tuskegee and longer-standing patterns of unequal treatment in clinical care (Quinn et al., 2017; Bogart et al., 2020). For other populations, skepticism centers on specific products, schedules, or adjuvants rather than on vaccination as a whole. Lumping these distinct positions under a single label invites interventions that miss the target.

Within the digital environment, a parallel terminological imprecision has caused its own difficulties. The word misinformation tends to be applied to any claim that public health authorities consider inaccurate. A more useful taxonomy distinguishes misinformation (false content shared without intent to deceive) from disinformation (false content deployed with such intent), and both from skepticism, uncertainty, and institutional mistrust positions that may be epistemically reasonable in light of incomplete evidence, inconsistent communication, or prior institutional failure (Wardle and Derakhshan, 2017; Vraga and Bode, 2020). Conflating these categories carries a practical cost: It pathologies legitimate questioning and, in doing so, can deepen the very mistrust public-health messaging seeks to address.

Decision-making about vaccination is shaped by cognitive, emotional, and social processes that established behavioral frameworks have characterized for decades. The Health Belief Model, the Theory of Planned Behaviors, Protection Motivation Theory, and the more recent 5C model of psychological antecedents to vaccination identify perceived risk, perceived benefit, social norms, confidence, complacency, convenience, and collective responsibility as recurrent determinants of behavior (Rosenstock, 1974; Ajzen, 1991; Rogers, 1975; Betsch et al., 2018). These models do not compete so much as illuminate different facets of the same phenomenon, and none, taken alone, account for the heterogeneity reported across populations.

Despite the volume of work on these topics, the scholarly literature on vaccine misinformation remains fragmented along disciplinary lines. Immunology rarely engages with the cognitive and communicative determinants of how vaccine science is received. Behavioral science often treats the information environment as a static backdrop. Platform studies frequently address misinformation in general without sustained attention to vaccines specifically. Developments since 2022 the proliferation of generative-AI tools, shifts in platform governance, and the slow recovery of vaccine confidence in some settings have outpaced earlier syntheses. Voices from the Global South, where structural conditions differ markedly from those of high-income settings, remain underrepresented in the most widely cited reviews (Wiysonge et al., 2022).

This review attempts five things. It situates the immunological case for vaccination in direct relation to the misconceptions most often encountered in the misinformation literature. It examines the structure of contemporary information environments with explicit attention to what recent platform-scale research can and cannot establish. It analyses the psychological and sociocultural drivers of hesitancy using established behavioral frameworks. It reviews public-health and societal consequences drawing on case material from both the Global North and the Global South. Finally, it appraises the evidence base for mitigation strategies, separating interventions with reasonable empirical support from those whose claims outrun their evidence. Three research questions structure the synthesis: how contemporary information environments differ from earlier vaccine controversies and what evidence supports causal claims about platform effects on behavior; which psychological, social, and structural factors most reliably predict hesitancy across diverse populations; and which interventions show evidence of sustained and scalable effectiveness.

Materials and Methods

The work presented here is a narrative review, prepared in line with the Scale for the Assessment of Narrative Review Articles (Baethge et al., 2019). A narrative rather than systematic format was chosen for two reasons. First, the relevant literature spans immunology, behavioral science, sociology, communication research, science and technology studies, and public-health practice; a systematic approach would have required separate protocols across each tradition. Second, parts of the evidence base, particularly those relating to generative AI and platform governance, are evolving sufficiently quickly that a fully systematic search would have aged poorly between submission and publication. A narrative format supports integrative reading across heterogeneous study designs and disciplines, although it is acknowledged to carry a higher risk of selection bias than a registered systematic review.

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Information Sources

Records were retrieved from PubMed, Scopus, Web of Science, and Embase, supplemented by targeted searches of Google Scholar and the websites of the WHO, the United States CDC, ECDC, Africa CDC, and UNICEF. Search strings combined three concept families. The first covered vaccines and immunization (vaccine; immunization; vaccine hesitancy; vaccine confidence). The second covered the information environment (misinformation; disinformation; infodemic; social media; algorithm; platform governance; generative AI; large language model; deepfake). The third covered behavioral and methodological constructs (debunking; inoculation theory; motivational interviewing; backfire effect; randomized trial). Boolean operators combined concepts across families.

Inclusion and Exclusion Criteria

Eligible sources were peer-reviewed empirical studies, systematic reviews and meta-analyses, conceptual or theoretical articles, and authoritative reports from major public-health agencies. The search window was 2000–2026, with priority given to scholarship published from 2018 onward and particular emphasis on post-2022 material addressing generative AI, platform governance, and the trajectory of vaccine confidence after the COVID-19 pandemic. Foundational older work, such as the original statements of the behavioral frameworks discussed below, was retained where relevant. Excluded items included non-peer-reviewed material other than authoritative agency reports, studies addressing non-vaccine health misinformation without transferable findings, and opinion pieces lacking empirical or systematic argument.

Synthesis

Titles and abstracts identified through the searches were screened against the inclusion criteria, full texts of plausibly relevant articles were examined, and snowball sampling of reference lists identified additional sources. Selected studies were grouped thematically and synthesized by comparison: Where multiple studies addressed the same question, their findings were placed alongside each other, points of agreement and disagreement were marked, and the strength of evidence was assessed in light of methodological features. The synthesis is therefore interpretive and integrative rather than quantitative.

Results

Vaccine Science and the Structure of Common Misconceptions

The immunological mechanisms underlying vaccination are well-characterized, but a textbook summary serves the present review less well than an account that maps mechanism onto the misconceptions most often encountered in the misinformation literature. Vaccines elicit adaptive immunity by introducing antigens or, in the case of nucleic-acid platforms, instructions to produce them in a controlled, non-pathogenic context. Dendritic cells and other antigen-presenting cells process these antigens and display them via MHC class I and class II molecules to CD8+ and CD4+ T lymphocytes (Murphy and Weaver, 2016). CD4+ help drive B-cell affinity maturation and class-switch recombination in germinal centers, yielding memory B cells and high-affinity antibodies; a fraction of CD8+ T cells differentiate into memory cytotoxic lymphocytes positioned for rapid recall (Victora and Nussenzweig, 2012). The net result is reduced susceptibility to infection and, more reliably, reduced severity of disease upon exposure.

Available platforms differ in immunogenicity, safety profile, and logistical demands, and these differences are summarized in Table 1. Live-attenuated vaccines remain a cornerstone of measles and yellow-fever control but carry contraindications in some immunocompromised individuals.

Table 1: Comparative features of principal vaccine platforms

Platform	Representative products	Immunological character	Practical strengths	Constraints and considerations
Live-attenuated	Measles; MMR; yellow fever; varicella	Broad innate and adaptive activation; combined mucosal and systemic response	Frequently single-dose; durable protection	Contraindicated in some immunocompromised patients; cold-chain demands
Inactivated	Inactivated polio (IPV); Hepatitis A	Predominantly humoral; limited T-cell engagement	Stable formulations; well-described safety	Adjuvants and boosters generally required
Subunit / protein-based	Human papillomavirus; Hepatitis B; NVX-CoV2373	Targeted antigen response; adjuvant-dependent	Low reactogenicity; defined composition	Multiple doses; adjuvant optimisation complex
Viral-vectored	rVSV-ZEBOV (Ebola); Ad26.COV2.S; ChAdOx1	Robust CD4+ and CD8+ memory; balanced Th1/Th2	No replicating pathogen; cellular immunity strong	Anti-vector immunity can limit re-dosing; rare thrombotic events with some adenoviral vectors
mRNA	BNT162b2; mRNA-1273	In situ antigen expression; balanced humoral and cellular response	Rapid design; scalable manufacture; non-integrating	Cold-chain logistics; transient reactogenicity; rare myocarditis, chiefly in young males
Mucosal / next-generation	Intranasal influenza; investigational pan-coronavirus candidates	Aims to elicit mucosal IgA and tissue-resident memory	Potential reduction in transmission; needle-free	Efficacy and durability under active investigation

Sources: Murphy and Weaver (2016); Pardi et al. (2018); Polack et al. (2020); Topol and Iwasaki (2024)

Inactivated and subunit products have well-characterized safety profiles but generally require adjuvants and booster doses. Viral-vectored vaccines, including those used in Ebola and COVID-19 responses, induce strong cellular immunity but may be limited by pre-existing immunity to the vector. The mRNA platform, the most visible newcomer, allows rapid antigen design and high-volume manufacture, and it does not enter the cell nucleus or integrate into the host genome (Pardi et al., 2018; Polack et al., 2020). Mucosal candidates and self-amplifying mRNA constructs represent the current frontier; their clinical performance is still being characterized (Bloom et al., 2021; Topol and Iwasaki, 2024).

Misconceptions identified in the misinformation literature tend to cluster around five points, each of which warrants direct engagement. The first is the claim that mRNA vaccines alter the recipient's DNA. The platform contains no reverse transcriptase and no integration machinery; the introduced mRNA does not cross the nuclear membrane under normal cellular conditions, and cytoplasmic ribonucleases degrade it within days (Pardi et al., 2018). A small number of in-vitro observations have occasionally been invoked to argue otherwise, but these have not been replicated as in vivo phenomena of clinical relevance. The second concerns fertility. Cohort studies in both natural and assisted conception have found no consistent adverse effect of COVID-19 vaccination on fertility outcomes in either women or men (Zauche et al., 2021; Wesselink et al., 2022).

The third is the notion of immunological overload from childhood schedules. Estimates of the theoretical antigen-binding capacity of the infant immune system exceed the antigenic load delivered by routine immunization by several orders of magnitude (Offit et al., 2002); the framing of overload misreads the underlying biology.

The fourth concerns adjuvants, particularly aluminum-containing salts. Reviews of pharmacokinetic and toxicological data have not identified clinically meaningful harm at the doses used in vaccines; placed alongside dietary aluminum exposure, vaccine-derived doses are small (Mitkus et al., 2011). The fifth concerns natural versus vaccine-induced immunity. Both confer some protection, and for SARS-CoV-2 hybrid immunity has been associated with particularly strong responses in some studies. The risk-benefit calculus nonetheless favors vaccination for diseases such as measles, pertussis, and SARS-CoV-2, because natural infection itself carries non-trivial risks of severe disease, complications, and onward transmission. Recommending infection as a route to protection is not a defensible public-health position.

A more difficult task than refuting these specific claims is acknowledging the real, if rare, adverse events that vaccination can produce and doing so in a manner that maintains rather than undermines public trust. Pharmacovigilance systems, including VAERS in the United States, EudraVigilance in the European Union, and the Yellow Card scheme in the United Kingdom, are supplemented by active linked-record surveillance such as the Vaccine Safety Datalink (Shimabukuro et al., 2015; McNeil et al., 2014). These systems detected, characterized, and openly reported myocarditis following mRNA vaccination in young males and thrombosis with thrombocytopenia syndrome following some adenoviral-vector products (Bozkurt et al., 2021; Greinacher et al., 2021). Two points follow. Rare adverse events do occur and are not concealed by surveillance. The proper comparator is not zero risk but the considerably higher risk of severe disease in unvaccinated populations.

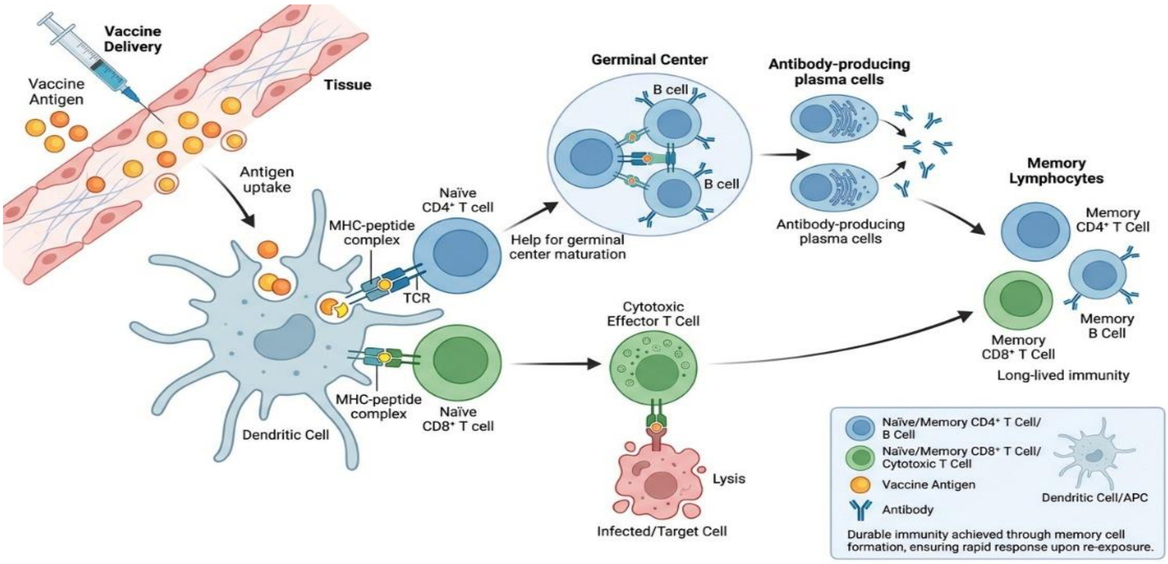
Honest communication of uncertainty about efficacy estimates, durability, and changing recommendations appears increasingly important to sustaining confidence, since communications that overstate certainty and are later revised can be perceived as evidence of dishonesty rather than appropriate scientific updating (van der Bles et al., 2020; Petersen et al., 2021).

Figure 1 schematically depicts vaccine-induced immune activation and memory formation. The process begins with the administration of a vaccine antigen, which is taken up by an Antigen-Presenting Cell (APC). The APC presents antigenic peptides to naïve CD4+ and CD8+ T cells, initiating their activation. CD4+ T cells assist B cells in germinal center maturation, leading to antibody production, while CD8+ T cells differentiate into cytotoxic effectors. Both pathways culminate in the formation of long-lived effector and memory lymphocytes, essential for durable immunity.

The Contemporary Misinformation Ecosystem

That vaccine controversy long predates the digital era is worth restating. Anti-vaccination leagues organized against compulsory smallpox vaccination in Late-Victorian Britain; the early-twentieth-century introduction of pertussis and polio vaccines provoked similar pushback; and the 1998 Wakefield publication, despite its eventual retraction, depressed MMR uptake in parts of the United Kingdom for years (Wolfe and Sharp, 2002; Larson et al., 2014). What distinguishes the contemporary environment is the speed, scale, and global reach of communication and the role of algorithmic curation in determining which content is seen.

Empirical work on digital diffusion has produced a recognizable set of findings: False content tends to travel faster and further than true content on at least some platforms (Vosoughi et al., 2018); communities of users producing and sharing anti-vaccine content cluster in identifiable network structures (Cinelli et al., 2020; Johnson et al., 2020); and coordinated inauthentic behavior has been documented around several health topics (Broniatowski et al., 2018).



Source: Author-generated synthesis from figure lab

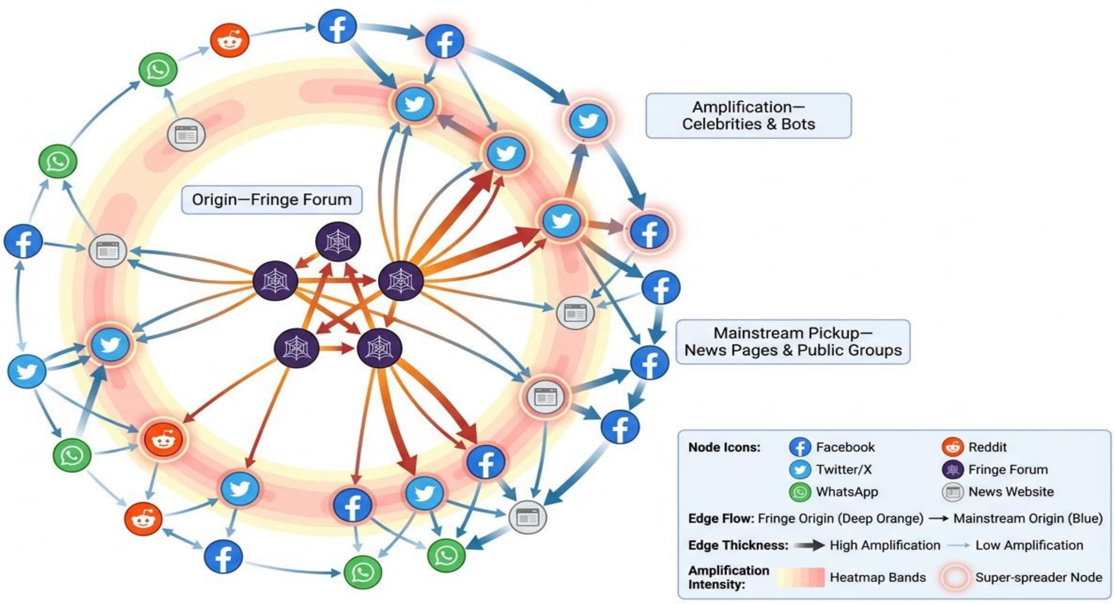
Fig. 1: Schematic illustration of vaccine-induced immune activation and memory formation

These findings together support the proposition that the information environment matters. They do not, on their own, establish strong causal claims about platform-level effects on attitudes or behavior, and recent platform-scale research has tempered earlier deterministic framings. Large-scale randomized studies on Facebook and Instagram conducted around the 2020 United States election period found that switching from algorithmically curated to reverse-chronological feeds altered exposure patterns in expected directions but produced only modest changes in attitudinal outcomes over the study window (Guess et al., 2023; Nyhan et al., 2023). User choice, network homophily, motivated selection, and offline social context appear to contribute substantially to which content reaches whom. The honest position is that algorithmic amplification is one factor among several whose relative weights remain to be established with greater precision. Figure 2 illustrates a cross-platform network visualization, with node sizes proportional to engagement metrics and edge thickness indicating share frequency.

Engagement-optimized recommender systems pose a related set of questions about governance. Content that elicits strong affective responses tends to perform well in such systems, and in some domains this category includes inaccurate or sensational material (Brady et al., 2017). Platforms have responded with several instruments: Down-ranking, fact-check labelling, removal of content that violates explicit policies, and the suspension or permanent banning of repeat violators. Each instrument carries trade-offs across accuracy, freedom of expression, transparency, and the risk of pushing communities into less moderated spaces. Studies of deplatforming have documented short-term reductions in the within-platform reach of removed accounts alongside migration to alternative platforms with weaker moderation (Jhaver et al., 2021; Rauchfleisch and Kaiser, 2021; Innes and Innes, 2023). Treating platform governance as a neutral lever, rather than as a domain of contested policy choices, oversimplifies a problem that is genuinely difficult.

The most rapidly evolving aspect of the contemporary environment is generative AI. Since 2023, large language models, synthetic-audio tools, and video-generation systems have lowered the marginal cost of producing fluent text and convincing media to a degree that has only begun to be characterized empirically. Four concerns are worth distinguishing. First, automated production of high-volume, scientific-sounding text at minimal cost. Second, the impersonation, through synthetic image or video, of clinicians, scientists, or public officials making fabricated claims.

Third, the use of large language models to tailor messages to specific audiences and communities. Fourth, the saturation of public comment processes, social-media replies, and search results with AI-generated material (Goldstein et al., 2023; Menz et al., 2024). Two cautions accompany these concerns. Much commentary on AI-driven misinformation outpaces what has been measured: The downstream effect on vaccine attitudes and behavior is, at present, more inferred than demonstrated. And generative-AI tools are simultaneously being deployed defensively, for translation of public-health messaging, scalable response to frequently asked questions, and detection of coordinated inauthentic behavior. The net effect will depend on choices made by platforms, regulators, public-health bodies, and end users choices that are not yet settled.



Source: Author-generated synthesis from figure lab

Fig. 2: Cross-platform network visualization depicting the genesis and amplification trajectories of vaccine misinformation across digital ecosystems. Nodes represent user accounts or pages, edges denote content-sharing events, and color gradients indicate origin (fringe vs. mainstream) and amplification intensity

A further dimension, often underemphasized in Anglophone reviews, is the role of encrypted messaging. In environments where WhatsApp, Telegram, and similar applications dominate everyday communication much of Latin America, parts of South Asia, and many countries in sub-Saharan Africa vaccine misinformation circulates through private group chats that are largely opaque to platform-level moderation and to external researchers (Resende et al., 2019; Pasquetto et al., 2020). Content frequently migrates across platforms, with claims originating on fringe sites or in messaging groups subsequently reaching broader audiences through cross-posting and amplification by influencers. Table 2 provides a structured summary of the main channels, actors, and tactics that characterize the contemporary ecosystem.

Psychological and Sociocultural Drivers of Hesitancy

Decisions about vaccination involve heuristics, emotions, identities, and material constraints, and the relative weight of these factors varies across populations. The decision-making literature catalogues several recurrent cognitive patterns relevant to vaccine attitudes confirmation bias, the availability heuristic, omission bias, ambiguity aversion, and the illusory-truth effect produced by repeated exposure to a claim (Tversky and Kahneman, 1974; Ritov and Baron, 1990; Fazio et al., 2015). Listening to such biases, however, can suggest that hesitancy is essentially a problem of poor individual reasoning. A substantial proportion of hesitancy reflects coherent responses to perceived institutional behavior, incomplete information, or contextual constraints; it is not always or principally a failure of cognition.

More productive than enumeration is engagement with established behavioural frameworks. The Health Belief Model frames vaccination behavior through perceived susceptibility, perceived severity, perceived benefits, and perceived barriers (Rosenstock, 1974). The Theory of Planned Behavior emphasizes attitudes, subjective norms, and perceived behavioural control (Ajzen, 1991). Protection Motivation Theory adds threat appraisal and coping appraisal as distinct constructs (Rogers, 1975).

The more recent 5C model confidence, complacency, convenience, calculation, and collective responsibility has been validated across multiple populations and provides a tractable operationalisation of psychological antecedents (Betsch et al., 2018). These frameworks are complementary rather than competing; they emphasise different determinants, predict overlapping but distinct outcomes, and together describe the range of considerations that vaccination decisions involve. No single framework dominates the empirical evidence.

Beyond cognition, emotional and identity-based processes shape what people come to believe and what they share. Emotional contagion through social networks can shift perceived norms and risk salience (Brady et al., 2017).

Table 2: Channels, actors, and tactics in the vaccine misinformation environment

Channel / surface	Principal actors	Characteristic tactics	Illustrative episodes	Strength of evidence
Mainstream and tabloid media	Editors; columnists; broadcast hosts	Sensational framing; selective sourcing; false-balance presentation	Coverage of the Wakefield report; declining MMR uptake in the UK (early 2000s)	Strong observational evidence
Open social platforms	Influencers; activist accounts; ordinary users; automated accounts	Engagement-driven amplification; emotionally charged content; cross-posting	Anti-vaccine hashtag campaigns during 2019 measles outbreaks and COVID-19	Mixed: Clear diffusion patterns; causal effects on behaviour contested
Forums and pseudonymous communities	Moderators; power users; lurkers	Testimonial framing; upvote-driven visibility; in-group reinforcement	Subreddits and forum threads valorising natural immunity	Observational
Encrypted messaging	Family and community networks; closed groups	Private sharing of unverified claims; limited corrective exposure	WhatsApp circulation of vaccine rumours in Brazil, India, Nigeria	Emerging; limited external visibility
Coordinated and state-linked operations	State-linked actors; troll farms; networks of inauthentic accounts	Astroturfing; cross-platform seeding; amplification of divisive narratives	State-linked accounts amplifying both pro- and anti-vaccine content to inflame polarisation	Documented but bounded in measured effects
Generative AI and synthetic media (2024–2026)	Individual users with LLM access; commercial and political operators	Mass-produced text; synthetic audio/video impersonation; tailored content	AI-generated text mimicking scientific style; deepfake videos attributed to health figures	Early and rapidly developing

Sources: Larson et al. (2014); Vosoughi et al. (2018); Broniatowski et al. (2018); Cinelli et al. (2020); Johnson et al. (2020); Resende et al. (2019); Goldstein et al. (2023); Menz et al. (2024). Strength of evidence refers to the maturity of empirical research, not the prevalence of the phenomenon

Identity-protective cognition motivated reasoning aligned with the perceived beliefs of one's social or political group has been associated with polarization on vaccination in several settings (Kahan et al., 2017). Trust dynamics are equally consequential. Communications that overstate certainty and are subsequently revised can be perceived as evidence of dishonesty rather than as appropriate scientific updating (Petersen et al., 2021). Although neural correlates of motivated reasoning and affective response have been described in the cognitive neuroscience literature, neuroscientific descriptions do not by themselves explain population-level patterns of hesitancy and should not be invoked as deterministic accounts of individual behavior.

The structural and historical dimensions of hesitancy deserve at least as much attention as the cognitive ones. Trust in clinicians, prior experience with health systems, perceived discrimination, language and cultural concordance, geographic access to services, and economic constraint all shape vaccination behavior (Larson et al., 2018; Quinn et al., 2017). Historical injustices unethical research, coercive sterilization, and asymmetric burdens in past public-health interventions continue to shape community-level orientations toward immunization programs (Bogart et al., 2020). Religious and cultural norms can support or constrain uptake depending on how programs are framed and which community figures are engaged. Treating these factors as mere barriers, to be removed in the service of higher coverage, understates their substantive importance and risks deepening the very distrust the interventions are meant to address.

Societal and Public-Health Consequences

Sustained gaps in coverage have been associated with the resurgence of vaccine-preventable disease. Global measles cases rose substantially between 2018 and 2019, with most of an estimated 140,000 measles deaths in 2018 occurring in low-coverage settings (Patel et al., 2020). The United States recorded its highest annual measles case count since 1992 in 2019, concentrated in unvaccinated communities (Patel et al., 2019). Pertussis has shown periodic resurgence in part as a function of waning acellular-vaccine immunity and uneven booster uptake (Decker and Edwards, 2021). During the COVID-19 pandemic, gaps in coverage and delays in vaccination contributed to differential mortality across populations and regions, although attributing any specific outcome to misinformation alone is methodologically difficult, since structural inequities, supply constraints, institutional trust, and access typically interact (Lazarus et al., 2022). The economic consequences of outbreaks include direct medical costs, response costs for containment, and indirect costs from school and workforce absence (Lo and Hotez, 2017).

The burden of under-vaccination falls unevenly. In high-income settings, racial, ethnic, and socioeconomic

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disparities in uptake are well-documented and reflect structural factors access, time costs, provider trust, and historical experience alongside attitudinal ones (Bogart et al., 2020). In low- and middle-income settings, structural drivers include stock-outs, distance to service points, conflict, and migration shape uptake. The combined experience of several regions, summarized in Table 3, illustrates how multiple drivers interact in specific contexts and how attributing outcomes to misinformation alone consistently underspecifies the problem.

Vaccination has also become politicized in several settings, with partisan identification correlating with attitudes toward COVID-19 vaccines in the United States and parts of Europe (Lazarus et al., 2022). The introduction of vaccine mandates during the pandemic produced documented increases in coverage in some jurisdictions alongside organized political and legal opposition, with attendant concerns about civil liberties and consent (Mello et al., 2020; Bardosh et al., 2022). Honest appraisal of these dynamics requires neither idealizing nor dismissing the concerns raised on multiple sides; the net effects of mandates remain a subject of active study rather than a settled question. The societal cost of misinformation is not just in disease statistics but in the fracturing of public trust, polarization of science communication, and entrenchment of institutional skepticism. A coordinated, multidisciplinary response is therefore vital to stem these cascading consequences and restore confidence in immunization systems worldwide (Figure 3).

Mitigation: Evidence and Limits

Intervention claims in this area frequently outrun the evidence that supports them, and a disciplined appraisal therefore requires organizing the available work by strength of empirical support. Three strata are useful.

The strongest empirical basis exists for three approaches. Inoculation or prebunking exposing audiences to weakened forms of misleading arguments accompanied by refutations has accumulated experimental support in both laboratory and online field settings, with effect sizes that are typically small to moderate and short- to medium-term effects on belief and sharing (van der Linden et al., 2017; Roozenbeek et al., 2022). Whether the effect transfers across domains and persists beyond a few weeks in highly polarized contexts is less well-established. Motivational interviewing delivered by clinicians has produced modest but reproducible effects on parental vaccination decisions in pediatric settings; scaling it across health systems remains challenging given provider training and time demands (Gagneur, 2020). Consistent provider recommendation is among the most reliably associated correlates of vaccine acceptance across populations and settings, and strengthening provider communication training continues to receive empirical support (Brewer et al., 2017).

A second tier comprises interventions with promising but mixed evidence. Fact-checking and corrective labelling can shift factual beliefs in the short term, but effects on sharing behavior and broader attitudes are smaller and more variable.

Table 3: Selected regional case studies

Region	Disease	Year(s)	Salient drivers	Public-health consequences	Key references
United States	Measles	2019	Religious-exemption clusters; online misinformation; gaps in routine coverage	More than 1,200 cases; public-health emergency in New York City	Patel et al. (2019)
Netherlands	Measles	2013–14	Religious-community resistance in the Bible Belt	Approximately 2,700 cases; estimated €4.7 million in costs	Lo and Hotez (2017)
Ukraine	Polio / measles	2015–19	Political instability; institutional mistrust; low routine immunisation	Paralytic polio cases and major measles resurgence	WHO (2020)
Pakistan and Afghanistan	Polio	2010s–2024	Conflict; attacks on vaccinators; rumours tied to historical intelligence-program revelations	Persistent wild poliovirus transmission; threat to eradication targets	Khan and Sahibzada (2016)
Northern Nigeria	Polio	2003–04 (recurrent)	Political and religious boycott citing safety rumours; legacy of mistrust	Suspended polio vaccination contributing to regional resurgence	Jegede (2007)
Democratic Republic of the Congo	Ebola / COVID-19	2018–22	Conflict; mistrust of external responders; rumour spread through interpersonal and digital channels	Disrupted vaccination campaigns; attacks on health workers	Vinck et al. (2019)
Brazil and India	COVID-19	2020–22	Polarised politics; WhatsApp-mediated rumour circulation; uneven leadership messaging	Differential uptake across regions and demographic groups	Resende et al. (2019); Lazarus et al. (2022)

Cases are illustrative, not exhaustive. Drivers are typically multiple and interacting; attribution to misinformation alone is not asserted

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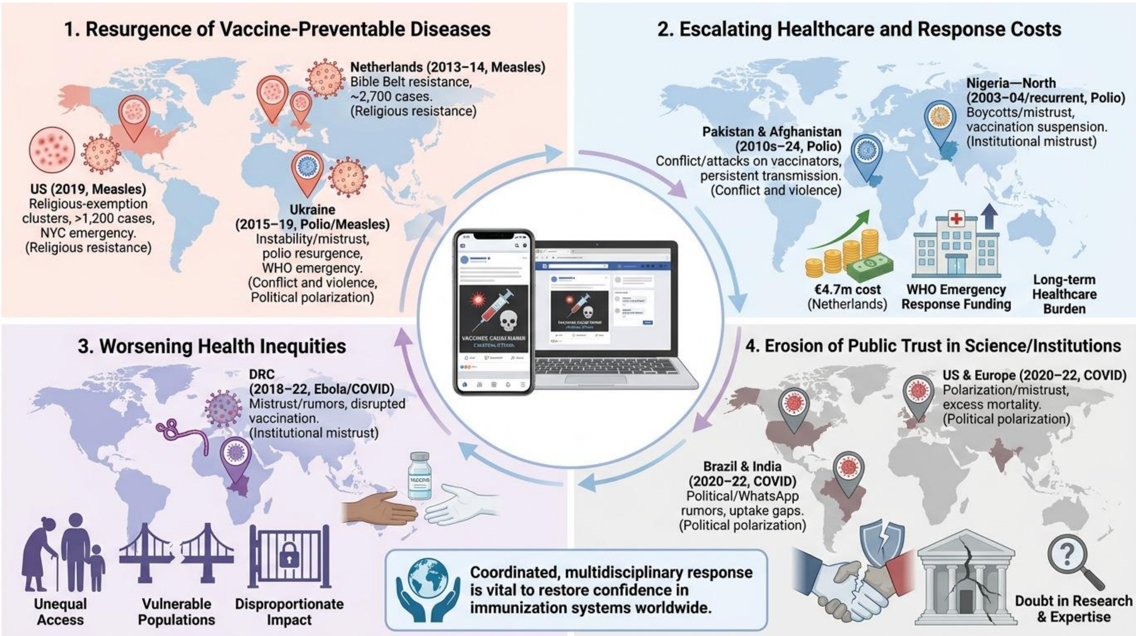

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Source: Author-generated synthesis from figure lab

Fig. 3: The politicization of vaccination and cascading societal consequences

The often-cited backfire effect the claim that corrections systematically strengthen the targeted misperception has not been reliably replicated; recent work suggests it is rare and highly context-dependent rather than a general phenomenon, which represents a meaningful update to the earlier literature that informed many communication recommendations (Wood and Porter, 2019; Swire-Thompson et al., 2022). Narrative messaging can increase persuasion in some studies, though effects are heterogeneous and depend on source credibility and authenticity (Green and Brock, 2000); narratives can also be exploited for the spread of misinformation, so the format itself is not protective. Brief accuracy prompts have shown reproducible reductions in sharing of low-quality content in experimental settings, with smaller effects in field deployments (Pennycook and Rand, 2022). Mandates and incentives can raise short-term uptake; their net effects depend on design and political context (Mello et al., 2020).

A third tier comprises approaches whose evidence is speculative or underpowered relative to the claims made for them. The long-term, scalable effect of generalized media-literacy curricula on vaccination outcomes is plausible but not robustly demonstrated. DE platforming reduces within-platform reach, but its broader effects on belief, behavior, and migration dynamics are mixed. AI-based detection of misinformation is technically advancing but its operational effectiveness depends on adversarial dynamics that are still unfolding.

Effect size is not the only relevant dimension. Interventions also differ in their sustainability, scalability, and ethical implications. Approaches delivered through trusted local actors and community organizations tend to have stronger sustainability characteristics but are resource intensive. Platform-level interventions scale easily but raise governance and free-expression questions. A pragmatic mitigation portfolio will combine multiple intervention types while accounting explicitly for these trade-offs.

Discussion

Several observations follow from the synthesis above. First, the immunological foundations of contemporary vaccine platforms are robust, but each platform involves trade-offs that warrant honest communication rather than absolutist framing. Replacing claims of unparalleled safety with calibrated, context-specific statements acknowledging rare adverse events alongside the considerably greater risks of severe disease in unvaccinated populations appears more likely to sustain trust than dismissive certainty (van der Bles et al., 2020). Second, the contemporary information environment differs from earlier eras in speed, scale, and the role of algorithmic curation, but the strongest causal claims sometimes made about platform-level effects on vaccine behavior are not yet well supported by the most rigorous available studies (Guess et al., 2023; Nyhan et al., 2023). The honest position is that platforms matter but that user choice, network homophily, motivated selection, and offline social context also contribute substantially to exposure patterns and that attributing outcomes to any single factor underspecifies the problem.

Third, the psychological, social, and structural drivers of hesitancy are heterogeneous; treating them as a single phenomenon obscures the interventions each may require. The cognitive frame, the affective and identity-based frame, and the structural and historical frame are complementary rather than competing, and effective programs will draw on all three. Fourth, the evidence base for mitigation strategies is uneven. Prebunking, motivational interviewing, and consistent provider recommendation have moderate support. Several widely cited claims, most notably the universality of the backfire effect, are weaker than previously believed, and intervention recommendations should be updated accordingly. Fifth, generative AI and platform governance represent the most rapidly evolving aspects of the environment; commentary in these areas frequently outpaced empirical evidence, and reviews written today will require updating within months.

Limitations

Several limitations bear on the conclusions reached here. Narrative reviews are vulnerable to selection bias, partially mitigated by transparent reporting of search terms and inclusion criteria but distinct from the protections of registered systematic reviews. The empirical literature on generative AI, platform governance, and post-pandemic confidence is evolving rapidly, and some statements made here may be revised by work published after the search window. Much of the available evidence on misinformation effects is correlational, and causal claims about platform-level effects on vaccine behavior should be interpreted with corresponding caution. Measurement of intervention effectiveness is methodologically uneven across studies in this area, with heterogeneous outcomes, follow-up periods, and populations. Despite efforts to include Global South perspectives, much of the published literature still originates from high-income settings; important findings from contexts with weaker research infrastructure may be underrepresented. Finally, the framing of "misinformation" itself remains contested, and the boundary between misinformation, legitimate skepticism, and minority scientific positions is not always crisp.

Conclusion

Vaccine hesitancy and vaccine misinformation are interdisciplinary phenomena that cannot be adequately addressed from within any single field. The immunological case for vaccination is robust; the contemporary information environment is reshaping how that case is received; the drivers of hesitancy are heterogeneous; and the mitigation evidence base, though uneven, is sufficient to guide a pragmatic intervention portfolio. Priority directions for future work include longitudinal studies of trust dynamics across diverse political and cultural contexts; rigorous evaluation of generative-AI-related misinformation and defenses; field studies of mitigation strategies in Global South settings, including encrypted-messaging-dominated environments; and methodological development to enable stronger causal inference about platform-level effects. Equally important is sustained attention to the conditions under which public-health communication itself maintains its credibility honest engagement with uncertainty, transparent acknowledgement of the limits of evidence, and consistent, culturally grounded engagement with the communities served.

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Conflict of Interest

The author declares no actual or potential conflict of interest, financial or otherwise, in relation to the subject matter of this manuscript.

References

Ajzen, I. (1991). *The theory of planned behavior*. Organizational Behavior and Human Decision Processes. https://doi.org/10.1016/0749-5978(91)90020-t

Baethge, C., Goldbeck-Wood, S., & Mertens, S. (2019). SANRA a scale for the quality assessment of narrative review articles. *Research Integrity and Peer Review*, *4*(1), 1–5. https://doi.org/10.1186/s41073-019-0064-8

Bardosh, K., de Figueiredo, A., Gur-Arie, R., Jamrozik, E., Doidge, J., Lemmens, T., Keshavjee, S., Graham, J. E., & Baral, S. (2022). The unintended consequences of COVID-19 vaccine policy: why mandates, passports and restrictions may cause more harm than good. *BMJ Global Health*, *7*(5), e008684. https://doi.org/10.1136/bmjgh-2022-008684

Betsch, C., Schmid, P., Heinemeier, D., Korn, L., Holtmann, C., & Böhm, R. (2018). Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. *PLOS ONE*, *13*(12), e0208601. https://doi.org/10.1371/journal.pone.0208601

Bloom, K., van den Berg, F., & Arbuthnot, P. (2021). Self-amplifying RNA vaccines for infectious diseases. *Gene Therapy*, *28*(3–4), 117–129. https://doi.org/10.1038/s41434-020-00204-y

Bogart, L. M., Ojikutu, B. O., Tyagi, K., Klein, D. J., Mutchler, M. G., Dong, L., Lawrence, S. J., Thomas, D. R., & Kellman, S. (2020). COVID-19 Related Medical Mistrust, Health Impacts, and Potential Vaccine Hesitancy Among Black Americans Living with HIV. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, *86*(2), 200–207. https://doi.org/10.1097/qai.0000000000002570

Bozkurt, B., Kamat, I., & Hotez, P. J. (2021). Myocarditis with COVID-19 mRNA Vaccines. *Circulation*, *144*(6), 471–484. https://doi.org/10.1161/circulationaha.121.056135

Brady, W. J., Wills, J. A., Jost, J. T., Tucker, J. A., & Van Bavel, J. J. (2017). Emotion shapes the diffusion of moralized content in social networks. *Proceedings of the National Academy of Sciences*, *114*(28), 7313–7318. https://doi.org/10.1073/pnas.1618923114

Brewer, N. T., Chapman, G. B., Rothman, A. J., Leask, J., & Kempe, A. (2017). Increasing Vaccination: Putting Psychological Science into Action. *Psychological Science in the Public Interest*, *18*(3), 149–207. https://doi.org/10.1177/1529100618760521

Broniatowski, D. A., Jamison, A. M., Qi, S., AlKulaib, L., Chen, T., Benton, A., Quinn, S. C., & Dredze, M. (2018). Weaponized Health Communication: Twitter Bots and Russian Trolls Amplify the Vaccine Debate. *American Journal of Public Health*, *108*(10), 1378–1384. https://doi.org/10.2105/ajph.2018.304567

Cinelli, M., Quattrociocchi, W., Galeazzi, A., Valensise, C. M., Brugnoli, E., Schmidt, A. L., Zola, P., Zollo, F., & Scala, A. (2020). The COVID-19 social media infodemic. *Scientific Reports*, *10*(1), 16598. https://doi.org/10.1038/s41598-020-73510-5

de Figueiredo, A., Simas, C., Karafillakis, E., Paterson, P., & Larson, H. J. (2020). Mapping global trends in vaccine confidence and investigating barriers to vaccine uptake: a large-scale retrospective temporal modelling study. *The Lancet*, *396*(10255), 898–908. https://doi.org/10.1016/s0140-6736(20)31558-0

Decker, M. D., & Edwards, K. M. (2021). Pertussis (Whooping Cough). *The Journal of Infectious Diseases*, *224*(Supplement_4), S310–S320. https://doi.org/10.1093/infdis/jiaa469

Fazio, L. K., Brashier, N. M., Payne, B. K., & Marsh, E. J. (2015). Knowledge does not protect against illusory truth. *Journal of Experimental Psychology: General*, *144*(5), 993–1002. https://doi.org/10.1037/xge0000098

Fenner, F., Henderson, D. A., Arita, I., Ježek, Z., & Danilovich Ladnyi, I. (1988). *Smallpox and Its Eradication*. *4*. https://doi.org/10.1163/182539189x01076

Gagneur, A. (2020). Motivational interviewing: A powerful tool to address vaccine hesitancy. *Canada Communicable Disease Report*, *46*(04), 93–97. https://doi.org/10.14745/ccdr.v46i04a06

Goldstein, J. A., Sastry, G., Musser, M., DiResta, R., Gentzel, M., & Sedova, K. (2023). Generative language models and automated influence operations: emerging threats and potential mitigations. *ArXiv*, 82. https://doi.org/10.48550/arXiv.2301.04246

Green, M. C., & Brock, T. C. (2000). The role of transportation in the persuasiveness of public narratives. *Journal of Personality and Social Psychology*, *79*(5), 701–721. https://doi.org/10.1037/0022-3514.79.5.701

Greinacher, A., Thiele, T., Warkentin, T. E., Weisser, K., Kyrle, P. A., & Eichinger, S. (2021). Thrombotic Thrombocytopenia after ChAdOx1 nCov-19 Vaccination. *New England Journal of Medicine*, *384*(22), 2092–2101. https://doi.org/10.1056/nejmoa2104840

Guess, A. M., Malhotra, N., Pan, J., Barberá, P., Allcott, H., Brown, T., Crespo-Tenorio, A., Dimmery, D., Freelon, D., Gentzkow, M., González-Bailón, S., Kennedy, E., Kim, Y. M., Lazer, D., Moehler, D., Nyhan, B., Rivera, C. V., Settle, J., Thomas, D. R., … Tucker, J. A. (2023). How do social media feed algorithms affect attitudes and behavior in an election campaign? *Science*, *381*(6656), 398–404. https://doi.org/10.1126/science.abp9364

Innes, H., & Innes, M. (2023). De-platforming disinformation: conspiracy theories and their control. *Information, Communication & Society*, *26*(6), 1262–1280. https://doi.org/10.1080/1369118x.2021.1994631

Jegede, A. S. (2007). What Led to the Nigerian Boycott of the Polio Vaccination Campaign? *PLoS Medicine*, *4*(3), e73. https://doi.org/10.1371/journal.pmed.0040073

Jhaver, S., Boylston, C., Yang, D., & Bruckman, A. (2021). Evaluating the Effectiveness of Deplatforming as a Moderation Strategy on Twitter. *Proceedings of the ACM on Human-Computer Interaction*, *5*(CSCW2), 1–30. https://doi.org/10.1145/3479525

Johnson, N. F., Velásquez, N., Restrepo, N. J., Leahy, R., Gabriel, N., El Oud, S., Zheng, M., Manrique, P., Wuchty, S., & Lupu, Y. (2020). The online competition between pro- and anti-vaccination views. *Nature*, *582*(7811), 230–233. https://doi.org/10.1038/s41586-020-2281-1

Kahan, D. M., Peters, E., Cantrell Dawson, E., & Slovic, P. (2017). Motivated numeracy and enlightened self-government. *Behavioural Public Policy*, *1*(1), 54–86. https://doi.org/10.1017/bpp.2016.2

Khan, T. M., & Sahibzada, M. U. K. (2016). Challenges to health workers and their opinions about parents' refusal of oral polio vaccination in the Khyber Pakhtoon Khawa (KPK) province, Pakistan. *Vaccine*, *34*(18), 2074–2081. https://doi.org/10.1016/j.vaccine.2016.03.008

Krammer, F. (2020). SARS-CoV-2 vaccines in development. *Nature*, *586*(7830), 516–527. https://doi.org/10.1038/s41586-020-2798-3

Larson, H. J., Clarke, R. M., Jarrett, C., Eckersberger, E., Levine, Z., Schulz, W. S., & Paterson, P. (2018). Measuring trust in vaccination: A systematic review. *Human Vaccines &Immunotherapeutics*, *14*(7), 1599–1609. https://doi.org/10.1080/21645515.2018.1459252

Larson, H. J., Jarrett, C., Eckersberger, E., Smith, D. M. D., & Paterson, P. (2014). Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: A systematic review of published literature, 2007–2012. *Vaccine*, *32*(19), 2150–2159. https://doi.org/10.1016/j.vaccine.2014.01.081

Lazarus, J. V., Wyka, K., White, T. M., Picchio, C. A., Rabin, K., Ratzan, S. C., Parsons Leigh, J., Hu, J., & El-Mohandes, A. (2022). Revisiting COVID-19 vaccine hesitancy around the world using data from 23 countries in 2021. *Nature Communications*, *13*(1), 3801. https://doi.org/10.1038/s41467-022-31441-x

Lo, N. C., & Hotez, P. J. (2017). Public Health and Economic Consequences of Vaccine Hesitancy for Measles in the United States. *JAMA Pediatrics*, *171*(9), 887–892. https://doi.org/10.1001/jamapediatrics.2017.1695

McNeil, M. M., Gee, J., Weintraub, E. S., Belongia, E. A., Lee, G. M., Glanz, J. M., Nordin, J. D., Klein, N. P., Baxter, R., Naleway, A. L., Jackson, L. A., Omer, S. B., Jacobsen, S. J., & DeStefano, F. (2014). The Vaccine Safety Datalink: successes and challenges monitoring vaccine safety. *Vaccine*, *32*(42), 5390–5398. https://doi.org/10.1016/j.vaccine.2014.07.073

Mello, M. M., Silverman, R. D., & Omer, S. B. (2020). Ensuring Uptake of Vaccines against SARS-CoV-2. *New England Journal of Medicine*, *383*(14), 1296–1299. https://doi.org/10.1056/nejmp2020926

Menz, B. D., Modi, N. D., Sorich, M. J., & Hopkins, A. M. (2024). Health Disinformation Use Case Highlighting the Urgent Need for Artificial Intelligence Vigilance. *JAMA Internal Medicine*, *184*(1), 92–96. https://doi.org/10.1001/jamainternmed.2023.5947

Mitkus, R. J., King, D. B., Hess, M. A., Forshee, R. A., & Walderhaug, M. O. (2011). Updated aluminum pharmacokinetics following infant exposures through diet and vaccination. *Vaccine*, *29*(51), 9538–9543. https://doi.org/10.1016/j.vaccine.2011.09.124

Murphy, K. M., & Weaver, C. (2016). *Janeway's Immunobiology*.

Nyhan, B., Settle, J., Thorson, E., Wojcieszak, M., Barberá, P., Chen, A. Y., Allcott, H., Brown, T., Crespo-Tenorio, A., Dimmery, D., Freelon, D., Gentzkow, M., González-Bailón, S., Guess, A. M., Kennedy, E., Kim, Y. M., Lazer, D., Malhotra, N., Moehler, D., … Tucker, J. A. (2023). Like-minded sources on Facebook are prevalent but not polarizing. *Nature*, *620*(7972), 137–144. https://doi.org/10.1038/s41586-023-06297-w

Offit, P. A., Quarles, J., Gerber, M. A., Hackett, C. J., Marcuse, E. K., Kollman, T. R., Gellin, B. G., & Landry, S. (2002). Addressing Parents' Concerns: Do Multiple Vaccines Overwhelm or Weaken the Infant's Immune System? *Pediatrics*, *109*(1), 124–129. https://doi.org/10.1542/peds.109.1.124

Orenstein, W. A., Offit, P. A., Edwards, K. M., & Plotkin, S. A. (Eds.). (2017). Plotkin's Vaccines. *Plotkin's Vaccines*, xi.

Pardi, N., Hogan, M. J., Porter, F. W., & Weissman, D. (2018). mRNA vaccines — a new era in vaccinology. *Nature Reviews Drug Discovery*, *17*(4), 261–279. https://doi.org/10.1038/nrd.2017.243

Pasquetto, I., Swire-Thompson, B., & Amazeen, M. A. (2020). Tackling misinformation: What researchers could do with social media data. *Harvard Kennedy School Misinformation Review*, *1*(18), 1–13. https://doi.org/10.37016/mr-2020-49

Patel, M. K., Goodson, J. L., Alexander, J. P., Kretsinger, K., Sodha, S. V., Steulet, C., Gacic-Dobo, M., Rota, P. A., McFarland, J., Menning, L., Mulders, M. N., & Crowcroft, N. S. (2020). Progress Toward Regional Measles Elimination — Worldwide, 2000–2019. *MMWR. Morbidity and Mortality Weekly Report*, *69*(45), 1700–1705. https://doi.org/10.15585/mmwr.mm6945a6

Patel, M., Lee, A. D., Clemmons, N. S., Redd, S. B., Poser, S., Blog, D., Zucker, J. R., Leung, J., Link-Gelles, R., Pham, H., Arciuolo, R. J., Rausch-Phung, E., Bankamp, B., Rota, P. A., Weinbaum, C. M., & Gastañaduy, P. A. (2019). National Update on Measles Cases and Outbreaks — United States, January 1–October 1, 2019. *MMWR. Morbidity and Mortality Weekly Report*, *68*(40), 893–896. https://doi.org/10.15585/mmwr.mm6840e2

Pennycook, G., & Rand, D. G. (2022). Accuracy prompts are a replicable and generalizable approach for reducing the spread of misinformation. *Nature Communications*, *13*(1), 2333. https://doi.org/10.1038/s41467-022-30073-5

Petersen, M. B., Bor, A., Jørgensen, F., & Lindholt, M. F. (2021). Transparent communication about negative features of COVID-19 vaccines decreases acceptance but increases trust. *Proceedings of the National Academy of Sciences*, *118*(29), e202459711. https://doi.org/10.1073/pnas.2024597118

Polack, F. P., Thomas, S. J., Kitchin, N., Absalon, J., Gurtman, A., Lockhart, S., Perez, J. L., Pérez Marc, G., Moreira, E. D., Zerbini, C., Bailey, R., Swanson, K. A., Roychoudhury, S., Koury, K., Li, P., Kalina, W. V., Cooper, D., Frenck, R. W., Hammitt, L. L., … Gruber, W. C. (2020). Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine. *New England Journal of Medicine*, *383*(27), 2603–2615. https://doi.org/10.1056/nejmoa2034577

Quinn, S. C., Jamison, A., Freimuth, V. S., an, J., Hancock, G. R., & Musa, D. (2017). Exploring racial influences on flu vaccine attitudes and behavior: Results of a national survey of White and African American adults. *Vaccine*, *35*(8), 1167–1174. https://doi.org/10.1016/j.vaccine.2016.12.046

Rauchfleisch, A., & Kaiser, J. (2021). Deplatforming the Far-right: An Analysis of YouTube and BitChute. *SSRN Electronic Journal*, *1*(1), 1–28. https://doi.org/10.2139/ssrn.3867818

Resende, G., Melo, P., Sousa, H., Messias, J., Vasconcelos, M., Almeida, J., & Benevenuto, F. (2019). (Mis)Information Dissemination in WhatsApp: Gathering, Analyzing and Countermeasures. *The World Wide Web Conference*, 818–828. https://doi.org/10.1145/3308558.3313688

Ritov, I., & Baron, J. (1990). Reluctance to vaccinate: Omission bias and ambiguity. *Journal of Behavioral Decision Making*, *3*(4), 263–277. https://doi.org/10.1002/bdm.3960030404

Rogers, R. W. (1975). A Protection Motivation Theory of Fear Appeals and Attitude Change1. *The Journal of Psychology*, *91*(1), 93–114. https://doi.org/10.1080/00223980.1975.9915803

Roozenbeek, J., van der Linden, S., Goldberg, B., Rathje, S., & Lewandowsky, S. (2022). Psychological inoculation improves resilience against misinformation on social media. *Science Advances*, *8*(34), 6254. https://doi.org/10.1126/sciadv.abo6254

Rosenstock, I. M. (1974). Historical Origins of the Health Belief Model. *Health Education Monographs*, *2*(4), 328–335. https://doi.org/10.1177/109019817400200403

Shimabukuro, T. T., Nguyen, M., Martin, D., & DeStefano, F. (2015). Safety monitoring in the Vaccine Adverse Event Reporting System (VAERS). *Vaccine*, *33*(36), 4398–4405. https://doi.org/10.1016/j.vaccine.2015.07.035

Swire-Thompson, B., Cook, J., Butler, L. H., Sanderson, J. A., Lewandowsky, S., & Ecker, U. K. H. (2022). Correction format has a limited role when debunking misinformation. *Cognitive Research: Principles and Implications*, *6*(1), 83. https://doi.org/10.1186/s41235-021-00346-6

Topol, E. J., & Iwasaki, A. (2024). Operation Nasal Vaccine Lightning speed to counter COVID-19. *Science Immunology*, *7*(74), 947. https://doi.org/10.1126/sciimmunol.add9947

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science*, *185*(4157), 1124–1131. https://doi.org/10.1126/science.185.4157.1124

van der Bles, A. M., van der Linden, S., Freeman, A. L. J., & Spiegelhalter, D. J. (2020). The effects of communicating uncertainty on public trust in facts and numbers. *Proceedings of the National Academy of Sciences*, *117*(14), 7672–7683. https://doi.org/10.1073/pnas.1913678117

van der Linden, S., Leiserowitz, A., Rosenthal, S., & Maibach, E. (2017). Inoculating the Public against Misinformation about Climate Change. *Global Challenges*, *1*(2), 1600008. https://doi.org/10.1002/gch2.201600008

Victora, G. D., & Nussenzweig, M. C. (2012). Germinal Centers. *Annual Review of Immunology*, *30*(1), 429–457. https://doi.org/10.1146/annurev-immunol-020711-075032

Vinck, P., Pham, P. N., Bindu, K. K., Bedford, J., & Nilles, E. J. (2019). Institutional trust and misinformation in the response to the 2018-19 Ebola outbreak in North Kivu, DR Congo: a population-based survey. *The Lancet Infectious Diseases*, *19*(5), 529–536. https://doi.org/10.1016/s1473-3099(19)30063-5

Vosoughi, S., Roy, D., & Aral, S. (2018). *The spread of true and false news online*. Science. https://doi.org/10.1126/science.aap9559

Vraga, E. K., & Bode, L. (2020). Defining Misinformation and Understanding its Bounded Nature: Using Expertise and Evidence for Describing Misinformation. *Political Communication*, *37*(1), 136–144. https://doi.org/10.1080/10584609.2020.1716500

Wardle, C., & Derakhshan, H. (2017). *Information Disorder: Toward an Interdisciplinary Framework for Research and Policy Making*.

Wesselink, A. K., Hatch, E. E., Rothman, K. J., Wang, T. R., Willis, M. D., Yland, J., Crowe, H. M., Geller, R. J., Willis, S. K., Perkins, R. B., Regan, A. K., Levinson, J., Mikkelsen, E. M., & Wise, L. A. (2022). A Prospective Cohort Study of COVID-19 Vaccination, SARS-CoV-2 Infection, and Fertility. *American Journal of Epidemiology*, *191*(8), 1383–1395. https://doi.org/10.1093/aje/kwac011

Wiysonge, C. S., Ndwandwe, D., Ryan, J., Jaca, A., Batouré, O., Anya, B.-P. M., & Cooper, S. (2022). Vaccine hesitancy in the era of COVID-19: could lessons from the past help in divining the future? *Human Vaccines & Immunotherapeutics*, *18*(1), 1–3. https://doi.org/10.1080/21645515.2021.1893062

Wolfe, R. M., & Sharp, L. K. (2002). Anti-vaccinationists past and present. *BMJ*, *325*(7361), 430–432. https://doi.org/10.1136/bmj.325.7361.430

Wood, T., & Porter, E. (2019). The Elusive Backfire Effect: Mass Attitudes' Steadfast Factual Adherence. *Political Behavior*, *41*(1), 135–163. https://doi.org/10.1007/s11109-018-9443-y

WHO. (2020). Measles vaccines: WHO position paper, April 2017 Recommendations. *Vaccine*, *37*(2), 219–222. https://doi.org/10.1016/j.vaccine.2017.07.066

Zauche, L. H., Wallace, B., Smoots, A. N., Olson, C. K., Oduyebo, T., Kim, S. Y., Petersen, E. E., Ju, J., Beauregard, J., Wilcox, A. J., Rose, C. E., Meaney-Delman, D. M., & Ellington, S. R. (2021). Receipt of mRNA COVID-19 vaccines preconception and during pregnancy and risk of self-reported spontaneous abortion. *Journal of the American Medical Association*, *326*(16), 1629–1631. https://doi.org/10.1001/jama.2021.15494