An Exploratory Study of a Theory-Based Comic Strip to Counteract Misinformation About Covid-19 Vaccine Among Adult Social Media Users in the United States.

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Abstract

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The outbreak of the COVID-19 pandemic found a fertile ground for the spread of online misinformation, with emphasis on social media. Avoiding misinformation spread requires rapid, engaging, and effective science communication in a clear, easy-to-understand, attractive, and entertaining format that can be readily shared online. Comics fulfill these characteristics, being a promising tool to fight misinformation on social media.

The goals of this study were: 1) Develop a novel narrative comic strip to promote recognition of misinformation about the COVID-19 vaccine among adult social media users (ages 18-65) based in the United States, drawing on the existing research on the Health Belief Model and Theory of Planned Behavior; 2.) Compare the comic strip evaluation and capacity to influence misinformation identification to those of an educational text about COVID-19 vaccination. 3a) Evaluate differences in the key outcomes (misinformation identification, and attractiveness, trust, perceived usefulness, willingness to share, and acceptance of each educational tool) across participants with varying demographic characteristics, health literacy levels, COVID-19 vaccination history, and demographic characteristics. 3b) Across the entire sample, evaluate the correlation between these constructs and health literacy, digital health literacy, vaccine attitudes, trust in science and health authorities, and social media use.

Participants (N = 285) were recruited via social media advertisements and randomly assigned to the comic strip group (CS) (N = 92), educational text (TX) (N = 96), or a control

group (CL) (N = 97), which had not read any educational material. An online survey accessed the main outcomes (misinformation about the COVID-19 vaccines, evaluation of the educational tool (attractiveness, trust, perceived usefulness, willingness to share, and acceptance of the educational material). Participants also answered demographics questionnaires, COVID-19 vaccine concerns scale, and questionnaires on Health literacy, eHealth literacy, social media use, trust in health authorities and scientists, and COVID-19 vaccination history. Group CS answered questions regarding transportation into the narrative. There were no differences in misinformation identification between groups, possibly explained by a low sensibility of the misinformation identification instrument, timing of the data collection, and sensitiveness of the vaccination topic, subject to accrued attitudes, such as believing in misinformation. Participants with lower health literacy in group TX scored less on the misinformation identification questionnaire than those with higher literacy, which was not observed in the CS group, indicating that the comic strip may benefit better individuals with low health literacy. Vaccine hesitant/ refusers' misinformation identification scores seem to have been benefited by the comic strip. The comic strip was better evaluated for trust in its content and acceptance than the educational text. Still, misinformation identification scores were not correlated to any evaluation construct in both groups CS and TX. Transportation into the narrative was positively correlated with all comic strip evaluation constructs but not with the misinformation identification score.

Future studies should focus on exploring different styles and sizes of comic strips, using a more heterogenous sample and addressing different health topics.

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Dedication

This dissertation is dedicated to my daughter Liz, who in the last years has often been deprived of my attention and time, but who has never been and never will be deprived of my infinite and deep love.

Chapter 1: Introduction

In late 2019 and early 2020, the world watched the outbreak of a new disease in China caused by a coronavirus, later called SARS-CoV-2. Its name refers to a severe acute respiratory syndrome caused by a coronavirus 2. In less than three months, the epidemic, initially restricted to the Asian country, spread quickly to dozens of other nations resulting in an outbreak that is still ongoing. As a result, on January 30, 2020, the World Health Organization declared the outbreak a Public Emergency of International Concern, and on March 11, 2020, it was declared a pandemic (World Health Organization, 2021a).

The disease caused by SARS-CoV-2 was named COVID-19. According to the World Health Organization (2021b), its symptoms include fever, cough, tiredness, loss of taste or smell (the most common ones); sore throat, headache, aches and pains, diarrhea, rash on the skin, discoloration of fingers or toes, red or irritated eyes (less common ones), and difficulty breathing or shortness of breath, loss of speech or mobility, confusion, and chest pain (the more severe symptoms).

According to the Coronavirus Resource Center from the Johns Hopkins University (Johns Hopkins University, n.d.), as of May 2022, the number of confirmed cases of COVID-19 worldwide since the beginning of the pandemic was higher than 500 million, with over 6 million deaths, more than 900,000 of which were just in the United States. However, the World Health Organization (2022c) reported that the death toll caused directly and indirectly by COVID-19 might be much higher, almost 15 million, when considering the global excess mortality between January 1, 2020, and December 31, 2021.

The impact on health systems was tremendous. In some countries, the population suffered from a lack of hospital beds, medical staff, supplies, medicines, and even oxygen for the most

severe cases, and there was even a funeral crisis, with insufficient staff to bury the deceased as fast as the death rate. In some cases, refrigerated trucks had to be used to transport the high number of bodies, and funerals had to be held without the presence of family and friends. In addition, lockdowns, quarantines, and travel bans were implemented to avoid spreading the disease. Fear and anxiety reached significant levels (Horesh & Brown, 2020), and the emotional, financial, and social toll was tremendous, with no precedent in the world's recent history.

Infodemic, Misinformation, Disinformation, and "Fake News"

Under the impact of feelings of uncertainty, confusion, worry, anxiety, and fear, there has been a worldwide search for information about medicines, treatments, infection avoidance, vaccines, and their safety. The World Health Organization and the United Nations called the overabundance of health information an "infodemic," which includes misleading and false information (World Health Organization, n.d). For example, on May 6, 2022, a Google search for the term "coronavirus" generated over 4 billion results. The current excess of information has no precedent since COVID-19 is the first pandemic in the era of the internet and social media, the primary vehicles of information spread. At the outset of the outbreak, a void in information due to the lack of scientific data about the new virus provided a fertile ground for misinformation. According to the World Health Organization (n.d.), a massive spread of misinformation may give rise to confusion and risky health behaviors beyond mistrust of health authorities' recommendations, which may increase the duration of the disease outbreak.

The spread of misinformation is not a new phenomenon that emerged with the COVID-19 pandemic, though. In fact, it was already an issue of concern before the emergence of the pandemic. For instance, in 2019, the United Nations Educational, Scientific and Cultural Organization (UNESCO) launched the book, "Journalism, 'Fake News' and Disinformation: A

Handbook for Journalism Education and Training" (Ireton & Posetti, 2019) to prepare journalists to hinder and counteract the spread of false or inaccurate information.

Under the umbrella term of *misinformation* some authors differentiate between what is considered misinformation and disinformation (Ireton & Posetti, 2019; O'Connor & Murphy, 2020; Office of the Surgeon General, 2021) as follows:

- *Misinformation* is false or inaccurate information without the deliberate intention of causing harm.
- *Disinformation* refers to information that is false and deliberately created to deceive, usually with the intention of gaining financial or political advantage.

According to Greene and Murphy (2021), misinformation and disinformation may overlap in practice: inaccurate information may at first be spread with the intention to cause harm (disinformation), afterward being shared innocently by people unaware of the original mal-intentions. It may also be hard to differentiate between them because intentionality needs to be determined (Greenspan & Loftus, 2020).

With less definition consensus, mal-information may be considered genuine information, based on reality, that is spread with the intention to cause harm to a person, social group, organization, or country (Ireton & Posetti, 2019; Shu et al., 2020).

So-called *fake news* is considered a type of disinformation, disguised as truth, created not just to deceive but mainly inflict harm on a person, social group, organization, or country, usually intending to get some advantage (Hartley & Vu, 2020; Shu et al., 2020). "Fake news" masquerades as a journalistic article and is a potent disinformation source (Bastick, 2021).

There is no consensus about which term would encompass the others. Greene and Murphy (2021), for example, use the term "fake news" as a catch-all term to describe inaccurate

information, whether it is misinformation or disinformation. However, following the most common nomenclature and classification, the term "misinformation" will be used in this dissertation to refer to all groups of misleading information described above (misinformation, disinformation, mal-information, and "fake news"), unless otherwise differentiated from the other terms. Misleading information may also be used synonymously with misinformation (in its broad conception, which includes all kinds of false information).

Misinformation related to COVID-19 covers a wide range of subjects: ways of infection and how to prevent it, treatments, vaccines, diagnostic tests, the origin of the virus, conspiracy theories, and pseudoscientific theories, among many others, thus making it hard for lay people to make informed health-related decisions (Naeem et al., 2021). In an attempt to clarify this misinformation, the World Health Organization website page about COVID-19 offers a session called "MythBusters," where it busts the more common myths (World Health Organization, 2022a).

COVID-19 misinformation is a pandemic itself. Studies from many different countries have explored this issue since the onset of the outbreak: the United Kingdom (UK), Ireland, United States (USA), Spain, and Mexico (Roozenbeek et al., 2020), UK and USA (Loomba et al., 2021); Australia (Martire et al., 2020; Saling et al. 2021), Korea (Lee et al., 2020), Lebanon (Kouzy et al., 2020), Bangladesh (Barua et al., 2020), and Norway (Filkukova et al., 2021), among many others. Therefore, misinformation about COVID-19 is a global problem with global consequences.

The spread of misinformation about COVID-19 presents a tremendous public health obstacle, with impacts on beliefs and attitudes toward safety measures to avoid contagion, among them the vaccination (Karabela et al., 2021), the most effective collective intervention to curb the

pandemic (Randolph & Barreiro, 2020). This scenario has created an unparalleled urge for effective and rapid science communication that could surpass or mitigate the spread of misinformation (Kearns & Kearns, 2020).

Sources and Spread of Misinformation

Traditional media such as TV, radio, and printed media like newspapers and magazines may convey misleading and inaccurate information about COVID-19. However, the internet, especially social media, has been the primary vehicle for disseminating misinformation at a speed never seen before, potentially reaching thousands, or even millions, of people. For example, Li et al. (2020) found that over one-quarter of the YouTube videos on COVID-19 conveyed misleading information and were seen by more than 60 million times. Another study that analyzed 1,225 misinformation claims about COVID-19 in the United States conveyed between 1 January 2020 and 30 April 2020 found that social media was responsible for the spread of half of them. The other half was disseminated by individuals, websites, newspapers, and tabloids (Naeem et al., 2021).

The usual sources of misleading online information are politicians, celebrities, public figures, the so-called "digital influencers," and the general public (Naeem et al., 2021). Most of these are not usually experts or authorities on medicine or public health but participate actively in developing and spreading false information that can be conveyed with no filters or fact-checking, not to mention misinformation based on conspiracy theories. As stated by Harnett (2020), virtually anyone can be a content creator on social media platforms, such as Facebook, Instagram, Twitter, and YouTube, and their questionable information can reach, directly and indirectly, millions of viewers.

According to Ireton and Posetti (2019), “disinformation is an old story, fueled by new technology” (p. 15). In other words, misinformation is not a new phenomenon, but in this digital era, the spread of misinformation has, indeed, a powerful booster. While traditional media are not exempt from spreading misinformation, journalists usually have training and instruction in fact-checking information, besides upholding, at least theoretically, a professional standard of ethics, which often is not true for social media users.

Counteracting Misinformation on Social Media

Recent literature on approaches to combat online misinformation has highlighted some strategies, which vary on complexity and coverage:

Fact-Checking Tools and Blocking of Social Media Profiles That Promote Misinformation

The first-line barrier to the online spread of misinformation in social media is blocking profiles that convey the misinformation, as well as creating tools to prevent the action of bots, shown to be responsible for the dissemination of 42% of the misinformation via social media (Foundazione Bruno Kessler, 2020). The major social media platforms took measures to mitigate the spread of misleading information regarding the pandemic, not just blocking it but also issuing warnings on potentially harmful content (Romer & Jamieson, 2020).

In turn, fact-checking refers to determining whether information actually exists or is true. That can be done independently by users, with search tools to get more information about a specific topic (Fondazione Bruno Kessler, 2020; Yu & Shen, 2021), but some websites specialize in verifying common information and making this verification available to the public, like FactCheck.org from the Annenberg Public Center of the University of Pennsylvania.

Recently, governmental agencies worldwide have promoted partnerships with social media giants (e.g., Google, Facebook, Instagram, Weibo, and WeChat) to flag, fact-check, and

eliminate misinformation (Chong et al., 2020). The video-sharing platform YouTube, for example, has launched COVID-19 alerts and has also blocked several channels of conspiracy theories (Naeem et al., 2021).

Unfortunately, according to Agley et al. (2021), preparing and disseminating misinformation takes much less time and effort than debunking it, and the time lag between the release of the misinformation and its detection, correction, and removal may allow it to reach thousands of people and even become "viral." In other words, it becomes repeatedly shared thousands (sometimes millions) of times, massively and quickly (Jamieson, 2021).

Moreover, solutions relying solely on debunking false information are insufficient because many other factors lead to the acceptance and sharing of misinformation, like emotions, distrust in government and health institutions, cognitive biases, racism, and xenophobia—factors that can hinder future attempts at correction (Chou et al., 2021). In addition, a study by Yu and Shen (2021) showed a negative association between the fact-checking habit and COVID-19 knowledge, an effect moderated by scientific knowledge. According to their conclusions, it may be difficult for people with poor scientific knowledge to find and discern good quality information when checking facts. This shows the importance of promoting basic science and health literacy.

Spread of Evidence-Based and Accurate Information and Increase of Trust in Science

According to Pennycook and Rand (2021), prior knowledge is an important factor when people try to determine the veracity of misinformation. Basic science knowledge is positively associated with the correct identification of misinformation about COVID-19 (Pennycook et al., 2020).

Misleading information is disseminated more quickly when accurate information is slow and scarce (Bin Naeem & Kamel Boulos, 2021). According to Wardle (2020), to fight misinformation, it is necessary to "swamp the landscape with accurate information." Effective health communication is crucial to speed up the availability of accurate information. Repeated exposure to accurate information prevents people from believing and sharing misleading information, but it would also help them make informed health decisions, such as opting to be vaccinated against COVID-19 (Naeem et al., 2021).

According to Kearns and Kearns (2020), the engagement of scientists in science communication is necessary to combat the intentional spread of inaccurate information. Roozenbeek et al. (2020) have shown that the higher the trust in scientists, the lower the susceptibility to believe and share misinformation on social media. That indicates the potential and importance of communicating scientific research in a clear, accessible way.

Jamieson et al. (2019) highlight that the general public's trust in science relies on researchers following norms like making their data and methods available and transparent and disclosing funding sources. Moreover, scientists should communicate these practices' value and clarify how their research is designed, applied, and analyzed. Failure to explain the typical uncertainties inherent in the production of scientific knowledge may give space to distrust—even conspiracy theories—and loss of confidence In official health organizations (Lee & Morling, 2021). According to Chou et al. (2021), educating the public about the scientific process could help them identify and reject spurious causal associations, which are very common in misinformation.

Improvement of Users' Health Literacy, Digital Health Literacy (eHealth Literacy), and Numeracy

Focused initially on functional literacy (the ability to read and understand medical information), health literacy's definition has broadened to include more complex abilities, including access to information and the understanding, appraisal, and application of knowledge (Funnell et al., 1991).

According to the WHO (WHO, Regional Office for South-East, 2015), health literacy refers to "the personal characteristics and social resources needed for individuals and communities to access, understand, appraise and use information and services to make decisions about health" (Information sheet 1). Health literacy is crucial for successful information seeking (Manganello et al., 2017) and is essential to empower and engage individuals in a person-centered care model (Parnell et al., 2019). A systematic review by Berkman et al. (2011) found that low health literacy is consistently associated with poor health outcomes, hospitalizations, and higher mortality rates.

Individuals and groups with low health literacy are more susceptible to online misinformation, especially via social media (Harnett, 2020). According to Smith and Magnani (2019), people with low health literacy are also predisposed to have low digital health literacy (also called eHealth literacy). Digital health literacy refers to "the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem" (Norman & Skinner, 2006, p. 2).

A study by Paige et al. (2017) showed that, in a sample of African Americans, having high digital heath literacy was associated with high perceived trust in online government sources. On the other hand, having low digital health literacy was associated with high perceived trust in

Facebook and Twitter social media platforms. In other words, there seems to be a tendency of people with lower digital health literacy to place greater trust in social media platforms—sources known to be flooded with misinformation—than in government sources, which may not be exempt from conveying inaccurate information, but at least are more frequently under the scrutiny of health organizations and experts.

Finally, health numeracy is defined as "the degree to which individuals have the capacity to access, process, interpret, communicate, and act on numerical, quantitative, graphical, biostatistical, and probabilistic health information needed to make effective health decisions" (Golbeck et al., 2005, p. 375). Although results from studies about the relationship between numeracy and health outcomes are inconsistent (Berkman et al., 2011), lower numeracy is associated with higher susceptibility to misinformation (Roozenbeek et al., 2020). For instance, a poor understanding of statistical data may result in a lower ability to discern accurate from misleading information about epidemiologic or scientific findings. So, increasing users' numeracy may increase their capacity to understand and apply numeric-related concepts, like risk, probabilities, efficacy, etc., to interpret health information.

Using a Neutral, Non-Judgmental Language

According to Stolle et al. (2020), demonstrating that arguments in defense of misinformation are biased or distorted may help reveal their inaccuracy, helping denialists realize they are not considering all the evidence but only one side of it. However, misinformed people may also resist consideration of others' attempts to correct them to avoid admitting they are wrong. Therefore, non-judgmental and neutral language should be used to open doors for discussion with skeptical people, avoiding defensive attitudes (Schulz & Nakamoto, 2022).

Use Clear, Quick, Attractive, and Entertaining Formats that Can Be Easily and Readily Shared

Avoiding the spread of misinformation requires "rapid and effective science communication that is able to engage the global public in mass-scale behavioral change" (Kearns & Kearns, 2020, p.1). To reach that, digital media are the best choice due to their fast and broad reach, as seen during the COVID-19 pandemic. Considering that repetition seems to increase the probability of believing (Pennycook et al., 2018) and sharing misinformation (Effron & Raj, 2020), the other way around may also be the truth: a strategy that stimulates sharing accurate information may have the power of repeatedly exposing people to reliable information, increasing familiarity with and memory of it. Among the formats to do that, there are texts, infographics, comics, videos, slide presentations, etc., using different genres (educational, documentary, narrative, etc.).

According to Yeo and McKasy (2021), when facing an overload of information online, users commonly adopt heuristics to help them make sense of it. For instance, being attracted to and driven to believe in emotional-packed information is a frequent shortcut. Misinformation usually embraces this strategy while, on the other hand, science communication is usually considered "cold" and "unemotional." So, using emotions and even humor to communicate science and promote health education may influence health-related behaviors and attitudes (Yeo & McKasy, 2021).

According to Wardle (2020), one of the best ways to fight online misinformation is finding ways and formats to spread accurate information that are easy to understand and accept, engaging, and easily shared on mobile devices while answering people's questions and fears.

Comics are a format that may encompass many of these strategies above and provide a promising tool to fight misinformation on social media.

Use of Comics to Counteract Misinformation about the COVID-19 Pandemic

Traditionally, comics have responded in bold and provocative ways to pandemics and catastrophes, educating and documenting the way we deal with such crises. Still, they may serve to criticize the way authorities respond or deal with such events (Saji et al., 2021). Yet, comics may also serve well as a format to convey information and counteract misinformation due to characteristics as simplicity, attractiveness, identification of the readers with the characters, emotional engagement, readers' control of the pace of information introduction, the combination of visual and text information that may improve comprehension and retention (supported by the Dual Coding theory), the potential to improve health literacy and reach individuals with low literacy, among others (Kearns & Kearns, 2020). Furthermore, comics can be easily and quickly shared on social media, which may promote mass dissemination of the information (Kearns & Kearns, 2020).

Several studies have shown positive results with the use of comics for health education purposes (Criado et al., 2018; Czerwiek, 2018; Dandolini et al., 2012; Furuno & Sasajima, 2015; Jacoby et al., 2015; Katz et al., 2014; Kearns & Kearns, 2020; Kilanowski, 2013, 2020; Ko et al., 2018; Kraft et al., 2017; Leiner et al., 2018; Leung et al., 2014; Liebman et al., 2007; Matsuzono et al., 2015; Mendelson et al., 2017; Mold & Elizabeth, 2019; Montgomery et al., 2012; Nsangi et al., 2020; Prokhorov et al., 2013; Rosas-Blum et al., 2018; Shimazaki et al., 2018; Sinha et al., 2011; Squier, 2018; Sridhar et al., 2019; Stothard et al., 2016; Tarver et al., 2016; Tekle-Haimanot et al., 2016; Wang et al., 2018).

However, many of these studies do not provide objective measures of value, have low power, are poorly designed, or use additional educational strategies beyond comics (Kearns et al., 2021). Furthermore, there are virtually no studies about comics' effectiveness in fighting misinformation about COVID-19. Although the internet and social media have been the main vehicles for disseminating misinformation, no objective studies have been conducted about the use of comics on social media to counteract misinformation.

Kearns and Kearns (2020) describe many positive aspects of using comics in public health communication during the pandemic, including many graphic examples of comics that have already been made on the subject. In addition, they highlight the fact that much scientific jargon, for example, “social distancing” and “flattening the epidemiological curve,” became clearer through the use of comics and cartoons. Still, objective studies about these comics’ effectiveness have not been conducted.

As mentioned before, people usually do not like to be corrected and told what to think, so they may be reluctant to have accrued misinformation debunked, especially if it aligns with their beliefs, values, and worldview (Cacciatore, 2021). Comics may be a helpful tool to help one open their mind to other points of view and new ideas without direct confrontation.

Finally, comics are considered graphic narratives, and the power of narrative on persuasion has already been demonstrated. For nonexpert audiences, narratives are easier to understand and more engaging than traditional logical-scientific communication (Dahlstrom, 2014; Green, 2006). Misinformation has always taken advantage of narratives as an effective tool to persuade and proliferate. For instance, the anti-vaccine movement widely and successfully uses anecdotes that appeal to emotions (Kearns & Kearns, 2020). According to Zucker (2020), since emotions, especially fear, fuel misinformation spread, it may be hard to

fight it using just facts. Therefore, testing tools that also use emotional appeal to counteract misinformation may be promising, as in graphic narratives.

Despite all the potential of comics in health education and the fight against misinformation, virtually no studies using social media to convey comics with this purpose have been found. Most health education studies through comics have used traditional printed media, such as pamphlets and comic books, with limited reach and potential for wide information propagation. Most studies use longer comics, like books, and have not tested shorter forms of comics (comic strips) with a limited number of panels that could potentially communicate information faster. The literature on this subject disproportionally focuses on individuals with low literacy; however, the full potential of comics as a health education strategy for the general population has not been explored. Also, the literature lacks quantitative, objective measures regarding comics' effectivity, credibility, and acceptability. Few studies have compared comics to other strategies (such as plain text) or used theory-based comics. Further studies are also needed regarding graphic narratives as a persuasion strategy in health education. To fill these gaps in the literature, this project describes an exploratory evaluation of the potential of comics to fight misinformation among adult social media users.

Aims of the Study

1. Drawing on the existing research and on the Health Belief Model and Theory of Planned Behavior, develop a novel comic strip to promote recognition of misinformation about the COVID-19 vaccine among adult social media users (ages 18-65) based in the United States.
2. Compare differences in social media users' misinformation identification and trust, perceived usefulness, acceptance, and willingness to share an educational material

between participants who read the comic strip versus those who instead read an informative text about COVID-19 vaccination.

3a. Evaluate differences in the key outcomes (misinformation identification, and attractiveness, trust, perceived usefulness, willingness to share, and acceptance of each educational tool) across participants with varying demographic characteristics, health literacy levels, COVID-19 vaccination history, and demographic characteristics.

3b. Across the entire sample, evaluate the correlation between these constructs (misinformation identification, and attractiveness, trust, perceived usefulness, willingness to share, and acceptance of each educational tool)) and health literacy, digital health literacy, vaccine attitudes, trust in science and health authorities, and social media use.

Chapter 2: Literature Review

In December 2019, a novel coronavirus, later called SARS-CoV-2, surged in the city of Wuhan, China, and caused an outbreak of unusual viral pneumonia, with symptoms that included fever, cough, chest discomfort, and, in severe cases, dyspnea and bilateral lung infiltration (Hu et al., 2021). Most cases were linked to the Huanan Seafood Wholesale Market, a wet market in downtown Wuhan, which used to sell seafood and live animals (Hu et al., 2021). The new disease caused by this virus was COVID-19 (Hu et al., 2021).

Coronaviruses (CoV) are part of a diverse group of enveloped positive-sense single-stranded RNA viruses, the *Coronaviridae* family, that may infect mammals (including humans, livestock, and companion animals) and avian species (Harrison et al., 2020; V'Kovski et al., 2021). Coronaviruses of zoonotic origin have caused three large-scale outbreaks in the last 20 years: severe acute respiratory syndrome (SARS) in 2002, Middle Eastern respiratory syndrome (MERS) in 2012, and COVID-19 in 2019 (Harrison et al., 2020; Hu et al., 2021). Among these three, SARS had a much higher impact regarding the number of infected and deceased people and its geographical reach (Hu et al., 2021). The COVID-19 outbreak was declared a pandemic by the World Health Organization on March 8, 2020, and since then, it has reached virtually all countries in the world, causing more than 6 million deaths (World Health Organization, 2022d).

Coronaviruses usually cause mild to severe respiratory infections and enteric diseases in humans (Hu et al., 2021; V'Kovski et al., 2021). In the case of the SARS-CoV-2, whose primary tropism is the lungs (Harrison et al., 2020), the disease causes mainly respiratory system-related symptoms, like cough, loss of taste or smell, sore throat, difficulty of breathing or shortness of breath, and chest pain. Other symptoms include fever, tiredness, headache, body aches, diarrhea,

skin rash, discoloration of fingers or toes, red or irritated eyes, loss of speech or mobility, and confusion (World Health Organization, 2020).

As an airborne disease, COVID-19 is transmitted when infected individuals sneeze, cough, speak, sign, or breathe, spreading in the air small liquid particles that carry the virus reaching other people's respiratory tract (World Health Organization, 2020). According to the World Health Organization (2020), the main preventive behaviors are:

- Getting vaccinated
- Practicing social distance, keeping at least 1 meter apart from others
- Wearing a well-fitted mask
- Sanitizing hands frequently with soap and water or alcohol-based hand rub

Other ways to prevent COVID-19 include choosing open spaces over closed ones, ventilating indoor spaces well, covering the mouth and nose when coughing or sneezing, and self-isolating if not feeling well (World Health Organization, 2020).

Although older people and those with chronic diseases, such as cardiovascular disease, diabetes, chronic respiratory disease, or cancer, have a higher probability of developing more severe cases of the disease, requiring hospitalization and even respiratory support, people at any age or physical condition may become seriously ill (World Health Organization, 2020).

Treatments for COVID-19 have been developed since the onset of the pandemic. Severely ill patients benefit from oxygen or even more advanced respiratory support such as ventilation. In these severe cases, corticosteroids such as dexamethasone may reduce the recovery time of hospitalized patients (World Health Organization, 2021a). Although drugs like the antiviral remdesivir and antiretroviral lopinavir, chloroquine, and hydroxychloroquine (used to treat autoimmune conditions), and interferon have been postulated as medicines to treat

COVID-19, the World Health Organization's Solidarity Trial (Pan et al., 2021) concluded that these medicines have little or no effect on hospitalized patients with COVID-19.

Regarding using antibiotics to prevent or treat COVID-19, the World Health Organization (2021a) has categorically affirmed that antibiotics should be used only to treat secondary bacterial infections and not the SARS-Cov-2 disease alone since antibiotics do not work against viruses.

COVID-19 Vaccines

In response to the virus's rapid propagation, vaccines started to be developed in the first months of the pandemic. By the end of 2020, developed countries began to vaccinate their populations.

Vaccination is known as the best strategy to promote herd immunity in a population. According to Randolph and Barreiro (2020), herd immunity is the "indirect protection from infection conferred to susceptible individuals when a sufficiently large proportion of immune individuals exist in a population" (p. 738). However, in the case of COVID-19, the cost of trying to reach herd immunity without vaccination—by letting the population be freely infected and get natural immunity—is unacceptable due to its infection and mortality rates, which would result in even more millions of deaths that the ones seen so far (Randolph & Barreiro, 2020).

According to Randolph and Barreiro (2020), the herd immunity threshold for SARS-CoV-2 is approximately 67%, which means that when 67% of the population is immunized, the infection rate is expected to decline. However, it is important to highlight that if immunity is unevenly distributed in a population, clusters of vulnerable individuals and groups will form, even if the percentage of the immunized population exceeds the herd immunity threshold (Randolph & Barreiro, 2020). This way, health inequities add to vaccine hesitancy and refusal,

and vaccine misinformation may hinder mitigating the pandemic. Furthermore, the higher the virus circulates, the higher the risk of variants that may evade current vaccines (United Nations International Children's Emergency Fund, 2022).

The goal of all COVID-19 vaccines is to train the immune system to recognize the virus using different technologies:

1. Messenger RNA (mRNA): Vaccines using this technology contain the messenger ribonucleic acid (mRNA) encoding instructions to cells to produce the Spike protein of the SARS-Cov-2. The resulting immune response is the production of antibodies against these proteins. Since the virus uses Spike protein as a key to attach to and infect the cells, when a vaccinated person is exposed to the virus, antibodies will block its Spike proteins and prevent their entry into the cells and consequent infection. In addition, T-cells are also activated, preparing the immune system for future exposure to the virus. The vaccines in this category are Pfizer/BioNtech, Moderna, and CureVac (Agenzia Italiana del Farmaco, n.d.; Fiolet et al., 2022).
2. Non-replicant viral vector vaccines: Vaccines based on non-replicant viral vectors use a virus unable to replicate (called “vector”) to carry nucleic acid encoding the SARS-Cov-2 Spike protein, generating the production of antibodies by the immune system. Examples of vaccines that use this technology are the AstraZeneca/University of Oxford and Johnson & Johnson (Jansen) (Agenzia Italiana del Farmaco, n.d.; Fiolet et al., 2022).
3. Inactivated virus and protein subunit vaccines: Vaccines based on inactivated virus or protein subunit have been used for decades to immunize people against diseases like polio and influenza. Inactivated virus vaccines against COVID-19 contain a modified

version of the SARS-Cov-2 that cannot infect cells and replicate. Subunit vaccines are made of fragments of Spike proteins. Both cause an immune reaction in the immune system that produces antibodies against the virus (Centers for Disease Control and Prevention, 2022a). Examples of vaccines using inactivated viruses are Sinovac and Sinopharm, while Novavax and VECTOR are examples of subunit COVID-19 vaccines (Fiolet et al., 2022).

Concerns have been raised regarding the speed with which vaccines have reached the arms of the population, especially among those unfamiliar with the mandatory phases of medication and vaccine development and testing. Among those, vaccines were not sufficiently tested, and people would be “guinea pigs” inoculated with experimental vaccines. However, an unusual combination of factors allowed scientists to speed up vaccine development and production: scientists had available large samples of individuals in a scenario of massive virus transmission, ideal for vaccine population tests; obstacles for government funding for research and development were removed; there was an unprecedented collaboration among the scientific community; advances in the technology of the mRNA vaccines were already available, and the production of the vaccines occurred simultaneously with the clinical trials (United Nations International Children's Emergency Fund, 2022; World Health Organization, 2022b).

Before being approved by Food and Drug Administration (FDA), COVID-19 vaccines were submitted to a three-phase clinical development process, common to all other vaccines. Phase I tests safety, dosing, and immune response in a small group. If and only if the vaccine is proven safe in this sample, it goes to the next phase. Phase II tests safety and immune response in a larger sample of hundreds of people. When proven to be safe, Phase III assesses not just its safety but also its efficacy. This phase often includes tens of thousands of individuals. and

usually may take two to four years. Still, it could be accelerated in the case of the COVID-19 vaccine because trials were conducted in areas of high risk of infection (Centers for Disease Control and Prevention, n.d.-a; Johns Hopkins University, n.d.-b). This way, COVID-19 vaccines were proven safe and effective against SARS-Cov-2 infection, and even after the end of Phase III and approval of the vaccines, they are constantly monitored for adverse effects. In the United States, the Vaccine Adverse Event Reporting System (VAERS), co-sponsored by the FDA and the Centers for Disease Control and Prevention, collects and analyzes reports of adverse effects (n.d.- a).

A recent meta-analysis (Zheng et al., 2022), considering fully vaccinated samples, found that the general effectiveness of vaccines to avoid infection was 89.1%, to prevent hospitalization 97.2%, and to avoid death 99%. Despite high efficacy, breakthrough infections may still occur in people already vaccinated. However, when they happen, the chances of developing severe illness are much lower than for unvaccinated individuals (United Nations International Children's Emergency Fund, 2022).

The duration of the immunity provided by the vaccines is the object of ongoing research; however, it has been shown that most people have strong protection against more severe disease cases for at least six months. Therefore, boosters have been recommended after six to nine months of the second dose, especially for the most vulnerable, like the elderly (United Nations International Children's Emergency Fund, 2022).

In the United States, as of July 27, 2022, 67% of the population was fully vaccinated with two vaccine doses (or one, in the case of the single dose-Johnson & Johnson vaccine). However, for e who were eligible, only 48.3% had received a first booster, and less than 40% had taken a second booster. Among the eligible people for the first booster, Hispanic/Latino and Black are

the groups with the lower percentage of boosters received (41.44% and 44.2%, respectively) (CDC, 2022c).

According to the United Nations International Children's Emergency Fund (2022), mild-to-moderate side effects of vaccines are normal and even expected because they are a signal that the immune system is reacting. Among these side effects, the most common are arm soreness at the injection site, mild fever, fatigue, headache, muscle or joint aches, chills, and diarrhea (United Nations International Children's Emergency Fund, 2022). Serious adverse effects, like anaphylaxis and myocarditis, are rare, and the benefits enormously outweigh the risks (Fiolet et al., 2022).

Misinformation about COVID-19

As mentioned earlier, the COVID-19 pandemic resulted in the widespread, massive, and quick circulation of misinformation, negatively affecting people's knowledge, attitudes, and behaviors regarding preventing and treating SARS-CoV-2 infection. Such misleading information can potentially undermine the credibility of scientists and health experts (Hartley & Vu, 2020).

The *MythBusters* session from the World Health Organization website (2022a) clarifies the most common myths about the pandemic, usually spread as misinformation. Some examples of debunked misinformation are:

- Prolonged use of masks causes CO2 intoxication or oxygen deficiency.
- Hydroxychloroquine or chloroquine is a preventive treatment for COVID-19.
- Antibiotics can treat or prevent COVID-19.
- Drinking alcoholic beverages and eating garlic prevent COVID-19 infection.
- 5G mobile networks spread COVID-19.

- Spraying or introducing bleach or another disinfectant in the body will protect against COVID-19.
- COVID-19 is transmitted through houseflies and mosquito bites.
- Zinc and Vitamins D and C can cure COVID-19.
- Young people and children are not susceptible to COVID-19 infection.
- High temperatures over 25°C protect against COVID-19, and the virus cannot spread in hot and humid climates.

COVID-19 vaccine is a topic that generates its own flood of misinformation and will be approached further in this review.

A common type of misinformation about COVID-19 refers to conspiracy theories. For example, in a study about susceptibility to misinformation around the world, Roozenbeek et al. (2020) found that 22–23% of participants in the UK and the USA believe that the coronavirus was engineered in a laboratory in Wuhan, China, as a bioweapon, or to sabotage U.S industrial production and economy. In addition, it is worth noting that conspiracy theories regarding the virus's origins have resulted in xenophobia, stigmatization, and even physical and verbal abuse against the Asian American population in the United States (Geisterfer-Black et al., 2022).

An online survey conducted by Geldsetzer (2020) between February and March 2020 showed that 23.9% of the American participants considered it likely that SAR-CoV-2 is a bioweapon developed by a government or terrorist organization; 61% believed that the number of deaths in the United States by the end of 2020 would be less than 500, 43.5% believed that using a hand dryer, rinsing the nose with saline solution, taking antibiotics, and gargling mouthwash would be effective in preventing infection; and 25.6% considered avoiding eating in Chinese restaurants to prevent against COVID-19 infection.

Misinformation about the COVID-19 Vaccines

As the pandemic has advanced from 2020 through 2022, new misinformation has surged, especially after vaccine development and vaccination campaigns. Misleading information about vaccines, and consequent vaccine hesitancy or refusal, is not a novelty (Stolle et al., 2020), even with the scientific consensus that vaccination benefits vastly outweigh their risks. The anti-vaccine movement has gained extra fuel since the surge of the COVID-19 outbreak, and the internet and social media platforms are flooded with misinformation, as identified by the CDC (2022b), United Nations International Children's Emergency Fund (2021), and Kelen and Maragakis (2022):

- The ingredients of the vaccines are dangerous and may include aborted fetal cells and latex.
- Natural immunity after getting COVID-19 (natural infection) is better than that generated by the vaccine.
- COVID-19 vaccines cause variants.
- COVID-19 vaccines contain microchips.
- COVID-19 vaccines can alter people’s DNA.
- COVID-19 vaccines can make one sick with COVID-19.
- COVID-19 vaccines affect women’s fertility.
- People with solid immunity handle the illness without a problem and do not need vaccination.
- After getting the COVID-19 vaccine, there is no need to wear masks anymore.
- The side effects of the COVID-19 vaccine are dangerous.
- COVID-19 vaccines are experimental.

Misinformation, Vaccine Attitudes, Vaccine Hesitancy and Vaccine Refusal

Vaccines are one of the most important public health tools for hindering the spread of infectious diseases (Fridman et al., 2021). According to Brown and Benson (2022), vaccines are "the most successful public health achievement in the history of mankind" (p. 431), and the COVID-19 vaccine is "one of the greatest triumphs in the history of medicine" (p. 439). As previously mentioned, the efficacy and safety of COVID-19 vaccines have consistently been proven (Fiolet et al., 2022). Despite that, a rise in anti-vaccine attitudes has been observed throughout the pandemic. These attitudes refer to the set of emotions, beliefs, and behaviors a person holds consciously or unconsciously about vaccines.

Negative attitudes regarding vaccines, in general, are not a new phenomenon (Yaqub et al., 2014). An already classic example of public health consequences of misinformation was the unproven link between MMR (measles, mumps, rubella) vaccine and autism in the late 1990s. Although the study that purported the link was later retracted, it had already resulted in a decrease in immunization rates and greater measles outbreaks in many states (Office of the Surgeon General, 2021). Interestingly, compared to the U.S. and U.K., this effect was not noticeable in countries like Australia, where the media did not extensively and repeatedly expose parents of vaccine-eligible children to the misleading information (Leask et al., 2010), likely showing the power of misinformation on behavior.

In studies made during the first year of the current pandemic, when vaccines were still unavailable, intention to be vaccinated was negatively influenced by misinformation. For example, Loomba et al. (2021) showed in a randomized controlled trial that misinformation induced a decline of 6.4 percentage points in vaccination intention in an adult U.S. sample.

The World Health Organization Strategic Advisory Group of Experts (SAGE) on immunization defines vaccine hesitancy as the "delay in acceptance or refusal of vaccination despite the availability of vaccination services" (MacDonald, 2015, p. 4161). Also, SAGE highlights that vaccine hesitancy is complex and context-specific (MacDonald, 2015).

SAGE described attitudes toward vaccines as a *continuum* from total acceptance to total refusal, with vaccine-hesitant individuals in the middle of it. Vaccine-hesitant individuals may even be vaccinated, despite their resistance and negative attitudes regarding vaccines (Yaqub et al., 2014). Vaccine-hesitant groups are often called "wait-and-see" people because they usually consider taking the vaccine but may still wait to see its long-term effects (Brown & Benson, 2022). A large percentage of this group comprises Black and Hispanic individuals and young adults from 18 to 29 years old (Hamel et al., 2021).

On the extreme opposite side of vaccine acceptance are the "anti-vaxxers" that refuse vaccines in all forms. The percentage of this group in the U.S. population has been stable at around 15% since the Kaiser Family Foundation started its surveys on this topic (Hamel et al., 2021).

According to Jamieson et al. (2021), these anti-vaccine groups hold strong attitudes that are stable and resistant to change. According to Jamieson (2021), time and effort are better spent focusing on persuading those who are reluctant (vaccine-hesitant) than trying to convince people that have a mind closed to the discussion (the "anti-vaxxers").

Anti-vaccine groups are very active in spreading misinformation (Jamieson, 2021), which can negatively influence vaccine-hesitant individuals (Kennedy, 2020). Much of this misinformation is distributed via the internet and social media. Even before the COVID-19 pandemic, social media was already considered one of the major spreaders of misinformation

addressing vaccines in general (Larson, 2018). One of the most common claims against vaccines regards their safety and adverse reactions (Kennedy, 2020; Larson, 2018; Yaqub et al., 2014). In early December 2021, the Households Pulse Survey by the U.S. Census Bureau found that half of the unvaccinated adults reported concerns about vaccine side effects, and 42% said they did not trust the COVID-19 vaccine (Monte, 2021). These allegations were generated or reinforced by misinformation. Only 1.7% of the respondents reported that they did not have easy access to the vaccine.

Fiolet et al. (2022) found a negative trend in attitudes toward the vaccine in a longitudinal study using a U.S. sample from March to August 2020. However, further analysis showed that Republicans were the participants negatively driving the trend, compared to Democrats. Republicans also expressed a more significant decline in perceived COVID-19 threat over time, so the trend of negative vaccine attitudes among them makes sense when considering the opposite: high perceived risk regarding a disease has historically resulted in greater adherence to behaviors to mitigate it, including vaccination. In the study, both Republicans and Democrats identified Facebook and Instagram as their top four sources of information. As explained later, social media works as an echo chamber, where misinformation finds fertile ground to reach those who already share similar political or world views (Cinelli et al., 2021).

Misinformation and Its Influence on COVID-19 Preventive Behaviors

Misinformation can harm public health (Swire-Thompson & Lazer, 2020); however, the mechanisms, magnitude, and extent to which it can modify health behaviors are still unclear. According to Bastick (2021) and Greene and Murphy (2021), confounding variables (like political inclination), interaction influences, and social determinants of behavior make it difficult to affirm that rational processing of misinformation will predict and affect complex behaviors.

For instance, according to Montesi (2021), rational processing does not entirely explain how misinformation can influence health behaviors, while emotions may be better predictors than cognition and knowledge. In addition, emotional appeal frequently permeates misinformation, making it more likely to cause a behavioral change than the presentation of facts and statistics.

Risk perceptions may increase or decline according to emotional states and are influenced by the kind of information people get. According to the Health Belief Model (HBM), people's beliefs about their susceptibility to a particular health problem (perceived threat) and their perceptions about the efficacy and barriers of adopting preventive behaviors may predict their engagement with them. (Lee et al., 2020).

Many studies on the effects of misinformation on behavior evaluate behavior intentions rather than actual behaviors, as is the case with vaccination intentions, for example. Furthermore, these effects seem to be moderated by such characteristics as health literacy, eHealth literacy, and, very frequently, partisanship. In an attempt to quantify the impact of misinformation on health behaviors intentions, Greene and Murphy (2021) conducted a study in which participants were exposed to fake and accurate information about COVID-19 in the form of short news items. A single exposure to fake news had a small effect on some behavior intentions linked to the false information (like being less willing to take the vaccine after seeing negative information about it) but not on others (like intending to eat more spicy foods after reading the information that they avoid virus replication). Exposing the participants to a generic warning about fake news had no moderating effect on the behavior's intention after exposure to fake news. That led the authors to suggest that generic warnings about online misinformation, such as the ones flagged by social media platform moderators, are probably ineffective.

In turn, Roozenbeek et al. (2020) measured self-reported preventive behaviors to evaluate to what extent participants complied with public health recommendations regarding COVID-19 during the month preceding the survey. Overall, adherence to recommendations like washing hands, using hand sanitizer, wearing a face mask, etc., was negatively affected by susceptibility to misinformation.

Misinformation and Social Media: Susceptibility

In the last two decades, the importance and reach of the internet and social media have risen extraordinarily. According to the Pew Research Center (2021a), in early 2000, about half of American adults had access to the internet, while in 2021, this percentage hit 93%.

Social media platforms have over 3 billion users worldwide (Stellefson et al., 2020). In 2005, only 5% of American adults used at least one social media platform, while by 2021, this percentage was 72%, especially among those from 18 to 29 years old (84% using social media), but also almost half (45%) among those older than 65 years. In the United States, Hispanics use more social media (80%), followed by Blacks (77%) and Whites (69%). American women access more than men (78% vs. 66%), and those who have completed their college education or higher access more than people with some college or with high school or less (77%, 76%, and 64%, respectively) (Pew Research Center, 2021b). According to the same survey, YouTube is the most accessed social media platform by Americans (81%), followed by Facebook (69%), Instagram (40%), Pinterest (31%), LinkedIn (28%), Twitter (23%), WhatsApp (23%), TikTok (21%), and Reddit (18%). Of those, 70% access Facebook daily, followed by Instagram (59%), YouTube (54%), and Twitter (46%). Notably, the facility and practicality promoted by smartphones, owned by 85% of American adults, have leveraged social media access.

The prevalence of the internet as a health information source has been rising yearly; in 2008, 61.2% of the American population used it on their most recent search, a percentage that rose to 74.4% by 2017. During the COVID-19 pandemic, social media became a major tool for seeking and sharing information, with a worldwide increase in users ranging from 20% to 87% (Naeem et al., 2021). With billions of people submitting to periods of lockdown, quarantine, and self-imposed social isolation, digital technologies have become the primary information-sharing vehicle (Pan American Health Organization, 2020).

Availability, convenience, wide coverage, affordability, interactivity, and anonymity are some characteristics of social media that make it so popular (Jia et al., 2021). However, usually not submitted to authority filters (Harnett, 2020) and professional verification or review (Lee et al., 2020), social media platforms potentially widespread misinformation. On top of that, the impact of anxiety and fear related to COVID-19 has made people frequently believe and share information without questioning its veracity (Biradar et al., 2022) - especially true for people with low literacy.

Role of Literacy, Health Literacy, and Digital Health Literacy

There are concerns regarding the ability of people with lower health literacy to discriminate between information and opinion, rumor and fact on social media (Harnett, 2020). Individuals with lower health literacy tend to rely more on information received through social media than from health authorities' websites (Paige et al., 2017) or mass media (Cheng & Nishikawa, 2022). For these authors, it is reasonable to hypothesize that the widespread use of the internet to access health information may be more harmful than helpful.

Literacy in general and health literacy are not the same but linked (Centers for Disease Control and Prevention, n.d.-b), since literacy skills, like reading and understanding texts, are

necessary to comprehend health-related information (Liu et al., 2020). Manganello et al. (2017) found that people with lower health literacy are more likely to seek health information from social media and prefer text messages due to using less complex language. Social media posts also have more appealing readability for those with lower health literacy. According to Chen et al. (2018), celebrities' websites and social media accounts usually use shorter, more palatable, and easier-to-read texts than scientific and medical sources. Twitter, for example, limits the length of the texts by the number of characters, which, according to Hoedebecke et al. (2017), may be more appealing to people with low literacy. Still, an analysis of Twitter posts showed that 33% are written at the 4th-grade level (Johnson, 2014), as opposed to tweets from health and science organizations that reach a mean of 9.45th-grade level (Hoedebecke et al., 2017). In contrast, the National Institutes of Health (NIH) recommend that the readability of health communication texts ranges from 6th to 7th-grade level (Hutchinson et al., 2016). Therefore, it is understandable why people with lower literacy tend to rely on social media as a source of health information, unfortunately becoming more susceptible to inaccurate and misleading information (Cheng & Nishikawa, 2022).

A study by Patil et al. (2021) with U.S. college students showed that 51% had low health literacy and were twice as likely to use social media than those with higher health literacy.

Individuals with lower health literacy also rely more on family and friends as information sources (Manganello et al., 2017). As Harnett (2020) pointed out, a social media network is considered by many as an extended community of family and friends, creating a sense of belonging, which Ventriglio and Bhugra (2017) relate to the capacity of these network users to influence and be influenced by others.

Increasing health literacy and digital health literacy is critical to promoting safe and effective internet use to get trustful health information, highlighting the information from scientific and public health authorities, organizations, and institutions.

The Role of Trust in Science

Beyond health literacy and digital health literacy, trust in science seems to be an antidote against misinformation. Roozenbeek et al. (2020) found that trust in scientists was associated with lower susceptibility to COVID-19 misinformation in a study that included samples from the U.S., U.K., Spain, and Mexico. Agley and Xiao (2021) showed that low trust in science was a strong predictor of believing in misinformation related to the pandemic, such as "Bill Gates caused the spread of COVID-19 to expand his vaccination programs," "COVID-19 was developed as a military weapon (by China, the United States, or some other country)," and "COVID-19 is no more dangerous than the flu, but the risks have been exaggerated as a way to restrict liberties in the United States."

People not acquainted with scientific epistemology have lower trust in science due to difficulties discerning probabilities from certainties and understanding the steps of scientific research and how scientific evidence is built (Nadelson et al., 2014). In a situation like the current pandemic, when scientists face a new and unknown pathogen, public health recommendations based on scientific studies about best preventive practices and treatments are updated as new evidence emerges. These uncertainties and the perception that scientist "change their mind all the time" may confound the lay public, cause mistrust in science and health authorities, and encourage people to fill knowledge gaps with misleading information (Jamieson, 2021). According to Agley and Xiao (2021), improving trust in science is prophylaxis against COVID-19 misinformation.

Trust in science may be influenced by personal worldviews, such as political partisanship and religiosity, with people with more conservative orientations and higher religious commitments showing lower trust in science (Agley, 2020).

The Role of World View and Political Partisanship

Although health literacy and science knowledge play an essential role in the vulnerability to misinformation, one's worldview may override them as a predictor of a person's beliefs (Lewandowsky & Oberauer, 2021). Studies have also shown that the more misinformation is aligned with people's preexisting attitudes and beliefs, the more susceptible they are to them (Greenspan & Loftus, 2020). In other words, people tend to believe in misinformation consistent with their worldviews (Scherer & Pennycook, 2020).

Chan et al. (2017) found that debunking misinformation is especially difficult when people have accrued persistent, inaccurate beliefs due to particular world views. Moreover, these beliefs tend to be even more persistent when they support pre-existing ones or increase the coherence of previous misleading narratives. In this case, even retraction may be unable to debunk misinformation because it is hard to detach it from one's worldview (Schulz & Nakamoto, 2022).

These beliefs are reinforced by selective exposure to misinformation imposed by social media algorithms. Algorithms may select the contents a person is exposed to according to their worldview indicated by previous searches and views and limit the exposure to different perspectives, creating echo chambers (Cinelli et al., 2021). According to the *Oxford Learner's Dictionaries* (n.d.), an echo chamber is "an environment in which a person encounters only beliefs or opinions that coincide with their own so that their existing views are reinforced, and alternative ideas are not considered."

Among individuals' world views, political partisanship in the U.S. plays a dominant role in the vulnerability to misinformation (Pennycook & Rand, 2021). According to Geisterfer-Black et al. (2022), individuals and groups may be united by political affiliation, resulting in political polarization. This phenomenon has intensified in the U.S. over the last three decades. In the context of the pandemic, groups more inclined to embrace an extreme, rightwing conservative political affiliation tend to trust science less and believe and share more misinformation provided by their political leaders, like the effectiveness of hydroxychloroquine to treat COVID-19 infection, a treatment without scientific support, though.

The Role of Trust in Public Health Authorities, Organizations, and Institutions

Despite the relationship between social media use and vulnerability to misinformation, some studies have shown that using social media platforms may promote the adoption of preventive measures against COVID-19 when the information sources are public health organizations and health authorities (Montesi, 2021). The public's trust in health authorities' recommendations is crucial for mitigating pandemics. In the case of COVID-19, this is reflected in the higher adoption of preventive behaviors, like wearing masks and practicing social distancing (Williams et al., 2021).

Karabela et al. (2021) have also found a moderate relation between willingness to get the COVID-19 vaccine and institutional trust. Notably, most people that stated they would be vaccinated showed no confidence in social media. Additionally, social media was the most trusted source of information for those who said they were undecided about being vaccinated (vaccine-hesitant). That may indicate the potential of using social media by health organizations and government institutions to reach both those who trust official sources and those who trust social media. Lee et al. (2020) emphasize that governments, health agencies, and researchers

should take advantage of social media, investing in information formats that are effective, palatable, and easy to share via social media. Eckert et al. (2018) point out that social media must be incorporated as a routine communication strategy of governmental agencies to create familiarity among users even before health-related crises happen.

Trust in institutions is an issue among underserved communities and people of color, predominantly Black and Native American groups, which experienced the highest COVID-19 death rates in the U.S. (Gawthrop, 2022). Compared to non-Hispanic white people, Black individuals are more likely to be infected and die from COVID-19 (Best et al., 2021). These groups have also been the most socially and economically affected by the pandemic (Jungkunz, 2021). These health and social inequities have pushed them to distrust the system that should be protecting them (Geisterfer-Black et al., 2022). Possibly aggravating this scenario, underprivileged communities, such as Hispanic and Black groups, have a high percentage of social media users (80% and 77%, respectively) (Pew Research Center, 2021b). As a result, they may be at greater risk of accessing misinformation, mainly because their search for health information may be impaired by lower trust in the institutions that convey the more scientifically reliable recommendations.

The Role of Exposure and Repetition

There is consistent evidence that the more people access social media, the more they are exposed to misinformation (Lee et al., 2020), which, according to Ecker et al. (2015), may influence memory and inferential understanding. Continued exposure to the same misinformation may increase familiarity with it. Even a single exposure to misinformation increases one's belief in it when later exposed to the same misinformation (Pennycook et al., 2018). So, attempts to retract false information may also find barriers due to familiarity.

According to Cacciatore (2021), retraction of misinformation usually starts by recalling it, which may inadvertently increase its strength and familiarity.

Finally, repeated exposure increases the probability of believing and sharing misinformation. Therefore, people may feel less unethical sharing information when exposed to it many times, even when it seems false (Effron & Raj, 2020).

The Role of Emotions

As mentioned previously, low trust in science is an essential predictor of vulnerability to misinformation, and increasing health literacy may support a better understanding of scientific processes. However, trust is multifaceted, and besides cognition and rationality, emotions and feelings also play a significant role in it. For instance, a study by Martel et al. (2020) found a correlation between reliance on emotion and belief in fake news. In a real-life example, people afraid of the deleterious effects of vaccines, like their (unproven) link to autism, base their concerns on emotions, like fear, which will hinder breaking mistrust of the scientific community (Nadelson et al., 2014).

As mentioned, many people consider the social media network an extension of their families and friends, creating a sense of support and belonging that brings a safety sensation (Harnett, 2020). Montesi (2021) highlights that social interactions, including social media, emotional support, and sharing of personal experiences, permeate the exchange of information. Experiential knowledge fills the information gaps in situations of uncertainty, as has been the case of the pandemic, especially in its first year. Rationality may fail when people are emotionally charged, and that may predispose them to misinformation. For example, in a sample of American internet users, Martel et al. (2020) found correlational and causal evidence that reliance on emotions increased belief in fake (but not actual) news.

The Role of Demographics

There is still no clear and consistent demographic profile of those who believe and share health misinformation. Associations between susceptibility to misinformation and demographics like age, gender, and race seem to be influenced by other already mentioned factors, like health literacy and digital health literacy, patterns of social media use, trust in science and public health authorities, world view and partisanship, and exposure to misleading information.

At least in the political field, some trends have been observed. For example, during the 2016 U.S. election, older adults (over 65 years old) and more politically conservative users were shown to be more prone to fake news sharing. According to Brashier and Schacter (2020), this tendency cannot be fully explained by cognitive declines due to aging; older adults probably lack digital literacy more than younger adults, making it harder to identify misinformation. Also, older adults use social media more for social purposes than for getting information, so accuracy is not a strong concern (Brashier & Schacter, 2020). On the other hand, a study by Roozenbeek et al. (2020) showed that being older was a predictor of lower susceptibility to misinformation regarding COVID-19. However, the authors highlight that the pandemic is a different context. Older adults are more susceptible to more severe cases of the disease, so motivations, emotions, and other factors may interfere with the belief in and sharing of online misinformation. Because of inconsistencies like this, Scherer and Pennycook (2020) raise the question of whether vulnerability to misinformation is a generalized trait or content-dependent (i.e., politics vs. health).

Use of Narratives for Both Spreading and Counteracting Misinformation

According to Sampathirao (2016), narratives and storytelling have been used to transmit knowledge as an ancient human tradition, and our brains are wired to respond to them. While

storytelling was made mainly face-to-face in the past, nowadays it can be done in several different media and formats, such as books, videos, audio, comics, text messages, social media posts, and countless other forms of human communication.

The terms "storytelling" and "narrative" are usually used interchangeably, and definitions of both have been a theme of discussion (Wiatr, 2020). Storytelling is basically what one will tell; narrative refers to how the story is told, not the story itself. According to the *Merriam-Webster Dictionary* (n.d), a story is "an account of incidents or events" while a narrative is "a way of presenting or understanding a situation or series of events that reflects and promotes a particular point of view or set of values." The narrative confers emotion to the story and may use testimonials, case studies, or eyewitness accounts, among other strategies (Dahlstrom, 2014). In this dissertation, the term "narrative" will be used interchangeably with the terms "narrative" and "storytelling".

In health education, simply providing scientifically accurate data and statistics, and expecting people to make wise health choices and adopt healthy behavior (a strategy supported by the "knowledge deficit model"), is unlikely to have positive results. The current paradigm considers that reasoning, scientific information, and education will necessarily lead humans to change (Montesi, 2021). However, as stated by Kearns and Kearns (2020), the public "needs to be presented information in such a way that their heuristic decision making, in fact, leads to the decision and change in behavior desired by public health campaigns" (p. 6), and storytelling and narratives may play this role well.

While logic-scientific communication provides abstract information that can be generalized to other contexts, narratives are context-dependent and use a cause-effect structure inside a defined temporal context (Dahlstrom, 2014). For example, using a narrative to provide

scientific information about the effectiveness of vaccines against COVID would consider the current context, including the emotions involved.

According to Dahlstrom (2014), narratives are easier to comprehend and more engaging than traditional logical-scientific communication, such as expository or argumentative communication, description, and presentation of statistics. Also, they are associated with increased recall and shorter reading times. Furthermore, health education narratives can reach more nonexpert individuals through mass media Indeed, according to Dahlstrom (2014), narratives are the most common source of science communication lay people receive.

Mass media journalists frequently use narrative strategies to communicate facts, using personification to tell stories of an individual or a small group, which makes the audience identify and empathize with the characters (Dahlstrom, 2014). This strategy, however, has become a powerful tool for disseminating disinformation, especially online.

As aforementioned, an excellent example of the power of narrative communication against the best public health interests is the anti-vaccine movement. It has been widely and successfully using anecdotes that appeal to emotions, especially fear (Kearns & Kearns, 2020), while data-driven arguments used to counteract the anti-vaccine misinformation have not been effective by themselves. According to Dahlstrom (2014), it is challenging to counteract narratives with facts because the legitimacy of the former is judged based on the genuineness of the situations, which makes them seem reliable.

As narratives are based on a cause-and-effect relationship, they lead to conclusions without the need for argumentation and justification. Counter-argumentation against narratives is also less common when there are high levels of engagement (Dahlstrom, 2014). The reader's engagement in a narrative is part of a phenomenon called "transportation." Green (2021) defines

transportation as a "combination of attention, imagery, and feelings, in which an individual becomes immersed in a narrative world" (p. 87). Green and Brock (2000) suggest that transportation into a story may cause people to be less motivated or able to criticize or disbelieve its content or conclusion. Experiments by these authors also showed that highly transported individuals likely alter their real-world beliefs after a narrative and find fewer false notes in stories compared to less transported persons. In other words, misinformation may not be noted when an individual is highly immersed in a narrative.

In health education, narratives may be used as an entertainment-education strategy to persuade readers to make better choices and adopt healthier behaviors. Green (2021) indicates some mechanisms by which transportation may change attitudes and behavior. First, as already mentioned, when transported into narratives, individuals may have a more open mindset about the attitudes and behaviors of the characters, which then may be accepted without much awareness. Second, individuals may create connections with the characters, seeing them as friends or with admiration, and then being influenced by their attitudes and behaviors. Third, mental imagery links vivid images with beliefs implied by the story. Fourth, transportation creates emotional engagement through the evocation of strong emotions. Finally, the cause-effect structure of the story promotes recall and persuasiveness.

Identification with the characters is not the same thing as transportation, but it may also help with persuasion. As Sampathirao (2016) mentions, it may enhance the power of the story to establish and reinforce social norms and increase the adoption of characters' beliefs or behaviors. According to Eisner (2008), one of the most influential comics' authors, "an audience is always interested in the experiences of someone with whom it can relate," and "the inner feelings of the

protagonist are understandable to the reader who would have similar emotions under the same circumstances." (p. 87).

Studies using narratives for health education purposes and persuasion show mixed results and continue to call for more studies due to their potential to lead people toward better health choices (Dahlstrom, 2014). Narratives may also be an effective and valuable tool to counteract misinformation, so more studies are essential to prove such potential.

Comics are one of the many ways to convey narratives and are considered graphic narratives. Due to particular characteristics discussed below, their potential to educate and counteract misinformation should be explored.

Use of Comics in Health Education

Educational comic books, magazines, or strips may be used in health education to raise awareness of a topic (like disease symptoms), to prepare patients for a medical procedure, to help with health-related decision-making, to promote self-management of chronic diseases, or to improve knowledge and acceptance of a health condition (McNicol, 2017).

Among a wide range of health education programs and research studies that use this tool either in muti-level interventions or as an individual-level strategy, we may cite the following examples according to their primary purpose:

- To obtain informed consent for stroke care (Furuno & Sasajima, 2015) and improve understanding of informed consent in medical research (Kraft et al., 2017)
- To educate about AIDS (Czerwiek, 2018)
- To promote skin cancer prevention in childhood (Criado et al., 2018)
- To increase awareness about the use of antibiotics (Dandolini et al., 2012)

- To improve health literacy and describe perinatal experiences with Somali immigrants (Jacoby et al., 2015)
- To promote agricultural safety for Latin migrant families and risks of pesticide exposure (Liebman et al., 2007)
- To increase knowledge and promote Human Papillomavirus (HPV) vaccination for adolescents (Katz et al., 2014)
- To prevent obesity and promote healthier eating and physical activities habits in Hispanic children in rural communities (Ko et al., 2018)
- To prevent childhood obesity, targeting children and their parents (Tarver et al., 2016)
- To increase knowledge about healthcare-related instructions, like understanding prescription labels, medical instructions, and emergencies (Leiner et al., 2018)
- To improve the snack selection of Black and Hispanic youth (Leung et al., 2014)
- To improve stroke education among junior high school students (Matsuzono et al., 2015; Ohyama et al., 2015)
- To help health decision-making among American Indians and Alaska Natives (Montgomery et al., 2012)
- To increase knowledge and self-management of juvenile idiopathic arthritis (Mendelson et al., 2017)
- In anti-smoking campaigns for children (Mold & Elizabeth, 2019)
- To combat second-hand smoke in Mexican American households (Prokhorov et al., 2013)

- To foment critical analysis of health claims and treatment effects for children (Nsangi et al., 2020)
- To increase understanding of typical 9-month-old developmental milestones in parents (Rosas-Blum et al., 2018)
- To promote burn safety for children (Sinha et al., 2011)
- To promote control of urogenital schistosomiasis (Stothard et al., 2016)
- To stimulate physical activity and healthy eating in Japanese patients with metabolic syndrome (Shimazaki et al., 2018)
- To increase knowledge about tropical disease drug development (Squier, 2018)
- To promote contraceptive knowledge for college students (Sridhar et al., 2019)
- To increase epilepsy-related knowledge, awareness, and attitudes among school children in Ethiopia (Tekle-Haimanot et al., 2016)
- To encourage and raise awareness about colorectal cancer screening in Asian American and Pacific Islander communities (Wang et al., 2018)
- To convey health and scientific information and promote behavioral change to prevent COVID-19 (Kearns & Kearns, 2020)

Comics: Definitions and Classification

There is no consensual definition of comics. McCloud (1994) defines comics as: "juxtaposed pictorial and other images in a deliberate sequence, intended to convey information and/or to produce an aesthetic response in the viewer" (p. 20). On the other hand, some authors give comics narrative and storytelling characteristics, like Eisner (2008): "Comics is a form of sequential art, often in the form of a strip or a book, in which images and text are arranged to tell a story" (p. xvii), and Pratt (2009): "Juxtaposed pictures that comprise a narrative."

Comics are not a recent format of communication or art; sequences of images have been historically used in a wide variety of media, including ancient and primitive ones, like cave paintings, stained windows, and marble carvings (Leiner et al., 2018). Comics are usually referred to as a medium (Eisner, 2008). However, according to Jungst (2010), comics cannot be classified as a medium because this term refers to the material used to convey it, as printed in a newspaper or digitally on the internet. It cannot be considered a genre by itself either because many different genres may be depicted by comics, such as superheroes stories, cooking, science, etc. Jungst (2010) used the word "format" to define the combination of the visual and verbal components typically found in comics.

Comics started popularizing in the first half of the 20th century when printed media were their primary communication vehicle. Comics originated as daily newspaper strips with very restricted lengths. With time, other forms emerged, like comic books. Comic strips are defined as a "series of adjacent drawn images, usually arranged horizontally, that are designed to be read as a narrative or a chronological sequence" (Britannica Online Encyclopedia, n.d.). In comic books, stories come to a definite conclusion, while newspaper strips usually depict patterns of real life (Eisner, 2008).

As digital technology started competing with printed media, comics adapted to it. As a result, webcomics, also known as online graphic storytelling, have grown in importance on the Internet (Eisner, 2008). However, Jungst (2010) points out that most comics on the internet are conveyed in the same format as printed media or in pdf files, not adapted to computers and smartphones screens. Therefore, developing more interactive ways to read comics online would be desirable. The World Health Organization Instagram profile, for instance, has already posted comics where the panels can be read by scrolling the screen to the side to create awareness about

emotions and stress among Ukrainian children during the war against Russia (World Health Organization, 2022e) and to bring attention to the correct use of antibiotics (World Health Organization, 2021c).

In general, comics can be divided into two types: entertaining and educational. Entertaining comics came first, while the educational ones use the format as a model for knowledge transfer. In some cases, educational comics may be entertaining as well (Jungst, 2010). In fact, entertainment-educational tools (comics included) have been used to promote changes in beliefs, attitudes, and behaviors, usually informed by Bandura's Social Cognitive Theory (Slater, 2002). Eisner (2008) says that a "process is easily taught when it is wrapped in an interesting 'package'" (p. 18), which supports the use of entertainment-educational tolls.

The definition and classification of educational comics have yet to reach a consensus among authors. The community of comics scholars generally accepts Rifas' (1988) broad definition of educational comics, which includes a large constellation of related categories, with health education comics among them. In turn, Jungst (2010) considers informational comics a subtype of educational comics, with the purpose of popularizing information, and Cadwell (2012) calls informational comics the ones "designed to educate, inform, or teach the reader something" (p. 1). A wide range of areas of knowledge could benefit from comics to educate the target audience. These may include science, academics, history, biographies, civil rights, health education, etc. (Jungst, 2010).

Health education comics may also have different subtypes or be a subtype of health-related comics. For instance, Ashwal and Thomas (2018) classify health-related comics as health education and personal memoir comics. Health education comics convey straightforward medical information through a narrative or a didactic form. On the other hand, personal memoir

comics (also called graphic pathography) narrate the personal health-related experiences of a particular person, usually the author/ illustrator of the piece.

In an example of the variety of types of comics to educate about the same issue, Czerwiek (2018) found three categories of comics that would fulfill her goals to educate about AIDS: health education comics, social and political activism, and testimony/ remembrance comics. This last one may be considered equivalent to what Ashwal and Thomas (2018) call a personal memoir. In the health education and sociological field, this format raises compassion and empathy toward those who suffer from one health-related problem or toward their relatives or friends.

In 2015, Czerwiec et al. (2015) defined the term "Graphic Medicine" as "the intersection of the medium of comics and the discourse of health," combining "the principles of narrative medicine with an exploration of the visual systems of comics art, interrogating the representation of physical and emotional signs and symptoms within the medium" (p. 1).

Advantages of Using Comics in Health Education

Technical Aspects

Visual images, used in any media, are processed thousands of times faster by the brain than plain text, besides improving engagement (Walter & Gioglio, 2014). That could represent a promising contribution to health education, especially in low-literacy and/or poorly motivated groups, as will be discussed later. Furthermore, according to Eisner (2008), texts alone require the reader's conversion of words to images, while in comics, this process is accelerated by providing the text and the images concomitantly.

Cadwell (2012) highlights that comics can potentially present more information in less space than plain text. Green and Myers (2010) assert that a single comic panel can convey as

much health information as 250 words of plain text, although their assumption could not be proven by quantitative analysis. Cadwell (2012) affirmed that comics, although intuitively and implicitly regarded as a valid medium in education, do not have enough supporting data, such as statistical analysis. That may have contributed to some resistance from health professionals to adopt this educational format until recently. Nevertheless, studies have shown that information presented only in text form on websites can overwhelm the reader, leaving a sense of information overload, especially among those with a propensity for visual information processing (Lee et al., 2020).

In recent studies, educational comics had better performance regarding understanding and recall of health-related information than plainly written instructions (Leiner et al., 2018). As mentioned by Jungst (2010), pictures give the reader greater attractiveness than words. Therefore, in cases in which words are necessary to explain facts, combining both words and images would be—at least theoretically—an effective way to convey information. Regarding a recall effect, Jungst mentions the pictorial superiority effect—a phenomenon by which pictures are recalled more frequently than words when both are presented serially. While the mechanisms of this effect are still unknown, McBride and Dosher (2002) point to dual-coding theory and sensory-semantic theory as underlying theories to explain it.

Comics' technical and style strategies may also present advantages of comics' overwritten instruction. For example, the manipulation of images (i.e., zooms) and visual alteration of the text (i.e., size and style of the font) could highlight situations, feelings, thoughts, and spoken sentences in a way rarely possible in plain texts (Green & Myers, 2010). Also, visual comprehension may be intuitive, which is not common regarding verbal understanding.

In comics, as opposed to videos, the reader is in total control of the reading rhythm and the information acquisition rate (Eisner, 2008), which can be beneficial in educational comics, especially in cases of less literate readers. The reader may imply their own particular rhythm in order to have the necessary time to process the information. It is even possible to return quickly to previous panels to recall information presented earlier, which is possible but not practical in the case of videos. In contrast to graphic comics, videos may also require too much attention and time. Campbell and Rudan's (2020) analysis of online public engagement with a series of videos on major global health topics on YouTube showed more than 90% of the viewers dropped off each video by 25% of its total time and less than 5% watched the videos until their end. Regarding educational comics, there is no consistent literature on whether readers actually read them thoroughly.

Comics and Health Literacy

In a 2008 survey by the Agency for Healthcare Research and Quality (2008), only 12% of the adult population showed proficient health literacy, and more than one-third were at the basic (21%) and below basic (14%) health literacy levels. Although 53% had an intermediate health literacy level, the survey showed that low health literacy disproportionately affects Latino and Hispanic communities (41% below basic level) and the Black community (24%) when compared to White Americans (9%). In addition, lower educational levels and low socio-economic status also may negatively impact health literacy (Muvuka et al., 2020).

Many assessments and interventions have been using comics to reach the communities most affected by health literacy disparities. For example, among rural Latin/Hispanic communities, studies from Kilanowski (2013, 2020), Liebman et al. (2007), and Ko et al. (2018) used comic books either in Spanish and English or only Spanish, which improved health

knowledge and behaviors and showed good acceptance and perceived usefulness of the educational tools. Prokhorov et al. (2013) tested a bilingual comic book among Mexican-American children as part of interventions to reduce second-hand smoke in the home, with better results than the control group. Leung et al. (2014) tested a Manga comic (Japanese comic art) to promote fruit snacks among Black and Hispanic youth in New York City with positive behavioral results and increased self-efficacy. Among non-English speaking immigrants other than Hispanic ones, Jacoby et al. (2015), together with Somali immigrants, developed a comic book about their perinatal experiences both in English and Somali, which was unanimously considered helpful as an educational tool. Among other vulnerable groups, Wang et al. (2018) found comics to be an engaging strategy to promote colorectal cancer screening among Asian American and Pacific Islander communities, and Montgomery et al. (2012) recruited Native American youth to participate in the production of comic books to inform better health choices.

The rationale for using comics among individuals with low literacy resides in many of its technical characteristics, such as the possibility of self-paced reading (Eisner, 2008). Furthermore, as emphasized by Jungst (2010), pictures make comics more attractive than plain text, and combining words and pictures improves understanding, making the use of words less necessary when the material is well-designed. Katz et al. (2014) also point out that combining visual stories with text promotes greater retention and interest. Leiner et al. (2018) emphasize that comics are able to convey medical information from experts in a straightforward, clear graphic format. Moreover, in promoting health literacy, the cause-and-effect relationship could be better depicted. The juxtaposition of different images on one page makes the contrast between healthy and unhealthy behaviors possible without needing a lengthy explanation (Ashwal & Thomas, 2018).

It is noteworthy that as most of the studies using comics for health education focus on low-literacy populations, it is still uncertain if this strategy would be valid and acceptable to a more literate population and for those with a higher need for cognitive stimulation. However, comparing a text pamphlet to a comic strip to educate about the prevention of sexually transmissible diseases (STDs), Carnaghi et al. (2007) found that the text pamphlet resulted in better results among individuals with higher levels of cognitive stimulation, as measured by the Need for Cognition Scale. Need for Cognition can be defined as the individual's intrinsic enjoyment in engaging in effortful information processing (Cacioppo & Petty, 1982), which tends to be related to higher academic achievement (Colling et al., 2022) and higher digital health literacy (Britt & Hatten, 2013).

Comics and Cultural Tailoring

Correlated with low health literacy, cultural challenges may add even more barriers to the processing and understanding of health-related information, especially among non-native English speakers and immigrants. Therefore, in order to show high adherence and positive outcomes, health promotion programs must be culturally appropriate and tailored to the target population (Kilanowski, 2013).

Many programs using comics are culturally tailored for their target readers, like immigrant or Native American communities, especially those who are not fluent in English (Jacoby et al., 2015; Kilanowski, 2020; Ko et al., 2018; Montgomery et al., 2012; Prokhorov et al., 2013; Wang et al., 2018). In comics, due to their graphic nature, cultural tailoring may be achieved not just by using readers' mother tongue but also by designing characters that physically resemble the readers, inserting physical elements (clothes, food, home decorations, instruments, etc.) that are part of their daily lives, depicting emotions and social relations as they

are usually expressed in their communities, etc. These strategies are more difficult, laborious, and probably less effective when there is an attempt to include them in a text without pictures, for example.

Comics, Emotions, and Humanizing Illness

In comics, Simpson (2018) calls "emotional contagion" the capacity to make the reader "catch" the emotional state of the character or the situation, which is related to the phenomena of identification and transportation described before.

In a study that compared comics to other strategies (visual-imaged based, narrative text, and general informative text) to promote physical activity and healthy diet among adults in Japan, Shimazaki et al. (2018) found that comics elicited superior emotional experiences, like risk perception (linked to fear), familiarity, and satisfaction. This higher emotional experience strongly predicted psychological mediators of positive change in the mentioned health behaviors. According to Eisner (2008), stories "touch on human fundamental concerns—fear and curiosity" (p. 76).

Czerwiek (2018) highlighted the potential of comics to quickly communicate important information to people that may be under stress due to a disease (of themselves, a relative, or a friend), besides its low-cost and low-tech characteristics and ability to "transcend language and literacy barriers" (p. 200). Furthermore, according to McNicol (2014, 2017), health educational comics can do much more than provide facts about illnesses; they can also support individuals and their families in dealing with socially and psychologically overwhelming situations.

Comics as Graphic Narratives

Comics may be considered graphic narratives, and, as such, they carry many of the narrative characteristics described before, such as higher engagement and understanding than

logic-scientific communication (Dahlstrom, 2014), increased recall of information, and appeal to emotions (Kearns & Kearns, 2020), transportation effect (Green, 2021), and identification with the characters (Sampathirao, 2016). Then, narrative characteristics give comics a potential advantage over other non-entertaining health educational tools.

Disadvantages of the Use of Comics for Health Education

Despite their potential as a tool to convey scientific and health information, social stigma and the idea that they are a media developed only for kids and adolescents have hindered their use until recently (Cadwell, 2012; Pew Research Center, 2021b). According to Green and Myers (2010), some professionals have been using comics to provide health education, mainly among young people and non-native English speakers, and their use is not more widespread because most doctors do not consider them valid. Finally, Ashwal and Thomas (2018) discussed the precautions that should be taken when using comics to provide health- and medical-related information to adult patients, who may consider it “juvenile” and “intended to be funny.”

Chapter 3: Methodology

The following chapter presents the methodology for this study, including the sampling frame, recruitment strategy, data collection effort, and analyses.

Study Design

This was a cross-sectional study; each volunteer answered the online survey once. Appendix A presents a schematic representation of the study flow and design. After being screened for eligibility and electronically signing the informed consent form, all volunteers were asked to provide demographic information and answer a scale regarding attitudes toward COVID-19 vaccination. Next, volunteers were randomly assigned to one of three groups: comic readers (CS), text readers (TX), and control group (CL). The comic readers (CS) group read an educational comic strip about COVID-19 vaccines and answered the questionnaires and scales described in the following session. The text readers group (TX) read an educational text about COVID-19 vaccines and then answered the same questionnaires and scales answered by the CS group. Finally, the control group (CL) answered the survey without the aid of any educational tool (neither the comic strip nor the educational text). For this group, the survey consisted of the same questionnaires, except for those evaluating the two educational tools. The function of the CL group was to check for differences in the misinformation identification scores with or without an educational tool.

Sample Recruitment and Data Collection

The study's sample consisted of 18- to 65-year-old adult Facebook and Instagram users in the United States. These two platforms were chosen because, apart from YouTube video-sharing platform, they are currently the most used social media platforms in the United States (Pew Research Center, 2021b). Exclusion criteria to participate in the study were non-fluent

English speakers, non-United States residents, and individuals that had not used any of the two social media platforms during the three months before the survey.

The primary option for participant recruitment was via paid Facebook and Instagram advertisements. This recruitment strategy was chosen because the survey could reach the target population directly. Also, previous studies have shown the validity of using social media recruitment for social sciences and health-related research (Ford et al., 2017). Additionally, posts on the Reddit social media platform invited participants to join the survey. Following recommendations by Shatz (2017), free advertisements were posted on subreddits (forums dedicated to a specific topic on the Reddit website). The subreddits selected were: r/SampleSize, with more than 190,000 participants; r/SurveyCircle, with 1,500 participants; and r/TakemySurvey (more than 10,000 participants), which all convey links to online surveys; besides r/Facebook, with more than 82,000 participants, which discusses topics relative to Facebook social media, and r/Instagram, with more than 240,000 participants, which discusses issues relevant to the Instagram platform. Advertisement posts were reposted every 24 hours to increase visualizations. Recruitment of participants lasted 15 days, from January 17 to 31, 2023, and aimed for at least 300 participants.

Paid ads on Facebook and Instagram conveyed the invitation (Appendix B) to participate in the study, and a link to the survey was provided. The budget for the ads was fixed at a maximum of US$1,000. The bid strategy was the “highest volume” one, aiming to get the most results possible from the specified budget without focusing on cost per answer. On Reddit, a call for volunteers was made using the title: “Participate in this survey about strategies to fight online misinformation and qualify for the drawing one of three $75 Amazon gift certificates (U.S., English speakers, Facebook and Instagram users, 18 to 65 y)”. Specifically for the subreddit

r/SampleSize, the flair (a 'tag' that can be added to threads) “academic” was used to explicit the nature of the survey. According to the rules of the subreddit, the target group is written in the title between parentheses. The same ad used for Facebook and Instagram (Appendix B) followed the title, providing a link to the research.

Participants who clicked on the link provided by the ad were automatically directed to the study landing page with information about the study (Appendix C), briefly describing the research purpose and stating that their voluntary participation would involve an online survey, taking around 10 to 15 minutes. In addition, the participants were informed that they should leave their email addresses if they wanted to participate in the drawing of three US$75 Amazon.com electronic gift cards as long as they completed the survey. This first page also assessed eligibility criteria. Individuals considered ineligible were thanked for their time and advised to close their web browsers. Individuals deemed eligible were directed to an informed consent form (Appendix D) that reminded participants of the study's purpose, survey completion procedures, and participation risks and benefits. Those who consented to participate signed the informed consent electronically, provided their e-mail address for the random drawing if they wished, and were directed to complete the survey developed and hosted by Qualtrics. The Qualtrics platform randomizer assigned participants to one of three groups: comic readers (CS), text readers (TX), and control group (CL).

Development of the Educational Tools

Comic Strip Development

A theory-based comic strip with ten panels was developed to approach major misinformation regarding COVID-19 vaccines and the most frequent reasons underlying vaccine hesitancy drawn from the current literature. These topics are frequently associated with

misinformation on social media. The comic strip was developed by an amateur comic artist, using the application Procreate® for Ipad.

Constructs and health determinants from the Health Belief Model (HBM) (Rosenstock et al., 1988) and the Theory of Planned Behavior (TPB) (Ajzen, 1991) were the theoretical basis for the design of the comic strip content that includes the narrative, the characters' lines, emotions, and thoughts, actions, and their consequences. The HBM and TPB were chosen to inform the development of the comic strip because they are the most used model to predict, explain and inform interventions regarding vaccine hesitancy and vaccine intentions (An et al., 2021; Chu & Liu, 2021; Rosental & Shmueli, 2021; Shmueli, 2021; Sieverdinget al., 2022; Wolff, 2021; Zampetakis & Melas, 2021; Bateman et al., 2022; Berg & Lin, 2021).

The Health Belief Model (HBM) has been the most widely used conceptual framework at the individual level in health behavior research. It has been used to explain changes or maintenance of health-related behaviors and to inform interventions. The HBM primary constructs are primarily based on personal (individual) beliefs. Perceived susceptibility refers to the beliefs about the vulnerability of getting or developing a particular disease or condition. Perceived severity refers to the belief about a certain health condition's seriousness and outcomes. Perceived benefits refer to the belief in the efficacy of behavior change to reduce risks or severity of a certain condition. These benefits may be non-health-related (for example, smoke cessation may result in personal financial benefits due to the income that can be now saved instead of being spent on cigarettes). Perceived barriers refer to the belief about the material and psychological costs of a particular behavior change. Cues to action are factors that activate readiness to take action, or in other words, that trigger to actions. Self-efficacy refers to a person’s confidence to successfully execute the behavior required to produce the desired

outcomes. Other factors include demographic factors (age, gender, ethnicity, socioeconomic status, and knowledge) (Champion & Skinner, 2008; National Cancer Institute, 1995).

The Theory of Planned Behavior (TPB) is a model of individual health behavior that considers behavior intention (perceived likelihood of performing the behavior) the best predictor of behavior change. According to this theory, behavior intention is determined by attitudes towards the behavior, subjective norms (or social normative perceptions), and perceived behavior control. Attitudes toward the behavior are determined by beliefs about the behavior (one's beliefs evaluations of behavioral outcomes) and the value (positive, neutral, or negative) attributed to the outcome of the behavior). Subjective norms are determined by normative beliefs (whether the behavior is approved or disapproved by important referent individuals) and motivations to comply with those important referent individuals. Finally, perceived behavioral control is determined by the belief that one has, and can practice, control over performing the behavior. In other words, according to TPB, the perception of how easy or difficult it is to adopt a specific behavior is an essential behavior intention determinant, along with attitude and subjective norm (Ajzen, 1991; Montano & Kasprzyk, 2008; National Cancer Institute, 1995).

According to Lee et al. (2020), if the perceived severity and susceptibility of a disease and the perceived benefits and accessibility of its vaccines influence vaccination intention, then any misinformation that affects these perceptions would result in an increase or decrease in vaccination hesitancy. For example, if misinformation about COVID-19 reduces perceived susceptibility to the disease, then this misinformation may result in reduced vaccine intention.

Some constructs from HBM and TPB may be more potent than personal factors, like age, race, household income, education level, etc. For example, according to Boyle et al. (2022), COVID-19 vaccine beliefs are a stronger predictor of vaccination than demographics. In other

cases, some factors may act as a mediator between constructs from TPB and HBM and vaccination intention, like the role of trust in science influencing determinants of both TPB and HBM related to vaccination intention (Barattucci et al., 2022).

The results session describes the comics developing process based on these theoretical frameworks. In addition, the developing process of the educational text was also described, as its content was designed to match the comic strip's content.

Readability Evaluation of the Educational Tools

Both educational tools were evaluated for readability using the Flesch Reading Ease Scale to evaluate the Flesch Reading Ease score (FRE) and Flesch-Kincaid Readability Formula to assess the Flesch-Kincaid Reading Grade Level (RGL).

The Flesch Reading Ease score (FRE) measures the readability of text written between grade 5 and college-graduate levels, and its scores range from 100 (very easy) to 0 (unreadable) (Friedman & Hoffman-Goetz, 2006). It is calculated using the following formula:

$$FRE = 206.835 - 0.846\ wl - 1.015\ sl$$

where: wl = number of syllables per 100 words (average word length) and sl = number of words per sentence (average sentence length).

The Flesch-Kincaid Reading Grade Level (RGL) is a modified version of the FRE that assesses the reading grade level of printed information from 5th grade to college graduate (Friedman & Hoffman-Goetz, 2006), and it is calculated using the formula:

$$RGL = 0.39\ sl + 11.8\ spw$$

Where: si = average number of words per sentence and spw = average number of syllables per word.

It is recommended to remove decimals, bullets, abbreviations, paragraph breaks, colons, semicolons, and dashes within a sentence to avoid underestimating the readability level (Friedman & Hoffman-Goetz, 2006). Scores were rated according to Table 3.

Table 1.

Reading Difficulty Rating according to Flesch Reading Ease (FRE) Scores and Flesh-Kincaid Grade Level (RGL) Scores

Reading difficult rating	FRE score	RGL score
Very easy	90-100	5^{th}
Easy	80-90	6^{th}
Fairly easy	70-80	7^{th}
Standard	60-70	8^{th} - 9^{th}
Fairly difficult	50-60	10^{th} – 12^{th}
Difficult	30-50	13^{th} – 16^{th}
Very difficult	0-30	College graduate or higher

The goal FRE score for the comic strip and text was between 70 to 90 since the NIH (National Institutes of Health) recommends that educational written information range between the 6th and 7th-grade level (Hutchinson et al., 2016). Therefore, modifications were provided until the proper reading level was reached.

Instruments

Unless otherwise specified, the instruments were applied to all three experimental groups (CS, TX, and CL). The order of the administration of the instruments is presented in Appendix A.

Demographics

Demographic data collected (Appendix E) corresponds to the most relevant factors indicated in the literature review regarding the susceptibility to misinformation. These include age, gender, educational level, economic status, ethnicity/race, and political orientation.

Identification of Misinformation

Participants of all three groups were instructed to classify ten information sentences regarding COVID-19 vaccines as true or false (Appendix F). The questionnaire was formulated using sentences totally or partially quoting information posted online, preferably on social media platforms. The sentences relate to the topics addressed by the comic strip and educational text and were designed to present a source followed by the information. The score for the misinformation identification questionnaire is presented as the percentage of correct answers (%MI)

Evaluation of the Educational Tool

For CS and TX groups, the evaluation of the educational tools (comic strip and educational text, respectively) had five components: the attractiveness of the educational tool (ATTR), perceived usefulness in helping identify misinformation (USE), trust in the information provided by the educational tool (TRUST), willingness to share or repost the educational material on social media (SHARE), and acceptance of the educational tool (ACCT) composed of the sum of the scores of the four first evaluation components, that were measured through 5-point Likert scale questions. Answers ranged from *strongly disagree* to *strongly agree* (Appendix G) and were coded as 1, 2, 3, 4, and 5, respectively.

Transportation into the Narrative

A selection and adaptation of two items from the Transportation Scale-Short Form (TS-SF) (Appel et al., 2015) was administered to the CS group to evaluate the capacity of the comic strip to provoke transportation; in other words, the experience of being immersed into the world of the story. The items' answers were presented using a 5-point Likert scale ranging from *strongly disagree* to *strongly agree* (Appendix H), coded from 1 to 5, respectively. Items 1 and 2 measured transportation's cognitive and emotional aspects, respectively.

Health Literacy

Health literacy was evaluated using the Single Item Literacy Screener (SILS) developed by Morris et al. (2006) to identify adults that need help with printed health material. The SILS consists of a single question: "How often do you need to have someone help you when you read instructions, pamphlets, or other written material from your doctor or pharmacy?" The possible answers are *never, rarely, sometimes, often,* and *always*, coded as 1, 2, 3, 4, and 5, respectively. Answers coded 3, 4, and 5 relate to difficulty in reading printed health-related material.

E-Health Literacy

E-Health literacy was evaluated using three questions selected from the eHealth Literacy Scale (eHEALS) (Appendix I). eHEALS is an 8-item scale developed to measure respondents' knowledge, comfort, and perceived skills at finding, evaluating, and using online health information (Norman & Skinner, 2006). A systematic review has shown it to be the most widely used scale to assess eHealth literacy (Karnoe Knudsen & Kayser, 2015). The answers were presented as a 5-point Likert scale ranging from *strongly disagree* to *strongly agree*, scoring 1, 2, 3, 4, and 5 points, respectively, with higher scores representing higher self-perceived eHealth literacy. The items selected were: "I know where to find helpful health resources on the Internet"

(item-total correlation of 0.76, and factor loading of 0.84), "I know how to use the health information I find on the Internet to help me" (item-total correlation of 0.73, and factor loading of 0.81), and "I have the skills I need to evaluate the health resources I find on the Internet" (item-total correlation of 0.63, and factor loading of 0.72).

Trust in Health Organizations and Trust in Government

Participants' level of trust in information posted on official health organizations and government social media pages or profiles was collected through two 5-point Likert questions. Answers ranged from *strongly disagree* to *strongly agree* (Appendix J), coded from 1 to 5 points, respectively.

Trust in Science and Scientists

Information about participants' trust in science and scientists was collected through a 5-point Likert scale question (Appendix J), with answers ranging from *strongly disagree* to *strongly agree*, coded from 1 to 5 points, respectively. According to Krüger et al. (2022), trust in science cannot be split from trust in the scientists themselves. So it is assumed that questions elaborated to assess trust in scientists also comprise trust in science.

COVID-19 Vaccination Attitudes

Concerns about COVID-19 vaccines, one facet of attitudes toward the vaccine, was accessed by the CVCS (COVID-19 Vaccine Concerns Scale) (Gregory et al., 2022) (Appendix K). CVCS is a 7-item validated scale to assess fears and concerns about COVID-19 vaccines. In addition, the scale has been shown to predict vaccination status and vaccine hesitancy (Gregory et al., 2022). Answers were presented as 5-point Likert scale questions, with responses ranging from *strongly disagree* to *strongly agree*, coded as 1, 2, 3, 4, and 5, respectively. The final score for the scale was the sum of the points on each question.

This scale was administered after the demographic questionnaire and before the identification of misinformation related to the COVID-19 vaccine. This option was made to avoid CVCS answers unintentionally being influenced by educational tools (comic strip or text). For instance, if the cartoon or text was applied before the CVCS, demystifying misinformation that provokes concerns may have resulted in CVCS answers being different from the original participants' concerns (before the survey).

Social Media Use

A selection of two questions from a modified version of the Social Media Use Integration Scale (SMUIS) (Jenkins-Guarnieri et al., 2013) was used to evaluate the intensity of the use of social media (Appendix L). According to the scale's authors, although the questions in the original scale focused on the use of Facebook, it was intentionally designed to be adapted to measure the use of other social media platforms. Intensity scales intend to measure general patterns of social media use and do not focus specifically on signs of social media addiction (Mieczkowski et al., 2020). Jenkins-Guarnieri et al. (2013) intended SMUIS to measure the use of online social media as a "degree to which social media is integrated into the social behavior and daily routines of users, and the importance of an emotional connection to this use" (p. 39).

In the adapted version of the SMUIS used in this study, the word "Facebook" has been replaced by "social media" to cover all possible social media platforms. The items in the scale are measured using a 5-point Likert scale with responses ranging from *strongly disagree* to *strongly agree*, coded from 1 to 5 points, respectively. From the ten items of the original scale, two items were chosen: "Using social media is part of my everyday routine" (item-total correlation of 0.683) and "Social media plays an important role in my relationships" (item-total correlation of 0.709). The final score was the sum of the questions' scores. Higher scores

represent a stronger emotional connection, more engaged use, and more social media integration in the user's life.

In addition to the previous questions, complementary ones were applied (Appendix M) to verify the most accessed social media platforms (question 1), the use of social media to get health information (question 2), and trust in health information from social media (question 3). For questions 2 and 3, 5-point Likert scale answers ranged from *strongly disagree* to *strongly agree*, coded from 1 to 5 points, respectively.

COVID-19 Vaccination History and Intentions

Questions collected information about the kind of vaccine, number of doses and booster shots, plans to be vaccinated if still not, and intent to be annually vaccinated if it becomes recommended (Appendix N). For each question, the distribution of the answers was calculated for the whole sample and for each group (CS, TX, and CL).

Data Analysis

SPSS® software (version 28.0) was used for the statistical analysis. The study's primary outcomes, the misinformation identification score (%MI), and the educational tools' evaluation components (ATTR, USE, TRUST, SHARE, and ACCEPTANCE) are the dependent variables in this study, while the remaining questionnaires and scales scores comprise the independent variables.

Shapiro-Wilk tests showed that none of the numeric variables had normally distributed data. This way, nonparametric tests were used for all the analyses, and the level of significance adopted was $p < 0.05$.

Mann-Whitney U tests were used to compare two independent groups as an alternative to the parametric independent-samples t-test. Kruskal-Wallis nonparametric tests were conducted to

check for differences between scores for three or more groups. When the Kruskal-Wallis test revealed a statistically significant difference, the groups that differed from each other were identified by *post hoc* pairwise comparisons using Dunn's procedure with a Bonferroni correction for multiple comparisons. Persons' Chi-Square tests for independence were used to verify the association of two nominal variables, such as age categories and groups. Spearman's correlation test was used to measure the strength and direction of the association/relationship between two continuous or ordinal variables. The strength of the correlations used the classification proposed by Cohen (1988, pp. 79-81): small for *rho* = .10 to .29, medium for *rho* = .30 to .49, and large for *rho* = .50 to 1.00.

Descriptive statistics described participants' socio-demographic characteristics. Means were presented as means ± standard deviation, and medians were calculated when necessary. Age was expressed as mean ± standard deviation, and the percentage of individuals in the following age categories: 18 to 29 years old, 30 to 49 years old, and 50 to 65 years old.

The descriptive session also describes and compares between groups the independent variables scores for CVCS (COVID-19 Vaccine Concerns Scale) (Gregory et al., 2022), health literacy measured by the Single Item Literacy Screener (SILS) developed by (Morris et al., 2006), digital health literacy, measured by three items selected from the eHealth Literacy Scale (eHEALS) (Norman & Skinner, 2006), social media use intensity measured by two selected items from the Social Media Use Integration Scale (SMUIS) (Jenkins-Guarnieri et al., 2013), and for questionnaires about trust in health organizations, government institutions, scientists and health information from social media, use of social media to find health-related information, social media platforms accessed, and vaccination history and intentions.

Misinformation identification

Identification of misinformation scores (%MI) were expressed as a percentage of correct identification of the questionnaire sentences as true or false. Mean %MI were compared between groups, and between groups according to demographic characteristics, level of health literacy, and vaccination history and intentions. These analyses used the Kruskal-Wallis H test. Spearman's correlation test was used to verify the direction and strength of the association of %MI with the scores for the educational tools' evaluation components and the remaining independent variables described above.

Evaluation of the educational tools

Mann-Whitney *U* test was used to compare: the scores of the educational tools' evaluation components (ATTR, TRUST, SHARE, USE, and ACCEPTANCE) between groups CS and TX, scores for the evaluation component between groups according to demographic characteristics, and scores for the evaluation components between participants with low literacy levels from each group. In addition, Spearman's correlation test was used to verify the direction and strength of the association of scores of each evaluation component and the scores of the remaining independent variables described above.

Within-group evaluations

Within-group comparisons of the study's outcomes of interest (M%, ATTR, TRUST, SHARE, USE, and ACCT) were made to investigate demographic characteristics associated with better evaluation of each educational tool or better misinformation identification scores. Kruskal-Wallis tests were conducted to check for differences in the %MI scores and educational tools' evaluation scores between categories of different demographic variables. When necessary, *post hoc* pairwise comparisons were used to identify the groups that differed from each other.

Transportation into the narrative

Transportation into the narrative was measured in group CS using two items from the Transportation Scale-Short Form (TS-SF) (Appel et al., 2015). TRANSP1 accessed a cognitive aspect of transportation, while TRANSP2 accessed an emotional component. TTRANSP is the total score composed of the sum of the two items. Spearman's correlation tests checked the association between these three scores and the scores for the key outcomes of the study (%MI scores and educational tools' evaluation scores)

Chapter 4: Results

Comic strip development

Based on the Theory of Planned Behavior (TPB) and the Health Belief Model (HBM), the main constructs determining vaccine intentions were reviewed from the literature. Table 3 illustrates the constructs positively and negatively correlated to vaccination intention and/or hesitancy. In some cases, the authors have used both theories for their analysis. Noteworthy, studies were conducted before or at the early stages of the vaccination campaigns; therefore, they have investigated the intention to get vaccinated instead of actual vaccination status.

Table 2

Correlation of HBM and TPB Constructs with the Vaccine Acceptance and Vaccine Hesitancy

Author	Theories of health behavior	Constructs correlation with vaccine intention	Constructs correlation with vaccine hesitancy
Rosental and Shmueli (2021)	HBM and TPB	Perceived susceptibility (+) Perceived benefits (+) Perceived barriers (-) Cues to action (+) Self-efficacy (+)	***
Shmueli (2021)	HBM and TPB	Perceived benefits (+) Perceived severity (+) Cues to action (+) Subjective norms (+) Self-efficacy (+)	***
Sieverding et al. (2022)	HBM and TPB	Perceived behavior control (+) Subjective norms (+) Perceived benefits (+) Negative Attitudes (-)	***
Bateman et al. (2022)	HBM	Perceived barriers (-) Cues to action (+)	***
Berg and Lin (2021)	HBM and TPB	***	Perceived susceptibility (-) Perceived severity (-) Perceived benefits (-) Cues to action (-) Attitudes (negative affect) (+) Subjective norms (-) Perceived behavior control (-) Perceived barriers (+)
Hayashi et al. (2022)	TPB	Perceived behavior control (+) Positive attitudes (+) Subjective norms (+)	***
Chu and Liu (2021)		Negative attitudes (-) Positive attitudes (+)	***

Author	Theories of health behavior	Correlation of constructs to vaccine intention	Correlation of constructs to vaccine hesitancy
Wolff (2021)	TPB[1]	Positive attitudes (+) Perceived behavior control (+)	
Barattucci et al. (2022)*	HBM[2] and TPB	Subjective norms (+) Perceived benefits (+) Perceived barriers (-)	***
Iacob et al. (2021)	HBM	Perceived threat (perceived susceptibility + perceived severity) (+)	
Limbu et al. (2022)**	HBM	***	Perceived susceptibility (-) Perceived benefits (-) Perceived barriers (+) Cues to action (-) Self-efficacy (-) Perceived severity (-)
Cordina et al. (2021)	HBM	Perceived benefits (+)	Perceived barriers (+)
Guidry et al. (2021)	HBM and TPB	Positive attitudes (+) Subjective norms (+) Perceived susceptibility (+) Perceived benefits (+) Perceived barriers (-) Self-efficacy (+)	***
Seddig et al.(2022)	TPB	Positive attitudes (+) Negative attitudes (-)	***
An et al. (2021)	HBM and TPB	Self-efficacy (+) Cues to action (+) Perceived barrier (-)	***
Badr et al. (2021)	HBM and TPB	***	Perceived susceptibility (-) Positive attitudes (-) Cues to action (-)

Note. [1]Theory of Planned Behavior; [2]Health Belief Model, *Study evaluated the intention to get a booster vaccination; **Systematic review; ***Not evaluated in the study; (-) = negative correlation; (+) = positive correlation.

From the findings of these studies, some recommendations from the authors include:

- Promote a sense of autonomy and control over the decision to be vaccinated to increase perceived behavioral control.
- Work on negative attitudes toward the vaccines, such as fear (of adverse effects, of the vaccine not being tested enough), mistrust in vaccine recommendations from scientists and governmental agencies, uncertainty regarding the production and approval of the vaccines
- Promote positive attitudes towards a vaccine, for example, increasing the sense of contributing to the safety of one's community or protecting loved ones and improving beliefs about the efficacy and safety of vaccines.
- Explore vaccination approval from significant others (family, friends, partners) to promote normative beliefs and motivations to satisfy them.
- Reduce perceived barriers, like fear of adverse effects of the vaccine and concerns about costs.
- Inform or reassure individual benefits from vaccination: reduced risk of infection and, if infected, reduced risk of severe complications and hospitalizations, in addition to protecting loved ones.
- Reinforce that everyone, regardless of age and health status, is susceptible to COVID-19, so vaccination will reduce their risk.
- Explore cues to action: experiences of having friends, family, or oneself infected or hospitalized, having an acquaintance who died of COVID-19.

Besides the use of TPB and HBM as the backbone of the comic strip, some other aspects were considered. For instance, using humor in the context of health education through comics

engages the reader's attention (Williams, 2012). However, it is recommended not to make fun of or ridicule characters that are less privileged or think differently from the author of the comics (McDermott et al., 2018), as it may create resistance to the message conveyed. Including analogies may bring humor to the story and, at the same time, make abstract concepts more tangible (McDermott et al., 2018). Evoking emotion is a strategy used in narratives that can also be used in comics to increase reader's engagement and identification, and may work much better than facts to stimulate reflection and change of mind (Simpson, 2018; Green, 2021; Kearns & Kearns, 2020).

An expert evaluated the comic strip for feedback and eventual corrections and modifications. The readability evaluation resulted in a Flesh-Kincaid grade level of 4.0 and a Flesh Reading Ease of 78.8.

Table 3 describes the theoretical framework for each of the ten comic strip panels. First, factors positively or negatively influencing vaccination intention were classified according to the HBM and TPB constructs. Next, misinformation that may impact each factor and construct was described. Not all constructs found relevant in the literature (table 2) could be used for a coherent narrative that could fit within ten panels without overwhelming the reader. Next, the element of each comic strip panel was described, having the characters named John and Linda. Finally, the author's intention in each panel was included. The final comic strip is presented in figures 1 to 10.

Table 3

Theoretical Framework Used to Inform the Comic Strip Panels

Panel	**Factor influencing vaccination intention**	**Theoretic Construct**	**Theoretic basis**	**Misinformation**	**Element in the comic**	**Function/author's intention**
1	Seeing close people being vaccinated	Subjective norms	TPB	----------	John is going to take the vaccine	Show Linda that people close to her are being vaccinated
2	The belief that healthy people do not need a vaccine (-) The belief that vaccines do not work (-)	Perceived susceptibility Negative attitudes	HBM TPB	Healthy people have strong immune systems and do not need vaccines If a vaccinated person has COVID-19, then the vaccine does not work	Linda shows disbelief that John is still going to get the vaccine despite having already had COVID Linda says that her mother was infected despite having been vaccinated	Introduce the first of a series of Linda's misunderstandings about the COVID vaccine and John's empathetic and not judgmental reaction.
3	The belief that vaccines do not work (-)	Negative attitudes	TPB	If a vaccinated person has COVID-19, then the vaccine does not work	Linda describes mild symptoms in her vaccinated mother. John says that mild symptoms are a good thing	Show that vaccinated people may be infected but usually show mild symptoms
4	If vaccinated people get infected, it happens because the vaccine is not effective. (-) When vaccinated, people that get COVID-19 usually have mild symptoms (+)	Negative attitudes Perceive benefits	TPB HBM	If a person has COVID-19 despite being vaccinated, the vaccine does not work.	John makes an analogy between getting vaccinated and using a seatbelt	Show that vaccinated people, if infected, have a lower probability of being severely ill

Panel	**Factor influencing vaccination intention**	**Theoretic Construct**	**Theoretic basis**	**Misinformation**	**Element in the comic**	**Function/author's intention**
5	Unvaccinated people have a higher risk of being severely ill and being hospitalized (+)	Perceived susceptibility Perceived severity	HBM	Vaccinated people are more susceptible to getting severely ill.	John makes an analogy between getting vaccinated and using a seatbelt.	Show that unvaccinated people have higher health risks when infected and higher risk of being hospitalized compared to vaccinated ones.
6	Fear about the vaccine being approved so quickly (-)	Perceived barrier Negative attitudes	HBM TPB	The approval of the vaccines was too quick; they are experimental	John explains that all the steps of testing and approval of the vaccine were followed, just like the character's medication approval.	Explain that the vaccine's approval followed the same rules as the approval of essential medicines used by the character
7	Fears about the vaccine being made so quickly and not being safe (-)	Perceived barrier Negative attitudes	HBM TPB	Vaccines were made too fast; they are not safe.	John explains why vaccines could be done so quickly	Show that an unprecedented combination of factors promoted the rapid development of vaccines.

Panel	Factor influencing vaccination intention	Theoretic Construct	Theoretic basis	Misinformation	Element in the comic	Function/author's intention
8	Fear of adverse effects (-)	Perceived Barriers	HBM	The adverse effects of the vaccines are severe.	John explains that adverse effects are due to an expected reaction from the immune system and that they vanish quickly and are usually mild.	Show that not taking the vaccine may be much worse than the side effects of it.
	Being vaccinated is far way less risky than getting COVID-19 (+)	Perceived benefits	HBM	Health risks related to the vaccine are high.		
9	The belief of not having autonomy over being or not vaccinated (-)	Perceived behavior control	TPB	The vaccine is mandatory, and my personal choice does not matter.	John explains that it is up to the character to choose to be or not be vaccinated and that Linda has to think well about the pros and cons.	Explain that choosing to be vaccinated is personal, but that should be an informed decision.
	The perception that one's vaccination option may influence how an important reference person sees him (+)	Subjective norms (normative beliefs)	TPB			Show that important people to them expect you to make informed decisions
10	Being vaccinated may protect vulnerable and significant people (+)	Subjective norms (normative beliefs and motivations to comply)	TPB	My vaccine decision is personal and does not affect anyone	John says that a major motivation to be vaccinated was to protect his students from being infected. Linda thinks about the being vaccinated and then visiting her grandmother without putting her health at risk	Show that one's personal decision may affect the health of people around him.
	Being vaccinated may allow me to see dear vulnerable people (+)	Perceived benefits (+)				

Note. TPB = Theory of Planned Behavior; HBM = Health Belief Model; (-) = negative influence; (+) = positive influence

Figure 1

Panel 1 of the Comic Strip

Figure 2

Panel 2 of the Comic Strip

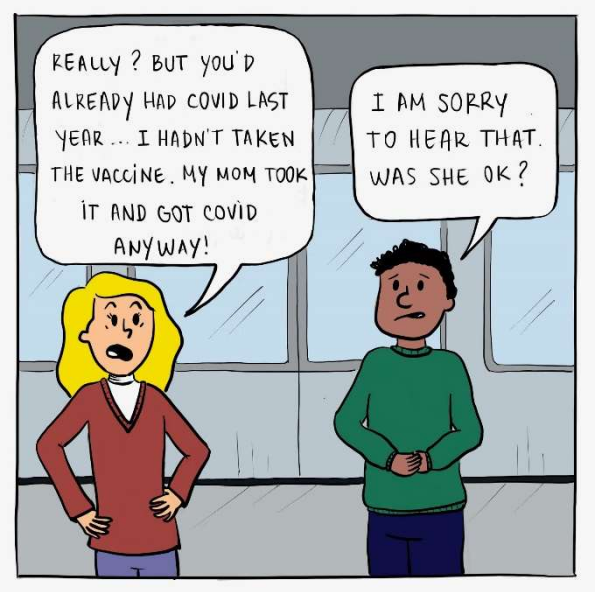


Figure 3

Panel 3 of the Comic Strip

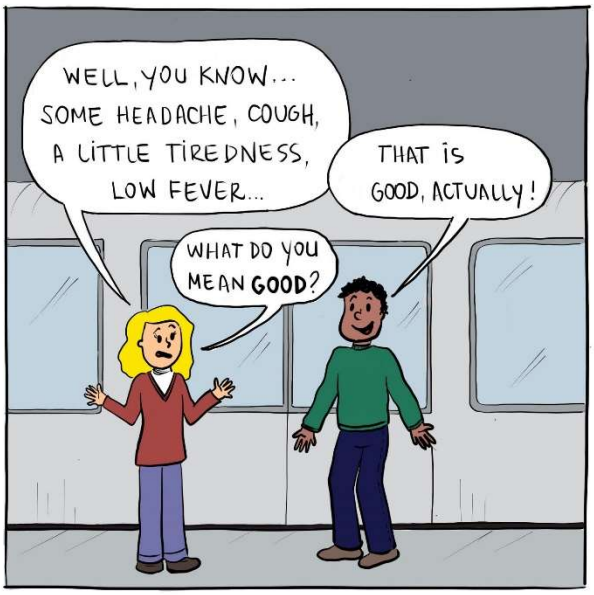


Figure 4

Panel 4 of the Comic Strip

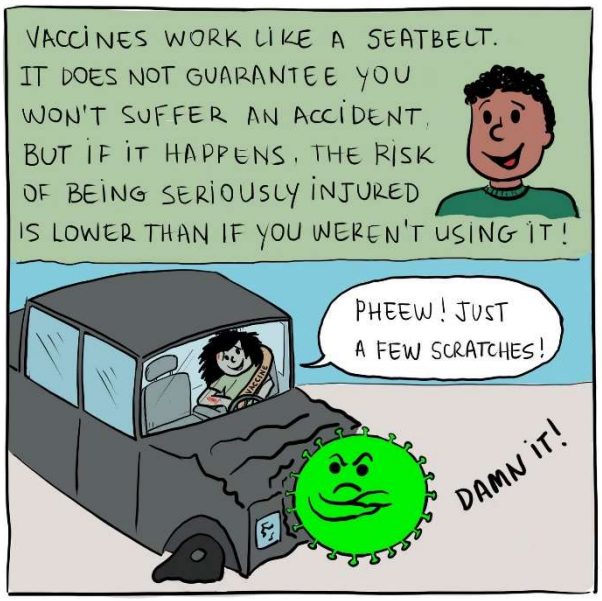


Figure 5

Panel 5 of the Comic Strip

Figure 6

Panel 6 of the Comic Strip

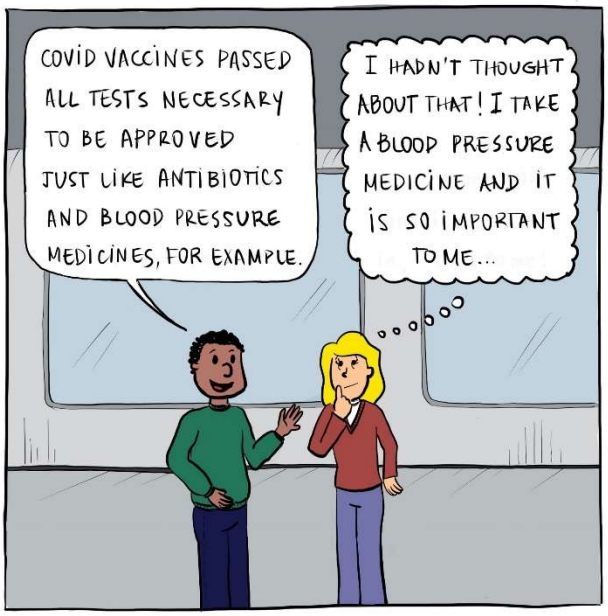


Figure 7

Panel 7 of the Comic Strip

Figure 8

Panel 8 of the Comic Strip

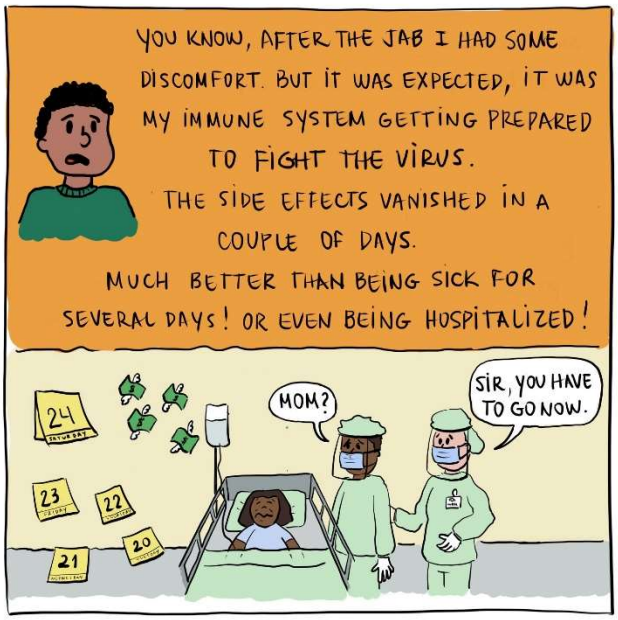


Figure 9

Panel 9 of the Comic Strip

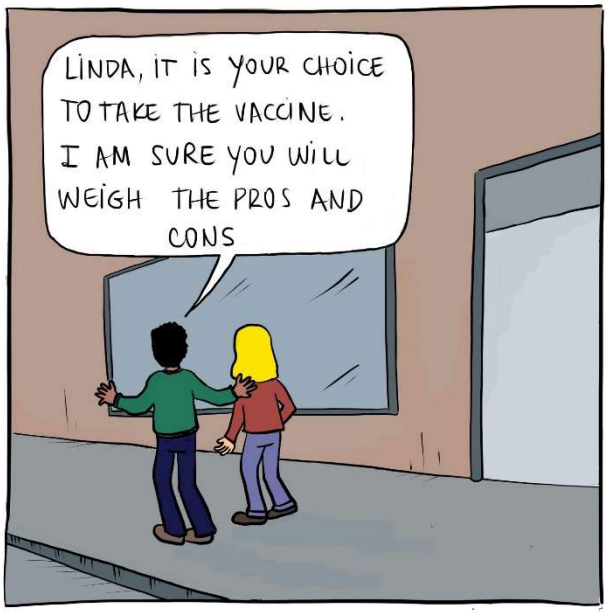
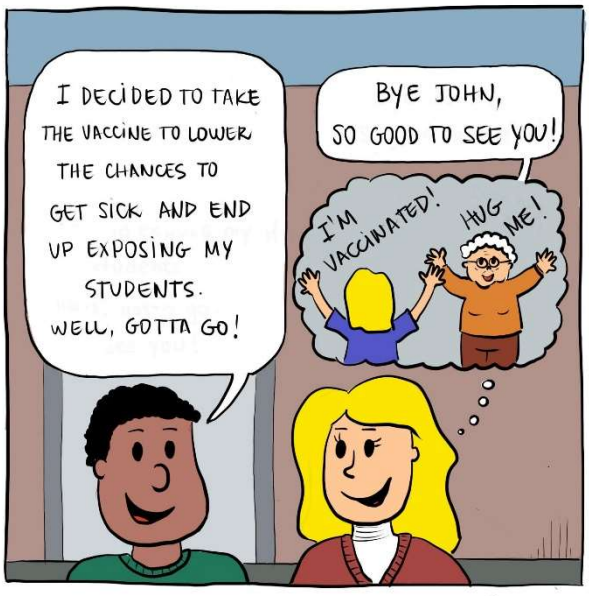


Figure 10

Panel 10 of the Comic Strip



Educational text development

The educational text about COVID-19 vaccines was developed to address the same comic strip topics. It was built using selected parts of texts conveyed online by official health, scientific or governmental agencies, preferably from their social media profiles, such as @who (World Health Organization), @cdcgov (Centers for Disease Control and Prevention), and @hhsgov (U.S. Department of Health & Human Services), from Instagram and World Health Organization Facebook page. When the desirable topics were not available in text form on social media, sentences from official health agencies were used. Furthermore, to exclude a possible effect of extreme differences in attractiveness between the comic strip and the text, the text was also presented using a sequence of panels, attractive colors, and fonts, the format usually posted on social media platforms.

The sentences collected were selected to match the intended message from each panel. Therefore, the pre-selected sentences and the respective comic strip panels matching them are presented as follows:

- Introduction (no specific panel matching):
    - "We are still living with COVID-19. Many people are still getting ill and dying every week" (WHO, Jul 29, 2022; https://www.facebook.com/WHO/photos/a.167668209945237/5687079284670741/?type=3&source=57).
    - "Staying up to date with your COVID-19 vaccine includes a booster for those eligible and provides the most protection from severe COVID-19." (@cdcgov May 3, 2022; https://www.instagram.com/p/CdG8hIiMLjL/).

    - "COVID-19 is continuing to spread. Get all vaccine doses recommended to you as soon as you can to get the best protection." @who; July 10, 2022; https://www.instagram.com/p/Cf1ZXuVtNDS/).
- Panel 2
    - "You should still get vaccinated for COVID-19 even if you have been sick with it before. Reinfection with the virus is possible, and you could get severely ill from COVID-19" (@cdcgov Jan 19, 2021).
    - "Getting vaccinated is a safer way for you to develop immunity against COVID-19 than getting infected and sick" (@who Oct 21, 2021; https://www.instagram.com/p/CVSV23IjR1A/).
    - "Vaccination develops immunity from COVID-19 more effectively than getting infected and sick." (@who, Aug 16, 2021; https://www.instagram.com/p/CSoBrL-DwA6/).
- Panel 3
    - "The vaccine can create mild effects such as headache, fever, and body aches, but these normally go away within a couple of days. Serious side effects are very rare." (@who Aug 30, 2021; https://www.instagram.com/p/CTM7GHGpldu/).
- Panel 4
    - "COVID-19 vaccines help prevent COVID-19 infection, severe illness, and death." (@cdcgov Sep 1, 2021; https://www.instagram.com/p/CTSV-1xDfYA/).

    - "The authorized COVID-19 vaccines are effective at preventing COVID-19, but no vaccine prevents illness 100% of the time. A small percentage of people who are fully vaccinated may still get COVID-19 if they're exposed to the virus that causes it." (@cdcgov Jun 15, 2021; https://www.instagram.com/p/CQJvRt_l0aH/).
- Panel 5
    - "Unvaccinated people have at least ten times higher risk of death from COVID-19 than someone who has been vaccinated" (WHO, Dec 16, 2021, https://m.facebook.com/1632929556995797/photos/a.1665514430403976/3143743345914403/).
- Panel 6
    - "The vaccine can create mild effects such as headache, fever, and body aches, but these normally go away within a couple of days. Serious side effects are very rare." (@who Aug 30, 2021; https://www.instagram.com/p/CTM7GHGpldu/).
    - "Side effects after getting your COVID-19 vaccine are normal and a sign your body is building protection. Compared to vaccine side effects, symptoms from COVID-19 can be wider-ranging and more severe" (@cdcgov Aug 13, 2021; https://www.instagram.com/p/CSha37rDLxd/).
    - "The average hospital stay related to COVID-19 can cost thousands of dollars. A COVID-19 vaccine is free and drops your risk of being hospitalized from COVID-19." (@cdcgov Dec 27, 2021; https://www.instagram.com/p/CX_u9g-M5tm/).

- Panel 7:
    - "It may appear they have been developed very quickly, but researchers around the world have been working hard to develop COVID-19 vaccines from the earliest stages of the pandemic. They have been able to speed up development of vaccines thanks to the collaboration between them, scientists, manufacturers, and distributors. The development and implementation planning phases have been run side-by-side instead of one after the other. This has been made possible because of unprecedented global funding." (https://www.health.gov.au/initiatives-and-programs/covid-19-vaccines/is-it-true/is-it-true-were-covid-19-vaccines-developed-too-quickly-to-be-safe#:~:text=COVID%2D19%20vaccines%20have%20been,earliest%20stages%20of%20the%20pandemic.)
    - "This is the first time so many nations have joined forces to develop a vaccine: Knowledge sharing and the support of the world's scientific community. When it comes to working together, the search for the COVID-19 vaccine is like no other. It is a safe solution developed at speed" (@who, Nov 30, 2020; https://www.instagram.com/p/CIO2L02DeuR/).
- Panel 8:
    - "COVID-19 vaccines are safe and effective." (@cdcgov, Jul 1, 2021; https://www.instagram.com/p/CQyuYWqDGQU/).
    - "COVID-19 vaccines have undergone some of the most intensive safety testing in the U.S. History. Not only are COVID-19 vaccines heavily tested and monitored, but they're also based on years of careful research ensuring

their safety and high effectiveness in the fight against serious illness." (@hhsgov Sep 13, 2021; https://www.instagram.com/p/CTxIn05tf-V/)

- "COVID-19 vaccines were evaluated in tens of thousands of participants in clinical trials." (@hhsgov Sept 17, 2021, https://www.instagram.com/p/CT7bzVUMhPL/)

- Panel 9:
  - "It's normal to have questions about COVID-19 vaccines and want to make the right decision for you and your loved ones." (@who May 28, 2021; https://www.instagram.com/p/CPbAQqXjwSu/).
  - "COVID-19 vaccines are new, and it's normal to have questions about them." (@cdcgov Apr 7, 2021; https://www.instagram.com/p/CNYI5RWlPdz/).
  - "Take charge of your health. Get a COVID-19 vaccine as soon as you can." (@cdcgov Jun 29, 2021; https://www.instagram.com/p/CQt3svFll-m/).
  - "The benefits of a COVID-19 vaccines far outweigh any risks." (@hhsgov Aug 15, 2021; https://www.instagram.com/p/CSmdkj_ASWb/)
- Panel 10:
  - "Getting a COVID-19 vaccine is a way to show your love to your neighbors and community." (@cdcgov Jun 1, 2021 https://www.instagram.com/p/CPlqlLJl-4G/)
  - "Getting a COVID-vaccine is something you can do for your family or neighbor who may be at risk of getting very sick from COVID-19." (@cdcgov Jun 9, 2021; https://www.instagram.com/p/CP58Zbkjs9f/).

The sentences were passed through a second selection process and combined to build a coherent text. In some cases, the sentences were slightly changed to make necessary adaptations and combinations. The first version of the text, using sentences precisely as they appear on social media, showed a Flesh-Kincaid grade level higher than 9. New versions of the text, using shorter synonyms for longer words, more succinct sentences, and less passive voice, were developed until the final version reached a Flesh-Kincaid grade level of 7.3 and a Flesh Reading ease of 61.9. The definitive text was then formatted in 9 panels (figures 11 to 19), the same model adopted by social media platforms to convey their messages.

Figure 11

Panel 1 of the Educational Text

Figure 12

Panel 2 of the Educational Text

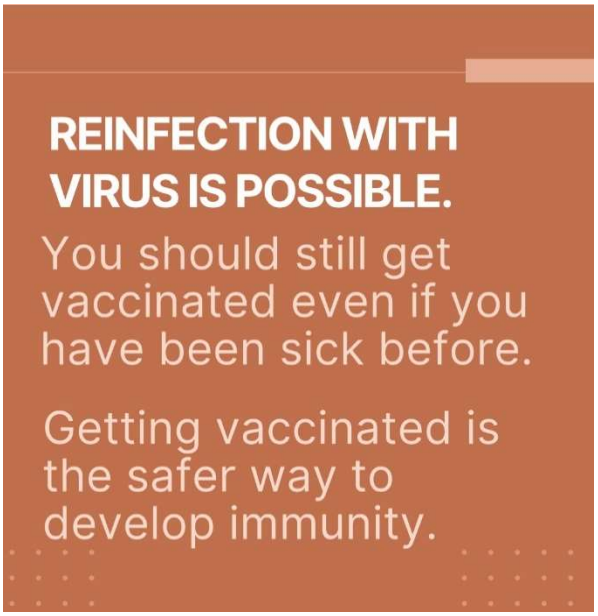


Figure 13

Panel 3 of the Educational Text

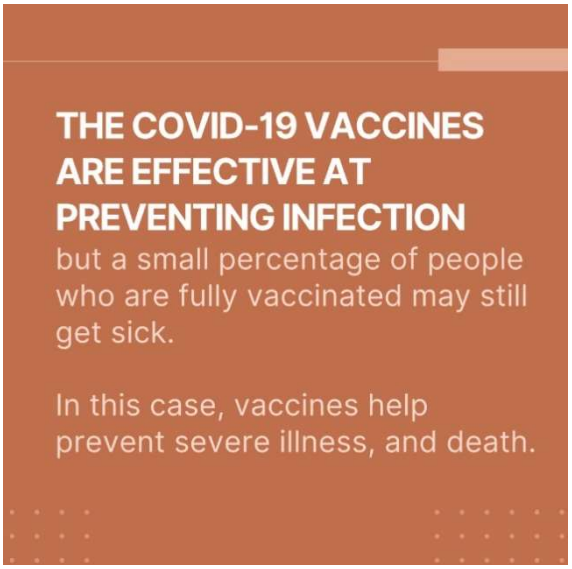


Figure 14

Panel 4 of the Educational Text

Figure 15

Panel 5 of the Educational Text

Figure 16

Panel 6 of the Educational Text

Figure 17

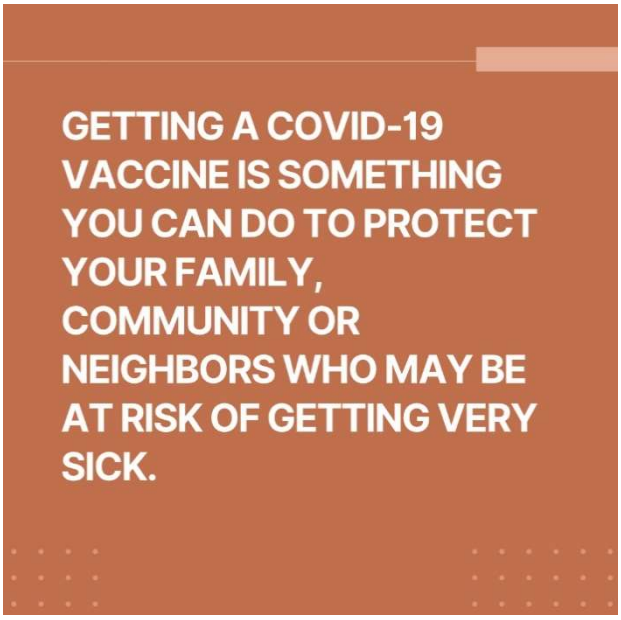
Panel 7 of The Educational Text

Figure 18

Panel 8 of the Educational Text

Figure 19

Panel 9 of the Educational Text



Descriptive Analysis

From 448 individuals who accessed the survey, 163 were excluded from the study for the following reasons: left the survey unanswered, did not meet the selection criteria specified in the screening questionnaire, did not sign the informed consent, or provided incomplete answers for one or more entire sessions. The final sample comprised 285 participants, randomized as follows: 92 in group CS, 96 in group TX, and 97 in group CL.

All numeric variables were tested for normality using Shapiro-Wilk, showing that none have a normal distribution, so non-parametric tests were used for the analysis.

Demographic Characteristics

A Kruskal-Wallis test showed no statistically significant differences in age between groups, χ^2 (2) = 2.15, p = 0.34. (Table 4).

Table 4

Mean Age According to Groups

	CS[1]	TX[2]	CL[3]	Total	χ^2*
Age					
Mean	42.0 (13.4)	42.9 (13.3)	40.4 (12.6)	42.0 (13.1)	2.15
Median	42.7	149.0	43.5	41.0	
Minimum	21	19	20	19	
Maximum	65	65	65	65	

Note. Standard deviations are presented in parentheses; N = 285; [1]Comic Strip group (n = 92), [2]Text group (n = 96), [3]Control group (n = 97).

* Kruskal-Wallis *H* test, $p > 0.05$

In addition, a Chi-Square test of independence between intervention groups and age groups showed no statistically significant association between these two variables (χ^2 (4, N = 285) = 2.57, p = .63) (Table 5).

Table 5

Distribution of the Participants According to Age Groups

Age Groups	CS[1]		TX[2]		CL[3]		Total		χ^2*
	N	%	N	%	N	%	N	%	
18-29	18	19.6%	21	21.9%	27	27.8%	66	23.2%	2.57
30-49	46	50.0%	42	43.8%	42	43.3%	130	45.6%	
50-65	28	30.4%	33	34.4%	28	28.9%	89	31.2%	
Total	92	100.0%	96	100%	97	100.0%	285	100.0%	

Note. N = 285; [1]Comic Strip group, [2]Text group. [3]Control group.

*Person's Chi-Square test for independence, $p > 0.05$

Table 6 describes the remaining demographic characteristics. Chi-Square tests of independence showed no statistically significant association between groups and those variables, attesting to the successful randomization of the sample.

Table 6

Distribution of Participants According to Sociodemographic Characteristics

Demographic Characteristics	CS[1]		TX[2]		CL[3]		Total		χ^2*
	N	%	N	%	N	%	N	%	
Gender									
Male	37	40.2%	29	30.2%	39	40.2%	105	36.8%	3.35
Female	53	57.6%	63	65.6%	56	57.7%	172	60.4%	
Other/ Prefer not to say	2	2.2%	4	4.2%	2	2.1%	8	2.8%	
Ethnicity									
White/ Caucasian	65	70.7%	59	61.5%	59	60.8%	183	64.2%	
Black/ African American	14	15.2%	13	13.5%	15	15.5%	42	14.7%	4.53
Hispanic/ Latino/ Spanish origin	8	8.7%	12	12.5%	12	12.4%	32	11.2%	
Other[4]	5	5.4%	12	12.5%	11	11.3%	28	9.8%	
Educational level									
High school diploma or less	22	23.9%	19	19.8%	28	28.9%	69	24.2%	
Bachelor's degree (e.g., B.A., B.S.)	38	41.3%	44	45.8%	38	39.2%	120	42.1%	2.66
Master's degree or Doctorate	26	28.3%	26	27.1%	24	24.7%	76	26.7%	
other/ prefer not to say	2	2.2%	2	2.1%	1	1.0%	5	1.8%	

Demographic Characteristics	CS[1]		TX[2]		CL[3]		Total		χ^2*
	N	%	N	%	N	%	N	%	
Household income									
Less than $25,000	17	18.5%	19	19.8%	19	19.8%	51	17.9%	
$25,000 - $49,999	18	19.6%	17	17.7%	17	17.7%	51	17.9%	
$50,000 - $99,999	24	26.1%	15	15.6%	15	15.6%	69	24.2%	9.38
$100,000 - $199,999	16	17.4%	25	26.0%	25	26.0%	61	21.4%	
$200,000 or more	11	12.0%	16	16.7%	13	13.4%	40	14.0%	
I do not know/ prefer not to say	6	6.5%	4	4.2%	4	4.2%	13	4.6%	
Political preference or affiliation									
Democrats	45	48.9%	59	61.5%	55	57.3%	159	56.0%	3.76
Republicans	16	17.4%	15	15.6%	17	17.7%	48	16.9%	
Independent and others[5]	31	33.7%	22	22.9%	24	25.0%	77	27.1%	

Note. N = 285; [1]Comic Strip group (n = 92), [2]Text group (n = 96), [3]Control group (n = 97); [4]Other ethnic/ racial groups: American Indian or Alaska Native (n = 3), Asian (n = 18), Middle Easter or North African (n = 5), Other/ multiracial/ do not know/ prefer not to say; [5]Other political preferences/ affiliations: Indigenous (n = 1), Libertarian (n = 2), Non-partisan (n = 1), None (n = 2), Not yet qualified to vote (n = 1), Prefer not to say (n = 1), Progressive/ Green (n = 1), Social-democratic (n = 1), Socialist (n =1).

*Person's Chi-Square test for independence; $p > 0.05$

COVID-19 vaccine concerns scale

Kruskall-Wallis *H* tests showed no statistically significant difference in partial and total scores for COVID-19 Vaccine Concerns Scale (CVCS) (Gregory et al., 2022) between the groups (Table 7). This was expected because the scale was administered before the random administration of the educational tools, which could have influenced CVCS answers if applied before it.

Table 7

CVCS Partial and Total Scores According to Groups

CVCS[1] scores	CS[2]	TX[3]	CL[4]	Total	χ^2*
CVCS1					
Mean	1.85 (1.09)	1.89 (1.20)	2.04 (1.28)	1.93 (1.19)	.935
Median	2.0	1.0	2.0	1.0	
CVCS2					
Mean	1.75 (1.07)	1.85 (1.27)	1.92 (1.30)	1.84 (1.21)	0.311
Median	1.0	1.0	1.0	1.0	
CVCS3					
Mean	2.01 (1.25)	2.10 (1.26)	2.34 (1.37)	2.15 (1.30)	3.142
Median	1.5	2.0	2.0	2.0	
CVCS4					
Mean	2.59 (1.43)	2.55 (1.40)	2.60 (1.40)	2.58 (1.41)	0.045
Median	2.0	2.0	2.0	2.0	
CVCS5					
Mean	2.57 (1.48)	2.60 (1.40)	2.76 (1.40)	2.65 (1.43)	1.139
Median	2.0	3.0	3.0	3.0	
CVCS6					
Mean	1.77 (1.06)	1.90 (1.30)	1.95 (1.15)	1.87 (1.17)	1.367
Median	1.0	1.0	2.0	1.0	
CVCS7					
Mean	1.80 (1.5)	1.87 (1.28)	1.92 (1.19)	1.87 (1.20)	0.490
Median	1.0	1.0	1.0	1.0	
Total score					
Mean	14.34 (6.48)	14.77 (7.33)	15.53 (6.83)	14.89 (6.89)	1.642
Median	14.0	13.0	15.0	14.0	

Note. Standard deviations are presented in parentheses; Total N = 285; [1]COVID-19 Vaccine Concerns Scale (Gregory et al., 2022), [2]Comic Strip group (n = 92), [3]Text group (n = 96),[4]Control group (n = 97).

*Kruskal-Wallis *H* test, $p > 0.05$

Health Literacy

Health literacy was measured using the Single Item Literacy Screener (SILS) (Morris et al., 2006). Higher scores (> 2) indicate a more frequent need for help to read health-related materials. A Kruskall-Wallis *H* test showed no statistically significant difference in SILS scores between groups (χ^2 (2) = .367, p = 0.832) (Table 8). Additionally, a Chi-Squaretest for independence showed no statistically significant association between health literacy level and groups, χ^2 (1, N = 428) = 0.44, p = .505 (Table 9).

Table 8

Single Item Literacy Screener Scores

SILS[1] score	CS[2]	TX[3]	CL[4]	Total	χ^2*
Mean	1.77 (1.04)	1.68 (0.95)	1.82 (1.15)	1.76 (1.05)	
Median	1.0	1.0	1.0	1.0	0.367
Minimum	1.0	1.0	1.0	1.0	
Maximum	5.0	4.0	5.0	5.0	

Note. Standard deviations are presented in parentheses; Total N = 285; [1]Single Item Literacy Screener (Morris et al., 2006), scores range from 1 to 5, higher scores (> 2) indicate more frequent need of help to read health-related materials; [2]Comic Strip group (n = 92), [3]Text group (n = 96),[4]Control group (n = 97).

*Kruskal-Wallis *H* test, p = 0.832

Table 9

Distribution of the Participants According to SILS classification

SILS[1] classification	CS[2]		TX[3]		CL[4]		Total		χ^2*
	N	%	N	%	N	%	N	%	
SILS ≤ 2[5]	71	32.1%	78	35.3%	72	32.6%	221	77.5%	0.500
SILS > 2[6]	21	32.8%	18	28.1%	25	39.1%	64	22.5%	

Note. Total N = 285; [1]Single Item Literacy Screener (Morris et al., 2006); [2]Comic Strip group (n = 92), [3]Text group (n = 96),[4]Control group (n = 97), [5]Participants who declared that never or rarely need help reading health-related materials. [6]Participants who declared that often or always need help reading health-related materials.

*Persons Chi-Square test for independence, $p > 0.05$

Digital Health Literacy

Digital health literacy was measured using three items from the eHealth Literacy Scale (eHEALS) (Norman & Skinner, 2006). Kruskal-Wallis tests showed no statistically significant difference between eHEALS items and total scores between groups (Table 10)

Table 10

Digital Health Literacy Partial and Total Score According to Groups

eHEALS[1] scores	CS[2]	TX[3]	CL[4]	Total	χ^2*
eHEALS1[5]					
Mean	4.07 (0.92)	4.27 (.70)	4.25 (0.91)	4.20 (0.85)	0.222
Median	4	4	4	4	
eHEALS2[6]					
Mean	4.08 (0.86)	4.22 (0.71)	4.22 (0.90)	4.17 (0.83)	0.307
Median	4	4	4	4	
eHEALS3[7]					
Mean	3.97 (0.91)	4.26 (0.76)	4.14 (0.92)	4.13 (0.93)	0.261
Median	4	4	4	4	
Total score					
Mean	12.11 (2.46)	12.75 (1.90)	12.61 (2.56)	12.49 (2.33)	0.122
Median	12	12	13	12	

Note. Standard deviations are presented in parentheses; Total N = 285; [1]Three selected items from the Health Literacy Scale (eHEALS) (Norman & Skinner, 2006), scores ranging from 1 to 5, with higher scores indicating higher digital health literacy, [2]Comic Strip group (n = 92), [3]Text group (n = 96),[4]Control group (n = 97).

[5]"I know where to find helpful health resources on the Internet", [6] "I know how to use the health information I find on the Internet to help me", [7]"I have the skills I need to evaluate the health resources I find on the Internet".

*Kruskal-Wallis H test coefficient, Chi-square, $p > 0.05$.

Trust in Health Organizations, Government Institutions, and Scientists

Levels of trust in health-related information posted on social media by official health organizations, government institutions, and scientists are described in table 11. There were no differences between groups.

Table 11

Trust in Health Authorities According to Groups

Trust[1] scores	CS[2]	TX[3]	CL[4]	Total	χ^2*
Health Organizations[5]					
Mean	3.97 (1.00)	3.93 (1.09)	4.03 (1.04)	3.98 (1.04)	0.561
Median	4	4	4	4	
Government Institutions[6]					
Mean	3.91 (0.93)	3.94 (1.10)	3.81 (1.03)	3.89 (1.03)	1.510
Median	4	4	4	4	
Scientists[7]					
Mean	4.03 (7.33)	3.91 (0.96)	3.89 (0.97)	3.94 (0.90)	0.596
Median	4	4	4	4	

Note. Standard deviations are presented in parentheses; Total N = 285; [1]Trust in health-related information posted on social media pages of health authorities and scientists; scores range from 1 to 5, with higher scores representing higher levels of trust, [2]Comic Strip group (n = 92), [3]Text group (n = 96),[4]Control group (n = 97).

[5]I trust health information posted on social media profiles of official health organizations (such as WHO- World Health Organization, AMA- American Medical Association, UNICEF- United

Nations International Children's Emergency Fund, APHA- American Public Health Association, etc.), [6]I trust health information posted on social media pages or profiles of official government organizations (CDC – Centers for Disease Control and Prevention, NIH – National Institutes of Health, HHS- U.S. Department of Health and Human Services, FDA – U.S. Food and Drug Administration, etc.), [7]I trust health information that comes from scientists.

*Kruskal-Wallis *H* test coefficient, $p > 0.05$

Social Media Use

Two items from the Social Media Use Integration Scale (SMUIS) (Jenkins-Guarnieri et al., 2013) were used to evaluate the use of social media intensity. Kruskall-Wallis *H* tests showed no statistically significant difference in items and total scores between groups (Table 12).

Table 12

Partial and Total Scores of Social Media Use Intensity

SMUIS[1] scores	CS[2]	TX[3]	CL[4]	Total	χ^2*
SMUIS1[5]					
Mean	3.70 (1.05)	3.66 (1.05)	4.03 (1.04)	3.74 (1.05)	2.970
Median	4	4	4	4	
SMUIS2[6]					
Mean	4.33 (0.70)	4.28 (0.86)	4.29 (0.91)	4.30 (0.83)	0.199
Median	4	4	4	4	
Total score					
Mean	8.02 (1.47)	3.91 (0.96)	3.89 (0.97)	8.04 (1.62)	2.525
Median	8	8	9	8	

Note. Standard deviations are presented in parentheses; Total N = 285; [1] Social media use intensity measured by two items from the Social Media Use Integration Scale (SMUIS) (Jenkins-Guarnieri et al., 2013), scores range from 1 to 5, with higher scores representing higher intensity, [2]Comic Strip group (n = 92), [3]Text group (n = 96), [4]Control group (n = 97).

[6]"Using social media is part of my everyday routine.", [7]"Social media plays an important role in my relationships."

*Kruskal-Wallis *H* test, $p > 0.05$

Besides the SMUIS items, two additional questions were used to assess social media use (table 13). Kruskal-Wallis *H* tests showed no statistically significant difference in scores between

groups (χ^2 (2) = 1.279, p = 0.527 and χ^2 (2) = 0.782, p = 0.676) for questions 1 and 2, respectively).

Table 13

Scores of Social Media Use Questionnaire

SM[1] scores	CS[2]	TX[3]	CL[4]	Total	χ^2*
SM1[5]					
Mean	2.76 (1.05)	2.81(1.18)	2.95 (1.11)	2.84 (1.12)	1.279
Median	3	4	3	3	
SM2[6]					
Mean	2.96 (0.93)	2.80 (0.846)	2.89 (0.82)	2.88 (0.86)	0.782
Median	3	3	3	3	

Note. Standard deviations are presented in parentheses; Total N = 285; [1]Social Media use questions, with answers ranging from "never" to "always", coded 1 to 5, respectively)

[2]Comic Strip group (n = 92), [3]Text group (n = 96), [4]Control group (n = 97).

[6]"Do you use one or more social media platforms to get health-related information?"

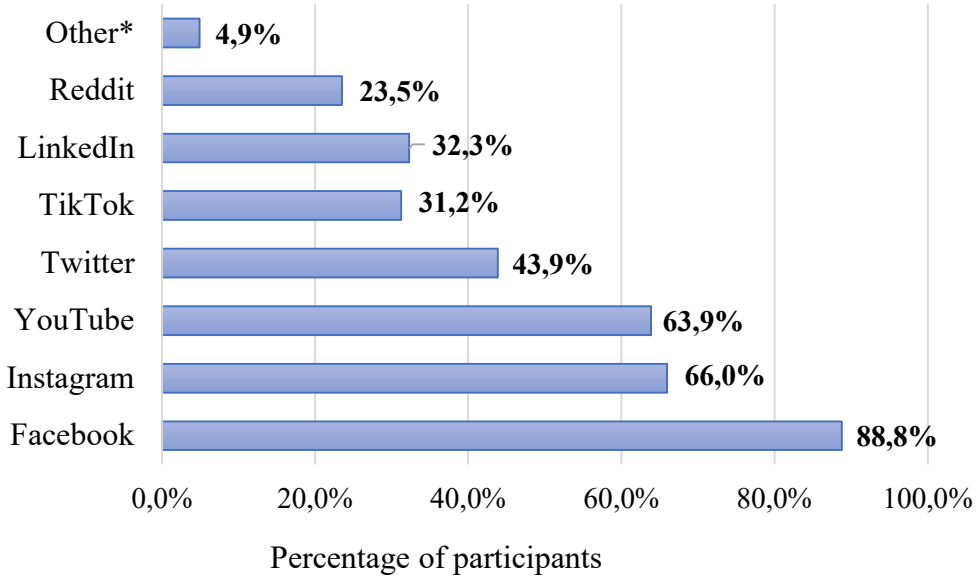
[7]"Do you trust health information on social media?"

*Kruskal-Wallis *H* test, $p > 0.05$

Figure 20 shows the percentage of participants that use each social media platform described.

Figure 20

Social Media Platforms Used



Note. *Other = Tumblr, Pinterest, Snapchat, Quora, Fediverse, Cohost, Rockfin,

Vaccination History

The vaccination history questionnaire assessed participants who were fully or partially vaccinated, who were not vaccinated at all, who took the booster shot, who still have plans to be vaccinated, and who would accept being annually vaccinated if recommended.

Table 14 describes the response frequencies for each question according to groups. Again, a Chi-Square test for independence resulted in no association between those frequencies and groups.

Table 14

Vaccination History and Intentions Responses According to Groups

Vaccination History and Intentions	CS[1]		TX[2]		CL[3]		Total		χ^2
	N	%	N	%	N	%	N	%	
Vaccination history									
One dose of a 2-dose vaccine	18	19.6	24	25.0	16	16.5	58	20.9	
Fully vaccinated	64	69.6	59	61.5	68	70.1	191	66.6	
Had not taken, although recommended	5	5.4	8	8.3	10	10.3	23	7.8	
Vaccine was contraindicated	2	2.2	2	2.1	1	1.0	5	1.7	4.563
I had not taken it because I did not know if recommend	3	3.3	3	3.1	2	2.1	8	3.0	
Vaccination Booster									
At least one COVID-19 booster shot	60	65.2	60	62.5	60	61.9	180	63.2	
Had not taken, although recommended	24	26.1	26	27.1	23	23.7	73	25.6	
I had not taken it because I did not know if recommend	8	8.7	10	10.4	14	14.4	32	11.2	1.790

Vaccination History and Intentions	CS[1]		TX[2]		CL[3]		Total		χ^2*
	N	%	N	%	N	%	N	%	
Vaccination Plans									
Yes	27	29.3	26	26.0	23	23.7	75	26.3	
No	8	8.7	18	17.7	19	19.6	44	15.4	
I do not know/ I am not sure	10	10.9	8	8.3	10	10.3	28	9.8	5.251
Not applicable; I have already been vaccinated	47	51.1	46	47.9	45	46.4	138	48.4	
Annual vaccination plans									
Yes	54	58.7	58	60.4	52	53.6	164	57.5	
No	15	16.3	22	22.9	19	19.6	56	19.6	3.926
I do not know/ I am not sure	23	25.3	16	16.7	26	26.8	65	22.8	

Note. Total N = 285; [1]Comic Strip group (n = 92), [2]Text group (n = 96), [3]Control group (n = 97).

*Persons' Chi-Square test for independence, $p > 0.05$.

Within-group comparisons were performed, between categories of each demographic variable, for scores of the following independent variables: CVCS (COVID-19 Vaccine Concerns Scale), health literacy (SILS), digital health literacy (eHEALS), transportation into the narrative, trust in health organizations, trust in government health institutions, trust in scientists, Social Media Use Intensity (SMUIS), use of social media to find health information, and trust in health information coming from social media.

In group CS, statistically significant differences were:

- Between age categories:
    - CVCS was lower in the 50-65 y group (11.29 (4.77), *Mdn* = 9) than in 30-49 y group (16.15 (7.11), *Mdn* = 15) ($\chi^2(2) = 17.734$, $p = 0.016$),
    - SILS was lower in 50-65 y group (1.29 (0.46), *Mdn* = 1) than in 30-49 y group (1.96 (1.13), *Mdn* =1.50) ($\chi^2(2) = 14.259$, $p = 0.041$)
    - Use of social media to find health information was higher in age group 18 – 29 y (3.61 (0.85), *Mdn* = 4) than age groups from 50 – 65 y (2.64 (1.03), *Mdn* = 3) and 30 – 49 y (2.50 (0.98), *Mdn* = 2) ($\chi^2(2) = 22.843$, p = 0,010, and $\chi^2(2) = 27.318$, $p = 0.000$, respectively)
    - Trust in health information coming from social media was higher in the age group from 18 -29 y (2.80 (0.96), *Mdn* = 3) than for the age group from 50 -65 y (2.61 (0.74), *Mdn* = 3)($\chi^2(2) = 19.655$, p = 0,025).
- Between gender categories:
    - Transportation into the narrative total score was higher in men (7.30 (1.76), *Mdn* = 7.00) than in women (6.06 (2.11), *Mdn* = 6.00) ($\chi^2(2) = 16.553$, p = 0,010)
- Between political affiliation categories:

- CVCS was lower for democrats (11.89 (5.50), *Mdn* = 10) than for independent and others (15.58 (6.44), *Mdn* = 15) ($\chi^2(2) = -15.535$, $p = 0.037$) and than for republicans (18.81 (6.35), *Mdn* = 18) ($\chi^2(2) = -27.975$, $p = 0{,}001$)
- Trust in health information coming from health organizations was higher for democrats (4.36 (0.65), *Mdn* = 4) than for independent and others (3.74 (1.06), *Mdn* = 4) ($\chi^2(2) = 15.112$, $p = 0.027$) and than for republicans (3.31 (1.19), *Mdn* = 3.50) ($\chi^2(2) = 25.154$, $p = 0{,}001$)
- Trust in health information coming from governmental institutions was higher for democrats (4.22 (0.67), *Mdn* = 4) than for republicans (3.35 (1.13), *Mdn* = 3.5) ($\chi^2(2) = 24.452$, $p = 0{,}001$)

In group TX, statistically significant differences were:

- Between age categories:
  - Health literacy was higher in 50-65 y group (1.30 (0.53), *Mdn* =1) than in 18 – 29 y group (1.95 (0.97), *Mdn* = 2) ($\chi^2(2) = 1.792$, $p = 0.030$)
  - Trust in health information coming from health organizations was lower in 50 - 65 y group (3.67 (1.,14), *Mdn* = 4) than in 18 – 29 y group (4.48 (0.75), *Mdn* = 5) ($\chi^2(2) = 20.764$, $p = 0.014$)
  - Use of social media to seek health information lower in 50-65 y group (2.42 (1,03), *Mdn* = 3) than in 30 – 49 y group (3.17 (1,27), *Mdn* = 3) ($\chi^2(2) = 15.929$, $p = 0.033$)
- Between gender categories:
  - CVCS was higher in male (19.8 (7.6), *Mdn* = 18) than in female participants (12.9 (6.2), *Mdn* = 11) ($\chi^2(2) = 24.884$ $p = 0{,}000$)

- Between political affiliation categories:
    - CVCS was lower for democrats (12.47 (6.25), *Mdn* = 11) than for independent and others (16.77 (6.60), *Mdn* = 17.5) ($\chi^2(2) = -18.325$, $p = 0.024$) and than for republicans (20.87 (8.34), *Mdn* = 21) ($\chi^2(2) = -29.313$, $p = 0{,}001$)
    - Trust in health information coming from governmental institutions was higher for democrats (4.22 (1.00), *Mdn* = 4) than for republicans (3.33 (1.75), *Mdn* = 4) ($\chi^2(2) = 22.281$, $p = 0{,}010$) and than for independent and others (3.59 (1.10), *Mdn* = 4) ($\chi^2(2) = -17.018$, $p = 0.029$)

In group CL, statistically significant differences were:

- Between age categories:
    - Health literacy was higher in 50-65 y group (1.36 (0.78), *Mdn* =1) than in 30 -49 y age group (2.12 (1.35), *Mdn* = 1) ($\chi^2(2) = 15.762$, $p = 0.031$)
- Between gender categories:
    - CVCS was higher in male (18.31 (7.89), *Mdn* = 17) than in female participants (13.8 (5.35), *Mdn* = 12.5) ($\chi^2(2) = 15.483$, $p = 0{,}024$)
- Between political affiliation categories:
    - CVCS was lower for democrats (13.85 (6.45), *Mdn* = 12) than for republicans (18.53 (6.40), *Mdn* = 19) ($\chi^2(2) = -21.117$, $p = 0{,}018$)
    - Trust in health information coming from health organizations was higher for democrats (4.44 (0.69), *Mdn* = 5) than for republicans (3.67 (1.20), *Mdn* = 4) ($\chi^2(2) = 30.4555$, $p = 0{,}000$)
    - Trust in health information coming from governmental institutions was higher for democrats (4.20 (0.73), *Mdn* = 4) than for republicans (3.47 (0.94), *Mdn* = 4)

($\chi^2(2) = 19.264$, $p = 0{,}023$) and than for independent and others (3.13 (1.26), *Mdn* = 3) ($\chi^2(2) = 25.409$, $p = 0.000$)

Misinformation identification

Misinformation identification was one of the two outcomes of interest in this study. The percentage of correct misinformation identification scores (%MI) was calculated for each participant, and then a mean %MI was calculated for each group and the total sample. A Kruskal-Wallis *H* test showed no statistical difference in the %MI between groups, χ^2 (2) = 1.960, p = 0.375 (Table 15). Table 16 shows the distribution of answers for each of the questionnaire's statements. Chi-Square test for independence showed no relationship between each answer's distributions and groups.

Table 15

Misinformation Identification Scores

%MI[1]	CS[2]		TX[3]		CL[4]		Total		χ^2*
	nca	%MI	nca	%	nca	%	nca	%	
Mean	8.46	84.6	8.44	80.9	8.15	81.6	8.35	83.5	
SD[5]	(1.77)	(17.7)	(1.73)	(17.3)	(1.83)	(18.3)	(1.78)	(17.8)	
Median	9	90	9	90	9	90	9	90	1.96
Minimum	4	40	3	30	1	10	1	10	
Maximum	10	100	10	100	10	100	10	100	

Note. Total N = 285; [1]Score for the percentage of correct answers for the Misinformation Identification Questionnaire, nca = number of correct answers; [2]Comic Strip group (n = 92),

[3]Text group (n = 96),[4]Control group (n = 97). [5]Standard deviations (presented between parentheses).

*Kruskall- Wallis test $H,$, $p > 0.05$.

Table 16

Frequencies of Answers for the Misinformation Identification Questionnaire

Statements[1]	CS[1]		TX[2]		CL[3]		Total		χ^2*
	N	%	N	%	%	%	N	%	
Statement 1									
True	9	9.8%	13	13.5%	17	17.5%	39	13.7%	2.40
False	**83**	**90.2%**	**83**	**86.5%**	**80**	**82.5%**	**246**	**86.3%**	
Statement 2									
True	15	16.3%	10	10.4%	23	23.7%	48	16.8%	6.20
False	**77**	**83.7%**	**86**	**89.6%**	**74**	**76.3%**	**237**	**83.2%**	
Statement 3									
True	**86**	**93.5%**	**86**	**89.6%**	**87**	**89.7%**	**259**	**90.9%**	1.11
False	6	6.5%	10	10.4%	10	10.3%	26	9.1%	
Statement 4									
True	**87**	**94.6%**	**90**	**93.8%**	**91**	**93.8%**	**268**	**94.0%**	0.68
False	5	5.4%	6	6.3%	6	6.2%	17	6.0%	
Statement 5									
True	29	31.5%	19	19.8%	27	27.8%	75	26.3%	3.51
False	**63**	**68.5%**	**77**	**80.2%**	**70**	**72.2%**	**210**	**73.7%**	
Statement 6									
True	**80**	**87.0%**	**88**	**91.7%**	**82**	**85.4%**	**250**	**88.0%**	1.93
False	12	13.0%	8	8.3%	14	14.6%	34	12.0%	
Statement 7									
True	13	14.1%	21	21.9%	18	18.6%	52	18.2%	1.90
False	**79**	**85.9%**	**75**	**78.1%**	**79**	**81.4%**	**233**	**81.8%**	

Statements[1]	CS[2]		TX[3]		CL[4]		Total		χ^2*
	N	%	N	%	%	%	N	%	
Statement 8									
True	**84**	**91.3%**	**83**	**86.5%**	**84**	**86.6%**	**251**	**88.1%**	1.35
False	8	8.7%	13	13.5%	13	13.4%	34	11.9%	
Statement 9									
True	**78**	**84.8%**	**84**	**87.5%**	**85**	**87.6%**	**247**	**86.7%**	0.42
False	14	15.2%	12	12.5%	12	12.4%	38	13.3%	
Statement 10									
True	31	33.7%	38	39.6%	38	39.2%	107	37.5%	0.86
False	**61**	**66.3%**	**58**	**60.4%**	**59**	**60.8%**	**178**	**62.5%**	

Note. Total N = 285; [1]Statements of the questionnaire, [2]Comic Strip group (n = 92), [3]Text group (n = 96),[4]Control group (n = 97). Correct answers in bold.

[1]Statements of the questionnaire (APPENDIX F)

*Kruskal - Wallis test H, $p > 0.05$.

Mean %MI was calculated for each category of demographic factors. According to demographic characteristics between groups, Kruskal-Wallis *H* tests showed no difference in %MI (Table 17).

Table 17

Scores of Correct Identification of Misinformation According to Demographic Characteristics

Demographic characteristics	CS[1]		TX[2]		CL[3]		TOTAL		χ^{2}*
	Mean (*SD*) (%)	Median (%)	Mean (*SD*) (%)	Median (%)	Mean (*SD*) (%)	Median (%)	Mean (*SD*) (%)	Median (%)	
Age group									
18 -29	76,7 (19.4)	70	83.8 (16.9)	90	79.3 (17.5)	80	80.0 (17.8)	85	1.226
30 – 49	83.5 (18.2)	90	81.9 (19.0)	90	80.7 (17.9)	90	82.1 (18.2)	90	0.704
50 -65	91.4 (13.3)	100	87.9 (14.9)	90	85.0 (19.9)	90	88.1 (16.2)	90	1.878
Gender									
Female	88.9 (17.2)	100	87.9 (15.2)	90	85.4 (16.3)	90	87.2 (16.0)	90	2.221
Male	77.6 (16.6)	80	75.2 (19.0)	80	75.1 (19.6)	75	75.4 (18.4)	80	0.216
Other/ Prefer not to say	100.0 (0.00)	100	95.0 (10.0)	100	100.0 (00.0)	100	97.5 (7.10)	100	1.000
Ethnicity									
White/ Caucasian	85.6 (18.8)	90	86.4 (15.6)	90	81.7 (20.3)	90	77.4 (16.9)	80	1.824
Black/ African American	80.0 (14.7)	80	77.7 (23.2)	90	75.3 (13.6)	70	85.0 (17.3)	90	0.941
Hispanic / Latino	85.0 (17.7)	90	77.5 (20.9)	80	91.7 (11.9)	95	84.3 (13.6)	90	2.796
Other[4]	84.7 (19.2)	90	85.9 (15.7)	90	81.1 (20.3)	90	83.9 (18.5)	90	3.540
Educational level									
High school or less	84.1 (18.9)	90	87.4 (17.3)	90	78.6 (17.8)	80	82.6 (18.1)	90	3.381
Bachelor's degree	85.8 (15.5)	90	80.2 (17.6)	90	78.4 (16.7)	80	80.7 (17.1)	90	3.486
Master's degree	82.7 (20.0)	90	89.4 (15.0)	100	90.7 (13.4)	90	86.5 (17.1)	90	0.847
Doctorate or higher	82.5 (12.6)	80	95.0 (8.40)	100	96.7 (8.20)	100	92.5 (10.6)	100	4.313
Other/ prefer not to say	95.0 (7.10)	95	70.0 (28.3)	70	100.0 (0.00)	100	68.0 (37.7)	90	3.053

Demographic characteristic	CS[1]		TX[2]		CL[3]		TOTAL		χ^2*
	Mean (*SD*) (%)	Median (%)	Mean (*SD*) (%)	Median (%)	Mean (*SD*) (%)	Median (%)	Mean (*SD*) (%)	Median (%)	
Household income									
Less than $25,000	85.9 (16.6)	90	83.2 (14.2)	90	76.0 (16.8)	70	81.3 (16.1)	80	2.783
$25,000-$49,999	85.6 (20.1)	90	85.9 (17.7)	90	76.9 (22.7)	80	82.9 (20.2)	90	2.937
$50,000 - $99,999	82.1 (18.6)	90	82.7 (21.2)	90	83.0 (15.2)	90	81.8 (18.1)	90	0.131
$100,000 - $199,999	84.4 (19.3)	90	83.6 (18.7)	90	79.0 (20.7)	85	82.7 (19.2)	90	0.758
$200,000 - $299,999	87.1 (13.8)	90	92.0 (7.90)	90	93.8 (9.20)	100	91.2 (10.1)	90	1.188
$300,000 or more	77.5 (18.9)	85	82.9 (19.8)	90	85.0 (20.7)	95	82.4 (18.9)	90	0.947
I don't know/ prefer not to say	87.1 (13.8)	90	80.0 (21.6)	85	93.3 (5.80)	90	86.4 (15.0)	90	0.801
Political affiliation									
Democrat	84.2 (16.9)	90	88.0 (16.3)	90	85.8 (15.1)	90	86.0 (16.0)	90	1.436
Republican	77.5 (22.7)	80	75.3 (17.7)	80	76.5 (20.0)	80	75.9 (20.0)	80	0.132
Independent and Others[5]	88.7 (15.2)	90	80.9 (17.4)	80	75.8 (22.1)	80	81.9 (18.5)	90	6.139

Note. Standard deviations are presented in parentheses. N = 285; [1]Comic Strip group (n = 92), [2]Text group (n = 96), [3]Control group (n = 97); [4]Other ethnic/ racial groups: American Indian or Alaska Native (n = 3), Asian (n = 18), Middle Easter or North African (n = 5), Other/ multiracial/ do not know/ prefer not to say; [5]Other political preferences/ affiliations: Indigenous (n = 1), Libertarian (n = 2), Non-partisan (n = 1), None (n = 2), Not yet qualified to vote (n = 1), Prefer not to say (n = 1), Progressive/ Green (n = 1), Social-democratic (n = 1), Socialist (n =1).

*Kruskal-Wallis *H* test, $p > 0.05$

Among participants with low health literacy levels, identified by the SILS (Morris et al., 2006), Kruskal-Wallis tests showed no difference in %MI scores between groups. (χ^2 (2) = .339, p = 0.844); (Table 18). Also, there were no differences between normal health literacy participants from each group χ^2 (2) = 1.294, p = 0.524). However, when using a Mann-Whitney *U* test to compare %MI scores of low health literacy participants with scores of normal health literacy participants within each group, low health literacy individuals showed lower %MI scores than normal health literacy level participants only in group TX (Md = 90, n =78 and Md = 80, n = 18, for low and normal health literacy, respectively; *U* = 477,5, z = -2.184, p = .029, r = 0.10)

Table 18

Misinformation Identification Scores According to Health Literacy levels

Health Literacy Level[1]	CS[2]	TX[3]	CL[4]	Total	χ^2*
Low					
Mean (*SD*)	78.6% (19.8)	76,1% (20.3)	76.4% (17.5)	77.0% (18.8)	0.339
Median	80%	80%	80%	80%	
Normal					
Mean (*SD*)	86.3 (16.8)	86.3% (16.0)	83.3% (18.4)	85,3% (17.0)	1.294
Median	90%	90%	90%	90%	

Note. N = 285; Standard deviations presented in parentheses; [1]Low literacy level = Individuals who need help reading printed health-related material, determined by the Single Item Literacy Screener (SILS) (Morris et al., 2006), (scores >2, answers "sometimes" (scores 3), "often"

(scores 4), and "always" (score 5)). [2]Comic Strip group (n = 21), [3]Text group (n = 18), [4]Control group (n = 25).

* Kruskal-Wallis *H* test, $p > 0.05$

Table 19 shows mean %MI scores per group according to the answers to the vaccine history and intentions questions. Again, Kruskal-Wallis *H* tests did not find differences in mean MI% scores between groups for each answer.

However, when Kruskall-Wallis *H* tests compared %MI of individuals vaccine-hesitant or refusers, partially and fully vaccinated in each group, there was a statistically significant different found in group CS, but not in groups TX and CL: %MI was higher in fully vaccinated (87.1 (15,3), *Mdn* = 90) than in vaccine hesitant/refusers (80 (15.1), *Mdn* = 80) ($\chi 2$ (4) = 11,725, $p = 0.020$). It is worth it to mention that the number of vaccine hesitant/ refusers was disproportionally lower than the number of fully vaccinated, both in the total sample (23 *vs*. 191, respectively) and in each group.

Table 19

Misinformation Identification Scores According to Vaccination History and Intentions

Vaccination history and intentions	CS[1]		TX[2]		CL[3]		TOTAL		χ^2*
	Mean (*SD*) %	Median %	Mean (*SD*) %	Median %	Mean (*SD*) %	Median %	Mean (*SD*) %	Median %	
Vaccination history									
Partially vaccinated[4]	80.0 (17.6)	80	84.0 (17.3)	90	79.4 (17.6)	85	81.5 (17.4)	85	1.039
Fully vaccinated[5]	82.0 (16.7)	90	86.9 (15.4)	90	84.1 (17.1)	90	86.0 (16.1)	90	2.146
Chose not to take it[6]	62.0 (13.0)	60	80.0 (15.1)	80	73.0 (27.1)	85	73.0 (21.2)	80	3.542
Booster vaccine history									
Yes, I had taken it	88.7 (14.3)	90	89.4 (14.8)	100	86.1 (16.7)	90	88.1 (15.3)	90	1.158
No, chose not to take it	74.0 (19.4)	70	80.7 (14.9)	80	74.0 (19.6)	80	76.4 (18.1)	80	2.104
No, I did not know if it was recommended	78.9 (24.2)	90	62.0 (18.1)	60	74.0 (17.2)	70	71.8 (20.1)	70	3.833
Plans to be vaccinated if still hasn't been									
Yes	77.0 (17.3)	80	81.9 (18.1)	85	74.8 (15.8)	80	77.9 (17.2)	80	2.667
No	74.4 (20.7)	80	73.9 (18.5)	80	72.6 (19.1)	80	73.5 (18.8)	80	0.077
Don't know/ not sure	77.3 (22.0)	80	75.0 (18.5)	75	69.0 (26.0)	65	73.8 (22.1)	80	0.458
Plans to be vaccinated annually if recommended									
Yes	87.6 (16.2)	90	89.5 (15.4)	100	84.6 (16.6)	90	87.3 (16.1)	90	3.479
No	77.1 (16.9)	80	77.7 (16.6)	80	73.2 (18.9)	80	76.0 (17.3)	80	0.631
Don't know/ not sure	80.4 (20.5)	85	75.8 (18.0)	80	80.4 (19.9)	85	79.2 (19.5)	80	1.196

Note. Standard deviations are presented in parentheses. N = 285; [1]Comic Strip group (n = 92), [2]Text group (n = 96), [3]Control group (n = 97); [4]Took one of a 2-dose COVID-19 vaccine, [5]Took two of a 2-dose or a monodose COVID-19 vaccine, [6]Had not taken the vaccine, although recommended and available.

* Kruskal-Wallis *H* test, $p > 0.05$

Table 20 describes Spearman's coefficients and level of significance for correlations between misinformation identification score (%MI) and scores from scales and questionnaires according to groups. MI% was not correlated to any of the components of the educational tools' evaluation (attractiveness of the educational instrument, perceived usefulness in helping identify misinformation, trust in the information provided by the educational instrument, willingness to share or repost the educational material on social media, and acceptance of the educational instrument). Health literacy measured by the Single Item Literacy Screener (SILS) (Morris et al., 2006)) and concerns regarding the COVID-19 vaccine (CVCS) (Gregory et al., 2022) were negatively correlated to %MI in the three groups (CS, TX, and CL). In other words, the higher the difficulty in reading healthy-related materials, the lower the score for correct misinformation identification percentage (%MI). Digital health literacy scale (eHEALS) (Norman & Skinner, 2006) partial score was positively and statistically correlated to %MI only in groups CS and TX, but not in the control group (CL). Trust in health-related information posted by scientists on social media was negatively correlated to %MI in the three groups. Trust in the information posted by government institutions was positively correlated to %MI in groups TX and CL but not in CS. Trust in health-related information posted by official health organizations was positively correlated to %MI only in the TX group. All statistically significant correlations were small to medium, except for medium to large correlations between CVCS and %MI scores.

Table 20

Correlations Between Misinformation Identification Scores and Study Questionnaires

Scales and questionnaires scores	Misinformation identification scores					
	CS[1]		TX[2]		CL[3]	
	*rho**	*p*	*rho**	*p*	*rho**	*p*
Educational instrument evaluation						
Attractiveness[4]	0.092	0.385	0.014	0.891	n/d	n/d
Usefulness[5]	0.026	0.804	0.146	0.156	n/d	n/d
Trust[6]	0.081	0.442	0.189	0.066	n/d	n/d
Willingness to share or repost[7]	-0.189	0.071	-0.009	0.932	n/d	n/d
Acceptance[8]	-0.026	0.802	0.105	0.307	n/d	n/d
SILS[9]	-0.224	0.032**	-0.224	0.028**	-0.267	0.008**
eHEALS[10]	0.322	0.002**	0.330	0.000**	0.196	0.055
Trust in Health Organizations[11]	0.124	0.240	0.358	0.000**	0.125	0.224
Trust in Government institutions[12]	0.181	0,085	0.416	0.000**	0.249	0.014**
Trust in scientists[13]	0.241	0.021**	0.351	0.000**	0.323	0.001**
CVCS[14]	-0.463	0.000**	-0.626	0.000**	-0.556	0.000**
SMUIS[15]	-0.044	0.678	-0.026	0.801	0.033	0.746
SM usefulness[16]	-0.191	0.068	0.146	0.156	-0.261	0.010
SM trust[17]	-0.260	0.012**	-0.050	0.629	-0.194	0.057

Note. N= 285 [1]Comic Strip group (N = 92), [2]Text group (N = 96) [3]Control group (N = 97), n/d = no data collected for this group.

[4]Attractiveness of the educational instrument, [5] Perceived usefulness in helping identify misinformation, [6]Trust in the educational instrument, [7]Willingness to share or repost the educational material on social media, [8]Acceptance of the educational instrument, corresponds to the sum of the four evaluation components,

[9] Health literacy accessed by the Single Item Literacy Screener (Morris et al., 2006) (higher scores indicate more need for help when reading printed health-related materials). (higher scores indicate higher digital health literacy).

[10] Digital health literacy, measured by three items from the eHEALS scale (Norman & Skinner, 2006)

[11]Trust in health information posted on social media profiles of official health organizations (Higher scores indicate higher trust).

[12]Trust in health information posted on social media profiles of official government organizations (Higher scores indicate higher trust).

[13]Trust in health information that comes from scientists (Higher scores indicate higher trust).

[14]COVID-19 Vaccine Concerns Scale (Gregory et al., 2022) (Higher scores indicate a higher level of concern).

[15] Intensity of social media use measured by two items of the adapted version of the Social Media Use Integration Scale (Jenkins-Guarnieri et al., 2013) (higher scores indicate higher intensity of social media use).

[16]Use of social media to find health-related information (higher scores indicate higher frequency of use).

[17]Trust in health-related information from social media (higher scores indicate higher intensity of social media trust).

*Spearman's correlation coefficient, **$p < 0.05$

Evaluation of the educational tools

The educational tools' evaluation was another primary outcome of this study. Groups CS and TX had their educational tools (comic strip and educational text, respectively) evaluated according to the scores of four components evaluation: the attractiveness of the educational instrument (ATTR), perceived usefulness in helping identify misinformation (USE), trust in the information provided by the educational instrument (TRUST), and willingness to share or repost the educational material on social media (SHARE), with scores ranging from 1 to 5. The higher the scores, the better the evaluation of the educational material. Acceptance of the educational instrument (ACCT) score was calculated from the sum of the scores of the four components.

Mann-Whitney U tests compared the evaluation scores between the two groups (Table 21), showing that ACCT and TRUST in the comic strip were higher than in the educational test.

Tables 22 to 26 describe the scores of ATTR,USE, TRUST, SHARE and ACCT according to groups and demographic characteristics. Mann-Whitney U tests showed that in group CS, participants with a Master's degree, household income of less than US$ 25,000, and democrat political affiliation assigned higher scores for the educational instrument's attractiveness the participants within the same demographic characteristics from group TX. USE scores for the CS group were higher than in the TX groups in male participants. TRUST scores for the CS group were higher than in the TX groups in male participants and the ones with ages ranging from 50 to 65 years old, household income of US$ 100,000 to 199,000, and democrat and independent or other political affiliations. Participants with household incomes from US$100,000 to 199,000 were more likely to share and repost the educational instrument in group CS than in group TX. There was no difference in the other evaluation component scores for the remaining demographic categories.

Table 21

Evaluation of the Educational Tools According to Groups

Components of the evaluation	CS[1] Mean (*SD*) Median	TX[2] Mean (*SD*) Median	*Z**	*p*
ATTRACTIVENESS (ATTR)[3]	3.96 (0.98) 4	3.70 (1.07) 4	-1.861	0.063
USEFULNESS[4] (USE)	3.78 (1.08) 4	3.64 (1.06) 4	-1.019	0.308
SHARE[5]	3.51 (1.23) 4	3.23 (1.29) 3	-1.494	0.135
TRUST[6]	3.94 (1.01) 4	3.59 (1.05) 4	-2.499	0.012**
ACCEPTANCE[7] (ACCT)	15.2 (3.51) 16	13.67 (4.15) 16	-2.445	0.014**

Note. Standard deviations are presented in parentheses.

[1]Comic Strip group (N = 92), [2]Text group (N = 96), [3]Attractiveness of the educational instrument, [4]Perceived usefulness in helping identify misinformation, [5]Willingness to share or repost the educational material on social media, [6]Trust in the information provided by the educational instrument, [7]Acceptance of the educational instrument, corresponds to the sum of the four evaluation components.

* Mann-Whitney *U* test, ***p* < 0.05

Table 22

Attractiveness Scores of the Educational Tools According to Demographic Characteristics

Demographic characteristics	CS[1]	TX[2]	*Z**	*p*
	Mean (*SD*)	Mean (*SD*)		
Age group				
18 -29	4.00 (0.91)	3.83 (1.17)	-0.866	0.386
30 – 49	3.91 (1.15)	3.71 (1.27)	-0.932	0.351
50 -65	4.00 (0.72)	3.75 (1.00)	-1.570	0.116
Gender				
Female	3.85 (1.05)	3.71 (1.01)	-1.407	0.159
Male	4.14 (0.82)	3.62 (1.21)	-1.399	0.162
Other/ prefer not to say	3.50 (2.12)	4.00 (1.15)	-0.500	0.617
Ethnicity				
White/ Caucasian	3.91 (1.01)	3.63 (1.21)	-1.275	0.202
Black/ African American	4.29 (0.61)	3.85 (0.80)	-1.453	0.146
Hispanic/ Latino	3.25 (1.04)	3.75 (0.87)	-1.066	0.286
Other[3]	4.83 (0.41)	3.77 (0.83)	-2.674	0.007
Educational level				
High school or less	3.60 (1.07)	3.89 (0.81)	-0.286	0.775
Bachelor's degree	3.79 (1.12)	3.75 (1.1)	-0.802	0.423
Master's degree	3.96 (1.11)	3.43 (1.14)	-2.078	0.038**
Doctorate or higher	4.00 (0.82)	3.83 (0.75)	1.271	0.079
Other/ prefer not to say	5.00 (0.00)	2.00 (1.41)	-1.633	0.102
Household income				
Less than $25,000	4.25 (1.04)	3.50 (1.24)	-1.991	0.046**
$25,000-$49,999	4.00 (0.93)	4.12 (0.49)	1.060	0.211
$50,000 - $99,999	3.78 (1.09)	3.31 (1.35)	0.000	1.000
$100,000 - $199,999	3.83 (0.98)	3.54 (1.10)	-1.225	0.221
$200,000 - $299,999	4.43 (0.79)	3.90 (1.20)	-0.999	0.318
$300,000 or more	2.75 (2.06)	4.00 (1.00)	-0.981	0.326
I do not know/ prefer not to say	4.14 (1.07)	3.75 (0.50)	-1.146	0.252
Political affiliation				
Democrat	4.06 (0.73)	3.69 (1.10)	-2.013	0.044**
Republican	3.40 (1.34)	4.07 (0.70)	-1.141	0.254
Independent and Others[4]	4.00 (1.15)	3.45 (1.14)	-1.840	0.066

Note. Standard deviations are presented in parentheses. N = 285; [1]Comic Strip group (n = 92), [2]Text group (n = 96), [3]Control group (n = 97); [4]Other ethnic/ racial groups: American Indian or

Alaska Native (n = 3), Asian (n = 18), Middle Easter or North African (n = 5), Other/ multiracial/ do not know/ prefer not to say; [5]Other political preferences/ affiliations: Indigenous (n = 1), Libertarian (n = 2), Non-partisan (n = 1), None (n = 2), Not yet qualified to vote (n = 1), Prefer not to say (n = 1), Progressive/ Green (n = 1), Social-democratic (n = 1), Socialist (n =1).

* Mann-Whitney *U* test, ***p* < 0.05

Table 23

Perceived Usefulness Scores of the Educational Tools According to Demographic Characteristics

Demographic characteristics	CS[1]	TX[2]	*Z**	*p*
	Mean (*SD*)	Mean (*SD*)		
Age group				
18 -29	3.94 (1.11)	3.67 (1.03)	-0.719	0.472
30 – 49	3.70 (1.26)	3.93 (0.92)	-0.360	0.719
50 -65	4.06 (1.31)	3.88 (0.89)	-0.981	0.326
Gender				
Female	3.58 (1.13)	3.76 (0.93)	-0.804	0.422
Male	4.05 (1.03)	3.38 (1.32)	-2.230	0.026**
Other/ prefer not to say	4.00 (0.00)	3.50 (1.29)	-0.492	0.623
Ethnicity				
White/ Caucasian	3.80 (1.05)	3.66 (1.20)	-0.437	0.662
Black/ African American	4.07 (1.07)	3.77 (0.93)	-0.834	0.404
Hispanic/ Latino	3.25 (0.89)	3.33 (0.65)	-0.680	0.497
Other[3]	3.67 (1.75)	3.62 (0.96)	-0.547	0.585
Educational level				
High school or less	3.90 (0.88)	3.84 (0.90)	-0.383	0.702
Bachelor's degree	3.64 (0.74)	3.66 (1.10)	-0.742	0.458
Master's degree	3.50 (1.21)	3.54 (1.10)	-0.072	0.943
Doctorate or higher	3.50 (1.29)	3.83 (0.75)	0.192	1.000
Other/ prefer not to say	5.00 (0.00)	2.00 (1.41)	-1.633	0.102
Household income				
Less than $25,000	4.00 (0.76)	3.42 (1.21)	-1.323	0.186
$25,000-$49,999	3.50 0.76)	4.00 (0.79)	0.530	0.941
$50,000 - $99,999	4.00 (0.87)	3.33 (1.76)	-1.539	0.124
$100,000 - $199,999	3.33 (0.82)	3.60 (1.16)	-1.298	0.194
$200,000 - $299,999	4.43 (0.98)	3.80 (1.23)	-1.201	0.230
$300,000 or more	3.50 (1.91)	4.14 (0.69)	-0.298	0.766
I don't know/ prefer not to say	4.29 (0.76)	3.25 (0.96)	-1.706	0.088
Political affiliation				
Democrat	3.72 (0.75)	3.73 (1.06)	-1.201	0.230
Republican	3.60 (0.55)	3.87 (0.99)	-0.469	0.639
Independent and others[4]	3.92 (1.04)	3.23 (1.10)	-1.029	0.304

Note. Standard deviations are presented in parentheses. N = 285; [1]Comic Strip group (n = 92), [2]Text group (n = 96), [3]Control group (n = 97); [4]Other ethnic/ racial groups: American Indian or Alaska Native (n = 3), Asian (n = 18), Middle Easter or North African (n = 5), Other/ multiracial/ do not know/ prefer not to say; [5]Other political preferences/ affiliations: Indigenous (n = 1), Libertarian (n = 2), Non-partisan (n = 1), None (n = 2), Not yet qualified to vote (n = 1), Prefer not to say (n = 1), Progressive/ Green (n = 1), Social-democratic (n = 1), Socialist (n =1).

* Mann-Whitney *U* test, ***p* < 0.05

Table 24

Trust in the Educational Tools According to Demographic Characteristics

Demographic characteristics	CS[1]	TX[2]	*Z**	*p*
	Mean (*SD*)	Mean (*SD*)		
Age group				
18 -29	4.06 (0.94)	4.00 (0.00)	-0.754	0.451
30 – 49	3.83 (1.20)	3.71 (0.91)	-1.320	0.187
50 -65	4.07 (0.72)	3.63 (1.31)	-2.399	0.016**
Gender				
Female	3.91 (1.01)	3.78 (0.89)	-1.091	0.275
Male	4.00 (1.08)	3.17 (1.31)	-2.450	0.014**
Other/ prefer not to say	4.00 (0.00)	3.75 (0.50)	-0.707	0.480
Ethnicity				
White/ Caucasian	3.98 (1.01)	3.64 (1.41)	-1.481	0.139
Black/ African American	4.21 (0.70)	3.62 (0.65)	-1.840	0.066
Hispanic/ Latino	3.25 (1.04)	3.33 (0.78)	-0.077	0.939
Other[3]	3.83 (1.47)	3.62 (0.96)	-0.841	0.401
Educational level				
High school or less	4.30 (0.48)	3.89 (0.81)	-0.803	0.422
Bachelor's degree	4.00 (0.55)	3.57 (1.07)	-1.754	0.079
Master's degree	3.73 (1.25)	3.39 (1.13)	-1.270	0.204
Doctorate or higher	3.50 (1.29)	3.50 (1.22)	0.605	0.857
Other/ prefer not to say	5.00 (0.00)	4.00 (1.41)	-1.000	0.317
Household income				
Less than $25,000	4.50 (0.76)	3.95 (0.85)	-0.278	0.781
$25,000-$49,999	3.75 (0.46)	3.59 (0.71)	0.445	0.989
$50,000 - $99,999	4.00 (0.50)	3.20 (1.08)	-0.835	0.403
$100,000 - $199,999	4.00 (0.00)	3.28 (1.24)	-2.698	0.007**
$200,000 - $299,999	4.29 (1.25)	3.70 (1.34)	-1.195	0.232
$300,000 or more	2.25 (1.89)	4.00 (1.15)	-1.559	0.119
I don't know/ prefer not to say	4.29 (0.76)	4.00 (0.00)	-0.886	0.375
Political affiliation				
Democrat	4.20 (0.84)	3.78 (0.98)	-2.192	0.028**
Republican	3.50 (1.10)	2.81 (1.19)	-0.428	0.669
Independent and others[4]	3.81 (1.14)	3.18 (1.05)	-2.575	0.010**

Note. Standard deviations are presented in parentheses. N = 285; [1]Comic Strip group (n = 92), [2]Text group (n = 96), [3]Control group (n = 97); [4]Other ethnic/ racial groups: American Indian or

Alaska Native (n = 3), Asian (n = 18), Middle Easter or North African (n = 5), Other/ multiracial/ do not know/ prefer not to say; [5]Other political preferences/ affiliations: Indigenous (n = 1), Libertarian (n = 2), Non-partisan (n = 1), None (n = 2), Not yet qualified to vote (n = 1), Prefer not to say (n = 1), Progressive/ Green (n = 1), Social-democratic (n = 1), Socialist (n =1).

* Mann-Whitney *U* test, ***p* < 0.05

Table 25

Willingness to Share or Repost the Educational Tools According to Demographic Characteristics

Demographic characteristics	CS[1]	TX[2]	*Z**	*p*
	Mean (*SD*)	Mean (*SD*)		
Age group				
18 -29	4.06 (1.31)	3.00 (1.90)	-1.658	0.097
30 – 49	3.28 (1.33)	3.14 (0.95)	-0.021	0.983
50 -65	3.54 (0.96)	3.38 (1.31)	-1.198	0.231
Gender				
Female	3.30 (1.28)	3.30 (1.25)	-0.059	0.953
Male	3.84 (1.07)	3.21 (1.40)	-1.584	0.113
Other/ prefer not to say	3.00 (2.83)	2.25 (0.96)	-0.238	0.812
Ethnicity				
White/ Caucasian	3.45 (1.30)	3.10 (1.44)	-1.181	0.238
Black/ African American	4.00 (1.04)	3.62 (0.96)	-1.189	0.235
Hispanic/ Latino	3.38 (0.74)	3.17 (1.12)	-0.277	0.782
Other[3]	3.33 (1.63)	3.46 (0.97)	-0.045	0.964
Educational level				
High school or less	3.20 (1.48)	3.58 (1.35)	-0.091	0.927
Bachelor's degree	3.29 (1.27)	3.16 (1.31)	-1.876	0.061
Master's degree	3.15 (1.35)	2.96 (1.26)	-0.533	0.594
Doctorate or higher	3.50 (1.00)	3.83 (0.75)	0.313	1.000
Other/ prefer not to say	3.00 (2.83)	3.50 (0.71)	0.000	1.000
Household income				
Less than $25,000	3.20 (1.67)	3.16 (1.34)	-0.210	0.834
$25,000-$49,999	3.13 (1.25)	3.59 (1.18)	0.393	0.998
$50,000 - $99,999	3.22 (0.97)	2.60 (1.40)	-0.513	0.608
$100,000 - $199,999	3.33 (1.21)	3.12 (1.33)	-2.291	0.022**
$200,000 - $299,999	4.29 (0.76)	3.40 (1.26)	-1.526	0.127
$300,000 or more	2.50 (1.29)	3.71 (1.11)	-1.451	0.147
I don't know/ prefer not to say	4.00 (1.15)	3.75 (0.50)	-0.703	0.482
Political affiliation				
Democrat	3.22 (1.22)	3.36 (1.20)	-1.643	0.100
Republican	3.00 (1.58)	3.20 (1.57)	-0.310	0.756
Independent and others[4]	3.62 (1.19)	2.91 (1.34)	-1.328	0.184

Note. Standard deviations are presented in parentheses. N = 285; [1]Comic Strip group (n = 92), [2]Text group (n = 96), [3]Control group (n = 97); [4]Other ethnic/ racial groups: American Indian or Alaska Native (n = 3), Asian (n = 18), Middle Easter or North African (n = 5), Other/ multiracial/ do not know/ prefer not to say; [5]Other political preferences/ affiliations: Indigenous (n = 1), Libertarian (n = 2), Non-partisan (n = 1), None (n = 2), Not yet qualified to vote (n = 1), Prefer not to say (n = 1), Progressive/ Green (n = 1), Social-democratic (n = 1), Socialist (n =1).

* Mann-Whitney *U* test, ***p* < 0.05

Table 26

Acceptance of the Educational Tools According to Demographic Characteristics

Demographic characteristics	CS[1]	TX[2]	*Z**	*p*
	Mean (*SD*)	Mean (*SD*)		
Age group				
18 -29	16,1 (3,3)	14,4 (3,2)	-1.599	0.112
30 – 49	14.7 (4.1)	13.6 (4.7)	-0.932	0.351
50 -65	15.4 (2.4)	13.3 (4.0)	-2.091	0.036*
Gender				
Female	14.6 (3.6)	14.1 (4.1)	-0.526	0.599
Male	16.1 (3.3)	12.9 (4.5)	-2.924	0.003*
Other/ prefer not to say	3.00 (2.83)	2.25 (0.96)	-0.238	0.812
Ethnicity				
White/ Caucasian	15.1 (3.6)	13.7 (4.5)	-1.613	0.107
Black/ African American	16.6 (1.9)	15.3 (3.2)	0.055	0.061
Hispanic/ Latino	13.1 (2.9)	13.1 (3.0)	0.815	0.851
Other[3]	15.4 (5.3)	13.8 (3.7)	0.427	0.442
Educational level				
High school or less	15.4 (3.8)	14.7 (3.5)	-0.709	0.478
Bachelor's degree	15.6 (2.9)	13.8 (4.2)	-1.866	0.062
Master's degree	14.4 (4.0)	12.7 (4.6)	-1.443	0.149
Doctorate or higher	14.5 (3.9)	15.2 (3.6)	0.492	0.730
Other/ prefer not to say	18.0 (2.8)	10.0 (1.4)	-1.549	0.333
Household income				
Less than $25,000	15.5 (2.9)	13.6 (3.6)	-1.565	0.121
$25,000-$49,999	14.4 (3.7)	14.8 (3.2)	0.149	0.883
$50,000 - $99,999	15.6 (2.8)	12.0 (4.4)	-2.666	0.007**
$100,000 - $199,999	14.6 (3.1)	12.9 (4.6)	-1.021	0.320
$200,000 - $299,999	17.4 (3.6)	14.5 (5.1)	-1.483	0.161
$300,000 or more	11.0 (6.8)	16.0 (4.3)	1.295	0.257
I don't know/ prefer not to say	16.7 (3.7)	14.8 (0.96)	-0.977	0.352
Political affiliation				
Democrat	16.0 (2.6)	14.2 (3.9)	151.410	0.030**
Republican	13.9 (4.1)	14.0 (4.4)	0.000	1,000
Independent and others[4]	3.62 (1.19)	2.91 (1.34)	-2.157	0.031**

Note. Standard deviations are presented in parentheses. N = 188; [1]Comic Strip group (n = 92), [2]Text group (n = 96),; [4]Other ethnic/ racial groups: American Indian or Alaska Native (n = 3), Asian (n = 18), Middle Easter or North African (n = 5), Other/ multiracial/ do not know/ prefer not to say; [5]Other political preferences/ affiliations: Indigenous (n = 1), Libertarian (n = 2), Non-partisan (n = 1), None (n = 2), Not yet qualified to vote (n = 1), Prefer not to say (n = 1), Progressive/ Green (n = 1), Social-democratic (n = 1), Socialist (n =1).

* Mann-Whitney *U* test, ***p* < 0.05

Scores for the evaluation components were compared between groups for participants with low literacy levels. A Mann-Whitney *U* test found no statistically significant difference between groups for any of the evaluation components (Table 27).

Table 27

Evaluation Scores of Individuals with Low Health Literacy[1] According to Groups

Components of the evaluation	CS[2]		TX[3]		*Z**	*p***
	Mean (*SD*)	Median	Mean (*SD*)	Median		
ATTRACTIVENESS (ATTR)[4]	4.10 (0.70)	4	4.00 (0.69)	4	-0.617	0.537
USEFULNESS (USE)[5]	4.00 (1.10)	4	3.89 (0.76)	4	-0.617	0.606
SHARE[6]	3.95 (0.97)	4	3.61 (1.30)	4	-0.764	0.477
TRUST[7]	4.10 (0.94)	4	3.94 (0.73)	4	-0.721	0.494
ACCEPTANCE (ACCT)[8]	16.14 (2.92)	16	14.61 (3.82)	16	-2.445	0.410

Note. N = 64; Standard deviations presented in parentheses; [1]Determined by the Single Item Literacy Screener (SILS) (Morris et al., 2006), individuals who need help reading printed health-related material (SILS score >2, answers “sometimes” (scores 3), “often” (scores 4), and

"always" (score 5)). [2]Comic Strip group (n = 21), [3]Text group (n = 18), [4]Attractiveness of the educational instrument, [5] Perceived usefulness in helping identify misinformation, [6]Trust in the information provided by the educational instrument, [7]Willingness to share or repost the educational material on social media, [8]Acceptance of the educational instrument, corresponds to the sum of the four evaluation components.

* Mann-Whitney *U* test, ***p* > 0.05

Tables 28 to 32 describe correlations of the evaluation components' scores with the scores of scales and questionnaires.

Spearman's correlation tests showed that attractiveness scores had a medium statistically significant positive correlation with trust in health organizations, government institutions, and scientists, and the partial total score of SMUIS (Social media use integration scale) (Jenkins-Guarnieri et al., 2013) in both groups (CS and TX) (Table 28).

Table 28

Correlation Between the Educational Tools' Attractiveness and Scales Scores

Scales and questionnaires	CS[1]		TX[2]	
	*rho**	*p*	*rho**	*p*
SILS[3]	0.159	0.130	0.159	0.130
eHEALS[4]	0.168	0.110	0.168	0.110
Trust health organizations[5]	0.461	0.000**	0.461	0.000**
Trust government institutions[6]	0.409	0.000**	0.409	0.000**
Trust in scientists [7]	0.396	0.000**	0.396	0.000**
CVCS[8]	-0.039	0.712	-0.072	0.483
SMUIS[9]	0.361	0.000**	0.361	0.000**
Social media use and health information[10]	0.135	0.199	0.135	0.199
Trust in health information on social media[11]	0.173	0.100	0.173	0.100

Note: N= 285 [1]Comic Strip group (N = 92), [2]Text group (N = 96).

[3]Health literacy accessed by the Single Item Literacy Screener (Morris et al., 2006) (higher scores indicate more need for help when reading printed health-related materials).

[4] Digital health literacy, measured by three items from the eHEALS scale (Norman & Skinner, 2006) (higher scores indicate higher digital health literacy).

[5]Trust in health information posted on social media profiles of official health organizations (Higher scores indicate higher trust).

[6]Trust in health information posted on social media profiles of official government organizations (Higher scores indicate higher trust).

[7]Trust in health information that comes from scientists (Higher scores indicate higher trust).

[8]COVID-19 Vaccine Concerns Scale (Gregory et al., 2022) (Higher scores indicate a higher level of concern).

[9]Intensity of social media use measured by two items of the adapted version of the Social Media Use Integration Scale (Jenkins-Guarnieri et al., 2013) (higher scores indicate the higher intensity of social media use).

[10]Use of social media to find health-related information.

[11]Trust in health-related information from social media.

*Spearman's correlation coefficient, **$p < 0.05$

Spearman's correlation tests in table 29 show a small but statistically significant positive correlation between TRUST scores and the total score for the digital health literacy scale (eHEALS) (Norman & Skinner, 2006) partial score in group CS but not in TX. In addition, group CS showed medium statistically significant positive correlations between trust in organizations, government institutions, and scientists. In contrast, in group TX the positive correlation was large for the former two scales and medium for the last scale. In addition, there were small statistically significant positive correlations between the score for trust in health information from social media for both groups. At the same time, there was a small positive correlation between social media use to get health-related information and trust in the educational instrument just in group TX.

Table 29

Correlation Between Trust in the Educational Tools and Scales Scores

Scales and questionnaires	CS[1]		TX[2]	
	*rho**	*p*	*rho**	*p*
SILS[3]	0.042	0.692	0.042	0.692
eHEALS[4]	0.260	0.011**	0.266	0.100
Trust health organizations[5]	0.379	0.000**	0.609	0.000**
Trust government institutions[6]	0.362	0.000**	0.582	0.000**
Trust scientists [7]	0.361	0.014**	0.361	0.000**
CVCS[8]	-0.172	0.101	-0.172	0.101
SMUIS[9]	0.167	0.111	0.167	0.111
Social media use and health information[10]	0.183	0.085	0.272	0.007**
Trust in health information on social media[11]	0.292	0.005**	0.295	0.003**

Note: N= 285 [1]Comic Strip group (N = 92), [2]Text group (N = 96).

[3]Health literacy accessed by the Single Item Literacy Screener (Morris et al., 2006) (higher scores indicate more need for help when reading printed health-related materials).

[4] Digital health literacy, measured by three items from the eHEALS scale (Norman & Skinner, 2006) (higher scores indicate higher digital health literacy).

[5]Trust in health information posted on social media profiles of official health organizations (Higher scores indicate higher trust).

[6]Trust in health information posted on social media profiles of official government organizations (Higher scores indicate higher trust).

[7]Trust in health information that comes from scientists (Higher scores indicate higher trust).

[8]COVID-19 Vaccine Concerns Scale (Gregory et al., 2022) (Higher scores indicate a higher level of concern).

[9]Intensity of social media use measured by two items of the adapted version of the Social Media Use Integration Scale (Jenkins-Guarnieri et al., 2013) (higher scores indicate the higher intensity of social media use).

[10]Use of social media to find health-related information.

[11]Trust in health-related information from social media.

*Spearman's correlation coefficient, ***p* < 0.05

Table 30 describes Spearman's correlation coefficients for USE and the scales of the independent variables. There was a small but statistically significant positive correlation between USEF and the total score digital health literacy scale (eHEALS) (Norman & Skinner, 2006) partial score in group CS but not in TX. In groups CS, there were statistically significant positive correlations between USE and trust in organizations, institutions, and scientists, all of them medium correlations, except for a large correlation with trust in scientists in group TX. Both groups had small statistically significant positive correlations of USE with the total score of the two selected items from the Social Media Use Integration Scale (SMUIS) (Jenkins-Guarnieri et al., 2013). In group TX, social media use to get health information and trust in health information from social media had medium correlations with the USE of the educational text.

Table 30

Correlation Between the Perceived Usefulness of the Educational Tools and Scales Scores

Scales and questionnaires	CS[1]		TX[2]	
	*rho**	*p*	*rho**	*P*
SILS[3]	0.108	0.304	0.062	0.549
eHEALS[4]	0.280	0.006**	0.184	0.073
Trust health organizations[5]	0.441	0.000**	0.473	0.000**
Trust government institutions[6]	0.361	0.004**	0.479	0.000**
Trust in scientists [7]	0.361	0.000**	0.526	0.000**
CVCS[8]	-0.186	0.324	-0.154	0.135
SMUIS[9]	0.245	0.019	0.245	0.016
Social media use and health information[10]	0.167	0.111	0.337	0.000**
Trust in health information on social media[11]	0.183	0.081**	0.302	0.003**

Note: N= 285 [1]Comic Strip group (N = 92), [2]Text group (N = 96).

[3] Health literacy accessed by the Single Item Literacy Screener (Morris et al., 2006) (higher scores indicate more need for help when reading printed health-related materials).

[4] Digital health literacy, measured by three items from the eHEALS scale (Norman & Skinner, 2006) (higher scores indicate higher digital health literacy).

[5]Trust in health information posted on social media profiles of official health organizations (Higher scores indicate higher trust).

[6]Trust in health information posted on social media profiles of official government organizations (Higher scores indicate higher trust).

[7]Trust in health information that comes from scientists (Higher scores indicate higher trust).

[8]COVID-19 Vaccine Concerns Scale (Gregory et al., 2022) (Higher scores indicate a higher level of concern).

[9]Intensity of social media use measured by two items of the adapted version of the Social Media Use Integration Scale (Jenkins-Guarnieri et al., 2013) (higher scores indicate the higher intensity of social media use).

[10]Use of social media to find health-related information.

[11]Trust in health-related information from social media.

*Spearman's correlation coefficient, ***p* < 0.05.

Regarding SHARE scores, Spearman's correlation tests revealed small to medium statistically significant correlations with health literacy (SILS), digital health literacy scale (eHEALS) (Norman & Skinner, 2006) partial score, trust in health organization and government institutions in group CS. In group TX, there were medium statistically positive correlations between SHARE and trust in health organizations, government institutions, and scientists. In both groups, social media use to get health information had a small correlation with SHARE, while the correlation with trust in health information from social media was small for group CS and medium for group TX. The total score for the social media use integration scale (SMUIS) had a statistically significant medium correlation with SHARE in group TX (Table 31).

Table 31

Correlation Between Willingness to Share or Repost the Educational Tools and Scales Scores

Scales and questionnaires	CS[1]		TX[2]	
	*rho**	*p*	*rho**	*p*
SILS[3]	0.269	0.009**	0.137	0.183
eHEALS[4]	0.216	0.039**	0.060	0.554
Trust health organizations[5]	0.367	0.000**	0.474	0.000**
Trust government institutions[6]	0.239	0.022**	0.451	0.000**
Trust in scientists [7]	0.181	0.079	0.337	0.000**
CVCS[8]	-0.035	0.736	-0.090	0.382
SMUIS[9]	0.135	0.199	0.343	0.000**
Social media use and health information[10]	0.337	0.001**	0.394	0.000**
Trust in health information on social media[11]	0.254	0.013**	0.455	0.000**

Note: N= 285 [1]Comic Strip group (N = 92), [2]Text group (N = 96).

[3]Health literacy accessed by the Single Item Literacy Screener (Morris et al., 2006) (higher scores indicate more need for help when reading printed health-related materials).

[4] Digital health literacy, measured by three items from the eHEALS scale (Norman & Skinner, 2006) (higher scores indicate higher digital health literacy).

[5]Trust in health information posted on social media profiles of official health organizations (Higher scores indicate higher trust).

[6]Trust in health information posted on social media profiles of official government organizations (Higher scores indicate higher trust).

[7]Trust in health information from scientists (Higher scores indicate higher trust).

[8]COVID-19 Vaccine Concerns Scale (Gregory et al., 2022) (Higher scores indicate a higher level of concern).

[9]Intensity of social media use measured by two items of the adapted version of the Social Media Use Integration Scale (Jenkins-Guarnieri et al., 2013) (higher scores indicate the higher intensity of social media use).

[10]Use of social media to find health-related information.

[11]Trust in health-related information from social media.

*Spearman's correlation coefficient, **$p < 0.05$

The ACCT score was composed of the scores from the four evaluation components. Using Spearman's correlation tests, ACCT had statistically significant positive correlations with digital health literacy (small correlation in CS, but not in TX), trust in health organizations, government institutions, and scientists (medium correlations in CS and medium to large correlations in TX); social media use integration (SMUIS), social media use to get health-related information and trust in health information coming from social media (small correlations in CS and medium correlations in TX). COVID-19 concerns (CVCS) were negatively and statistically correlated to acceptance just for group TX (small correlation) (Table 32)

Table 32

Correlation Between Educational Tools' Acceptance and Scales Scores

Scales and questionnaires	CS[1]		TX[2]	
	*rho**	*p*	*rho**	*p*
SILS[3]	0.178	0.089	0.090	0.384
eHEALS[4]	0.282	0.006**	0.158	0.125
Trust health organizations[5]	0.473	0.000**	0.557	0.000**
Trust government institutions[6]	0.372	0.000**	0.557	0.000**
Trust in scientists [7]	0.348	0.000**	0.413	0.000**
CVCS[8]	-0.106	0.313	-0.216	0.035**
SMUIS[9]	0.264	0.011**	0.382	0.000**
Social media use and health information[10]	0.248	0.017**	0.382	0.000**
Trust in health information on social media[11]	0.256	0.014**	0.462	0.000**

Note: N= 285 [1]Comic Strip group (N = 92), [2]Text group (N = 96).

[3]Health literacy accessed by the Single Item Literacy Screener (Morris et al., 2006) (higher scores indicate more need for help when reading printed health-related materials).

[4] Digital health literacy, measured by three items from the eHEALS scale (Norman & Skinner, 2006) (higher scores indicate higher digital health literacy).

[5]Trust in health information posted on social media profiles of official health organizations (Higher scores indicate higher trust).

[6]Trust in health information posted on social media profiles of official government organizations (Higher scores indicate higher trust).

[7]Trust in health information that comes from scientists (Higher scores indicate higher trust).

[8]COVID-19 Vaccine Concerns Scale (Gregory et al., 2022) (Higher scores indicate a higher level of concern).

[9]Intensity of social media use measured by two items of the adapted version of the Social Media Use Integration Scale (Jenkins-Guarnieri et al., 2013) (higher scores indicate higher intensity of social media use).

[10]Use of social media to find health-related information.

[11]Trust in health-related information from social media.

*Spearman's correlation coefficient, ***p* < 0.05.

Within-groups evaluation and misinformation identification scores

To check for specific demographic categories that could benefit better from each educational instrument, within-group comparisons of the scores for the study's primary outcomes (educational instrument's evaluation components and %MI scores) were made between demographic categories.

Table 33 describes the scores for each primary outcome according to age ranges and groups. In group CS, a Kruskal-Wallis *H* test revealed statistically significant differences in %MI score between age range groups. A *post hoc* test using pairwise comparisons using Dunn's procedure with a Bonferroni correction for multiple comparisons revealed a statistically significant difference between age groups 18 to 29 (*Mdn* = 70) and 50 to 65 (*Mdn* = 100) (p = 0.027). Additionally, a Kruskal-Wallis *H* test found a marginally statistically significant (p = 0.05) difference in SHARE between the age range groups. A *post hoc* test showed a statistically significant difference between age group 30 to 49 (*Mdn* = 3) and 18 to 29 (*Mdn* = 4.50) (p = 0.045).

Table 33

Within-Group Comparison of the Main Outcomes Between Age Groups

Main outcomes per group	18 - 29 years		30 - 49 years		50 - 65 years		$\chi 2$*	*p*
	Mean (*SD*)	Median	Mean (*SD*)	Median	Mean (*SD*)	Median		
Comic strip group (CS)								
ATTRACTIVENESS[1]	4.00 (0.91)	4.00	3.91 (1.15)	4.00	4.00 (0.72)	4.00	0.143	0.931
USEFULNESS[2]	3.94 (1.11)	4.00	3.70 (1.26)	4.00	4.06 (1.31)	4.50	0.693	0.707
TRUST[3]	4.06 (0.94)	4.00	3.83 (1.20)	4.00	4.07 (0.72)	4.00	0.268	0.875
SHARE[4]	4.06 (1.31)	4.50	3.28 (1.33)	3.00	3.54 (0.96)	3.50	5.99	0.050
ACCEPTANCE[5]	16.06 (3.28)	17.00	14.72 (4.10)	15.50	14.49 (2.43)	15.5	1.446	0.485
%MI score[6]	76.7 (19.4)	70.00	83.5 (18.2)	90.00	91.4 (13.3)	100.00	7.301	0.026**
Educational text group (TX)								
ATTRACTIVENESS[1]	3.83 (1.17)	4.00	3.71 (1.27)	4.00	3.75 (1.00)	3.50	0.654	0.721
USEFULNESS[2]	3.67 (1.03)	4.00	3.93 (0.92)	4.00	3.88 (0.89)	4.00	0.919	0.613
TRUST[3]	4.00 (0.00)	4.00	3.71 (0.91)	4.00	3.63 (1.31)	3.50	2.084	0.353
SHARE[4]	3.00 (1.90)	3.00	3.14 (0.95)	3.00	3.38 (1.31)	3.00	0.455	0.796
ACCEPTANCE[5]	14.38 (3.17)	15.00	13.62 (4.70)	15.00	13.27 (4.02)	13.00	0.811	0.667
%MI score[6]	83.8 (16.9)	90.00	81.9 (19.0)	90.00	87.9 (15.0)	90.00	2.037	0.361
Control group (CL)								
%MI score[6]	79.3 (17.5)	80.00	80.7 (17.9)	90.00	85.0 (19.9)	90.00	2.499	0.287

Note. Standard deviations are presented in parentheses. [1]Attractiveness of the educational instrument, [2]Perceived usefulness in helping identify misinformation, [3]Trust in the information provided by the educational instrument, [4]Willingness to share or repost the educational material on social media, [5]Acceptance of the educational instrument, corresponds to the sum of the four evaluation component, [6]Misinformation identification score.

*Kruskal-Wallis *H* test, ***p* < 0.05.

Within-group comparison of the main outcomes between gender categories is described in Table 34. In group CS, male participants scored higher for the comic strip evaluation components USE, SHARE, and ACCT than females. In group TX, male participants scored higher TRUST scores in the educational text than females. In turn, female participants showed higher %MI scores than males in the three groups (CS, TX, and CL).

Table 34

Within-Group Comparison of the Main Outcomes Between Gender Categories

Main outcomes per group	Female		Male		$\chi 2$*	*p*
	Mean (*SD*)	Median	Mean (*SD*)	Median		
Comic strip group (CS)						
ATTRACTIVENESS[1]	3.85 (1.05)	4.00	4.14 (0.82)	4.00	1.404	0.236
USEFULNESS[2]	3.58 (1.13)	4.00	4.05 (1.03)	4.00	4.524	0.033***
TRUST[3]	3.91 (1.01)	4.00	4.00 (1.08)	4.00	0.430	0.512
SHARE[4]	3.30 (1.28)	3.00	3.84 (1.07)	4.00	3.849	0.050**
ACCEPTANCE[5]	14.64 (15.0)	15.00	16.03 (3.29)	16.00	3.887	0.049***
%MI score[6]	88.9 (17.2)	100	77.6 (16.6)	80	13.575	0.000***
Text group (TX)						
ATTRACTIVENESS[1]	3.71 (1.01)	4.00	3.62 (1.21)	4.00	0.000	0.989
USEFULNESS[2]	3.76 (0.93)	4.00	3.38 (1.32)	4.00	1.015	0.314
TRUST[3]	3.78 (0.89)	4.00	3.17 (1.31)	3.00	4.368	0.037***
SHARE[4]	3.30 (1.25)	3.00	3.21 (1.40)	4.00	0.020	0.883
ACCEPTANCE[5]	14.08 (4.05)	15.00	12.90 (4.46)	13.00	1.112	0.292
%MI score[6]	87.9 (15.2)	90	75.2 (19.0)	80	10.753	0.001***
Control group (CL)						
%MI score[6]	85.36 (16.3)	90	75,1 (19.6)	80	7.487	0.006***

Note. Standard deviations are presented in parentheses. [1]Attractiveness of the educational instrument, [2]Perceived usefulness in helping identify misinformation, [3]Trust in the information

provided by the educational instrument, [4]Willingness to share or repost the educational material on social media, [5]Acceptance of the educational instrument, corresponds to the sum of the four evaluation components, [6]Misinformation identification score.

*Kruskal-Wallis *H* test, **$p = 0.05$, ***$p < 0.05$.

Within-group analysis for outcomes between ethnic/ racial categories is described in table 35. Kruskal-Wallis *H* tests found statistically significant differences in attractiveness and ACCT scores between ethnic groups in group CS, no statistical differences in group TX and statistically significant differences in %MI in group CL (control group). In CS group, *post hoc* test using pairwise comparisons using Dunn's procedure with a Bonferroni correction for multiple comparisons revealed that ACCT is statistically higher in White/ Caucasian (*Mdn* = 16.0) and Black/ African American (16.5) than in Hispanic/ Latino group (*Mdn* = 12.0) (p = 0.043). A lower attractiveness in the Hispanic/ Latino than Black/African group was not confirmed by a *post hoc* test. A Kruskal-Wallis *H* test found a statistically significant difference in %MI scores between ethnic groups, and the *post hoc* test revealed higher scores for Hispanic/ Latino (*Mdn* = 95) than for Black/ African American (*Mdn* = 70) (p = 0.047).

Table 35

Within-Group Comparison of Main Outcomes Between Ethnic/ Racial Categories

Main outcomes per group	White/ Caucasian		Black/ African American		Hispanic/ Latino		χ^{2}*	*p*
	Mean (*SD*)	Median	Mean (*SD*)	Median	Mean (*SD*)	Median		
Comic strip group (CS)								
ATTRACTIVENESS[1]	3.91 (1.01)	4.00	4.29 (0.61)	4.00	3.25 (1.04)	3.00	6.033	0.049**
USEFULNESS[2]	3.80 (1.05)	4.00	4.07 (1.07)	4.00	3.25 (0.89)	3.00	4.732	0.094
TRUST[3]	3.98 (1.01)	4.00	4.21 (0.70)	4.00	3.25 (1.04)	3.00	5.134	0.077
SHARE[4]	3.45 (1.30)	3.00	4.00 (1.04)	4.00	3.38 (0.74)	3.50	3.074	0.215
ACCEPTANCE[5]	15.14 (3.63)	16.00	16.57 (1.91)	16.50	13.13 (2.85)	12.00	6.905	0.032**
%MI score[6]	85.6 (18.8)	90	80.0 (14.7)	80	85.0 (17.7)	90	2.86	0.239
Educational text group (TX)								
ATTRACTIVENESS[1]	3,63 (1,21)	3.50	3.85 (0.80)	4.00	3,75 (0.87)	4.00	0.177	0.915
USEFULNESS[2]	3.66 (1.20)	4.00	3.77 (0.93)	4.00	3.33 (0.65)	3.00	2.797	0.247
TRUST[3]	3.64 (1.41)	4.00	3.62 (0.65)	4.00	3.33 (0.78)	3.50	1.889	0.389
SHARE[4]	3.10 (1.44)	3.00	3.62 (0.96)	3.00	3.17 (1.12)	3.50	1.169	0.557
ACCEPTANCE[5]	13.69 (4.53)	14.00	13.92 (3.80)	15.00	13.08 (3.74)	13.50	0.473	0.789
%MI score[6]	86.4 (15.6)	90	77.7 (23.2)	90	77.5 (20.9)	80	2.645	0.266
Control group (CL)								
%MI score[6]	81.7 (20.3)	90.00	75.3 (13.6)	70.00	91.7 (11.9)	95.00	7.060	0.029**

Note. Standard deviations are presented in parentheses. [1]Attractiveness of the educational instrument, [2]Perceived usefulness in helping identify misinformation, [3]Trust in the information provided by the educational instrument, [4]Willingness to share or repost the educational material on social media, [5]Acceptance of the educational instrument, corresponds to the sum of the four evaluation components, [6]Misinformation identification score.

*Kruskal-Wallis *H* test, ***p* < 0.05.

When comparing the study's primary outcomes between education level categories, Kruskal-Wallis *H* tests found statistically significant differences in %MI scores in groups TX and CL (Table 36). In group CL, *post hoc* pairwise comparisons using Dunn's procedure with a Bonferroni correction for multiple comparisons revealed that participants with Master's degrees or Doctorates got higher %MI scores (*Mdn* = 95) than the ones with Bachelor's degrees (Md = 80) (p = 0.012) and with high school diploma or less (*Mdn* = 80) (p = 0.046). However, the same *post hoc* procedure did not find statistically significant differences in %MI scores between educational level categories in group TX.

Within-group comparison of the study's main outcomes between categories of annual household income using Kruskal-Wallis *H* tests did not find any statistically significant differences (Table 37).

Regarding political affiliation, a Kruskal-Wallis *H* test revealed a statistically significant difference in TRUST scores between categories in groups CS and TX and in %MI scores for group TX (Table 38). *Post hoc* pairwise comparisons using Dunn's procedure with a Bonferroni correction for multiple comparisons showed that in group CS, Democrats had higher TRUST scores than Republicans (*Mdn* = 4.0 and *Mdn* = 3.50, respectively) (p = 0.44). In group TX, Democrats had higher TRUST scores than Independent and other categories (*Mdn* = 4.0 and *Mdn* = 3.0, respectively) (p = 0.013). Another *post hoc* test revealed that %MI score was statistically higher for Democrats (*Mdn* = 90) than for Republicans (*Mdn* = 80) (p = 0.013) in group TX.

Table 36

Within-Group Comparison of Main Outcomes Between Educational Level Categories

Main outcomes per group	High school or less		Bachelor's degree		Master's or Doctorate		$\chi 2$*	p
	Mean (*SD*)	Median	Mean (*SD*)	Median	Mean (*SD*)	Median		
Comic strip group (CS)								
ATTRACTIVENESS[1]	3.60 (1.07)	4.00	3.79 (1.12)	4.00	3.97 (0.85)	4.00	4.870	0.182
USEFULNESS[2]	3.90 (0.88)	4.00	3.64 (0.74)	4.00	3.90 (0.74)	4.00	5.771	0.123
TRUST[3]	4.30 (0.48)	4.00	4.00 (0.55)	4.00	3.90 (0.74)	4.00	4.512	0.211
SHARE[4]	3.20 (1.48)	4.00	3.29 (1.27)	4.00	3.40 (1.07)	3.00	3.033	0.387
ACCEPTANCE[5]	15.4 (3.85)	16.00	15.6 (2.87)	16.00	14.37 (3.40)	14.50	3.238	0.356
%MI score[6]	84.1 (18.9)	90	85.8 (15.5)	90	82.7 (20.0)	90	0.724	0.868
Text group (TX)								
ATTRACTIVENESS[1]	3.89 (0.81)	4.00	3.75 (1.14)	4.00	3.61 (1.02)	4.00	1.019	0.601
USEFULNESS[2]	3.84 (0.90)	4.00	3.66 (1.10)	4.00	3.58 (1.10)	4.00	0.854	0.652
TRUST[3]	3.89 (0.81)	4.00	3.57 (1.07)	4.00	3.42 (1.15)	4.00	1.895	0.388
SHARE[4]	3.58 (1.35)	4.00	3.16 (1.31)	3.00	3.10 (1.27)	3.00	1.751	0.417
ACCEPTANCE[5]	14.74 (3.54)	16.00	13.80 (4.17)	14.00	13.06 (4.48)	14.00	1.827	0.401
%MI score[6]	87.4 (17.3)	90	80.2 (1.76)	90	89.4 (15.0)	100	7.321	0.026**
Control group (CL)								
%MI score[6]	78.6 (17.8)	80	78.4 (16.7)	80	90.7 (13.4)	95	11.37	0.003**

Note. Standard deviations are presented in parentheses. [1]Attractiveness of the educational instrument, [2]Perceived usefulness in helping identify misinformation, [3]Trust in the information provided by the educational instrument, [4]Willingness to share or repost the educational material on social media, [5]Acceptance of the educational instrument, corresponds to the sum of the four evaluation components, [6]Misinformation identification score.

*Kruskal-Wallis *H* test, ***p* < 0.05.

Table 37

Within-Group Comparison of Main Outcomes Between Household Income Categories

Main outcomes per group	Less than $25,000		$25,000 - $49,999		$50,000 - $99,999		$100,000 - $199,999		$200,000 or more		χ^2*	*p***
	Mean (*SD*)	*Mdn*	Mean (*SD*)	*Mdn*	Mean (*SD*)	*Mdn*	Mean (*SD*)	*Mdn*	Mean (*SD*)	*Mdn*		
Comic strip group												
ATTRACT[1]	4.25 (1.04)	4.50	4.00 (0.93)	4.00	3.78 (1.09)	4.00	3.83 (0.98)	4.00	4.50 (0.71)	4.50	2.567	0.633
USEFUL[2]	4.00 (0.76)	4.00	3.50 (0.76)	4.00	4.00 (0.87)	4.00	3.33 (0.82)	3.50	4.00 (1.41)	4.00	5.230	0.265
TRUST[3]	4.50 (0.76)	5.00	3.75 (0.46)	4.00	4.00 (0.50)	4.00	4.00 (0.00)	4.00	4.00 (1.41)	4.00	2.765	0.598
SHARE[4]	3.25 (1.67)	3.00	3.13 (1.25)	3.00	3.22 (0.97)	3.00	3.33 (1.21)	3.50	4.50 (0.71)	4.50	1.767	0.778
ACCEPT[5]	15.53 (2.90)	16.00	14.44 (3.70)	15.00	15.58 (2.85)	15.50	14.63 (3.14)	14.00	15.09 (5.65)	18.00	2.143	0.709
%MI score[6]	85.9 (16.6)	90	85.6 (20.1)	90	82.1 (18.6)	90	84.4 (19.3)	90	83.6 (15.7)	90	1.118	0.891

Main outcomes per group	Less than $25,000		$25,000 - $49,999		$50,000 - $99,999		$100,000 - $199,999		$200,000 or more		χ^{2}*	*p**
	Mean (*SD*)	*Mdn*	Mean (*SD*)	*Mdn*	Mean (*SD*)	*Mdn*	Mean (*SD*)	*Mdn*	Mean (*SD*)	*Mdn*		
Text group (TX)												
ATTRACT[1]	3.42 (1.22)	4.00	4.12 (0.49)	4.00	3.47 (1.25)	3.00	3.56 (1.21)	4.00	4.00 (1.10)	4.00	5.873	0.209
USEFUL[2]	3.42 (1.21)	4.00	4.00 (0.79)	4.00	3.33 (1.76)	4.00	3.60 (1.16)	4.00	3.94 (1.06)	4.00	5.178	0.269
TRUST[3]	3.95 (0.85)	4.00	3.59 (0.71)	4.00	3.20 (1.08)	3.00	3.28 (1.24)	3.00	3.94 (1.81)	4.00	8.241	0.083
SHARE[4]	3.16 (1.34)	3.00	3.59 (1.18)	3.00	2.60 (1.40)	3.00	3.12 (1.33)	3.00	3.56 (1.21)	4.00	5.291	0.269
ACCEPT[5]	13.63 (3.62)	13.00	14.76 (3.20)	16.00	12.00 (4.44)	11.00	12.88 (4.64)	14.00	15.06 (4.70)	16.00	5.963	0.202
%MI score[6]	83.2 (14.2)	90	85.9 (17.7)	90	82.7 (21.2)	90	83.6 (18.7)	90	88.1 (14.7)	90	1.616	0.806
Control group (CL)												
%MI score[6]	76.0 (16.8)	70.00	76.9 (22.7)	80.00	83.0 (15.6)	90.00	79.0 (20.7)	85	91.5 (14.6)	100	7.565	0.109

Note. Standard deviations are presented in parentheses. *Mdn* = median. [1]Attractiveness of the educational instrument, [2]Perceived usefulness in helping identify misinformation, [3]Trust in the information provided by the educational instrument, [4]Willingness to share or repost the educational material on social media, [5]Acceptance of the educational instrument, corresponds to the sum of the four evaluation components, [6]Misinformation identification score.

*Kruskal-Wallis *H* test, $p > 0.05$

Table 38

Within-Group Comparison of the Main Outcomes According to Political Affiliation

Main outcomes per group	Democrats		Republicans		Independent and others		χ^2*	*p*
	Mean (*SD*)	Median	Mean (*SD*)	Median	Mean (*SD*)	Median		
Comic strip group (CS)								
ATTRACTIVENESS	4.06 (0.73)	4.00	3.40 (1.34)	4.00	4.00 (1.15)	4.00	2.081	0.353
USEFULNESS	3.72 (0.75)	4.00	3.60 (0.55)	4.00	3.92 (1.04)	4.00	2.123	0.346
TRUST	4.20 (0.84)	4.00	3.50 (1.10)	3.50	3.81 (1.14)	4.00	6.457	0.040**
SHARE	3.22 (1.22)	3.00	3.00 (1.58)	3.00	3.62 (1.19)	4.00	3.305	0.192
ACCEPTANCE	16.04 (2.61)	16.00	13.94 (4.11)	14.00	14.61 (4.08)	15.00	4.179	0.124
%MI score	84.2 (16.9)	90	77.5 (22.7)	80	88.7 (15.2)	90	2.953	0.228
Text group (TX)								
ATTRACTIVENESS	3.69 (1.10)	4.00	4.07 (0.70)	4.00	3.45 (1.14)	3.50	2.682	0.262
USEFULNESS	3.73 (1.06)	4.00	3.87 (0.99)	4.00	3.23 (1.11)	3.00	4.824	0.090
TRUST	3.78 (0.98)	4.00	2.81 (1.19)	3.00	3.18 (1.05)	3.00	6.360	0.042**
SHARE	3.36 (1.20)	4.00	3.20 (1.57)	3.00	2.91 (1.34)	3.00	1.774	0.412
ACCEPTANCE	14.24 (3.90)	15	14.00 (4.44)	13	11.91 (4.32)	11.5	4.894	0.087
%MI score	88.0 (16.3)	90	75.3 (17.7)	80	80.9 (17.4)	80	9.623	0.008**
Control group (CL)								
%MI score	85.8 (15.1)	90	76.5 (20.0)	80	75.8 (22.1)	80	5.543	0.063

Note. Standard deviations are presented in parentheses. [1]Attractiveness of the educational instrument, [2]Perceived usefulness in helping identify misinformation, [3]Trust in the information provided by the educational instrument, [4]Willingness to share or repost the educational material on social media, [5]Acceptance of the educational instrument, corresponds to the sum of the four evaluation components, [6]Misinformation identification score.

*Kruskal-Wallis *H* test, ***p* < 0.05.

Transportation into the narrative

In group CS, transportation into the comic strip's narrative was measured using two items selected from the Transportation Scale-Short Form (TS-SF) (Appel et al., 2015). The first and second items, TRANSP1 and TRANSP2, accessed cognitive and emotional components, respectively. TTRANSP is the total score for transportation composed of TRANSP1 and TRANSP2 scores. Table 39 shows Spearman's correlation coefficients for the correlation transportations scores and the study's main outcomes: scores of misinformation identification and educational instrument evaluation components. The misinformation identification score (MI%) was not correlated to partial and total transportation scores. However, all comic strip's evaluation components had a positive and statistically significant correlation with partial and total transportation scores.

When categories of each demographic variable had their transportation scores compared, the only significant difference found was in total transportation score (TTransp) between men (7.30 (1.18), *Mdn* = 7) and women (6.06 (2.11), *Mdn* = 6) participants (χ^2 (2) = 16.553, p = 0.010).

Table 39

Correlation Between Transportation and the Main Outcomes of the Study

Study outcomes	TRANSP1[1]		TRANSP2[2]		TTRANSP[3]	
	*rho**	*p*	*rho**	*p*	*rho**	*p*
Misinformation identification[4]	0.111	0.285	-0.200	0.052	-0.089	0.391
ATTRACTIVENESS[5]	0.414	0.000**	0.332	0.001**	0.470	0.000**
TRUST[6]	0.481	0.000**	0.231	0.024**	0.413	0.000**
USEFULNESS[7]	0.388	0.000**	0.236	0.021**	0.356	0.000**
WILLING TO SHARE[8]	0.607	0.000**	0.290	0.004**	0.539	0.000**
ACCEPTANCE[9]	0.623	0.000**	0.361	0.000**	0.579	0.000**

Note. N = 92. [1]Cognitive component from the Transportation Scale-Short Form (TS-SF) (Appel et al., 2015), "I could picture myself in the scene of the events described in the comic strip.", [2]Emotional component from the TS-SF, "The comic strip affected me emotionally.", [3]Transportation into the narrative total score, [4]Correct identification of misinformation. [5]Attractiveness of the educational instrument, [6]Trust in the information provided by the educational instrument, [7] Perceived usefulness in helping identify misinformation, [8]Willingness to share or repost the educational material on social media, [9]Acceptance of the educational instrument, corresponds to the sum of the four evaluation components,

*Spearman's correlation coefficient, **$p < 0.05$.

Chapter 5: Discussion

This study aimed to develop a theory-based comic strip to demystify COVID-19 vaccine misinformation besides evaluating and comparing its efficacy and acceptability to an educational text. It was thought to fill important gaps in the literature about using comics in health education, like the scarcity of objective, quantitative measures (Kearns et al., 2021) and studies comparing their effectiveness to texts (Leiner et al., 2018). Only one study was found comparing a comic strip to plain written text. Carnaghi et al. (2007) evaluated the effects of three experimental conditions (the use of a 16-panels comics strip, a written text without pictures or figures, and a no-message condition) on attitudes and subjective norms regarding safe sex behavior in students (from 15 to 17 years old). The authors found that in participants with higher need for cognition had better attitudes and instrumental norms after reading the written instructions than after reading the comic strip. However, the educational tools were offered in printed media. Few studies on health educational comics developed specifically for social media vehiculation have been done (Chernick et al., 2022; Koinig, 2022), with inconsistent results.

Although comics have been successfully used as a health educational tool (Criado et al., 2018; Czerwiek, 2018; Dandolini et al., 2012; Furuno & Sasajima, 2015; Jacoby et al., 2015; Katz et al., 2014; Kearns & Kearns, 2020; Kilanowski, 2013, 2020; Ko et al., 2018; Kraft et al., 2017; Leiner et al., 2018; Leung et al., 2014; Liebman et al., 2007; Matsuzono et al., 2015; Mendelson et al., 2017; Mold & Elizabeth, 2019; Montgomery et al., 2012; Nsangi et al., 2020; Prokhorov et al., 2013; Rosas-Blum et al., 2018; Shimazaki et al., 2018; Sinha et al., 2011; Squier, 2018; Sridhar et al., 2019; Stothard et al., 2016; Tarver et al., 2016; Tekle-Haimanot et al., 2016; Wang et al., 2018) and Kearns and Kearns (2020) had pointed out the potential of

comics in public health education during pandemics, only one quantitative study addressing misinformation about COVID-19 using comics was found (Veletsiano et al., 2022). In that study, data revealed the positive effects of the comics on the participants' comprehension of the factors underlying the misinformation spread on social media. However, there was no comparison of the comics with other strategies, nor was it developed in a friendly format to be conveyed on social media, a significant vehicle for misinformation dissemination (Naeem et al., 2021). The present study brought new information to fill these gaps and bring further questions to be explored.

Development of the Comic Strip

This study explored the application of the Health Belief Model (HBM) and the Theory of Planned Behavior (TPB) as theoretical frameworks for the comic strip development. These models were chosen because they are the most frequent ones used to explain and support interventions on vaccine hesitancy and intentions (An et al., 2021; Chu & Liu, 2021; Rosental & Shmueli, 2021; Shmueli, 2021; Sieverdinget al., 2022; Wolff, 2021; Zampetakis & Melas, 2021; Bateman et al., 2022; Berg & Lin, 2021). However, the use of health behavior models to inform the development of health education comics is still inconsistent.

For example, Katz et al. (2014) developed and evaluated the acceptance of a narrative comic book to improve parents' and adolescents' attitudes toward the Human Papillomavirus (HPV) vaccine, using the same theoretical basis used in the present study TPB and HBM. In another study, Sridhar et al. (2019) tested four narrative comics with 22 panels each, informed by the HBM and Social Cognitive Theory (Bandura, 2004), to increase knowledge about contraceptive methods in young women. However, unlike those studies, the present one developed a 10-panel comic strip - much shorter than a comic book – designed to be vehiculated digitally instead of in printed format. Although the comic strip format adjusts well to social

media, the challenge of addressing several HBM and TPB constructs in a shorter narrative is greater than doing it in a more extended format as a comic book.

The strategy of short comics to be vehiculated online was tested by Veletsianos et al. (2022) and Chernick et al. (2022). They developed short narrative comics (5 and 4 panels, respectively) for online health education but adopted different strategies. Veletsianos et al. (2022) grounded their intervention on microlearning techniques based on small chunks of information that can be easily shared on social media. Chernick et a. (2022) presented to young women different scenarios addressing sexual and reproductive healthcare lived by a peer-age character. Then, she collected messages that the volunteers would send to this character as if she was a friend and developed five narrative comics (four panels each), each incorporating 5 to 12 messages, to be posted on Instagram. The comics had good acceptance in both studies and were considered relatable, useful, practical, and simple. These studies point to the potential of short narrative comics, using fewer theoretical constructs in each one. This way, each construct could be better explored, and additional comics addressing different constructs may be developed if necessary.

Creating a narrative that is, at the same time, technically solid and entertaining is an ambitious and arduous task that requires technical knowledge, creativity, and narrative and artistic skills. Therefore, many authors rely on the help of professional screenwriters in developing their comics (Chernick et al., 2022; Li-Volmer, 2022). However, that was not the case in this study, where the author, who does not have formal training in narrative development, put together the theoretical content and the story script.

Designing appealing visual communication, including compelling and convincing emotional facial expressions, is another challenge usually reached with the participation of

professional illustrators in the creative team (Chernick et al., 2022; Katz et al., 2014; Sridhar et al., 2019; Rosas-Blum et al., 2018). In some cases, different specialized artists are in charge of each step of the comic artistic design, such as drawing, coloring, and lettering development (Kilanowski, 2020). But, again, this was not the case in this study, where the author was also the comic strip artistic designer. Noteworthy, in the evaluation process of the educational tools, attractiveness scores (ATTR) were not statistically different between the comic strip and the educational text. However, the information collected is insufficient to affirm that it happened because a non-professional artist or story writer executed the comic strip design. Also, the same participants did not directly compare the comic strip and the text; the evaluation of each educational tool was made by different groups. In other words, each participant had no access to the other educational tool to make a direct comparison.

On the other hand, some studies had not counted on professional help in designing the health education comic and yet had good acceptance. For instance, Wang et al. (2018) describe how culturally tailored comic strips developed by health education students helped the promotion of colorectal cancer screening in Asian American and Pacific Islander Communities. According to Li-Volmer (2022), opting not to include comics professionals may work well in small educational interventions with a low budget. However, social media, large-scale educational and public health interventions counting on grants and higher budgets, compensating the time and skills of professional artists and screenwriters is fair and desirable. Moreover, for those campaigns where the comics will have greater exposure, a more polished result may make the difference between its success or failure, besides conferring the right look and tone for particular audiences (Li-Volmer, 2022). Young adults and teenagers, for example, are more familiar with

professional entertainment comics and may have higher expectations regarding artistic quality (Diamond et al., 2021).

This study chose a storytelling style to address the COVID-19 vaccine misformation to explore the narrative as a way of persuasion. However, there are countless ways comics may convey the same message - more narrative styles, more informative, different genres, number of panels, graphic style, use of color, and so on – and there is not just one formula that will work well for all kinds of public or topics (Li-Volmer, 2022).

Usually, the development steps of health education comics include extensive formative evaluations with focus groups, interviews, and brainstorming with a specific target population (Leung et al., 2014; Chernick et al., 2022), especially while addressing a specific ethnic or age group, when cultural tailoring is highly desirable (Kilanowski, 2013). However, this study opted not to include this step. It is an exploratory study to reach a broad and heterogeneous audience, making cultural tailoring not desirable at this first moment. Nevertheless, one of the objectives of this study was to explore gender, age, ethnic, political, economic, and educational level groups that would accept and benefit better from a comic strip educational strategy. From there, health education campaigns using comics in social media could be directed to these specific groups, even using particular Facebook and Instagram pages to reach them.

A formative analysis could have explored the impact of specific comics images on its acceptance. For instance, fear or scare-evoking messages may have particular effects that are worth it to be discussed.

As the current study used the Health Belief Model to inform the comic strip development, panels 5 and 8 used fear-evoking illustrations aiming to increase the perceived susceptibility to illness and perceived illness severity of not taking the COVID-19 vaccine. Panel 5 illustrated the

analogy between not using a seat belt and not taking the vaccine resulting in a woman being severely wounded. Panel 8 depicted a hospitalized woman sick with COVID-19. Increasing those perceptions would result in more positive attitudes toward vaccination and improve the identification of vaccine misinformation.

For decades, there have been discussions about the efficacy of the use of fear in health promotion campaigns (Ruiter et al., 2014). In the anti-tobacco mass media advertisement for example, it has been shown that evoking negative emotions, such as sadness, fear, and guilt, may be counterproductive, while more positive messages, including help-to-quit information that increases self-efficacy, get better results (Durkin et al., 2018; Bandura, 2001).

The inefficacy of fear-based health messages is not a consensus, though (Fairchild & Bayer, 2017). Also, fear-based messages may have positive results when combined with hope-based ones. For example, a meta-analysis (Tannenbaum et al., 2015) found that fear appeals (depicted as high susceptibility and severity), when followed by self-efficacy messages, result in positive attitudes, intentions, and behaviors, especially in female audiences. Additionally, these messages seem to be more effective when addressing one-time-only behavior (like being vaccinated) versus a repeated one (like exercising).

A review from Soames (1988) concluded that for effective use of fear in health promotion campaigns: 1) the fear component should come before the desired behavior one; 2) the feared event should appear to be likely; 3) the desired behavior should be part of the campaign; 4) the desired behavior is sufficient to reduce considerably the risk of the feared outcome; and 5) the desired behavior should compensate the fear.

In this sense, the comic strip's inclusion of fear-based graphic messages attended the conditions described by Tannenbaum et al. (2015) and Soames (1988). For instance, the fear-

inducing panels (5 and 8) are followed by panels evoking hope-based and positive messages, like panels 6 and 7 (reducing perceived barriers and negative beliefs), and 9 and 10 (increasing perceived behavior control and perceived benefits). Also, being severely sick and needing hospitalization are likely results from not being vaccinated, and the desired behavior (being vaccinated) reduces the risk of the feared events.

This study did not focus on the emotional influence of individual images or specific panels. This way, it is not possible to know if and how the fear-inducing images and messages from the comic strip emotionally influenced the participants in such a way that it would have resulted in different beliefs regarding vaccination (and consequently different misinformation identification scores) and different levels of perceived attractiveness and intention to share or repost it. Moreover, despite many studies exploring the use of scare-inducing photographs in health promotion campaigns, that are no studies comparing the emotional effect of those to illustrations like in the comic strip, where the fear message is passed supposedly without the same potentially aversive impact of the real-life images.

Additionally, it is worth it to mention that some studies have shown the efficacy of the use of fear in health promotion campaigns may be different according to the campaign's topic and individual characteristics (e.g., self-efficacy, past behavior, self-control, etc) (Farias, 2020).

Vaccination, for example, is a health topic strongly influenced by accrued beliefs and attitudes, that are in turn differently influenced by individual characteristics. Due to a lack of studies, it is unknown how fear-inducing messages impact actual vaccination rates, not to mention beliefs and attitudes toward vaccination. In addition, there is a current national context of health decisions influenced by political polarization (Curtis et al., 2022). Regarding health topics strongly influenced by this political polarization, as it is the case of COVID-19 vaccination, it is unknown

if scare and fear-based health messages may have the opposite effect from the desired one in more vaccine-hesitant individuals, usually more politically conservative-inclined. So, more studies should address how fear-inducing messages affect more conservative-oriented and vaccine-hesitant individuals.

Said that, the risk of getting ill, getting severe complications, or dying from a COVID-19 infection has been shown to increase perceived susceptibility to and severity of the COVID-19 infection (Rosental & Shmueli, 2021; Shmueli, 2021; Iacob et al., 2021; Guidry et al., 2021). These factors are some of the most relevant ones when it comes to reasons to be vaccinated (Susło et al., 2022).

It is unknown what is the impact of graphic representation of these factors in health promotion campaigns using comics. Increasing perceived susceptibility to and severity of life-threatening health issues, like COVID-19, without using strong and potentially aversive illustrations (like the ones in panels 5 and 8 from this study's comic strip) is a challenge, and comparisons of the effect of illustrations to the effect of real-life photos may be an interesting subject to be explored. If shown to increase perceived susceptibility to and severity of diseases without the undesirable potential aversive effect of photographs, comics may be an alternative for those in fear or scare-based campaigns.

Quantitative analysis

Descriptive statistics

Demographic characteristics did not differ between groups (table 7), nor did the scores for the other independent variables, which may indicate successful sample randomization. Overall, the demographic profile of this sample of social media users is somewhat similar to that described by the Pew Research Center (2021b), with more women using Facebook and

Instagram than men (in this sample, 60.4% and 36.8% were women and men, respectively), adults from 30 to 49 years old as the majority of Facebook users and young adults from 18 to 29 the majority of Instagram users (45.6% of adults from 30 to 49 years old in this sample), and more users with a bachelor's degree or higher than the ones with high school or less (68.8% and 24.2% of this sample). Regarding ethnicity and race, White/ Caucasian made up the majority of the sample (64.2%), followed by Black / African American (14.7%) and Hispanic/ Latino (11.2%). Although the Pew Research Center (2021b) revealed that the group with the highest percentage of Facebook and Instagram was Hispanic/ Latino, followed by Black/ African American and White/ Caucasian, the ethnic distribution of the sample reflects the data from the 2020 Census (United States Center Bureau, 2021). This sample's most frequent annual household income was within the range of $50,000 to $100,00, compatible with the American median income of $70,000 (United States Census Bureau, 2022). In summary, this sample was predominately composed of white, female individuals with high education levels, from 30 to 49 years old.

No differences were found between groups in scores for the scales CVCS (COVID-19 Vaccine Concerns Scale), SILS (Single Item Literacy Screener), eHEALS (eHealth Literacy Scale), SMUIS (Social Media Use Integration Scale), and for the questionnaires of social media use, trust in health organizations, government institutions and scientists, and vaccination history and intentions. The homogeneity of these independent variables indicates again the good randomization of the sample and allowed comparison of the outcomes between groups without further adjustments.

The low percentage of participants identified with low health literacy by SILS (22.5%) (table 9) and the high scores for the questions from the digital health literacy scale (eHEALS)

reflect the overall high education level of the sample (table 10). That is supported by the literature, which has shown that education level and literacy are linked to health and digital health literacy (Centers for Disease Control and Prevention, n.d.-b, Liu et al., 2020; Manganello et al., 2017).

The vaccination history and intentions questionnaire show that 66.6% of the sample was fully vaccinated (i.e., took two doses of the vaccine or one dose of a monodose one). This percentage is less than the national estimate of 79% (Centers for Disease Control and Prevention, 2023). However, the rate of vaccinated individuals varies according to state, and since data from participants' origin was not collected, it is not possible to affirm that this data does not reflect the American social media users' vaccination rates.

Quantitative analysis of outcomes of interest

Misinformation identification scores (%MI) did not differ between groups, including the control group (CL), which had answered the questionnaire without the aid of either the comic strip or the educational text. Even taking each questionnaire sentence individually, there were still no differences between groups. Moreover, there were no differences in %MI between groups according to categories of demographic characteristics accessed in this study.

These data could lead to the conclusion that neither the comic strip nor the educational comic affected the participants' ability to identify misinformation correctly. However, important considerations should be made regarding the instrument used to measure misinformation identification, the health topic addressed (vaccines), and the timing of the study.

Concerning the misinformation identification questionnaire, this study developed and administered a customized instrument whose items matched the content approached in the comic strip and the educational text (whose content, in turn, matched the one from the comic strip).

This questionnaire was not a tested and validated scale, but this option was made for two reasons.

First, until the data collection, tested and validated COVID-19 vaccine misinformation scales were not available. Just recently, Bok et al. (2023) developed and tested the COVID-19 Vaccine Misinformation Scale (CVMS). Second, even if available for the data collection, generic scales such as the CVMS would not serve the specific needs of this study. For example, CVMS items such as “Herbs like thyme are a natural COVID-19 vaccine.”, and “Elderberry is a natural COVID-19 vaccine.” would assess respondents' COVID-19 vaccine misinformation level generically. However, to successfully test the efficacy of the comic strip in aiding misinformation identification, the questionnaire items should have reflected the contents approached, which specifically addressed the theoretical constructs from TPM and HBM. When affected by misinformation, those may result in reduced vaccination intentions and increased vaccine hesitancy (Lee et al., 2020). Furthermore, the items used in the questionnaire were carefully selected and quoted from information vehiculated on internet web pages and social media platforms to test their perceived veracity. This way, generic items from a non-specific scale would not meet these purposes.

Another possible issue with the questionnaire was the structure of the sentences, which included the source of information to boost their credibility and check if the participants could identify false information even when supported by apparent reliable sources. The inclusion of perceived reliable sources is a strategy frequently used to increase belief in misinformation (Ecker et al., 2022). However, an unforeseen problem arose from this strategy. During the data collection, a social media user contacted the primary investigator to ask if participants should judge the veracity of the information based either on the source mentioned or on the content of

the information itself. For example, in the sentence “Study published in the scientific journal Clinical and Experimental Vaccine Research affirms that serious side effects and the risk of death related to any one of the COVID-19 vaccines are extremely rare.”, some respondents may have judged the information itself accurate but answered that it was false because they thought the source of the information was wrong.

Although this may have been a critical issue, the data cannot prove or disprove this hypothesis. Furthermore, some studies have already used similar structures while developing a misinformation identification questionnaire. For example, Loomba et al. (2021) used the software Meltwater® to select actual and fake information with high circulation in social media. Then, they used the posts and quotations to build a questionnaire to collect the perceived veracity of the information. Many sentences included a source and a piece of information, the same model used in this study, while all cited the social media source. One example was:

> “PREPARING THE PROPAGANDA BLITZ. Yale University and the U.S. government are running clinical trials to develop propaganda messaging to persuade Americans to take experimental, genetically engineered, unlicensed, “Warp Speed,” zero liability, expedited vaccines with limited short duration safety testing. Researchers compared reactions in 12 focus groups using “guilt, embarrassment, bravery, anger, trust” and “fear” to overcome vaccine hesitancy. (Loomba et al., 2022, Supplementary material, pp. 6-7).”

According to the authors, neither the source nor the piece of information was accurate in this sentence.

Despite uncertainties raised regarding the specificity and sensitivity of the questionnaire in identifying individuals with higher or lower capacity to distinguish between false and accurate

information, some data plead in favor of the methodology used. In the control group (CL), that answered the survey without the help of any educational aid, the %MI score had a negative statistically significant correlation (*rho* = - 0.556, $p < 0.001$) with the COVID-19 Vaccine Concerns Scale (CVCS) (Gregory et al., 2022). This correlation was also found in groups CS and TX. In other words, higher vaccine concerns were correlated to lower %MI scores. Furthermore, Gregory et al. (2022) showed that the CVCS scale has a strong correlation with COVID-19 vaccine hesitancy (*rho* = 0.82, $p < 0.001$) and predicted COVID-19 vaccination status. Vaccine hesitancy increases with beliefs in misinformation about COVID-19 (Lee et al., 2022; Garret et al., 2021), so the negative correlation between CVCS and %MI in the CL group is consistent with the literature.

Health literacy scores, measured by the Single Item Literacy Screener (SILS) (Morris et al., 2006), also had a negative correlation with the %MI not only in the CL group but also in CS and TX groups, meaning that the higher the frequency individuals need help to understand health-related materials, the lower was the %MI scores. That is also consistent with the literature showing that low health literacy is associated with susceptibility to misinformation about COVID-19, COVID-19 vaccine (Song et al., 2019; Cheng & Nishikawa, 2022), vaccines in general (Scherer et al., 2021) and social media misinformation (Harnett, 2020).

Another consistency with the literature was the positive correlation of %MI scores with trust in scientists in the three groups. Roozenbeek et al. (2020) and Agley & Xiao (2021) have shown that the higher the trust in science, the lower the susceptibility to COVID-19 misinformation.

The correlations mentioned were not tested for interactions with other factors, though, and they do not prove the questionnaire's validity. However, they indicate that the

misinformation identification questionnaire resulted in scores that behave as expected when correlated to some independent variables of the study.

A second consideration to be done is regarding the health topic addressed by this study, COVID-19 vaccine misinformation. Vaccine hesitancy and refusal are not a problem that surged with the COVID-19 pandemic; they have been a serious public health issue for many years (MacDonald, 2015; Yaqub et al., 2014). Vaccine misinformation has been shown to reduce COVID-19 vaccine intentions (Loomba et al., 2021). Still, although it reinforces vaccine negative beliefs and misconceptions, it seems to be just part of the explanation for this complex phenomenon. Vaccine refusers (the so-called "anti-vaxxers) consist of 15% of the U.S. population (Hamel et al., 2021). They present very powerful, stable, and difficult to change attitudes, and no persuasion strategies seem to work to change their minds (Jamieson et al., 2021). Reasons underlying this strong position include not just safety reasons and misinformation but also, and usually more consistently, political partisanship (Roberts et al., 2022), mistrust in science (Barattuci et al., 2022), "anti-establishment" positions, lower deference to those in a position of power, and stronger defense of individual rights (Kennedy, 2020; Mukthar, 2021), religious and moral convictions (Lee et al., 2022) and psychological determinants (Schimid et al., 2017). Those are virtually immutable regardless of educational efforts, and do not necessarily depend on misknowledge or lack of cognitive skills (Jamieson, 2021).

Vaccine-hesitant individuals may share attitudes with vaccine-refusers; however, they are much more flexible and usually adopt a "wait and see" behavior, waiting for vaccine safety and efficacy data to make a decision (Brown & Benson, 2022). Their main concern is usually related to vaccine side effects. Their hesitant position frequently finds roots in fear and anxiety,

emotions that can be managed or even vanish with time, and effective persuasion strategies that involve empathy and compassion (Brown & Benson, 2022).

Hence, rationality is insufficient to explain such a complex behavior as vaccination. In addition, we can not rule out the possibility of social desirability bias. Concerning sensitive and polemic subjects, it is well known that survey respondents may give the answers they think the researcher would accept better (Krumpal, 2013). It is usually related to behaviors. For example, self-reported vaccine intake may be overestimated due to social desirability bias and does not necessarily reflect the real vaccination rates (Lindholt et al., 2021). However, studies have not investigated whether social desirability affects knowledge-related questionnaires. For instance, in this study, vaccine-hesitant participants might not necessarily believe an allegation was true but answer what they think would be the most acceptable answer.

It is reasonable to suppose that health topics with choices less dependent on ideological motivations would respond better to misinformation demystification strategies like comics, especially using narratives addressing emotions and concerns. For example, some topics to be explored could be misinformation about nutrition and physical activities to prevent obesity, the use of antibiotics, and sexual behavior and contraceptive practices.

Finally, the percentage of participants that reported they chose not to take the vaccine consisted of 7.8% of the sample, similar to the total national rate of 8%, found by Rane et al. (2022). However, although data from the Centers for Disease Control (2023) show that vaccine hesitancy rates are not homogeneously distributed across the country, this survey had not collected data regarding the state of origin of the participants. Therefore, there is the possibility that most participants come from states with low vaccine hesitancy and probably already less susceptibility to misinformation. So, using any educational tool, be it the comics or the

educational text, would not make any difference in misinformation identification, as it was seen when comparing %MI for groups CS and TX in comparison to the control group (CL).

Regarding the timing of the study, the data collection took place in January 2023. At that point, much has changed regarding misinformation about the COVID-19, COVID-19 vaccine, and vaccine hesitancy. In December 2019 and throughout the first months of 2020, very little scientific information was available about the new coronavirus. Salvi et al. (2021) highlight that uncertain situations often push people to seek information to alleviate their fear and anxiety, making them vulnerable to misinformation. In their study in April 2020 in the U.S., first months of the pandemic, fear was positively correlated to misinformation receptivity. From December 2019 to July 2020, Pullan and Dey (2021) used Google Trends to monitor the search popularity of anti-vaccination terminology associated with COVID-19, like “mercury” and “autism”, usually mentioned in vaccine misinformation. Within the period studied, those searches increased and remained high, with peaks especially after important announcements, such as about new vaccine trials. Pullan and Dey (2021) affirm that an increased disease burden could raise positive interest in vaccines but shows that exposure to misinformation may also increase.

A national cohort study with U.S. adults revealed that vaccine delay or refusal decreased from 51% and 8% to 8% and 6%, respectively, from October 2020 to July 2021 (Rane et al., 2022). In another research, vaccine acceptance increased by 20.4% from June 2021 to June 2022 in the U.S. (Lazarus et al., 2023). In the same study, a significant rate of Americans reported paying less attention to new information about COVID-19 vaccines from 2021 to 2022 (36% of young adults from 18 to 19 years old, more than 60% of both men and women, 31% of the ones with university degree and 33% of those with below the American median household income) (Lazarus et al., 2023). Although less interest in new information about vaccines may have also

reduced the search for accurate information, one may hypothesize that it also reduced the exposure to misinformation.

After the launch of the vaccination campaigns in December 2020, cases and deaths dropped significantly in the U.S. until August 2021, and then, with the surge of new variants of the virus, reached the highest peak since the beginning of the pandemic, with more than 5 million cases and 17 thousand deaths in just one week of January 2021. However, by January 2023, rates of deaths and cases had already dropped to one of the lowest points since the surge of the virus (little more than 300 thousand cases and 3,700 deaths per week) (Centers for Disease Control and Prevention, 2023b).

Although the number of deaths and infections is still high, the sense of fear and that "the worst is already gone" probably makes people feel less emotionally vulnerable. It is not improbable that, for a great part of the participants, much misinformation in the questionnaire had already been debunked months before they completed the survey. In this case, reading the comic strip or the educational text would not affect the %MI scores. Indeed, even without any educational tool, the control group (Cl) had MI% score similar to those from groups CS and TX. It is not possible to affirm categorically that the scores for %MI would have been lower one or two years ago, with the greatest vulnerability to misinformation motivated by fear. Neither can it be asserted that this same survey could have been more successful in verifying possible differences in the capacity of the materials to assist the misinformation identification. Indeed, this study showed that the perceived usefulness of the comic strip and the educational text to help identify the misinformation did not differ, nor was there a correlation between %MI and usefulness score in any group. However, it could have happened because of the current context and not because the tools were not efficient and maybe in another situation or time, the comic

strip or the educational tool (or both) would have been useful on helping the identification of misinformation.

Regardless of possible reasons underlying the lack of difference in %MI between groups, a closer look at within-group comparisons and correlations brings interesting information to be discussed.

There was no difference in MI% scores between groups according to age range. There is no consensus in the literature regarding age susceptibility to health misinformation. Among younger adults (18 to 55 years old), Vijaykuma et al. (2021) found stronger COVID-19 misinformation beliefs than among adults older than 55. Roozenbeek et al. (2020) found that older age (65+) was associated with lower susceptibility to COVID-19 misinformation, while other studies point to a higher vulnerability to misinformation in older adults (over 65 years old) (Bapaye & Bapaye, 2021). According to Brashier and Schacter (2020), older adults may even successfully categorize true and false headlines but become confused when exposed to viral fake news due to low digital health literacy. However, the present study did not include the age range over 65, and future studies may include it to allow comparisons with younger age ranges.

Women presented higher %MI scores than men, regardless of the educational intervention. Literature about misinformation susceptibility according to gender shows mixed results (White, 2022). Additionally, discussion regarding differences between genders may be oversimplified since many other factors are involved, such as conservationism, emotional aspects, health literacy, and social media use (White, 2022).

In this study, in groups TX and CL, women had lower scores for concerns toward the COVID-19 vaccine (assessed by the CVCS) than men, which could help explain their better %MI scores since they would be less susceptible to misinformation (Garret et al., 2021), while

other differences between genders were not found regarding health literacy, eHealth literacy, social media use, and trust in health authorities. Study from Alsharawy et al. (2021) showed that women were more concerned than men regarding the health consequences of a COVID-19 infection and reported taking more preventive behaviors, and that may support the current study's finding of lower concerns about the COVID-19 vaccines and consequently better misinformation identification scores, including in the control group, that had not used any educational tool prior to the questionnaire.

In the comic strip group (CS) there were no differences in CVCS scores between groups, so the associations described above probably cannot explain higher %MI score in women than in men. In the case of the comic strip, it has already been discussed the use of fear-based situations, and how it may have impacted the effectiveness of the message. However, studies addressing the implications of fear-based illustrations in comics according to genders are scarce. Hendriks and Janssen (2018) evaluated persuasiveness of cartoon and graphic messages about health consequences of binge drinking and caffeine consumption according to the combination of low/ high threat messages and with/ without humor component, in men and women. They found that women prefer the low threat/ with humor message, while men preferred the high threat/ with humor message. These results may help explain the better acceptance (ACCT) of the comic strip by men than in women, but do not explain the better %MI score of women in the CS group.

In group CS, transportation score was higher in men than in women. Interestingly, in the comic strip, the male character was the one explaining the scientific data ("wiser") and maybe men have had a more positive identification with the comics. Although in group CS higher transportation in men had not translated into a higher %MI than in women., males in group CS presented higher scores for perceived usefulness (USE) and acceptance (ACCT) than women. It

is possible that positive evaluation of the comics in fact does not influence the %MI scores in men. Finally, one possible explanation for better evaluations of comics by men than women may reside on the fact that historically comics has been made "by men, for men and about men" (Hickey, 2014). This way, men may have more familiarity than women with this format, and better acceptance then.

In the control group (CL), the %MI score was higher in participants holding a master's or doctorate degree than the ones with a bachelor's degree or less. That is consistent with the findings that a higher educational level translates into higher health literacy and digital health literacy (Levin-Zamir & Bertschi, 2021; Neter & Brainin, 2012), which in turn are related to lower susceptibility to health-related misinformation (Scherer et al., 2021).

As already mentioned, vaccination is a very sensitive topic, with vaccine-refusers holding very strong opposition behavior (Jamieson et al., 2021), most of the time associated to conservative partisanship (Roberts et al., 2022). This scenario illustrates how politics may be a determinant of health. Cornelson & Miloucheva (2022), for example, found that individuals are less willing to comply with COVID-19 preventive measures when a party different from their preference holds the state governorship. This degree of polarization may strongly interfere with vaccine misinformation beliefs, making rational persuasion efforts fruitless (Jamieson et al., 2021). That may help explain the few differences found between misinformation identification scores in democrats and republicans according to educational tool accessed.

Partisanship, specifically right-wing and conservative preference, has been strongly associated with misinformation sharing and beliefs (Pennycook & Rand, 2021; Geisterfer-Black et al. (2022). This way, it was expected to find higher %MI scores among Democrats than Republicans. However, within-group comparisons revealed this difference only in the group

submitted to the text reading (TX). On the other hand, concerns about the COVID-19 vaccine (CVCS), a construct associated with increased predisposition to misinformation (Lee et al., 2022; Garret et al., 2021), showed a negative correlation with %MI in all groups, not just in the TX group. Furthermore, within-group comparisons revealed that Democrats had lower CVCS scores than Republicans in all groups, not only in the TX group. Therefore, one hypothesis is that in the CS group, the difference in %MI between Democrats and Republicans would also be present, but the comic strip has "smoothed" this difference. This hypothesis may be explained by the better evaluation of the comic strip than the educational text for attractiveness (ATTR), trust in the content of the educational material (TRUST), and acceptance (ACCT) among Democrats. It can also be assumed that among Republicans the educational text was not as effective to help misinformation identification as the narrative comic strip. This data is in accordance with studies that show the persuasion power of narratives (Dhalstrom, 2014).

Another supposition was that the transportation into the narrative was a factor reducing the difference in %MI score between Democrats and Republicans in group CS, by opening the mindset of people with more accrued beliefs (Green, 2021). However, transportation scores were not correlated to %MI and there was no difference in transportation scores between categories of political affiliation, indicating that other factors may have promoted lack of variance in %MI between Democrats and Republicans.

The way partisans process information may determine the best formats to convey health messages. For example, Carnaghi et al. (2007) showed that teenagers with high need for cognition (NFC) – the individual's tendency to engage in and enjoy thinking (Cacioppo & Petty, 1982) - preferred and had better outcomes reading text pamphlets over a comic strip to inform about safe sex. Studies about partisanship and information processing style ae scarce, though. It

had been shown that partisans with high need for cognition tend to engage in more analytic and unbiased thinking when confronted with partisan information than those with higher in need for affection (NFA), which hold strong emotional ties to partisan identification (Arceneaux & Wielen, 2013). In other words, the last ones seem to evaluate as more positive the information coming from their own party, which seems to a trend in Republicans/ conservative partisans. Although we had not evaluated NFC and NFA in this study, maybe higher NFA and lower NFC in Republicans than Democrats may help explain the higher %MI in Democrats than Republicans in the TX group.

The results from this work indicate that comics may be a valid strategy to access more conservative audiences. However, since there are no studies addressing health education comics' evaluation and effectiveness according to political preferences, future studies are necessary to understand the role of partisanship in health misbeliefs and find the most effective formats to fight biased information.

The distribution of vaccination status did not differ between groups and there were no differences in %MI scores according to vaccination status between groups. However, within groups comparisons showed that vaccine refusers/ hesitant presented lower %MI than fully vaccinated participants only in group CS. These data taken together may indicate that the comic strip was efficient in increasing misinformation identification scores among vaccine hesitant/ refusers, since the total %MI for group CS did not differ between groups. This is a promising result, showing that comics may be particularly efficient among those that usually present more vaccine misbeliefs and share more vaccine misinformation (Loomba et al. 2021). Yet, since the number of vaccine hesitant and refusers were disproportionately lower than fully vaccinated

participants, the effectiveness of the comics to improve misinformation identification among people that refuse to take the vaccine still need further studies.

Health literacy has been shown to be one of the most important factors of misinformation susceptibility (Harnett, 2020; Paige et al., 2017). Although in this study there were no differences between groups in %MI for both low health literacy level individuals and normal health literacy ones, in group TX the low health literacy individuals showed lower MI% scores than the ones with higher health literacy (table 18). In other words, the performance of lower literacy level individuals in the misinformation identification test was worse than the performance of higher literacy level individuals. That difference was not observed in group CS. These results in group TX may suggest that maybe low health literacy individuals benefited less from the educational text than the higher health literacy ones. In addition, the lack of performance difference in group CS may indicate that the comic strip was effective in promoting accurate misinformation identification in lower health literacy individuals, so that their performance was not different from the higher health literacy participants that also read the comic strip (group CS). This is supported by the literature, that shows effective health education among low health literacy groups (Jacoby et al., 2015, Kilanowski et al, 2013, Ko et al., 2018).

Evaluation of the educational tools showed that the comic strip had better overall acceptance (ACCT) than the educational text. Previous studies have reported good acceptance of their health educational comics among adults (Chernick et al., 2022; Wang et al., 2018; Furuno et al., 2015; Kilanowski, 2011), although the construct “acceptance” has not been clearly defined in many studies, and they had not compared the comics with other strategies. Results are inconclusive, though. For example, Koining (2022) collected quantitative data to evaluate different formats mental health influencers use on Instagram. Comics scored the lowest

compared to motivational quotes, and an influencer post with her photo and a positive sentence. On the other hand, Muzumdar and Pantaleao (2017) found that a comic flyer providing immunization information to adults had a better evaluation than the one developed by the Centers for Disease Control and Prevention (CDC), with text and photos.

Among the individual evaluation components, trust in the content of the educational material (TRUST) was higher for the comic strip than for the educational text. Within-groups comparison showed that there was no difference in any evaluation construct between age categories inside both group CS and TX (table 33). This data is interesting, considering that comics have been culturally attached to the stigma of lacking academic or intellectual value (Farthing & Priego, 2016), besides being considered juvenile and inappropriate for adults (Ashwal & Thomas, 2018). This data also indicates that among adults from 50 to 65 years, the older age range in this sample, comics was as acceptable as in younger groups. Indeed, comics have shown good acceptance among adults of all ages (Muzumdar & Pantaleao, 2017; Veletsianos et al., 2022; Shimazaki et al., 2021). This information, added to the data from the present study, may encourage more studies using health educational comics targeted at adults, in contrast to studies targeting children and teenagers, which had been the majority (Sinha et al., 2011; Tekle-Haimanot et al., 2016; Nsangi et al., 2020; Mendelson et al., 2017; Mold & Elizabeth, 2019; Matsuzono et al., 2015; Ohyama et al., 2015 Ko et al., 2018 Katz et al., 2014; Criado et al., 2018; Chernick et al., 2022).

Better acceptance and trust in the comic strip compared to the text had not translated into better %MI scores, though. In this study, the %MI scores seemed to be independent from the acceptance of the educational tools. Indeed, none of the evaluation components' scores had positive correlations with MI% scores, including perceived usefulness. That may corroborate the

hypothesis already discussed that the COVID-19 vaccines misinformation may not be significantly sensitive to changes with educational tools, even when one of them (the comic strip) uses strategies theoretically appropriate, such as narratives, to address difficult to change attitudes.

The attractiveness of the educational tool was not different between the comic strip and the text. As mentioned, few studies have objectively compared comics to text among adults, making it difficult to discuss the data. At least theoretically, comics were supposed to be superior to texts regarding attractiveness (Kearns & Kearns, 2020). In the only study that indirectly compared attractiveness between comics and a text, Muzumdar and Pantaleao (2017) showed that the likelihood of adults in an ambulatory picking up a comics flyer about immunization was higher than picking up a flyer developed by the CDC, with text and photos.

The information available is insufficient to understand the subtleties underlying the lack of difference in the attractiveness of the two tools. Moreover, almost all studies using comics face the subjectivity of the evaluation since different studies may consider comics attributes to assess their attractiveness.

Within-group comparisons revealed lower acceptance of the comic strip in the Hispanic/ Latino group than in White/ Caucasian and Black/African groups. One possible explanation would be the uneven representativeness of each group in the comic strip, which portrayed White and Black characters, but no Latino ones. Cultural tailoring is an important strategy used in comics (Kilanowski, 2013) and in health education programs in general (Chandler et al., 2021). For example, Chernick et al. (2022) showed that culturally tailored comics with Latina characters were considered relatable and well accepted among young Hispanic women. In another study, Wang et al. (2018) heard from their Asian and Pacific Islanders subjects suggestions of including

Asian clothing and facial expressions and Asian names to make the comics more relevant for them. Although no cause-consequence can be established, the positive correlation of transportation scores (that included the cognitive score of identification with the scene of the comic strip) with all evaluation components, including acceptance and attractiveness, may reinforce the assumption that lack of representativeness has impacted Hispanic/ Latino acceptance of the comic strip. However, there were no differences in transportation scores between ethnic/ racial categories. It is worth it to note that the number of individuals of the Latino/ Hispanic in group CS was small (N = 8), though. As no other independent variables (for example, health literacy, digital health literacy, etc) had lower or higher scores for Hispanic/ Latino in group CS, future studies with larger samples could explore more deeply the relationship between cultural tailoring, ethnic representativeness, and transportation as a factor underlying the acceptance of narrative comics in different ethnic groups.

Willingness to share and repost (SHARE) was also not different between the two tools. It makes sense, considering that attractiveness between the two groups was also not different. A possible explanation was the option to design the text in panels like on a social media post, making it appear readily “sharable”. There were positive correlations between SHARE and social media use to find health information and trust in health information from social media, in both groups (CS and TX). That makes sense, because the people who seek and trust more health information coming from social media would be proner to share and repost the informnation that they found and judged acurate. Similar social media behaviors may help to explain that the willingness to share would be prevalent in both groups. Yet, the inexistence of studies comparing comics and text also regarding this parameter allows just assumptions, which should be tested in future studies.

Sharing and reposting accurate health-related content is highly desirable in fighting against health misinformation (Wardle, 2020). However, few studies have evaluated real online engagement with health comics, and when they do, the evaluation is usually subjective, with no quantitative data (Chernick et al., 2022). In fact, some studies have measured intentions to share, "likes", or leave a comment, but not the actual behavior engagement (Veletsiano et al., 2020). For example, Veletsiano et al. (2020) revealed that 20% of mothers reported that if they came across a comic strip about online health misinformation, they would ignore or scroll past it, while 17% said they would share it on social media and 2.7% would share it on a messaging app such as WhatsApp or Messenger, but what would be the real-life reaction of the comic on social media is unknown.

Scores for trust in information posted on social media coming from health organizations, government institutions, and scientists were not different between groups and had the same high median score. These scores were also positively correlated to all evaluation components of both educational tools (attractiveness, willingness to share, trust, perceived usefulness and acceptance). Although not showing a causation association, these data indicate that in a sample with high education levels, there is a tendency for participants to attribute higher evaluation scores for both educational materials according to their trust in health authorities and scientists.

Despite no difference in the educational tool evaluation between participants with low literacy in the two groups, health literacy (SILS) was positively correlated to trust in the content of the comic and willingness to share it. That means the lower the health literacy, the lower the trust in the comic, and the lower the willingness to share it. Also, digital health literacy was correlated to the usefulness, trust, and willingness to share the comic. These correlations were not observed in the TX group. Apart from the lack of causation relation and the possibility of

interference from other factors, this data is important to be considered while planning health interventions using comics targeted at low literacy, low health literacy, and low digital health literacy social media users. Studies that, by the way, are essential since individuals and groups with low health literacy are more susceptible to online misinformation (Harnett, 2020). Interventions using health educational comics administered to groups with low health literacy have used printed media (Jacoby et al., 2015; Kilanowski, 2020), though. With the increasing use of social media by American adults with a high school education or less (from 54% in 2015 to 64% in 2021) (Pew Research Center, 2021), it is crucial to understand which factors could affect social media interventions using comics with these groups.

Although transportation into the narrative was not correlated to the %MI scores, it was positively correlated with all evaluation components of the comic strip. It signals that more studies should evaluate the effects of transportation in health education narrative comics, addressing topics that face less resistance than vaccination.

Study Limitations

To my knowledge, this is the first study using objective measures to evaluate a comic strip capacity to help identify misinformation on social media and its acceptance while comparing these outcomes to those of an educational text. However, it has some limitations that should be considered in further studies.

First, the lack of standardized instruments to evaluate health informational comics, added to the lack of clear definitions of constructs like “acceptance”, for example, makes not just comparisons between studies very difficult. It also makes it unclear whether we are measuring what we were intended to. So, the development of standardized and validated instruments is crucial and urgent. Furthermore, constructs like “attractiveness” may represent different concepts

depending on the reader. It could be related to the format *per se* (the comic), but also to the artistic style, coloring, lettering, and genre (narrative versus informative comic).

The study used a convenience sample, and the underrepresentation of some demographic groups precluded more detailed analysis. There were categories disproportionally smaller than others, as, for example, Latino/Hispanic group were a small part of the sample (n = 32) when compared to White/ Caucasians (n = 183), vaccine hesitant/ refusers were only 23 individuals while fully vaccinated ones were 191, and there were The total sample (n = 285) may not have enough large to detect significant differences. This way, the statistical power of the sample is compromised and many test results may be questionable. So, they should be tested again in further studies with larger and more heterogeneous samples.

The non-normal nature of the data required the use of non-parametric tests, that may be less powerful than parametric tests. Also, regression analysis, a parametric test, could not be conducted, and the strongest predictors of dependent variables like the misinformation identification scores could not be identified.

Data regarding the educational level of the participants was limited to academic level and did not access the percentage of participants with technical backgrounds regarding COVID-19, such as healthcare workers, scientists, and academic researchers. Therefore, despite the similar demographic profile of each group pointing to successful randomization of the sample, it is not possible to know if one group had more capacity to identify COVID-19 vaccine misinformation than another before the survey, including the control group.

The online survey was developed to provide the desired information while being as short as possible to avoid abandonment of the respondents. For this reason, scales such as eHEALS (Norman & Skinner, 2006), Social Media Use Integration Scale (SMUIS) (Jenkins-Guarnieri et

al., 2013), and Transportation Scale-Short Form (TS-SF) (Appel et al., 2015) were partially administrated. Although the items were carefully selected, these short versions of the scales have not been validated. Therefore, the results for health literacy, social media use, and transportation into the narrative could have been different if the scales had been entirely administered.

Health literacy was evaluated using the Single Item Literacy Screener, which is a self-reported measure of help needed to read health-related materials. Besides the risk of participants do not admit their true difficulties to reading health related materials, the SILS does not actually measure health literacy, and in future studies a more consistently validated instrument to assess health literacy should be used, like the Short Test of Functional Health Literacy in Adults (S-TOFHLA) (Baker et al., 1999).

Still regarding the survey, many questionnaires were not validated or extensively tested, such as the educational tools evaluation, the complementary social media information, and the identification of misinformation.

The misinformation identification questionnaire, the health topic (COVID-19 vaccination), and the data collection timing were also important limitations, which have been extensively discussed above.

As a cross-sectional study, behavior changes and behavior intentions, like willingness to share the educational tool, were not evaluated. Also, "real life" data about the actual engagement of social media users with the comic strip, such as measuring the number of "likes" or comments, was not collected.

An important limitation regarding the images of both educational tools – the comic strip and the panels from the educational text – was the lack of a formative evaluation which could have assessed comprehension of the content, appropriate use of language, size and legibility of

the letters, representativeness of the comic strip characters and its impact on trust, the impact of specific images that may result in negative or repulsive emotional reactions (like the car accident on the panels 4 and 5, and the hospital scene on panel 8),

Finally, the study's design did not allow a direct comparison between the comic strip and the text. Instead, different randomized groups evaluated each one a different educational tool, and then had their scores compared. However, the participants had no access to both tools to indicate which one they would prefer regarding the evaluation components, such as attractiveness. This design was chosen because otherwise, data about misinformation identification could not be related to a specific educational tool. Future studies should prioritize using a within-subject design to make comparisons.

Implications for Future Research

Although bringing some new data to the field of health educational comics, many other questions were raised.

The effectiveness of comics should be investigated in more conservative groups, like Republicans, vaccine-hesitant individuals and vaccine refusers, and across different ethnic groups, like Latino/Hispanic and others such as Asians and Native Americans, that . Larger and more heterogenous samples should be used to allow more detailed assessments of the influence of comics in each demographic subgroup.

Further studies can compare the efficacy and acceptance of the different educational tools according to information processing styles, such as need for cognition and need for affection.

Future studies should focus on exploring specific characteristics of comics, like artistic style, coloring, lettering, characters, tone of the language, and genre, and test which different

groups would better accept them. Also, other less sensitive health topics should be addressed and tested.

Specifically regarding the vehiculation of comics via social media, it is necessary to explore which number of panels would be more effective. In addition, studies directly measuring social media users' engagement with health educational comics are necessary due to the importance of these platforms as health information sources.

Finally, more studies should explore the effects of transportation into the narrative due to its positive correlation with the acceptance of health education comics.

Implications for practice

Health authorities (health organizations and government health institutions) should invest in comics for health education through their social media pages since comics' acceptance and trust seem higher than in educational text posts.

In order to effectively address social media misinformation using comics, health authorities should have a creative team available, including screenwriters and illustrators. They could work together with health educators to promptly launch educational comics to counteract social media health misinformation.

Comics should be used by health authorities and institutions in social media campaigns targeting groups with low health literacy since they are the ones to seem to benefit better from this strategy. However**,** since preferences and efficacy of health information formats may vary according to particularities of the social media audience, each educational campaign should be vehiculated in more than one format, both comics and text posts, in order to reach and impact people with different characteristics and preferences.

Conclusions

The present study showed that a narrative comic strip to help social media users identify COVID-19 vaccine misinformation performed no better than an educational text in a social media post format.

However, some data suggest that some subgroups may have benefited from the comics, like low health literacy individuals and vaccine hesitant/ refusers. Additionally, limitations raised regarding the lack of validation and testing of the instruments used to measure misinformation identification, the data collection timing, the topic's sensitiveness may have precluded more positive results, and low statistical powers due to the sample size.

The scores for misinformation identification were not correlated to the overall acceptance of the comic strip and educational text. However, trust in the information vehiculated by the comic and its overall acceptance was higher than the educational text.

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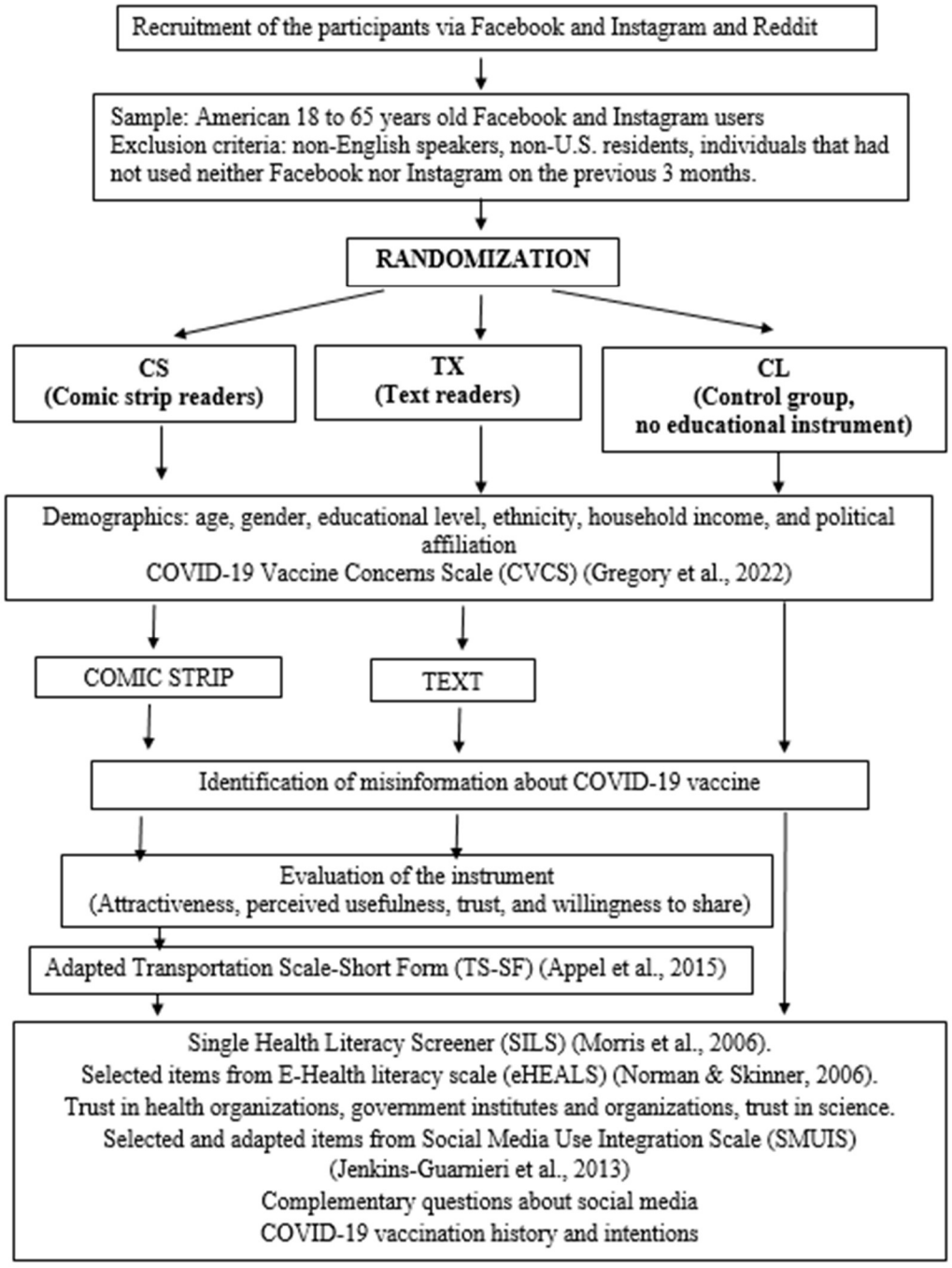
Appendix A

Schematic Representation of the Study Design and Flow



Appendix B

Recruitment Advertisement

Hi! I am a Doctoral student at Teachers College, Columbia University, and I am inviting you to participate in a 10- to 15-minute online survey and be eligible for a raffle of US$75.

To participate, click on the link [LINK]

Appendix C

Information about the Study and Eligibility Criteria Assessment

The present study aims to investigate different strategies of health communication information on Social Media and involves answering an online survey. The questionnaire takes around 10 to 15 minutes to be completed. Your participation is voluntary, and your information will be kept confidential. After filling out the questionnaire, you may participate in the drawing for three $75 Amazon.com electronic gift cards if you agree to participate. If you wish to participate in the drawing, please leave your email.

e-mail address: _____

If you wish to participate in this survey, please answer the following questions:

1. Are you a Facebook and/or Instagram user?

- o Yes
- o No

2. Have you used Facebook and/or Instagram during the three previous months?

- o Yes
- o No

3. Are you between 18 and 65 years old?

- o Yes
- o No

4. Are you fluent in English?

- o Yes

- No

5. Are you a resident of the United States or its territories?

- Yes
- No

Appendix D

Informed Consent Form

INFORMED CONSENT

Protocol Title: **The use of a theory-based comic strip to counteract misinformation about covid-19 vaccine among adult social media users in the United States.**

Principal Researcher: **Viviane Ozores Polacow, M.S., Ed.D. candidate, Teachers College. (+39)3496446465, vop2103@tc.columbia.edu**

IRB PROTOCOL N. 23-129

INTRODUCTION You are invited to participate in this research study called "The use of a theory-based comic strip to counteract misinformation about covid-19 vaccine among adult social media users in the United States". You may qualify to take part in this research study because you are between 18 to 65 years old, are a Facebook and/or Instagram user, are a current resident in the United States and are fluent in English. Approximately three hundred people will participate in this study and it will take from 10 to 15 minutes of your time to complete once.

WHY IS THIS STUDY BEING DONE? This study intends to investigate different strategies of communicating health information and fight against health misinformation in Social Media.

WHAT WILL I BE ASKED TO DO IF I AGREE TO TAKE PART IN THIS STUDY? If you decide to participate, you will be asked to answer to a 10 to 15 minutes online questionnaire.

The questionnaire will collect information about your age, gender, educational level, economic status and political affiliation, get information about your use of internet, your opinions about vaccines, your vaccination history and in which information sources you trust. You will be asked to identify misinformation about the COVID-19 vaccines and you may also be asked to read and evaluate an educational tool that may help on the identification of the misinformation. Completing the questionnaire will take between 10 and 15 minutes.

After answering the whole questionnaire, you will be eligible to participate in the draw for three $75 Amazon electronic gift cards. If you wish to participate in the draw, you will be asked to leave your e-mail address.

WHAT POSSIBLE RISKS OR DISCOMFORTS CAN I EXPECT FROM TAKING PART IN THIS STUDY?

This is a minimal risk study, which means the discomforts that you may experience are not greater than you would experience accessing Social Media

You may be uncomfortable about answering some personal questions. You do not have to answer any questions or share anything you do not want to talk about. You can stop participating in the study at any time without penalty.

The primary researcher is taking precautions to keep your information confidential and prevent anyone from discovering or guessing your identity, such as using a numeric code instead of your name and keeping all information on a password protected computer.

WHAT POSSIBLE BENEFITS CAN I EXPECT FROM TAKING PART IN THIS STUDY?

There is no direct benefit to you for participating in this study. However, the data collected in this study will help finding efficient strategies to mitigate and fight online health-related misinformation, which has the potential to benefit all social media users in the future.

WILL I BE PAID FOR BEING IN THIS STUDY?

You are not going to be paid for participating in this study. However, if you agree to participate, after completing the questionnaire, you may leave your email for a draw of three $75 Amazon gift certificates.

WHEN IS THE STUDY OVER? CAN I LEAVE THE STUDY BEFORE IT ENDS? The study is over when you have finish filling out the on-line survey. However, you can leave the study at any time even if you have not finished.

PROTECTION OF YOUR CONFIDENTIALITY The primary researcher will keep any electronic or digital information stored on a computer that is password protected. A numeric code will replace your name.

For quality assurance, the study team, the study sponsor (grant agency), and/or members of the Teachers College Institutional Review Board (IRB) may review the data collected from you as part of this study. Otherwise, all information obtained from your participation in this study will

be held strictly confidential and will be disclosed only with your permission or as required by U.S. or State law.

HOW WILL THE RESULTS BE USED? The results of this study will be published in journals and presented at academic conferences. Your identity will be removed from any data you provide before publication or use for educational purposes. Your name or any identifying information about you will not be published. This study is being conducted as part of the Doctorate dissertation of the primary researcher.

WHO CAN ANSWER MY QUESTIONS ABOUT THIS STUDY?

If you have any questions about taking part in this research study, you should contact the primary researcher, Viviane Ozores Polacow, M.S, (+39) 349-6446465, vop2103@tc.columbia.edu, or the research coordinator, Sonali Rajan, Ed.D., M.S. 212-678-3458 | E: sr2345@tc.columbia.edu

If you have questions or concerns about your rights as a research subject, you should contact the Institutional Review Board (IRB) (the human research ethics committee) at 212-678-4105 or email IRB@tc.edu or you can write to the IRB at Teachers College, Columbia University, 525 W. 120th Street, New York, NY 10027, Box 151. The IRB is the committee that oversees human research protection for Teachers College, Columbia University.

PARTICIPANT'S RIGHTS

- I have read the Informed Consent Form and have been offered the opportunity to discuss the form with the researcher.
- I have had ample opportunity to ask questions about the purposes, procedures, risks and benefits regarding this research study.
- I understand that my participation is voluntary. I may refuse to participate or withdraw participation at any time without penalty.
- The researcher may withdraw me from the research at the researcher's professional discretion. if for any reason they don't meet your inclusion criteria, they may be withdrawn from your study

- If, during the course of the study, significant new information that has been developed becomes available which may relate to my willingness to continue my participation, the researcher will provide this information to me.
- Any information derived from the research study that personally identifies me will not be voluntarily released or disclosed without my separate consent, except as specifically required by law.
- Your name and other identifiers may be removed from the data. Your data will not be used in further research studies.
- I should receive a copy of the Informed Consent Form document.

My signature means that I agree to participate in this study:

Print name: _____ **Date**: _____

Signature:

_____

_____

Appendix E

Demographics Questionnaire

1. Age _____

2. How do you describe your gender?

- male
- female
- other/prefer not to answer

3. Which category better describes you?

- White/ Caucasian
- Black/ African American
- Hispanic, Latino, or Spanish Origin
- American Indian or Alaska Native
- Asian
- Middle Eastern or North African
- other/multiracial/ do not know

4. What is the highest degree or level of education you have completed?

- Less than a high school diploma
- Complete high school degree or equivalent
- Bachelor's degree (e.g., BA, BS)

- Master's degree (e.g., MA, MS, MEd)
- Doctorate (e.g., Ph.D., EdD
- other/ prefer not to say.

5. What is your annual household income?

- Less than $25,000
- $25,000 - $49,999
- $50,000 - $99,999
- $100,000 - $199,999
- $200,000 - $299,999
- $300,000 or more
- I do not know/ prefer not to say.

6. What is your political preference/ affiliation?

- Democrats
- Republicans
- Independent
- other. Which: _____

Appendix F

Identification of Misinformation Questionnaire

Please identify the following information as TRUE or FALSE.

1. Luc Montainier, 2008 Nobel Prize in Physiology or Medicine for his discovery of the human immunodeficiency virus (HIV), alerts that the COVID-19 vaccines are creating variants able to create an antibody-dependent enhancement that will kill vaccinated people within two years.

- o True
- o False

2. According to vice-president Kamala Harris, virtually every person who is in the hospital sick with Covid-19 right now is vaccinated.

- o True
- o False

3. John Hopkins Coronavirus Resource Center announced that COVID-19 vaccines fully authorized by Food and Drug Administration (FDA) in the United States have gone through the standard steps used for vaccines approvals. The FDA has enough data demonstrating that the vaccines are safe and effective for most people who receive them.

- o True
- o False

4. The World Health Organization (WHO) states that side effects of the vaccine are temporary and include headache, fatigue, and fever, which are signs the immune system is revving up - a normal response to vaccines.

- True
- False

5. The Food and Drug Administration (FDA) revealed that vaccinated people are far more susceptible to getting ill than someone with natural immunity provoked by a previous COVID-19 infection.

- True
- False

6. Study published in the scientific journal Clinical and Experimental Vaccine Research affirms that serious side effects and the risk of death related to any one of the COVID-19 vaccines are extremely rare

- True
- False

7. Recent news showed that vaccines testing was deliberately short and fake, and that they are still experimental.

- True

- False

8. Pfizer, BioNTech says COVID-19 vaccine is more than 90% effective — 'great day for science and humanity.'

- True
- False

9. The Mayo Clinic clarifies that some fully vaccinated people will still get COVID-19 if they are exposed to the virus. These are called vaccine breakthrough infections. People with vaccine breakthrough infections may spread COVID-19 to others.

- True
- False

10. The Washington Post revealed that, in some countries, like Peru, vaccination against COVID-19 is now compulsory, and anyone who refuses to do it will be fined. The CDC is studying to implement that in the U.S. soon.

- True
- False

Appendix G

Evaluation of the Educational Tools

Evaluation of the Comic Strip (group CS)

1. I consider the comic strip an attractive format for receiving information about the COVID-19 vaccine.

- o Strongly disagree
- o Disagree
- o Neutral
- o Agree
- o Strongly agree

2. Reading the comic strip helped me identify the correct information.

- o Strongly disagree
- o Disagree
- o Neutral
- o Agree
- o Strongly agree

3. If I saw this comic strip posted on social media, I would share or repost it.

- o Strongly disagree
- o Disagree
- o Neutral
- o Agree
- o Strongly agree

4. I trust the information I received through this comic strip.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Evaluation of the Educational Text (group TX)

1. I consider the text an attractive format for receiving information about the COVID-19 vaccine.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

2. Reading the text helped me identify the correct information.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

3. If I saw this text posted on social media, I would share or repost it.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

4. I trust the information I received through this text.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Appendix H

Evaluation of the Transportation into the Narrative

1. I could picture myself in the scene of the events described in the comic strip.

    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree

2. The comic strip affected me emotionally.

    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree

Appendix I

Digital Health Literacy Evaluation

Selected items from the Digital Health Literacy Scale

(Norman & Skinner, 2006)

1. I know where to find helpful health resources on the Internet.

    - Strongly Disagree
    - Disagree
    - Undecided
    - Agree
    - Strongly Agree

2. I know how to use the health information I find on the Internet to help me.

    - Strongly Disagree
    - Disagree
    - Undecided
    - Agree
    - Strongly Agree

3. I have the skills I need to evaluate the health resources I find on the Internet.

- Strongly Disagree
- Disagree
- Undecided
- Agree
- Strongly Agree

Appendix J

Trust in Health Organizations, Government Institutions, and in Scientists

1. I trust health information posted on social media profiles of official health organizations (such as WHO- World Health Organization, AMA- American Medical Association, UNICEF- United Nations International Children's Emergency Fund, APHA- American Public Health Association, etc.)

- o Strongly disagree
- o Disagree
- o Neutral
- o Agree
- o Strongly agree

2. I trust health information posted on social media pages or profiles of official government organizations (CDC – Centers for Disease Control and Prevention, NIH – National Institutes of Health, HHS- U.S. Department of Health and Human Services, FDA – U.S. Food and Drug Administration, etc.)

- o Strongly disagree
- o Disagree
- o Neutral
- o Agree
- o Strongly agree

3. I trust health information that comes from scientists.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Appendix K

COVID-19 Vaccine Concerns Scale (CVCS) (Gregory et al., 2022)

1. If a person has already had COVID-19, they do not need to get a vaccine.
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly disagree

2. I am worried I could get COVID-19 from a vaccine.
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly disagree

3. The risks of COVID-19 are less than the risks of a vaccine.
    - o Strongly agree
    - o Agree
    - o Neutral
    - o Disagree
    - o Strongly disagree

4. I am concerned about a COVID-19 vaccine causing severe adverse reactions (e.g., severe allergic reaction, death, etc.).

- o Strongly agree
- o Agree
- o Neutral
- o Disagree
- o Strongly disagree

5. I am concerned about the long-term side effects of getting a COVID-19 vaccine.

- o Strongly agree
- o Agree
- o Neutral
- o Disagree
- o Strongly disagree

6. I am worried a COVID-19 vaccine could change my DNA.

- o Strongly agree
- o Agree
- o Neutral
- o Disagree
- o Strongly disagree

7. COVID-19 and vaccinations are all part of a larger plot.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Appendix L

Evaluation of the Social Media Use Integration

Selected items from the Social Media Use Integration Scale (SMUIS) (Jenkins-Guarnieri et al., 2013)

1. Social media plays an important role in my social relationships.
    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree
2. Using social media is part of my everyday routine.
    - Strongly disagree
    - Disagree
    - Neutral
    - Agree
    - Strongly agree

Appendix M

Complementary Social Media Use Questionnaire

1. Which social media platform have you accessed at least once a week in the last month? (you may choose more than one answer if that applies to you)
    - Facebook
    - Twitter
    - Instagram
    - YouTube
    - TikTok
    - LinkedIn
    - Pinterest
    - others
2. Do you use one or more social media platforms to get health-related information?
    - Never
    - Rarely
    - Sometimes
    - Often
    - Always

3. Do you trust health information on social media?
    - Never
    - Rarely
    - Sometimes
    - Often
    - Always

Appendix N

COVID-19 Vaccination History and Intentions Questionnaire

1. Regarding the COVID-19 vaccine:
    - I have taken at least one dose of a 2-dose vaccine (Pfizer or Moderna).
    - I have taken two doses of a COVID-19 vaccine (Pfizer or Moderna) or one dose of Johnson & Johnson.
    - I know the COVID-19 vaccine was recommended for me, but I have not taken it.
    - The vaccine was contraindicated for me, so I have not taken it.
    - I do not know if the vaccine was recommended for me, and I have not taken it

2. Regarding the vaccine booster:
    - I have had at least one COVID-19 booster shot.
    - I know the COVID-19 booster is recommended for me, but I have not taken it.
    - I do not know if the COVID-19 booster is recommended for me; I have not taken it.

3. If there is a recommendation for you to be vaccinated, but you still had not, do you have plans to be vaccinated in the next 6 months?
    - Yes
    - No
    - I do not know/ I am not sure
    - Not applicable; I have already been vaccinated.

4. If the COVID-19 vaccine becomes recommended every year, would you take it?
    - Yes
    - No
    - I do not know/ I am not sure