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Abstract:

Misinformation about the coronavirus disease of 2019 (COVID-19) health crisis has been widespread on social media and caused various types of harms in society. While some researchers have investigated the way in which people perceive misinformation harm in crises, little research has systematically examined harms from health-related misinformation. In order to address this gap, we focus on non-comparative and comparative harm perceptions of the affected community in the COVID-19 pandemic context. We examine non-comparative harms (which component harms and contextual harms reflect) and comparative harms (which counter-contextual harms reflect) in order to understand harm perceptions. We also investigate how harm perception varies based on COVID-19 victimization experience. We used a professional survey company named Cint to collect data using a scenario-based survey with 343 participants. We extract various findings such as how contextual features shape perceived harms and reveal the scenarios in which COVID-19 victims perceive higher contextual harms but lower counter-contextual harms. We also examine how corrective actions of social media shape harm perceptions.

Keywords: Health-Related Misinformation, Misinformation Harms, Contextual Harm, Counter-contextual Harm, Corrective Actions, COVID-19

Shuk Ying (Susanna) Ho was the accepting senior editor for this paper.

1 Introduction

During humanitarian crises where affected communities seek a large amount of information to make critical decisions quickly (Tran et al., 2020a, 2020b), social media can be an effective communication channel for quickly circulating updates (Beydoun et al., 2018; Rao et al., 2020). However, as social media users can spread unverified claims, the media can also expose readers to different types of misinformation (Zhang et al., 2019). Defined as either intentional or unintentional false information that can mislead readers (Wardle & Derakhsan, 2017), misinformation can lead to various types of harms to individuals, such as life harms, injury harms, financial harms, emotional harms, confusion harms, or trust harms (Tran et al., 2020a). For instance, in the recent coronavirus disease of 2019 (COVID-19) pandemic, widespread misinformation on social media has worsened numerous existing physical and psychological harms from the crisis (Ozili & Arun, 2020) by misleading people to make incorrect decisions (Lytvynenko, 2020), such as consuming ineffective and toxic treatments (Rosenbloom, 2020) or downplaying preventive efforts of using facemasks or hand sanitizer (Lytvynenko, 2020).

Facing harmful misinformation's spread on social media, various governments have tried to seek different solutions. According to Funke and Flamini (2018), despite various efforts to combat misinformation (e.g., checking information, reporting facts, and removing or blocking misinformation) and campaigns to raise the community awareness on misinformation issues, several countries have strictly used law enforcement and bills to prosecute, punish, or imprison misinformation creators or spreaders as criminals (e.g., India, Brazil, Cameroon, China, Indonesia, Malaysia or Egypt). While legal artefacts may have some deterrent effect and prevent misinformation from spreading, they alone have clearly not prevented the massive amount of health-related misinformation available in the world. Therefore, social media organizations need to raise community vigilance and awareness about misinformation issues and consequences and to institute corrective actions, such as removing misinformation sources or blocking people's access to them (Nyilasy, 2020; Rosen & Lyons, 2019).

Recently, several researchers have started investigating harms from health-related misinformation in the COVID-19 context. For instance, claims stating that consuming poisonous substances such as bleach or fish tank cleaners can cure COVID-19 infection have led to several deaths or severely affected health consequences. Chary et al. (2021) examined objective harms for such claims by capturing call logs to poison control centers related to COVID-19 health-related misinformation. Others have investigated how the extent to which people accept health-related misinformation results in their incorrectly perceiving harms can affect the chances that they will experience harm (Motta et al., 2020). Research has also characterized perceived harms from misinformation albeit not in the COVID-19 context (Tran et al., 2019). However, to our knowledge, no study on harms has considered health-related misinformation and corrective actions. Examining these questions will significantly contribute to not only the current health-related misinformation literature but also to strategic plans for misinformation mitigation (such as social media corporates) or emergency response teams seeking to minimize harms toward the victim community.

Specifically, in this paper, we address the following research questions (RQ):

RQ1: How can one measure perceived harm from health-related misinformation?

RQ2: What comparative effect do corrective actions have on how people perceive health-related misinformation harms?

RQ3: How do harm perceptions vary between people whom the crisis has affected (victims) and not affected (non-victims)?

In order to answer these questions, we use the literature in social philosophy on harm assessment related to non-comparative and comparative harms (Bradley, 2012; Hanna, 2016). We link that theoretical background to factual and counter-factual thinking (Effron, 2018; Siciliani et al., 2019), and to the risk assessment literature (Vassie et al., 2005; Tran et al., 2020a) to examine non-comparative and comparative harm perceptions (Funke & Flamini, 2018; Nyilasy, 2020; Rosen & Lyons, 2019). Thus, by applying these concepts, we can measure perceived misinformation harms (RQ1) and examine the affect that corrective actions have on harms (RQ2), which, in turn, we consider to investigate whether misinformation harm perceptions differ between victims and non-victims.

Accordingly, we draw on COVID-19 health-related misinformation scenarios popular in social media to capture misinformation harms in two distinct types: 1) harms perceptions from non-comparative situations, which we term as component harm and contextual harm, and 2) harm perceptions in comparative situations

that involve responses to corrective actions on social media as conditional imaginary contexts, which we term counter-contextual harm. While component harms (e.g., life-related harms or emotional harms) (Tran et al., 2020a, 2020b) and contextual harms (that refer to the severity of harms in total) (Vassie et al., 2005) refer to harms for specific health-related misinformation contexts or scenarios (such as asking people to drink bleach), counter-contextual harms refer to conditional harms given some imaginary corrective situations (such as if the misinformation got removed from social media platforms immediately to minimize possible harms) (Bradley, 2012; Rosen & Lyons, 2019).

For the research design, we recruited 343 participants from a professional crowdsourcing website named Cint in the United States (US). Each participant judged how they perceived harms regarding six chosen COVID-19 health-related misinformation scenarios. We choose U.S. participants because the US had reported the highest number of confirmed cases and deaths worldwide with nearly 30 million cases and more than half a million deaths as of February, 2021[1].

With this paper, we make several contributions to the literature. First, we contribute to the literature on misinformation harms by explaining component harms, contextual harms, and counter-contextual harms. Our framework, which comprises the three types of harms, can act as a measurement guideline for further studies in quantifying health-related misinformation harms. Second, we describe how corrective actions can shape harm perceptions. Finally, we determine how harm perceptions vary based on one's experience with being a crisis victim. We need to investigate such perceptions since doing so can provide guidance to social media companies about quantifying harms from misinformation and identifying the effectiveness of corrective actions in order to prioritize limited resources for tackling certain types of health-related misinformation scenarios.

This paper proceeds as follows: in Section 2, we review the existing literature on misinformation and misinformation harm. In Section 3, we discuss the COVID-19 health-related misinformation scenarios we used in our research methodology, how we collected data, the measures we used, and how we analyzed the data. In Section 4, we present the data analyses' results, which include some visualizations of the harm scores. In Section 5, we perform some post hoc analyses on the records from participants as COVID-19 victims and nonvictims in certain considerations. In Section 6, we discuss the values of key findings. Finally, in Section 7, we conclude the paper.

2 Research Background

In this section, we review misinformation in the COVID-19 context. We also discuss misinformation harms, which includes component harms, contextual harms, and counter-contextual harms.

2.1 The COVID-19 Infodemic and Health-related Misinformation

The COVID-19 pandemic has become the deadliest health crisis of the century with more than two million deaths and more than 100 million confirmed cases as of February 2021. Many countries have attempted painstaking efforts to slow down the virus spread, including stay-at-home orders, economic lockdowns, or mandatory prevention methods and protocols. With disruptions to organizations, supply chains, events, financial markets, and the economy at large (Ozili & Arun, 2020), the pandemic has resulted in job furloughs, suspended schools, restricted travel, and cancelled sports and public events (Fernandes, 2020; Ozili & Arun, 2020).

With substantial ambiguity surrounding COVID-19's origin, its mortality rate, its symptoms (Gallagher, 2020), whether it can transmit between humans and animals (Boehringer Ingelheim, n.d.), and whether the immune system or antibodies can effectively combat it (Walker, 2020), the pandemic has created conditions ripe for widespread health-related misinformation, especially on social media such as Facebook, Twitter, and so on (Lytvynenko, 2020; Waterfield, 2020). It comes as no surprise that several researchers have called it the "parallel pandemic of medical misinformation" (Love et al., 2020, p.1) or (mis)infodemic (Carson, 2021). Regardless of whether the actors who create/spread misinformation do so with good or bad intentions, health-related misinformation diffusion can persuade and harm people much more significantly under crises (Valecha et al., 2020) such as the COVID-19 pandemic "where people have little control over environmental threats" (Nyilasy, 2020). Thus, COVID-19 health-related misinformation has resulted in various harms such as "slowing the federal government responses" (Motta et al., 2020, p. 355) or life-threatening risks due to

[1] See https://www.worldometers.info/coronavirus/

people using “toxic substances” as “unapproved treatments” (Chary et al., 2021, p. 324) or dangerous drugs (Love et al., 2020).

In general, due to widespread confusion, conspiracy theories, and actors who sought benefits (e.g., political propaganda), “the global spread of online falsehoods poses a serious threat to foundational elements of democratic society including social cohesion, public health and political stability” (Carson, 2021). In addition, as COVID-19 pandemic is a health crisis, several studies have identified that “health-related fake news (67.2%) is on the top of the list [of issues that need to be tackled] that includes medicine, medical and healthcare facilities, viral infection, and doctor-patient issues” (Al-Zaman, 2021, p. 100). Therefore, given the potentially severe harms from health-related misinformation during a large-scale pandemic such as the COVID-19 pandemic, we anchor our focus on particularly addressing health-related misinformation rather than generic misinformation.

Recently, researchers have started to examine harms from COVID-19 health-related misinformation (Chary et al., 2021; Tran et al., 2020a). They have argued that we need to not only detect and mitigate health-related misinformation but also address harms from misinformation (Love et al., 2020; Motta et al., 2020). As a case in point, Motta et al. (2020) have reported that “even seemingly innocuous denials or false claims from relied-upon media sources may lead individuals either into a false sense of security or lead others to ignore government recommendations” (p. 336).

In examining health-related misinformation harms, Chary et al. (2021) tracked the emergency call logs after COVID-19 health-related misinformation and identified that “[misinformed] online discussions directly inform behavior that leads to adverse health outcomes” (p. 4). Leng et al. (2021) examined whether peoples’ pre-existing beliefs and cultural practices in relation to various COVID-19 specific topics such as lockdown, cures and preventions, and school reopening worsened the extent to which they believed misinformation and fake claims. Love et al. (2020) reported that fear about possible harm from COVID-19 compounded by swift information propagation on social media can deepen the harmful effects of health-related misinformation.

2.2 Non-comparative and Comparative Harm Perceptions

In order to investigate how people perceive health-related misinformation harms, we adopt the widely addressed literature in social philosophy on non-comparative and comparative harms (Bradley, 2012; Hanna, 2016; Klocksiem, 2012). In general, when facing risky contexts, one can capture harms for victims in two distinct forms: non-comparative and comparative harms.

One obtains non-comparative harms from specific contexts (such as specific misinformation claim scenarios), while one obtains comparative harms from comparing counterfactual contexts (such as the imaginary and contrary context; for instance, if the corporations removed or reduced the extent to which misinformation claims spread on their social media platforms). For example, consider the claim that drinking bleach can cure COVID-19: non-comparative harm would depend on the extent to which one believed one would experience harm from drinking bleach (the specific (supposedly factual context), while comparative harm would depend on whether one perceived reduced or increased harm if an imaginary condition (the counterfactual context) occurred, such as the change in how much harm one would experience if someone removed the “drinking bleach” claim in a timely manner.

We consider non-comparative harms from two perspectives: 1) harms as a whole that arise from the context (overall harms) and 2) harms as separate parts (“pro tanto” harms; i.e., events that have some harmful features) (Bradley, 2012, p. 393; Rabenberg, 2015; Hanna, 2016). In this study, adapting suggestions from current literature into the misinformation harm context (Tran et al., 2020a; Vassie et al., 2005), we address overall harms as “contextual harms” and “pro tanto” harms as “component harms”, which we further explain next.

Regarding comparative harms, Bradley (2012) describes a term called “counterfactual comparative account” (CCA). CCA measures the difference in harm between two contexts: one with and one without a concerned event (e.g., it measures whether shifting between the two contexts causes more harm or less benefits). While the philosophy literature has long debated the CCA concept (for details, see Rabenberg, 2015), many researchers consider it the most plausible available account of harm (Bradley, 2012, Hanna, 2016). In a similar vein, Holtug (2002) has suggested that scholars should consider different varieties of harms (similar to “pro tanto” harms) and counterfactual baseline for comparison (similar to counterfactual comparative harms).

We summarize the differences between non-comparative and comparative harms in Table 1.

Table 1. Different Types of Perceived Harms

Main type	Sub type	Definition	Example
Non-comparative harms	Component harms	Types of misinformation harms (life harms, financial harms, emotional harms, etc.)	Perceived life-threatening harms when following the claim and drinking bleach
	Contextual harms	Overall harm from misinformation in specific contexts	A harm's overall perceived severity when following the claim and drinking bleach
Comparative harms	Counter-contextual harms	Increased or decreased harms if an imaginary or counterfactual condition happened	How much higher or lower harm would occur if someone removed the drinking bleach claim right away

Adapting the above harm literature as our theoretical background, we argue that, in the COVID-19 health-related misinformation context, one can quantify the harms that people perceive by considering their non-comparative and comparative aspects.

2.2.1 Non-comparative Harm Perceptions: Component Harms and Contextual Harms

We first address non-comparative harms as the type of harms based on a certain specific context. In the same vein as prior studies, we propose that one can express non-comparative harms as two types of harms: "component harms" (reflecting the "pro tanto" harms) and "contextual harms" (reflecting overall harms). Studies in the misinformation harms domain have considered these types of harms in various contexts, such as humanitarian crises (Tran et al., 2019, 2020a). Tran et al. (2019) conceptualized harm perceptions based on the likelihood and impact of harm from misinformation. Tran et al. (2020a) proposed a taxonomy of misinformation harms from social media and examined harm severity in natural and man-made crises. The taxonomy includes physical harms (such as life and injury), psychological harms (such as emotion, trust, discrimination), financial harms (related to income), and other harms (such as privacy harms or confusion harms). To summarize, in this study, we consider the pandemic as a crisis to examine health-related misinformation harms and refer to the different applicable types of harms in the taxonomy as pro tanto or component harms as an expression of non-comparative misinformation harms.

Besides the component harms, we conceptualize that non-comparative harms also involve another concept: contextual harms. When examining misinformation harms, people perceive them based on their beliefs or opinions regarding the context (Vassie et al., 2005). Some researchers have conceptualized harm perceptions based on the perceived severity in relation to the specific misinformation contexts such as health crises, natural disasters (Tran et al., 2020a), or man-made crises (Tran et al., 2020b). In researching online privacy issues, Nissenbaum (2011) used the theory of contextual integrity to consider "context-specific substantive norms" (p. 32). In a similar vein, we investigate harm by treating misinformation as resulting from context. In this way, we can consider the harm that arises from the context as a contextual harm. We measure contextual harms based on their perceived severity given the specific context[2].

Specifically, regarding the harms from actual context, literature has conceptualized them based on severity of consequences (Slovic et al., 1987; Tran et al., 2020a; Vassie et al., 2005; Wang et al., 2015). Prior studies have used various terms to reflect that seriousness, such as severity (Slovic et al., 1987; Vassie et al., 2005) and dread (Slovic et al., 1987; Vassie et al., 2005; Wang et al., 2015). Moreover, several other scholars have also considered the possibility that individuals will become victims when they face risky contexts, which might be applicable to various types of threats (Vassie et al., 2005) or to activities that involve handling crisis misinformation flows (Tran et al., 2019). Accordingly, we added contextual harms in terms of both "severity" and "victimization" in this paper.

[2] This harm does not reflect the beliefs about the falsity of the misinformation from readers; it reflects the resulting harms from given situation without any imagination of possible changes (which we indicate in Section 2.2.2).

2.2.2 Corrective Actions and Comparative Harm Perceptions

Realizing the potential for widespread misinformation to cause severe harm, social media companies such as Facebook or Twitter have employed various "corrective actions" to correct misinformation (Rosenberg et al., 2020). For instance, in its community policy, Facebook has enforced "remove, reduce, and inform" actions to deal with content that may have harmful consequences for its users (Rosen & Lyons, 2019). In the same vein, Nyilasy (2020) has also stated that governments and social media platforms need to collaborate efforts in three ways: 1) by cutting fake news supplies (similar to removing misinformation), 2) blocking community access to view fake news (similar to reducing misinformation diffusion), and 3) encouraging Internet or social media users to practice vigilance (similar to informing about debunked misinformation). In addition, Miner et al. (2020) concluded that several technologies, such as chatbots, can significantly help in "sharing up-to-date information quickly, encouraging desired health impacting behaviors, and lessening the psychological damage caused by fear and isolation" (p. 1). In this study, we focus on corrective actions that target misinformation and misinformation diffusion, which involve removing and reducing actions, rather than informing efforts. Despite their importance, no studies that we know about have focused on examining harm perceptions shaped by corrective actions.

In order to address this gap and considering the counterfactual comparative account of harms (CCA) (Bradley, 2012; Hanna, 2016), we refer to the literature on "counter-factual thinking" (Effron, 2018; Siciliani et al., 2019) that reflects corrective actions. In counter-factual thinking, people face a situation that has not happened yet and then asked, "If given the opportunity to make the decisions again, would you make different or same decisions?" (Siciliani et al., 2019). Similar to Bradley's (2012) suggestions about using counterfactual contexts as comparative consideration, Holtug (2002) has stated that researchers should employ a "counter-factual baseline" when investigating harm features (p. 369). In this paper, we refer to counter-factual thinking as counter-contextual thinking since we consider the specific context in which the misinformation spreads rather than in general. By doing so, we can estimate misinformation harms in a condition with an available corrective active in the future. We consider two corrective actions that Facebook employs: 1) remove (which involves deleting content that goes against the community standards or threatens people's safety) and 2) reduce (which involves lowering content's rank in terms of trending popularity)[3]. Since, counter-contextual thinking involves harm perceptions in a futuristic corrective action condition that has yet to occur, we can consider harm in such a context as a "counter-contextual harm". Thus, in this paper, we measure comparative harms (i.e., counter-contextual harms) with respect to two corrective actions: 1) immediately *removing* misinformation and 2) immediately *reducing* misinformation diffusion. While non-comparative harms (including component harm and contextual harm) directly involve the severity of harm from actual contextual health-related information, comparative harms (including counter-contextual harm related to corrective actions) involve the severity of harm from counter-contextual situations (in our case, situations based on corrective actions to remove or reduce health-related misinformation).

3 Methodology

In this section, we discuss the COVID-19 health-related misinformation scenarios we used as our research methodology, how we collected data, the measures we used, and how we analyzed the data.

3.1 COVID-19 Misinformation Scenarios

We designed our study as a scenario-based survey to better capture different aspects of perceived COVID-19 misinformation harms. Scholars have previously used scenarios when examining "information security contexts" (Effron, 2018; Siciliani et al., 2019; Vassie et al., 2005). We found it particularly relevant to use scenario-based surveys to examine perceived misinformation harms for several reasons. First, scenarios help participants focus their thoughts on a specific context as real-life misinformation examples (e.g., drinking bleach to cure COVID-19) that can give rise to both types of non-comparative harms (i.e., component harms and contextual harms). Second, scenario-based self-reporting surveys allow participants to narrow down and compare relevant thoughts on counter-contextual harms (such as harms from counter-contextual conditions that involve removing drinking bleach claims in a timely manner) in order to make effective comparative harm judgements. Finally, contextual scenarios and counter-contextual instructions act as experiments to stimulate participants' thinking process.

[3] See https://about.fb.com/news/2018/05/hard-questions-false-news/

We chose the health-related misinformation scenarios that we used in our study based on two criteria: 1) the scenarios needed to be popular so that people sufficiently understood them and 2) they needed to cover a wide range of topics in the COVID-19 pandemic context. Based on prior literature, we chose six health-related misinformation scenarios, which we show in Table 2.

Table 2. Chosen Six COVID-19 Health-related Misinformation Scenarios

Scenarios	Summary of misinformation messages	References
S1: wearing masks	Initial guidelines from the Centers of Disease Control (CDC) asked people to wear masks only if they had some symptoms and did not encourage them to wear masks in public.	Achenbach et al. (2020)
S2: bioweapon	A Chinese lab created COVID-19 as a biological weapon.	Lewis (2020)
S3: natural treatments	People can strengthen immune systems and prevent or cure COVID-19 infection by consuming lemon juice, vitamin C, or bananas.	Lytvynenko (2020)
S4: hand sanitizer	Hand sanitizer does not effectively kill the virus and can only work on bacteria.	Lytvynenko (2020)
S5: toxic treatments	Patients can kill COVID-19 by drinking bleach.	Rosenbloom (2020)
S6: immune children	COVID-19 cannot affect children who essentially exhibit “immunity” to it.	Phillips (2020)

The six scenarios cover various health-related misinformation topics: the first and fourth scenarios refer to methods to prevent infection, the third and fifth to claims about things that can cure COVID-19, and the second and sixth to COVID-19’s overall spread and severity. Thus, we expected these health-related misinformation scenarios to cover different concerns and perceptions from the public surrounding the pandemic’s characteristics.

3.2 Participant Recruitment and Data Collection

We collected data from U.S. residents who were 18 years or older. According to Coronavirus Misinformation Tracking Center[4], the US has the most misinformation-spreading websites with 259 out of 412 (62.86% worldwide) misinformation websites as of February, 2021.

We recruited participants from a global leading marketing research company, Cint, which has more than 149 million users from more than 130 countries as of June, 2022[5]. Using Cint to obtain responses offers several benefits. Cint provides high-quality data. We requested the following target groups from Cint for this study: 1) participants whom COVID-19 directly affected (i.e., people who contracted the virus) or indirectly affected (i.e., people who knew someone in their social media network who contracted the virus) and 2) participants whom COVID-19 did not affect (whom we classified as non-victims).

Cint distributed survey links and collected responses in May, 2020, as the COVID-19 pandemic began its highest surge (from around 100 cases in March, 2020, to more than 30,000 cases at the beginning of April, 2020)[6] to ensure participants could provide up-to-date and fresh knowledge, experience, and perceptions. We offered participants US$3 as payment per each completed and qualified survey (i.e., they did not violate the attention-check questions). Based on a pilot test result we conducted as survey takers, we found it took from 5 to 10 minutes on average to complete the survey.

3.3 Survey Design

Since we focus on examining how people perceive health-related misinformation harms in the COVID-19 context, obtaining people’s judgments through vignette studies using surveys constitutes an effective methodology (Slovic et al., 1987; Vassie et al., 2005; Wang et al., 2015). In accordance, we created a survey to capture how respondents perceive health-related misinformation harms. We asked participants to read health-related misinformation scenarios and judge how they felt about harm from the scenarios.

[4] See https://www.newsguardtech.com/coronavirus-misinformation-tracking-center/
[5] See https://www.cint.com/access
[6] See https://www.nytimes.com/interactive/2021/us/COVID-cases.html

We designed the survey on the Qualtrics platform (see https://www.qualtrics.com). We then sent the survey link to participants. Each participant answered questions regarding six health-related misinformation scenarios. We randomized the order in which the health-related misinformation scenarios appeared for each participant. The survey also captured participants' basic demographic information, including whether COVID-19 had infected the participants or someone in their network. To ensure we obtained quality responses, we added attention-check questions.

3.4 Measures of harm perceptions

Borrowing from Vassie et al. (2005), we use severity and victimization as two items to capture how people perceive contextual harms. In the COVID-19 health-related misinformation scenario context, we asked questions about severity and victimization from health-related misinformation in the surveys. We provide the entire survey and sections regarding the types of harms in the Appendix.

Also, adapting from the literature on counter-factual thinking (Siciliani et al., 2019) and using the two Facebook's corrective actions[7] removing misinformation and reducing misinformation (Rosen & Lyons, 2019), we created questions regarding perceived counter-contextual harms from health-related misinformation.

Finally, adapting the taxonomy of 15 component harms from Tran et al. (2020a), we measured the likelihood that (Tran et al., 2019) 11 component harms that pertained to the COVID-19 pandemic context would occur and their impact severity. We measured these harms on a scale from 1 (low) to 10 (high) or 0 (if harms could not happen) by specifically asking the respondents "Please rate each of the harms in terms of two characteristics: the likelihood of occurrence and the magnitude of impact toward the victims."

3.5 Descriptive Statistics

We obtained responses from 343 participants. Among them, COVID-19 either directly or indirectly affected 200 (58.31%), while it had not affected 143 (41.69%) (i.e., non-victims). Our sample also contained 53 participants with healthcare working experience (15.45%). We summarize this information in Table 3.

Table 3. Participant Summary

Participants	Number of participants	% of participants
Victims	200	58.31%
Non-victims	143	41.69%
Total participants	**343**	**100.00%**
Healthcare staff	53	15.45%
Not healthcare staff	290	84.55%
Total participants	**343**	**100.00%**

4 Analysis and Results

In this section, we discuss how we analyzed contextual and counter-contextual harms. Subsequently, we compare scenarios with varying levels of counter-contextual harms.

4.1 Visualizing Contextual and Counter-contextual Harms

We examined the differences among six COVID health-related misinformation scenarios based on contextual harms and counter-contextual harms. We display the results in Figure 1. We can see the first, fifth, and sixth scenarios resulted in higher values on both contextual and counter-contextual harms, which means participants estimated higher harm from these COVID-19 health-related misinformation scenarios and higher harm after corrective efforts such as removing and reducing the health-related misinformation. These findings concur with the literature that has shown that preventive methods (S1: facemasks), toxic

[7] See https://about.fb.com/news/2018/05/hard-questions-false-news/

substance consumption (S5: toxic treatment), and virus spread among children (S6: immune children) result in large-scale physical harms (Phillips, 2020; Rosenbloom, 2020).

In addition, the third and fourth scenarios had lower scores on contextual and counter-contextual harms, which indicates that participants perceived these scenarios to have lower harms compared to the other scenarios. Interestingly, while both the third and fifth scenarios relate to treating the virus infections, participants perceived them to have different harms (i.e., high for the fifth scenario but low for the third scenario). This finding indicates that certain characteristics related to consumption (such as consuming vitamin C compared to bleach) can shape how people perceive harms.

Participants rated the second scenario as low on contextual harms but higher on counter-contextual harms. This finding implies that participants think applying corrective actions such as removing or reducing health-related misinformation will result in higher harms. They have thought so because bioweapons have become a deeply rooted topic in the long-term conflicts between the US and China at both the governmental and societal levels (Chen et al., 2020). Chen et al. (2020) state that:

> *Chinese nationalism in the posts in portraying the United States as a political and economic threat fuels the bioweapon conspiracy. Correcting such conspiracies thus requires further addressing constructed nationalism.* (p. 3)

Simply removing or reducing the health-related misinformation messages cannot sufficiently fix the issues, but social media companies need to participate in a collaborative effort with "government agencies, media, and educators [to] work on developing more constructive and unbiased narratives of the pandemic and its global responses" (Chen et al., 2020, p. 3).

From Figure 1, we identified that we could classify the six COVID-19 health-related misinformation scenarios into two groups based on the counter-contextual harms:

- **Group 1 (low counter-contextual harms):** this group contains scenarios that have relatively lower counter-contextual harm scores (e.g., third and fourth scenarios).
- **Group 2: (high counter-contextual harms):** this group contains scenarios that have higher counter-contextual harm scores (e.g., first, second, fifth, and sixth scenarios).

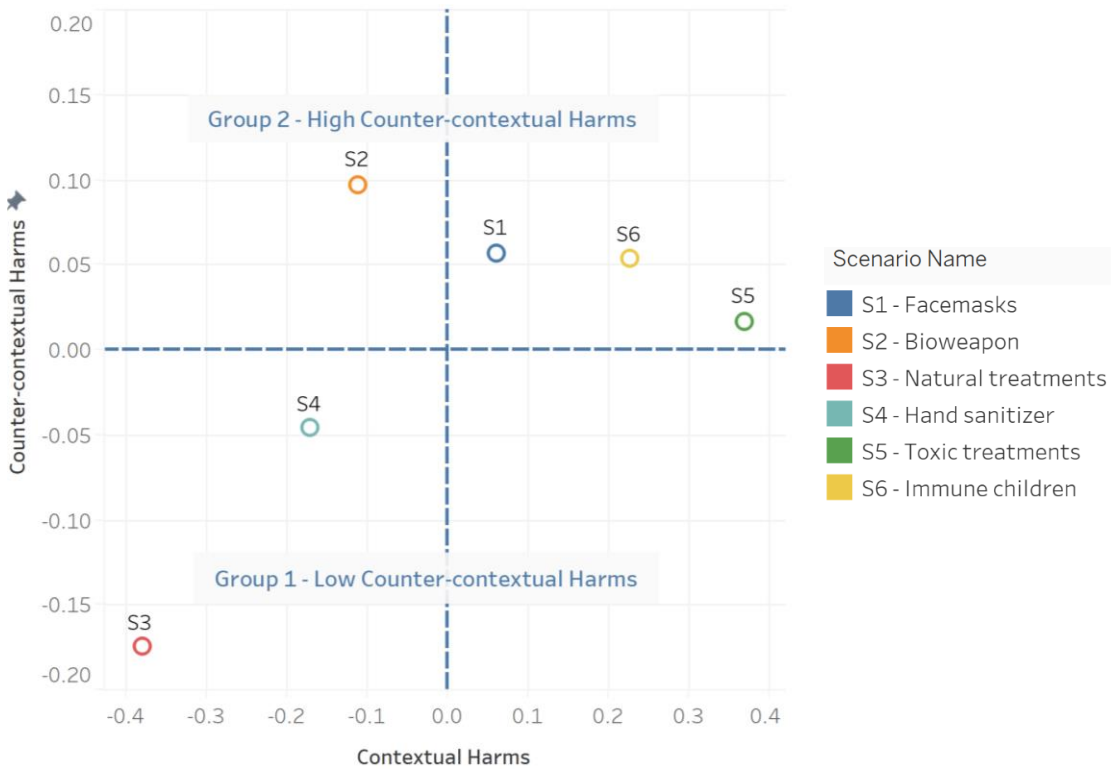

Figure 1. Perceived Contextual Harms and Counter-contextual Harms of COVID-19 Scenarios

For validation purposes, we used ANOVA in order to examine the mean difference in counter-contextual harm between the two groups. The results confirm the significant mean difference in counter-contextual harm between them ($F = 12.752$; $p < 0.05$). This result sets the base for our subsequent efforts to examine component harms based on the two defined groups.

4.2 Visualizing Component and Counter-contextual Harms

We show our results from analyzing component harms for low and high counter-contextual harms based on likelihood and impact in Figures 2 and 3.

We can see that, from the first (low harm) group to the second (high harm) group, most of the component harms shifted from the lower left to upper right quadrant, which indicates a shift from lower to higher values for likelihood and impact. Note that we set the mean to 0. For interpretation, we compared the harms values with the horizontal or vertical axes (the zero values) to classify them as "higher" (≥ 0) or "lower" (< 0).

The first group had three higher likelihood harms and eight lower likelihood harms, while the second had eight higher likelihood harms and three lower likelihood harms. Similarly, the first group had three higher impact harms and eight lower impact harms, while the second group had nine higher impact harms and two lower impact harms. In addition, the first group had five harms with lower likelihood and impact values (45.45%), while the second group had seven harms with higher likelihood and impact values (63.64%). These findings suggest that, when people believe that corrective actions such as removing or reducing health-related misinformation messages will not effectively lower harms, they perceive component harms to have a higher likelihood and impact. Similarly, when people believe that the corrective actions will effectively lower harms, they perceive component harms to have a lower likelihood and impact.

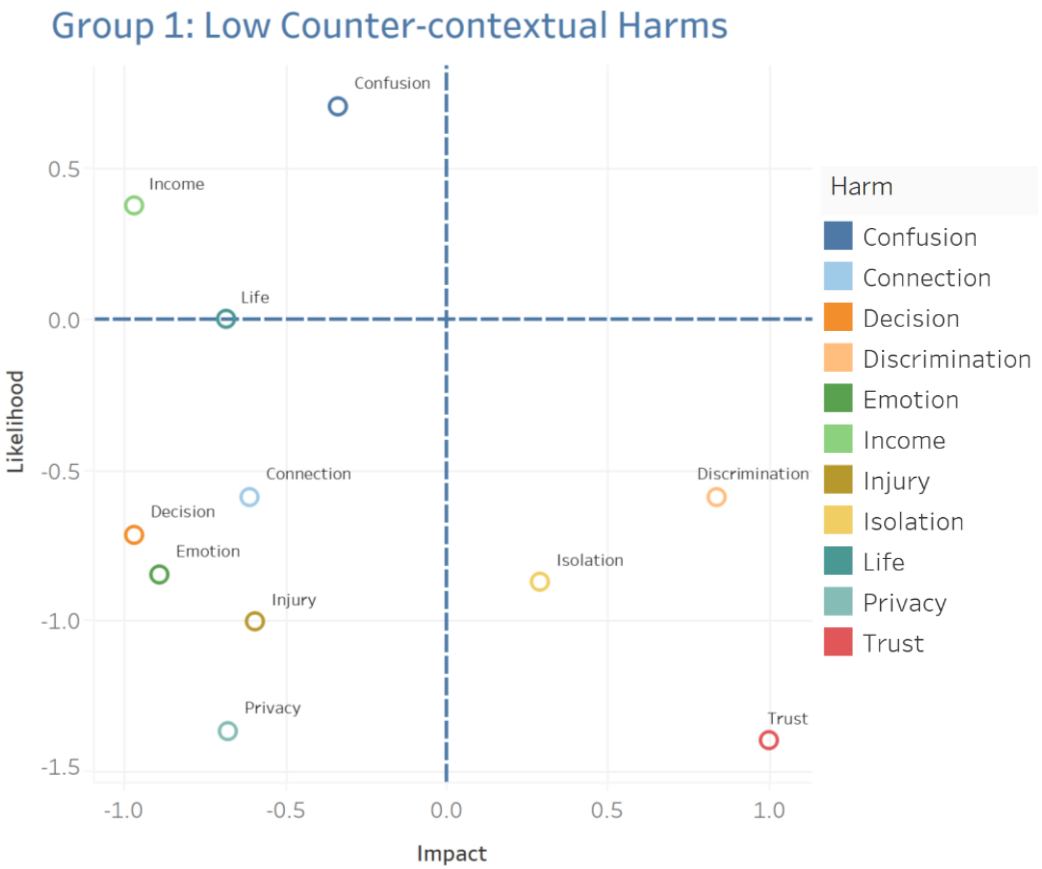

Figure 2. Component Harms for First Group

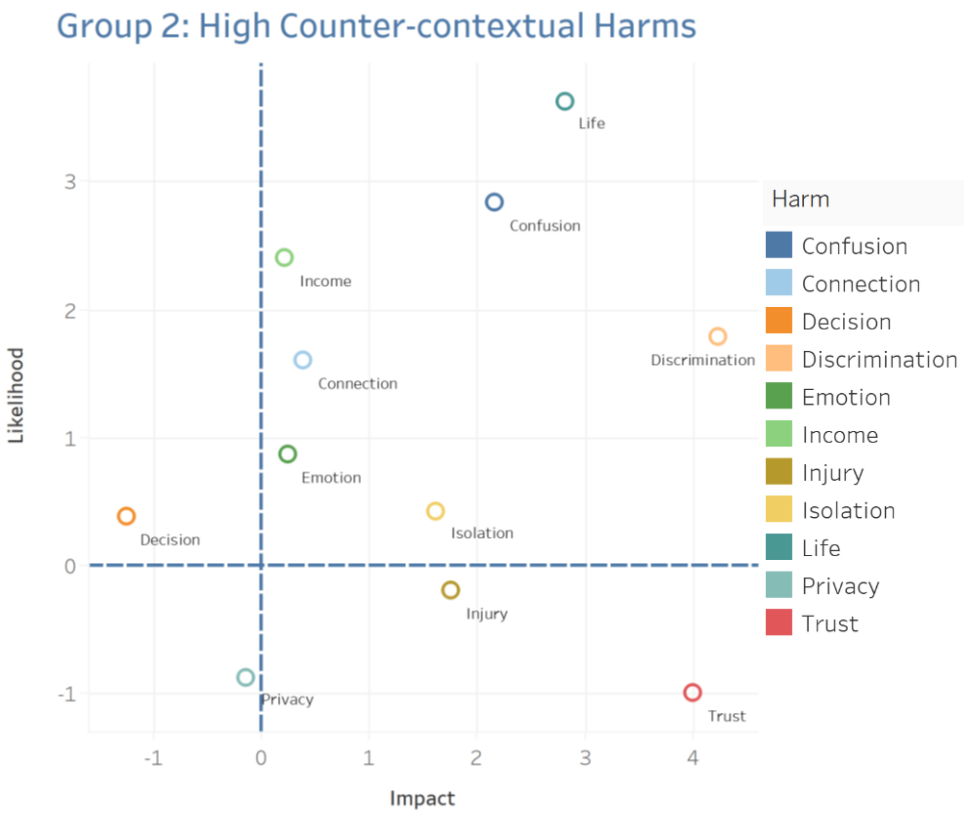

Figure 3. Component Harms for Second Group

5 Post Hoc Analysis

In this section, we investigate whether the victimization experience can shape the differences in how people perceive harms. For this purpose, we compare COVID-19 victims and non-victims. We define COVD 19 victims as participants whom COVID-19 either directly or indirectly affected. Similarly, we define COVID-19 non-victims as participants whom COVID-19 did not affect directly or indirectly. Note that we consider the actual values of perceived harms, which range from 0 to 10 for component harms and from 1 to 7 for contextual and counter-contextual harms.

5.1 Harm Perceptions of Victims and Non-victims

To view harm perceptions generically, we compared the mean values for the harms between the COVID-19 victim and non-victim group by using an ANOVA test. We present the results in Table 4. We can see that victims and non-victims significantly differ in how they perceived contextual harms, counter-contextual harms, and component harms except for the counter-contextual harm after reducing health-related misinformation.

Table 4. Differences in Harm Perceptions between Victims and Non-victims in Three Aspects

Harm	Items	F-statistic	Victims		Non-victims		Difference
			Mean	SD	Mean	SD	
Contextual harms	Severity	13.439	5.222	1.734	4.937	1.740	0.285***
	Victimization	16.909	5.173	1.620	4.875	1.622	0.298***
Counter-contextual harms	Harm after removal	6.037	4.147	1.700	4.332	1.673	-0.185*
	Harm after reduction	2.192	4.179	1.592	4.286	1.628	-0.107 (NS)
Component harms	Average likelihood	5.417	5.170	1.966	4.962	2.046	0.208*
	Average impact	6.533	5.284	1.968	5.056	2.039	0.228*

SD: Standard deviation, NS: not significant;
*: p-value ≤ 0.05; **: p-value ≤ 0.01; ***: p-value ≤ 0.001

In particular, victims rated contextual harms with respect with severity and victimization significantly higher compared to non-victims. Victims also rated component harms with respect to likelihood and impact significantly higher than non-victims. On the other hand, victims rated counter-contextual harms with respect to harm after removal and reduction significantly lower compared to non-victims. The lower scores on counter-contextual harms indicate lower perceived harms after corrective actions, which means that the victims perceived lesser harm after corrective actions compared to the non-victims.

5.2 Victim and Non-victim Harm Perceptions by Scenarios

Figures 4 and 5 show the differences in contextual and counter-contextual harms between the victim and non-victim groups for the six scenarios. We can see that victims and non-victims rated contextual and counter-contextual harms for the second, third, and fourth scenarios at a similar level. In addition, the fifth and sixth scenarios both had higher contextual harms for victims and non-victims; however, non-victims rated counter-contextual harms more highly compared to victims. These findings mean that, while both victims and non-victims agreed on the contextual harms from these scenarios, the victims expected that corrective actions would be more effective in mitigating health-related misinformation harms compared to non-victims. Furthermore, the first scenario had higher counter-contextual harms for victims and non-victims but higher contextual harms for victims compared to non-victims. These findings imply that the victims rated health-related misinformation regarding facemasks as more harmful compared to the non-victims.

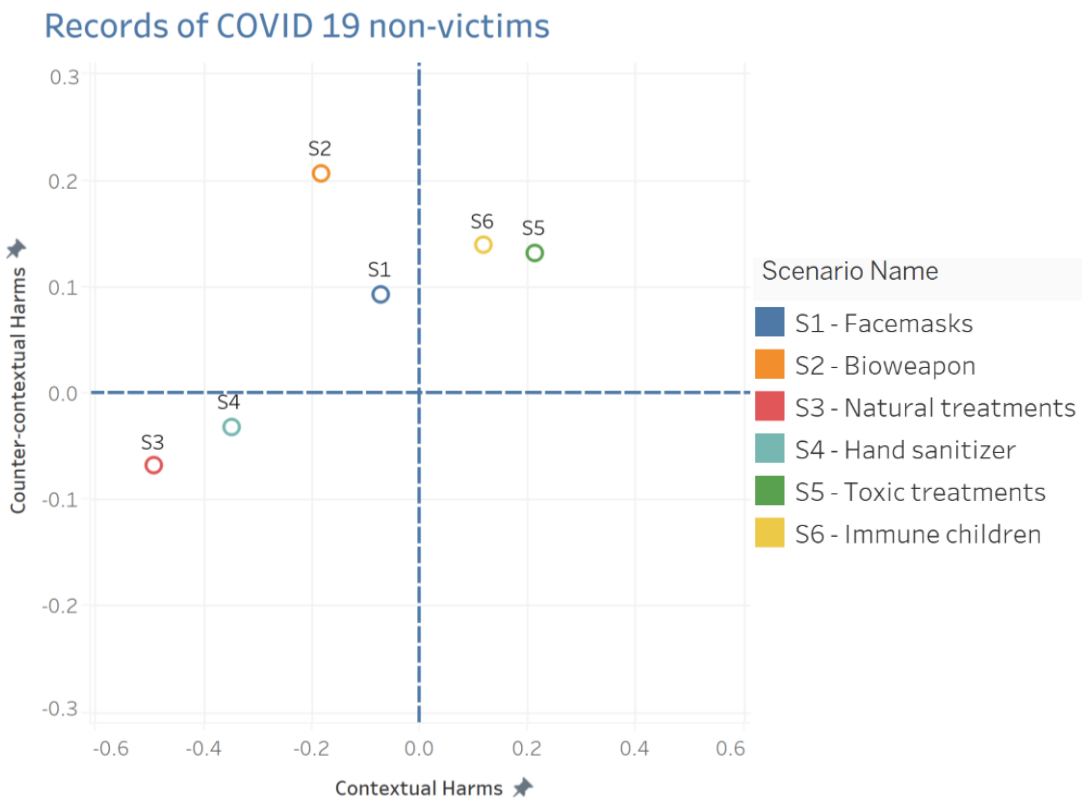

Figure 4. COVID-19 Non-victims

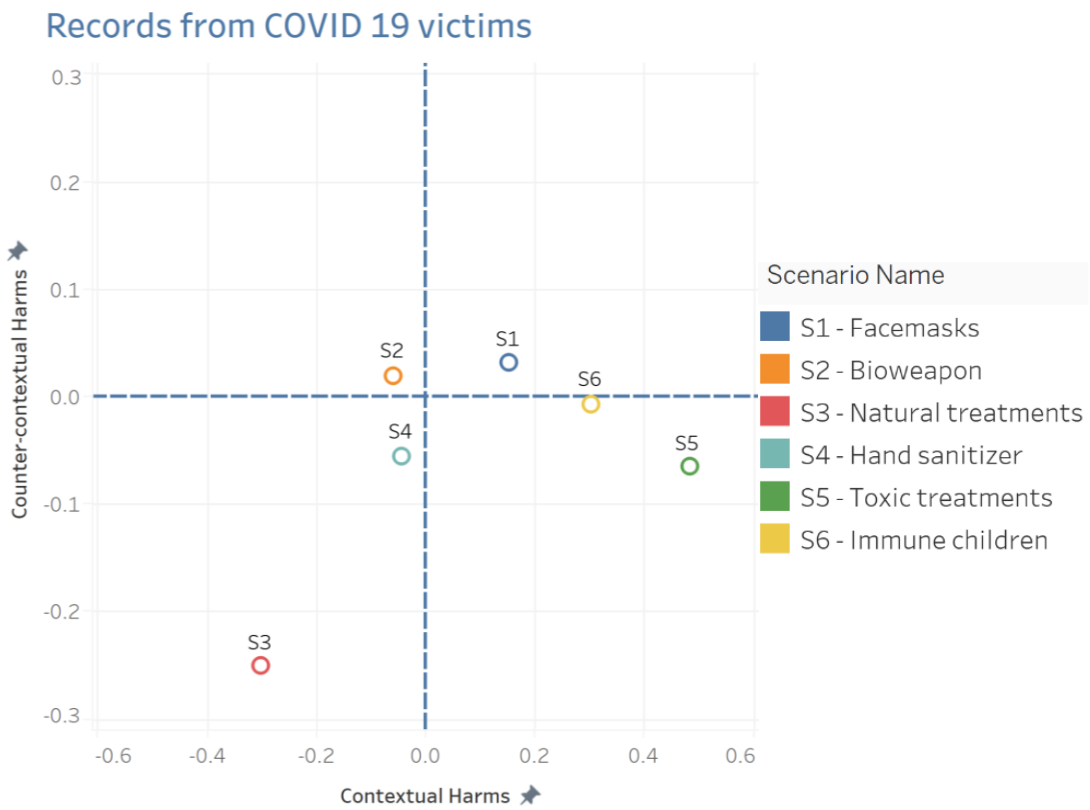

Figure 5. COVID-19 Victims

6 Discussion

In this paper, we extract several key findings related to harm perceptions to answer our research questions. First, to answer RQ1 about measuring harm perceptions, we conceptualized health-related misinformation harm using perceived contextual harms and counter-contextual harms. We characterized COVID-19 health-related misinformation scenarios using component, contextual, and counter-contextual harm perceptions. Second, to answer RQ2 about how corrective actions shape harm perceptions, we extracted insights about corrective actions (e.g., remove or reduce) and contextual characteristics (e.g., natural treatments or toxic substances) that shape harm perceptions. Third, to answer RQ3 about whether and how harm perceptions vary between victims and non-victims, we identified that COVID-19 victims had significantly higher perceptions of harms compared to non-victims. We also identified that victims rated perceived counter-contextual harms from corrective actions of removing or reducing health-related misinformation messages as lower compared to non-victims.

Our findings have several implications. First, significant differences in harm perceptions between victims and non-victims show that personal factors and their background/experience (such as their victimization experience, prior exposure to digital crimes, cyber security training, or the awareness of information quality and information threats) can shape harm perceptions. Organizations can use our findings about how personal factors affect people's perceptions to develop plans for interventions to help them manage health-related misinformation. Second, in addition to personal factors, contextual factors and scenario features can also shape how people perceive health-related misinformation harms. Social media companies may find such knowledge useful to certain features that health-related misinformation exhibits in order to mitigate its harm. Third, corrective actions might help to mitigate health-related misinformation harm perceptions. By examining such actions, social media companies could create different corrective actions they could take against health-related misinformation messages.

7 Conclusion

In a large-scale crisis such as the COVID-19 pandemic, people can easily become victims to widespread health-related misinformation. While several scholars have examined misinformation in a crisis context, we lack research on how people perceive health-related misinformation harm and the effects that corrective actions have on those perceptions. This paper represents an initial effort to examine people's harm perceptions from health-related misinformation scenarios (contextual harms) and harm perceptions after corrective actions against health-related misinformation (counter-contextual harms).

With this study, we contribute to the literature that addresses the role that corrective actions play in health-related misinformation contexts. In addition, we provide directions to quantify misinformation harms via using three types of harms in combination: component harms, contextual harms, and counter-contextual harms. Others can replicate our harm measurements in similar contexts outside the health-related misinformation scope, such as misinformation harms during natural disasters, man-made crises, and crises such as the vaccine hesitancy resulting from anti-vaccination movements (Tran et al., 2019; Tran et al., 2020a, Tran et al., 2020b). Consequently, our findings contribute to not only the emergency response literature but also our knowledge about psychological mechanisms that underpin harm perceptions when people face risky phenomena such as the COVID-19 pandemic and its by-product threats as different misinformation scenarios. Moreover, considering that health-related crisis misinformation can spread quickly on social media and cause significant harm, the perceived harm measurement we propose (that comprises component harm, contextual harm, and counter-contextual harm) broadens our knowledge about misinformation harm perceptions that uniquely pertain to social media conversations and may allow relevant stakeholders to derive valuable insights to minimize or mitigate harms to people. For instance, it can help social media companies qualify harms, predict the effectiveness of corrective actions based on examining component harms, define strategic action plans that can help mitigate harm perceptions, and prioritize limited resources to certain types of health-related misinformation scenarios.

As with any study, this one has several limitations. First, due to the nature of our chosen scenarios and the COVID-19 health-related misinformation context, we obtained responses only from U.S. participants. Second, while we choose six health-related misinformation scenarios due to resource constraints, several other misinformation scenarios spanning different crisis response and recovery stages. Third, in the COVID-19 pandemic context, we considered only health-related misinformation harms even though other types of misinformation messages related to other topics such as political or racial tensions exist.

Accordingly, we suggest several future research directions to expand our study. First, future research can examine other factors (such as predictability) that one can use to conceptualize health-related misinformation harms or misinformation harms in general. Second, researchers can consider other forms of corrective actions (such as informing about false claims or warning about affected communities). Third, future research can obtain harm perceptions of participants from other countries to detect possible cultural differences that might affect how people perceive misinformation harms. Fourth, researchers could consider other types of misinformation messages surrounding the COVID-19 pandemic or similar contexts. Fifth, researchers could replicate our study in other crisis contexts such as natural disasters (e.g., earthquakes, floods, or wildfires), man-made crises (e.g., gunshots or terrorisms), and other health crises (e.g., other disease outbreaks or vaccine hesitancy due to anti-vaccination movements) (Tran et al., 2020a) to enrich our findings. Sixth, researchers could consider other factors (such as political biases and beliefs on misinformation sources) that affect harm perceptions to enrich future research. Finally, researchers may deepen our findings about differences in harm perceptions between victims and non-victims by using appropriate theoretical backgrounds such as maladaptive fear responses (Buss & Larson, 2012) or similar theories. Thus, they might explore how fear when people face uncertain or risky contexts can shape wrong or harmful judgements or decisions.

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Appendix A: Scenario-based Survey

Scenario Description

Dear participants,

Please read the following scenarios of misinformation related to the novel coronavirus (or COVID-19) outbreak. Each scenario has several following questions that needs your judgements according to the detailed guidance later with values ranging from 1 to 7.

Please note that all scenarios are misinformation or fake news messages derived from actual reports. Those scenarios have been considered as misinformation by fact-checking organizations (e.g., Snopes.com, FactCheck.org, etc.) because either they are not based on scientific evidence or experts have specifically refuted their content.

Please use your own background, knowledge and experience to imagine that you are in the situation of reading that misinformation. Please think how you can judge the misinformation harm according to those questions.

- Scenario 1 (wearing masks): Early healthcare guidelines asked people not to wear masks in public and masks can only be used when you have proper symptoms.
- Scenario 2 (bioweapon): Coronavirus is a biological weapon created by a Chinese lab.
- Scenario 3 (natural treatments—lemon juice and banana): Drinking lemon juice, consuming vitamin C or eating bananas will boost immune systems and prevent or cure coronavirus.
- Scenario 4 (ineffective hand sanitizer): hand sanitizer can only kill bacteria and not the virus.
- Scenario 5 (toxic treatments—drinking bleach): drinking bleach will kill coronavirus.
- Scenario 6 (immune children): children are immune to coronavirus and should not be worried about being infected.

Section 1: Component Harms

From reviewing the related literature, we pre-identified a list of 11 harms derived from misinformation in social media during humanitarian crises (see Table A1). Please rate each of the harms or injuries in terms of its two characteristics: the likelihood of occurrence and the magnitude of impact toward the victims. Victims refer to affected individuals or communities during the considered situations. Your answer can range from 1 as lowest level to 10 as highest level for each characteristic. If you feel that the harms cannot happen or there is totally no impact in your considered scenario, please choose the answer 0.

For the likelihood of occurrence (second column), a very likely value (10) means that it is very likely for the harm to occur in a humanitarian crisis context. For the degree of impact (third column), a high impact (10) refers to a consequence of the harm that is very serious and hard to fix or costly to fix. The last row in the table is empty; please add anything that you feel has been missed.

Again, please make sure that you are answering the questions for the harms from the misinformation, not the harms from the crises or disasters themselves (for example, during Hurricane Sandy in New York, misinformation circulated on social media about sharks on the streets). This misinformation created unnecessary panic among many New York City residents. Therefore, for example, though likelihood of occurrence of loss of life would be low, while likelihood of occurrence of emotional sufferings would be high.

Table A1. Harms from Misinformation on Social Media

Very unlikely / low impact < ---- > Very likely / high impact		
0 1 2 3 4 5 6 7 8 9 10		
Misinformation harm: misinformation can result in:	**Likelihood of occurrence (0,1, 2, …,10)**	**Degree of impact (0,1, 2, …,10)**
Loss of life.		
Loss due to bodily injury.		

Table A1. Harms from Misinformation on Social Media

Loss of jobs or temporary loss of work-in-process and income.		
Loss due to emotional suffering, such as sadness, anger, fear or changed attitudes toward the environment and community.		
Loss of belief and trust in people or social media.		
Loss due to discrimination against people based on protected characteristics (eg. ethnicity, gender, etc).		
Loss of social connections with family, friends or working partners.		
Social isolation from the community.		
Loss due to leakage of personal private information.		
Wrong decisions that may lead to dangers.		
Loss of reaction time and confusion resulting in delayed decisions.		

Section 2: Contextual Harms

How severe will be the consequences if someone acts according to the misinformation in the scenario? (1 = very low severity; 7 = very high severity)

How many people can become victims when they read such misinformation, which might include local community, national community or worldwide community? (1 = very few victims; 7 = very many victims)

Section 3: Counter-contextual Harms

If the misinformation was detected and removed immediately, how harmful would the consequences be? (1 = much less harmful; 7 = much more harmful).

If the misinformation was detected and reduced immediately (for example by downranking in news feeds), how harmful would the consequences be? (1 = much less harmful; 7 = much more harmful)

Section 4: Demographics

Victim

V1: Did you ever get sick because of coronavirus? (Yes/no)

V2: Do you have any family members, relatives or close friends that got sick because of coronavirus? (Yes/no)

Working Experience

Healthcare professionals consists of personnel or staffs working in the healthcare industry that specifically deal with efforts of prevention, treatment or any healthcare management activities related to healthcare crises similar to this Coronavirus pandemic. These people can be doctors, nurses, ambulance drivers or staff, healthcare researchers, and hospitals staff.

W1. Are you currently working, or did you work in any jobs that can be said as “healthcare professionals” as described above? (Yes/no).

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