

A SYSTEMATIC REVIEW ON THE ELEMENTS OF INFORMATION DISORDER THAT INFLUENCE COVID-19 VACCINE HESITANCY

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Abstract

The aim of this study is to examine elements of information disorders that leads to vaccine hesitancy. To realize this objective, we systematically reviewed literature from three databases: Web of Science, Scopus, and PubMed. To retrieve studies from the three databases the following search string was used. (Disinformation OR Misinformation OR Misleading Information OR Fake News OR False News OR False content OR Deep fake) AND COVID AND Vaccin*

A total of 151 studies were retrieved from the three databases. A total of 142 studies were excluded at screening and eligibility stages of the review process. 9 studies met all the inclusion criteria and were taken through the process of information extraction and synthesis.

We concluded that the three elements of information disorders use various mechanisms to achieve their objectives of influencing people towards vaccine hesitancy. Thus, a disruption on how their mechanisms functions can result in low levels of vaccine hesitancy among populations. Some of the strategies that may be used in disrupting them includes creating tough conditions for the agents of information disorders, heavily fining platforms that host information disorders, and empowering recipients with scientific knowledge on pandemics.

Keywords: Information disorder, Misinformation, mal-information, disinformation, vaccine hesitancy, COVID-19

Introduction

Severe acute respiratory syndrome - coronavirus-2 (SARS-CoV-2), one of the viruses under the beta coronavirus family, is the virus behind coronavirus disease 2019 (COVID-19) (Amirfakhryan & safari, 2021). COVID-19 is a respiratory disease that mostly presents with high fever, difficulty in breathing, dry cough, sore throat, and nasal congestion. In severe cases it leads to the collapse of the respiratory system necessitating ICU admissions and placement on ventilation support machines. The disease has an incubation period of 2-14 days before its symptoms emerges after bout of infection. It takes approximately 19 days, as shown in the figure below, for its symptoms to clear away from the body after successful treatment and management (Kakodkar et al., 2020).

Timelines for symptoms of covid-19



Source: (Kakodkar et al., 2020)

On 11th March 2020, the World Health Organization (WHO) declared COVID-19 as a pandemic after the spread of the virus had been reported and confirmed in several countries (Amirfakhryan & safari, 2021). Governments throughout the world responded to this declaration by developing containment measures that focused on isolating and restricting movements of their citizens, through lockdowns, curfews, and restrictions on gatherings. In addition, some governments also introduced measures of hygiene such as mandatory wearing of facemasks in public spaces and hand washing using either running tap water and soaps or with alcohol-based sanitizers. Later, during the pandemic, the WHO, and other regional regulatory authorities, such as the European Medicines Authority (EMA) and Food and Drug Administration (FDA), approved COVID-19 vaccines for emergency use. The introduction of vaccines was a game changer in the containment and management of the COVID-19 pandemic. It changed the tide of the pandemic by significantly reducing the number of people who either became sick or died because of the disease. As more

and more people became vaccinated, the number of people who needed hospitalization or who succumbed as a result of COVID-19 also reduced significantly (Victoria et al., 2021). Although most governments invested heavily in availability and accessibility of vaccines, there were pockets of people who completely refused or were hesitant in taking up COVID-19 vaccines (Zelič et al., 2022).

Vaccine hesitancy is a major problem that hinders countries from reaching herd immunity, i.e., a level where a good proportion of people living in a community are immune to an infectious disease, such as COVID-19. According to Loomba et al., (2021) for a herd immunity to be reached at least 55% to 85% of the population needs to be vaccinated. Although both vaccination and natural immunization are the two main routes through which communities acquire herd immunity against infectious diseases. Unlike natural immunization that requires communities to be exposed to infectious diseases over a longer period of time, running from months to years, before they can develop a herd immunity, vaccination on the other hand only requires a few days for herd immunity to develop after a certain proportion of the community has been vaccinated (Cihan, 2021).

Information is a key component of a pandemic management; it guides people on how to protect and minimize their chances of contracting or dying from infectious diseases. Depending on the kind of information they have been exposed to, people may opt to either comply or fail to comply with containment measures put in place by relevant authorities. For instance, in a randomized study carried out in the US and UK by Loomba et al., (2021), observed that information disorder was a key factor that influenced whether their respondents would take vaccines or not. Wardle, (2018) used the term information disorder to refer to kinds of information that are created and distributed with the intention of swaying the public away from the truth or to harm them. According to him, information disorders are of three types, based on their degree of falsehood and severity of harm they inflict on their recipients: disinformation, misinformation, and Mal-information. **Disinformation** refers to false or misleading information that are intentionally created, distributed, asserted, or disseminated to cause harm, deceive, confuse, or sway people's opinion on a given issue, such as vaccines or elections (Kadenko et al., 2021). Disinformation messages are normally designed in such a way that they contain half-truth statements that are used to bait people into believing or accepting misleading or incorrect conclusions. Such half-truth statements are

normally based on recent events that recipients are aware of or familiar with (Pathak et al., 2021). **Misinformation** on the other hand, refers to false or incorrect information that is created or distributed without the intention of causing harm. They usually result from honest mistakes, negligence, or unconscious biases attributed to the use of outdated or incomplete information (Kadenko et al., 2021). Misinformation can come in the form of satires, i.e., use of humour to criticize people or organizations, clickbait i.e., use of headlines that are not in tandem with content of their messages, or misleading quotes and images i.e., when they are used out of their contexts or are wrongly framed (Wardle, 2018). People who disseminate misinformation, most often, believe that such information are true. **Mal-information** refers to true or correct information that is timely distributed to inflict harm on individuals, organizations, or countries. Examples of mal-information include private conversations, emails, pictures, health records, and videos of individuals that get leaked to the public without their consents (Wardle & Derakhshan, 2017). Such private information may influence people's intentions, especially if they are leaked just before they make decisions on public issues, such as vaccination or voting. For instance, leaking to the public, medical records of dead individuals who had received given vaccines but omitting sections that specify causes of their deaths, may make people to question safety of such vaccines, and thus may make people to become hesitant in signing up for them.

The interaction between information disorder and vaccine hesitancy is of a key scientific interest. Information plays an important role in shaping people's worldview which consequently influences their behaviours or their responses to events (Breakwell, 2020). People respond differently when exposed to information disorders, some react by engaging themselves in activities that they believe would protect them from harm, such as delaying or not being vaccinated at all, while others may opt to engage themselves in harm reduction activities, such as not taking all doses of vaccines. Purveyors of information disorders have always linked COVID-19 vaccines with poor health outcomes, such as development of disabilities, infertility, and deaths, without giving scientifically based evidence. Since good health is a very valuable human resource, most people who get exposed to such information, tend to avoid, or prolong the intervals between which they take vaccines. Creators and distributors of information disorders, normally target, three important components of managing pandemics: vaccine, health systems, and social attributes of individuals.

i) The vaccine component comprises of the vaccines and the entire process that leads to their development and mass production, including clinical trials. Creators of information disorder, who target this component, normally create messages that either discredits the entire process of vaccine development and mass production or cast doubts on the effectiveness of vaccines in preventing infectious diseases. Some of their messages normally claim that their target vaccines were not ethically developed, while others allude, without giving evidence, that such vaccines contain harmful elements that may lead to medical conditions such as cancers, autism, sexual dysfunctions and infertilities (Alamoodi et al., 2021; Calvo et al., 2022).

ii) Health systems component comprises of all State agencies and, health institutions and facilities that are involved in the processes of developing, manufacturing, and approving vaccines for use by the public, issuing pandemic containment measures (such as mandatory face masks), administering vaccines, or treating and managing individuals who have already contracted infectious diseases. Authors of information disorders that targets this component, normally create messages that question abilities, roles, and motives of healthcare workers, healthcare agencies, and the government in managing pandemics. Some of the authors of such messages claim, again without giving evidence, that the State and its agencies have no role or lack capacities needed in managing pandemics, while others read malicious motives behind State's interventions, such as instigating that the State's aim of vaccination is to 'install' microchips into people for purposes of closely monitoring them. By discrediting healthcare institutions, authors of such messages achieve their objectives of creating atmosphere of discontent, which may eventually make people to engage in activities such as attacking healthcare workers and scientists, disregarding pandemic containment measures, or not taking up vaccines (Alamoodi et al., 2021; Calvo et al., 2022; Šupínová et al., 2022).

iii) social attributes of individuals, are characteristics of individuals that influences their decision-making processes. They comprise of factors such as social norms and beliefs, emotions, religious practices, socio-economic status, literacy levels, personality traits etc. People tend to respond positively to information disorders that appeal to their social attributes, this is because people normally use them as blue prints for making decisions. Kušnířová & Kačmár, (2022) observed in their literature review, that people with personality traits such as Agreeableness, Openness, and Conscientiousness tend to easily accept pandemic containment measures while those with personalities traits such as Neuroticism and Extroversion tend to have difficulties in complying

with such measures. Thus, people who have neurotic and extroversive personalities are more likely to be vaccine hesitant if exposed to misleading, incorrect, and harmful information (Alamoodi et al., 2021; Calvo et al., 2022).

Materials and Methods

2.1 data retrieval strategies

We retrieved studies for this systematic review from three scientific databases: Web of Science, Scopus, and PubMed. Our search strategy for retrieving studies from the three databases involved the use of wildcard symbols and combining keywords with Boolean operators. During the search, we combined our keywords as follows: (Disinformation OR Misinformation OR Misleading Information OR Fake News OR False News OR False content OR Deep fake) AND COVID AND Vaccin*. When retrieving studies from the Web of Science database, we refined our search by excluding review articles, editorial materials, proceeding papers, letters, news items, Meeting abstracts, book chapters, corrections, and articles that were not published in English language. In the Scopus database, we refined our search by excluding review articles, book chapters, conference papers, and conference review. In the PubMed database, we also refined our search by excluding books and documents, Meta-Analysis, Reviews, and Systematic Reviews. We later sent all studies we had retrieved to the endnote reference manager for purpose of removing duplicates and managing bibliographies.

2.2 Study selection

We selected studies into our systematic review in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. We enlisted studies into the review that had met the following inclusion criteria:

- Were written in English language and had been published between December 2019 and June 2022. We settled on these dates because they coincided with the dates when the World Health Organization was 1st notified of the COVID-19 outbreak and the time when we retrieved studies from the three databases.
- Had used quantitative research designs and were reporting results of primary data
- Had been peer reviewed

We excluded the following articles from the review

- Protocols, reviews, letters to the editor, editorials, study protocols, commentaries, opinions, conference abstracts, errata, and books or book chapters.
- Studies with qualitative research designs,

2.3 Data extraction, Quality assessment, and Analysis

The process of data extraction, quality assessment, and analysis was done in three stages. The 1st stage involved retrieving articles from the three databases: Web of Science, Scopus, and PubMed. In this stage, one of the three authors was asked to retrieval articles from the three databases using search terms that had been jointly agreed upon. The retrieved articles were later sent to EndNote reference manager. Another author cleaned the retrieved articles by removing duplicates. This was later followed by assessing relevance of the retrieved studies, independently by each the three authors based on their titles and abstracts. Later, the three authors independently determined whether each of the assessed studies had met all laid criteria. Reference to the review protocol and discussions were used in making decisions on studies that the three authors differed on their eligibilities.

The 2nd stage involved the three authors independently assessing quality of the studies that had passed the eligibility stage. In doing so, they were guided by the following criteria: i) research designs i.e., whether research objectives and methods were clearly stated, ii) data collection methods, i.e., whether they were adequately described, iii) Data analysis procedures i.e., whether the authors of the article adequately described and executed data analysis procedures, iv) conclusions reached from the study i.e., whether they were drawn from the study. We also developed a scale for scoring studies that had been assessed. A score of 1 was entered for each study that had satisfied all the four outlined criteria, 0.5 for those that had partially satisfied all the four criteria, and 0 for those that failed to satisfy any of the four set criteria. Later, an average of scores awarded by all the three authors for each study was tabulated. A study that had an average score of 1 were considered to have met all the criteria and were thus included in the study, those that had an average of 0 score were considered not to have met all the criteria and were thus excluded from the study, while those that had average scores that were greater than 0 but less than 1, were enlisted or rejected from the review after thorough discussions among the three authors.

The 3rd stage involved extracting and analysing data from the studies that had been assessed and enlisted into the systematic review. Information that was extracted from the studies were titles of

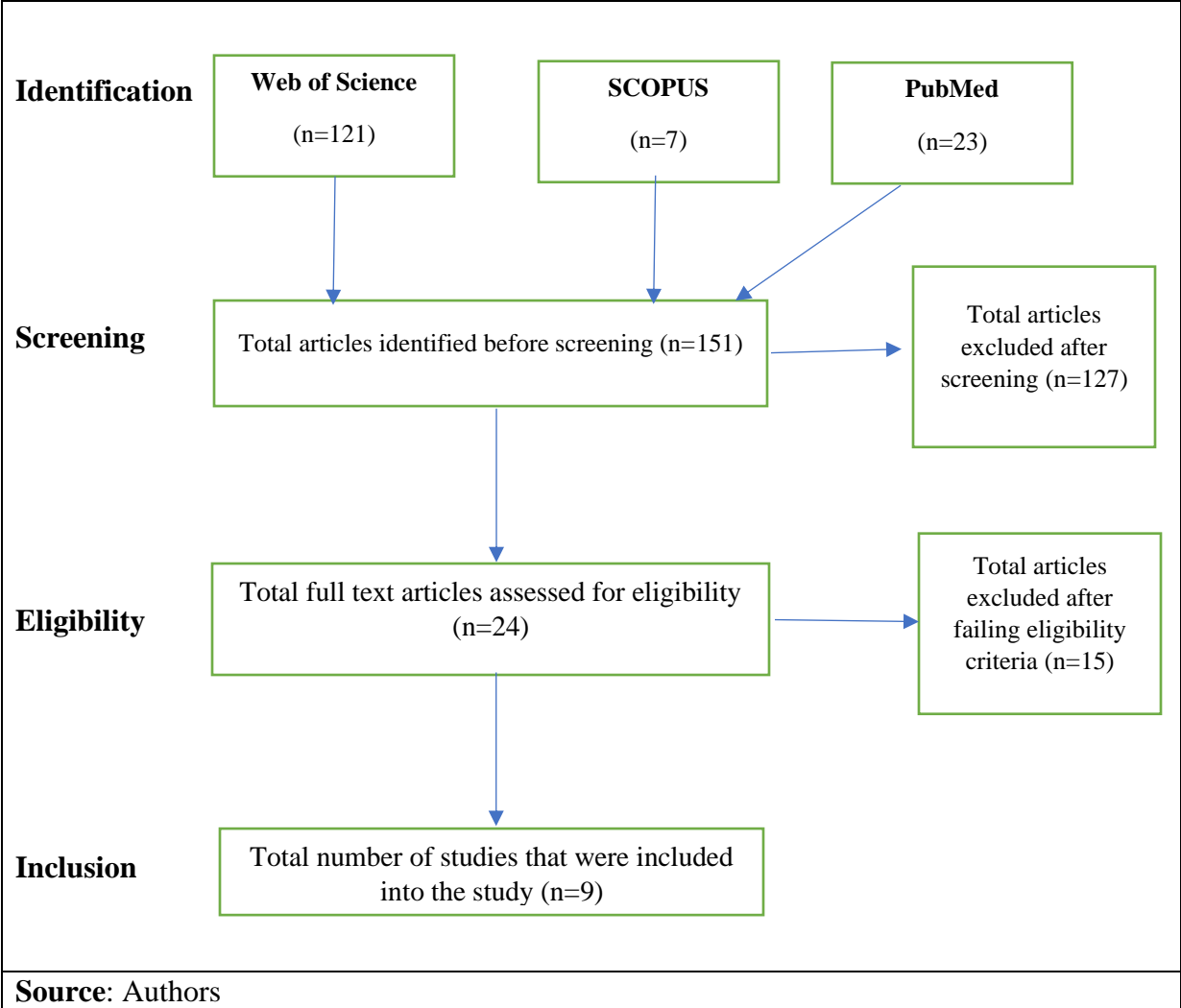
the articles, sources of the primary data and duration of the studies, vaccine hesitancy, and disinformation. A narrative synthesis was later used to analyse included studies, in accordance with the guidelines for Conducting Narrative Synthesis in Systematic Reviews.

Results

3.1 Study selection

The process of selecting studies for the review was split into four different stages, in accordance with the PRISMA guidelines: Identification, Screening, Eligibility, and Inclusion stages. In the identification stage, a total of 151 studies were retrieved from the three databases: Web of Science (n=121), Scopus (n=7) and PubMed (n=23). In the Screening stage, a total of 127 studies were excluded from the review, of which 3 were duplicates, 86 were irrelevant based on their titles, and 38 were irrelevant based on their abstracts. At the eligibility stage, 15 more studies were excluded after a full text reading found them ineligible for review. In the inclusion stage, 9 articles were found to have satisfied all laid down inclusion criteria and were appraised and later taken through the process of data extraction and synthesis.

Figure 1: Flow diagram of study selection



3.2 Characteristics of the selected studies

Authors	Element of information disorder under study	Key findings
(Almansa-Martínez et al., 2022)	<ul style="list-style-type: none"> Message 	<ul style="list-style-type: none"> Topics preferred by authors of misleading and harmful information on COVID-19 pandemic: Vaccines, Mask, Virus variants and, remedies and treatment of the COVID-19. Text only is the most preferred format of presenting disinformation and misinformation, followed by texts with pictures, and finally video formats Audio was the least used format for creating and distributing misinformation and disinformation.
(Calvo et al., 2022)	<ul style="list-style-type: none"> Agent Message 	<ul style="list-style-type: none"> Deception techniques videos under study used were manipulation of context (53%), false context (16%), exaggerations (12%), fabrication of content (7%), and false connections (6%). 89.13% of anti-vax videos used everyday language while only 10.87% used scientific language
(Dai et al., 2021)	<ul style="list-style-type: none"> Audience 	<ul style="list-style-type: none"> Text-based reminders that elicits feelings of ownership encourages vaccine uptake
(Freeman et al., 2021)	<ul style="list-style-type: none"> Audience 	<ul style="list-style-type: none"> Strongly vaccine hesitant individuals are less likely to see collective benefits of vaccination Information that personalizes benefits of vaccines to individuals reduces their levels of vaccine hesitancy
(Herrera-Peco et al., 2021)	<ul style="list-style-type: none"> Audience Message 	<ul style="list-style-type: none"> Anonymous twitter accounts were mostly used in spreading conspiracy theories related to COVID 63.36% of anti-vaccine tweets claimed that COVID vaccines were not safe, 8.9% doubted their effectiveness, 8.7% associated them with business, and 18.83% were about unverified COVID beliefs
(Loomba et al., 2021)	<ul style="list-style-type: none"> Audience 	<ul style="list-style-type: none"> Misinformation reduces the intent to get vaccinated
(Okuhara et al., 2022)	<ul style="list-style-type: none"> Audience 	<ul style="list-style-type: none"> Messages that show personal benefits, such as kin care, are more effective in encouraging people to take COVID-19 vaccines than those that focus on disease control
(Okuno et al., 2022)	<ul style="list-style-type: none"> Audience 	<ul style="list-style-type: none"> Providing information regarding side effects of a vaccine does not necessarily lead to vaccine hesitancy
(Yuan & Chu, 2022)	<ul style="list-style-type: none"> Audience 	<ul style="list-style-type: none"> Messages framed to provide personalized benefits encourages people to take vaccines

Discussion

Infectious diseases are one of the three factors that causes morbidity and mortality. The other two are non-infectious diseases, and lethal cell injuries caused by either undernutrition or exposure to either violence, extreme temperatures, and corrosive or radioactive elements. Infectious diseases are caused by microorganisms, such as bacteria, viruses, and parasites, that disrupt the normal physiological processes of the body. Disease-causing microorganisms have developed complicated mechanisms that enables them to enter the human body, evade its immune system, obtain nutrients from it, and replicate within it. Some of the microorganisms have also developed mechanisms that enables them to not only survive while outside the human body but also to move

from one host to another. Their abilities to survive, while outside the bodies of living organisms, and to spread from one host to another, has been of great concern to human beings since time in memorial. Historically, human beings have tried various strategies to prevent them from spreading from one individual to another. Some of such strategies involved the use of theological based approaches, such as prayers and offering of sacrifices to calm evil spirits; pseudo-scientific approaches, such as taking sick people to the mountain to breathe fresh air; and observation-based strategies such as isolation of the sick and cremation of the dead. Modern science has developed more effective methods of controlling infectious diseases through proper sanitation and hygiene, use of antibiotics, and vaccination of susceptible populations. Though these modern strategies are effective in preventing and managing infectious diseases, sadly, there are people who harbour doubts and reservations on vaccines, even when they are readily available and accessible to them (Herrera-Peco et al., 2021). Exposure to information disorder, besides ‘forgetfulness, hassle costs, and procrastination’, is one of the leading factors that gravitate people towards vaccine hesitancy (Cummings et al., 2021; Dai et al., 2021). The aim of this study is to examine elements of information disorders that leads individuals to vaccine hesitancy. To realize this objective, we examined three of the six elements of information disorders in relation to vaccine hesitancy, namely, agent (i.e., source), message, and recipients. The other elements of information disorder that we did not examine are context, channels, and interference (also called noise).

Agents of information disorders (i.e., sources) refers to individuals and organizations that author and/or disseminate such kinds of information. In this systematic review, we examined two aspects of agents who author information disorders; their identity and factors that motivates them to author information disorders. Our findings on the identity of agents indicated that most messages of information disorders were authored by individuals, such as politicians and fake scientists, and organizations, such as governments and private business firms. Further still, we observed that some of these agents opted to use pseudonyms that concealed their identities while other had no problem with revealing their identities. In a study done by, Calvo et al., (2022) observed that the majority of the videos, (96.72%, n=177), they had examined had been created by agents whose identities had not been concealed, 1.64% (n=3) of them were from fictitious sources (i.e., non-existent identities), while 0.55% (n= 1) were from anonymous sources. The 2nd aspect of the agents that we examined was on factors that motivates them to author information disorders. Our findings

indicated that most of them were driven by either political reasons or financial benefits that come with the sale of advertisements (Almansa-Martínez et al., 2022).

Message is the second element of information disorders. It involves the exchange of ideas between agents, i.e., source, and recipients. Messages are of three types: *i) feedforward*, i.e., messages that are sent by the source to prepare recipients for the main message. Feedforwards can be in the form of captivating titles, cover photographs, or introductory statements/paragraphs; *ii) feedback*, i.e., reactions that recipients send to the source after a message has been delivered. In the context of COVID-19 pandemic such reactions may include actions such as not wearing medical face masks in the public, holding large gatherings, or refusing to take vaccines and *iii) metamessage*, i.e., messages that have deeper meanings other than what has been presented. For instance, silence after a message has been delivered may have deeper meaning such as lack of interest or a protest directed towards the speaker/source. Intentional refusal to observe hygiene measures during a pandemic, may be interpreted as a protest against the body that issues such measures. In this review we examined techniques agents of information disorders use when authoring their messages. The three most common techniques agents of information disorders use are: i) deceptions that involve gaining trusts of their recipients through dubious means based on distorted facts, such as authoring messages that have either manipulated contexts, exaggerated facts, fabricated contents, or draw misleading conclusions (Almansa-Martínez et al., 2022; Calvo et al., 2022); ii) using simple and plain language that resonates well with their recipients, who in most cases have no technical knowledge on the issue. Calvo et al., (2022) observed in their study that agents of information disorders often preferred creating messages that were simple and easy to understand, but emotionally charged, over those that were neutral but complex. They further observed that agents of such information also preferred supporting their messages with ‘real life situations’, ‘people’, and ‘common sense’, instead of scientific references and citations, to convince their audiences, viewers, or readers; iii) packaging their messages as news, interviews with their so called ‘experts,’ ‘big’ announcements, conferences, and investigative documentaries. Herrera-Peco et al., (2021) classified messages of information disorders into four categories:

a) Conspiracy-based messages that purports to simplify or give backgrounds to concepts that are either too complex or requires expert knowledge before one can understand them. In most cases, such messages attempt to explain causes or motives behind COVID-19 or its vaccination

programs. This category of messages can be further sub-divided into three sub-categories: the 1st subcategory comprises of those that claim SARS-CoV-2 is a bio-weapon that was created in the lab and later leaked into the public for purpose of creating a new world order with the intention of controlling people at a global level; the 2nd sub-category comprises of messages that claim that SARS-CoV-2 was created with the intention of systematically exterminating certain groups of people from the world, through calculated moves, such as making them infertile; and finally the 3rd subcategory comprises of messages that claims that vaccination is a ploy by the State to ‘install’ microchips into ‘uninformed population’. Further still under this subcategory, other messages claim vaccination is a tactic to mark people with some digits prescribed in some religious texts to usher in ‘rapture’ i.e., end of the earthly living.

b) Denial messages, this category comprises of messages that contradicts tested, verified, and proven scientific principles, such as transmission of SARS-CoV-2 through air droplets. Such messages are usually based on flawed reasonings that supports certain beliefs, ideologies, and assumptions of their authors. For instance, individuals who believe that their freedoms of association and movements should never be restricted at all, may resort to denying the existence of COVID-19 pandemic when measures such as curfews and lockdowns are issued (Wawrzuta et al., 2021). Fackler, (2021) referred to this strong adherence to false beliefs to as backfire effect, a cognitive bias that people develop when their belief system is challenged. The more deniers are exposed to correct information or evidence that contradicts their beliefs, the more they are likely to strongly support their erroneous beliefs, assumptions, and ideologies. Such individuals may resort to cherry picking of information that only affirm their stand on an issue.

c) Anti-vaccine messages, this category comprises of messages that call to question the efficacy, safety, and importance of vaccines. These types of messages achieve their objectives, of misleading or harming recipients, by evoking negative emotions in them, especially fear, anger, and sadness. In addition, anti-vaccines messages most often advocate for alternative methods for stimulating immunity, other than through vaccination, such as the meditation and yoga. According to Xu, (2019)there are two strategies these anti-vaccines use to evoke emotions of their recipients: i) discrediting health institutions through conspiracy theories, and ii) emotional narratives, such as creating fictitious stories tries to link vaccines with negative health outcomes, such as deaths or permanent disabilities.

The 3rd element of information disorder that we examined in this review was the recipients i.e., characteristics of individuals that makes them susceptible to information disorders. Naturally, people tend to engage in activities or behaviours that reduces their risks of contracting or dying from infectious diseases. Their decision to engage in risk reduction behaviours are largely influenced by their backgrounds and worldviews. For instance, in a study done by Gentsch et al., (2022) observed that some of their respondents viewed vaccines as an effective approach of preventing infectious diseases while others viewed it differently, i.e., vaccines don't offer protection against infections. In this review, we examined characteristics that shapes perspectives of individuals on COVID-19 vaccines. We observed that some of these characteristics are: low levels of scientific knowledge and media literacy; lack of trust in healthcare institutions; emotional states of individuals that influence how they react to information disorders presented to them; demographic factors such as gender where women are more likely than men to accept complementary and alternative medical therapies; beliefs and attitudes; personality traits such as neuroticism and extraversion which may be worsened by computer algorithms that have tendencies of grouping and sharing with such individuals information disorders that appeals to them (Calvo et al., 2022; Filkuková & Langguth, 2021; Kopinec, 2020; Kušnířová & Kačmár, 2022; Čavojová et al., 2022; Neszméry, 2019).

Conclusion

We concluded that the three elements of information disorders that we examined in this review, i.e., agents (i.e., source), message, and recipients, use various mechanisms to influence people towards vaccine hesitancy. Thus, disrupting how their mechanisms functions can have positive outcome on lowering the levels of vaccine hesitancy. Some of the strategies that may be used in disrupting them include creating tough conditions for the agents of information disorders, heavily fining platforms that host information disorders, and empowering recipients with scientific knowledge on pandemics.

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