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Thi Tran

*Department of Information Systems and Cyber Security*

*The University of Texas at San Antonio*

*thi.tran@utsa.edu*

Rohit Valecha

*Department of Information Systems and Cyber Security*

*The University of Texas at San Antonio*

*rohit.valecha@utsa.edu*

H. Raghav Rao

*Department of Information Systems and Cyber Security*

*The University of Texas at San Antonio*

*hr.rao@utsa.edu*

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## Health-Related Misinformation Harm during the COVID-19 Pandemic: An Investigation of Non-comparative and Comparative Harm Perceptions

**Thi Tran**

Department of Information Systems and Cyber Security  
The University of Texas at San Antonio, USA

**Rohit Valecha**

Department of Information Systems and Cyber Security  
The University of Texas at San Antonio, USA

**H. Raghav Rao**

Department of Information Systems and Cyber Security  
The University of Texas at San Antonio, USA

### Abstract:

Misinformation about the COVID-19 health crisis has been widespread on social media and has caused various types of harms in society. While some researchers have investigated perceptions of misinformation harm in crises, there is limited research that systematically examines harms from health related misinformation. In order to address this gap, this paper focuses on non-comparative and comparative harm perceptions of the affected community in the context of the COVID-19 pandemic. The paper examines non-comparative harms (reflected by component harms and contextual harms) and comparative harms (reflected by counter-contextual harms) in order to gain an understanding of the harm perceptions. This paper also investigates how harm perception varies based on COVID-19 victimization experience. A professional survey company named Cint collected data using a scenario-based survey with 343 participants. The paper extracts various findings such as how contextual features shape perceived harms, and reveals the scenarios wherein COVID-19 victims perceive higher contextual harms but lower counter-contextual harms. The paper also examines how corrective actions of social media shape harm perceptions.

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

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[Department statements, if appropriate, will be added by the editors. Teaching cases and panel reports will have a statement, which is also added by the editors.]

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## 1 Introduction

During humanitarian crises where affected communities seek a large amount of information to make critical decisions quickly (Tran et al. 2020), social media can be an effective communication channel for fast circulating updates (Beydoun et al., 2018). 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 and 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., 2020). For instance, in the recent COVID-19 pandemic, widespread misinformation on social media has worsened numerous existing physical and psychological harms from the crisis (Ozili and Arun, 2020) by misleading people to take incorrect decisions (Lytvynenko, 2020), such as consuming in-effective and toxic treatments (Rosenbloom, 2020) or downplaying preventive efforts of using facemasks or hand sanitizer (Lytvynenko, 2020).

Facing the issues of harmful misinformation spread on social media, various governments have tried to seek different solutions. According to Funke and Flamini (2018), despite some efforts on fact checking, reporting, removing or blocking misinformation as well as several campaigns to raise the community awareness on misinformation issues, a number of countries have strictly utilized 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 allow the stemming of misinformation, that is surely not sufficient to handle the massive amount of health – related misinformation available in the world. Therefore it is important for social media organizations to raise community vigilance and awareness about the issues and consequences of misinformation, and institute corrective actions including efforts to remove sources of misinformation or block people's access to those sources (Nyilasy, 2020; Rosen and 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 like bleach or fish tank cleaners can cure COVID-19 infection, have led to several deaths or severely affected health consequences. Chary, et. al. (2021) have examined objective harms for such claims through capturing call logs to Poison Control centers related to COVID-19 health-related misinformation. Others have investigated how people's acceptance of health-related misinformation resulting in incorrect perceptions of harms can lead to higher chances of harms to victims (Motta et al., 2020). There is also research on characterizing perceived harms from misinformation, albeit not in the COVID-19 context (Tran et al., 2019). However, there is no research to our knowledge that considers health-related misinformation and corrective actions in a study of harms. Examining these questions will significantly contribute to not only the current literature of health-related misinformation 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.

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

**RQ1:** How is the perceived harm from health-related misinformation measured?

**RQ2:** What is the comparative effect of corrective actions on the perception of health-related misinformation harm?

**RQ3:** How does harm perception vary between people who are affected by the crisis (victims) and those who are not (non-victims)?

In order to answer these questions, we utilize the literature in social philosophy on harm assessment related to non-comparative and comparative harms (Bradley, 2012; Hanna, 2016). This theoretical background is linked to factual and counter factual thinking (Effron, 2018; Siciliani et al., 2019), and to the literature of risk assessment (Vassie et al., 2005; Tran et al., 2020) to examine non-comparative and comparative harm perceptions (Funke and Flamini, 2018; Nyilasy, 2020; Rosen and Lyons, 2019). Thus, the application of these concepts allows us to measure perceived misinformation harms (RQ1) and examine the roles of corrective actions on harms (RQ2), which in turn can be further considered to investigate victimization experience (RQ3) on perceptions of misinformation harms.

Accordingly, we draw on COVID-19 health-related misinformation scenarios popular in social media to capture misinformation harms in two distinct types: (1) perceptions of harms from non-comparative situations, which we term as component harm and contextual harm, and (2) perceptions of harm in comparative situations that involve response to corrective actions on social media as conditional imaginary contexts, termed as counter-contextual harm. While component harms (such as life related harms or emotional harms) (Tran et al., 2020) and contextual harms (such as the overall severity of harms) (Vassie et al., 2005) are judgements of harm for specific health-related misinformation contexts or scenarios (such as the claim of asking people to drink bleach), counter-contextual harms refer to the 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 and Lyons, 2019).

For the research design, we recruited 343 participants from a professional crowdsourcing website named Cint. Each participant gave judgements on their perceptions of harms regarding 6 chosen COVID-19 health-related misinformation scenarios. Specifically, we choose US 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 at the end of February 2021<sup>1</sup>.

This paper makes several contributions: First, it contributes to the literature on misinformation harms by providing an understanding of component harms, contextual harms and counter-contextual harms. The framework consisting of the three types of harms can act as a measurement guideline for further studies in quantifying health-related misinformation harms. Second, this research describes how corrective actions can shape harm perceptions. Finally, it determines how harm perception varies based on crisis victimization experience. This investigation is important because it can provide guidance to social media companies for 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.

The remaining sections are organized as follows. In the next section, we review the existing literature on misinformation and misinformation harm. Subsequently, we discuss the methodology focusing on COVID-19 health-related misinformation scenarios, data collection, measures and analyses. Finally, we discuss the findings and conclude this work by suggesting future directions.

## 2 Research Background

In this section, we provide a review of misinformation in the COVID context. Subsequently, we discuss misinformation harms, including component harms, contextual harms and counter-contextual harms.

### 2.1 The COVID-19 Infodemic and Health-Related Misinformation

The Coronavirus outbreak, also known as COVID-19 pandemic, has become the deadliest health crisis of the century with more than 2 million deaths and more than 100 million confirmed cases as of February 2021<sup>2</sup>. 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 the disruption of economy and interruption in supply chains together with the shutdown of financial markets, corporate offices, businesses and events (Ozili and Arun, 2020), COVID-19 has resulted in job furloughs, suspended schools, restricted travel, cancelled sports and public events (Fernandes, 2020; Ozili and Arun, 2020).

With substantial ambiguity surrounding the virus origin, mortality rates, full range of symptoms (Gallagher, 2020), virus transmission between humans and animals (“COVID-19: Science against fake news and misinformation”, n.d.) or effectiveness of immune systems or antibodies (Walker, 2020), COVID-19 has created conditions ripe for widespread health-related misinformation, especially on social media including Facebook, Twitter and the like (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 good or bad intention from the misinformation creators or spreaders, health-related misinformation diffusions are much more persuasive and harmful under such a crisis as COVID-19 pandemic “where people have little control over environmental threats” (Nyilasy, 2020, para. 16). 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 the use of “toxic substances” as “unapproved treatments” (Chary et al., 2021, p. 324) or dangerous drugs (Love et al., 2020).

In general, with various confusion, widespread conspiracy theories and the involvement of various groups seeking 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, para. 8). 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 that includes medicine, medical and healthcare facilities, viral infection, and doctor-patient issues” (Al-Zaman, 2021, p.100). Therefore, realizing the exaggerated severity of harms from health-related misinformation during such a large-scale pandemic as COVID-19, 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., 2020). They have argued that it is important not only to detect and mitigate health-

<sup>1</sup> COVID-19 Coronavirus Pandemic, Last updated: February 25, 2021, 02:55 GMT: <https://www.worldometers.info/coronavirus/>

<sup>2</sup> <https://g.co/kgs/2RYvwA>

related misinformation but also to 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), by tracking the emergency call logs in the aftermath of a COVID-19 health-related misinformation, have identified that “[misinformed] online discussions directly inform behavior that leads to adverse health outcomes” (p. 4). Leng et al. (2021) have examined the effects of peoples’ pre-existing beliefs and cultural practices in relation to a series of COVID-19 specific topics such as lockdown, cures and preventions, and school reopening in worsening of misinformation and fake claims. Love et al. (2020) have reported that COVID-19 specific issues of fear and desperation compounded by the swiftness of information propagation on social media can deepen harmful effects of health-related misinformation.

## 2.2 Non-comparative and Comparative Harm Perceptions

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

Non-comparative harms can be extracted from specific contexts (such as specific scenarios of misinformation claims) while comparative harms should be obtained from the comparisons of counterfactual contexts (such as the imaginary and contrary context - for instance, if the social media corporates would have removed or reduced the spread of the misinformation claims). For example, about the drinking bleach claim, non-comparative harms would be based on the perception of expected levels of harms if someone drinks bleach (the specific (supposedly factual) context), while comparative harms would be based on the perception of reduced or increased harms if an imaginary condition (the counterfactual context) had happened, such as the changes in harms given that there could be a timely removal of the “drinking bleach” claim.

Non-comparative harms are considered from two aspects, harms as a whole that arise from the context (overall harms) and as separate parts of harms (“pro tanto” harms, i.e., events that have some harmful features) (Bradley, 2012, p. 393; Rabenberg, 2015; Hanna, 2016). In this study, adapting the suggestions from current literature into the context of misinformation harms (Tran et al., 2020; Vassie et al., 2005), we address overall harms as “*contextual harms*” and “*pro tanto*” harms as “*component harms*”, which will be further explained.

Regarding comparative harms, Bradley (2012) describes a term called “counterfactual comparative account (CCA) of harm”. The comparative aspect measures the differences between two contexts with and without the existence of a concerned event, and harms are identified if more harms or less benefits are caused by shifting between the contexts of having or not having the event. While there has been much debate in the philosophy literature (see Rabenberg, 2015 for details), CCA, is often considered the most plausible account of harm that is available (Bradley, 2012, Hanna, 2016). This is in a similar vein to Holtug (2002) who suggested that scholars should consider different varieties of harms (similar to “*pro tanto*” harms) and counterfactual baseline for comparison (similar to counterfactual comparative harms).

The differences between non-comparative and comparative harms are summarized 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	Overall perceived severity of harm when following the claim and drinking bleach
Comparative harms	Counter-contextual harms	Increased or decreased harms if an imaginary or counter-factual condition happened	Amount of higher or lower harm that would occur if the drinking bleach claim was removed right away

Adapting the above harm literature as our theoretical background, we argue that in the context of COVID-19 health-related misinformation, perceptions of harms can be quantified by utilizing non-comparative and comparative aspects of harms.

### 2.2.1 Non-comparative harm perceptions: Component harms and contextual harms

We first address non-comparative harms as the type of harms that is based on a certain specific context. In the same vein of prior studies, we propose that non-comparative harms can be expressed in terms of two types of harms, namely “component harms” (reflecting the “*pro tanto*” harms) and “contextual harms” (reflecting overall harms). These types of harms have been considered in various studies in the field of misinformation harms, such as in humanitarian crises (Tran et al., 2019; Tran et al., 2020). Tran et al. (2019) have conceptualized harm perceptions based on likelihood and impact of harm from misinformation. Tran et al. (2020) have proposed a taxonomy of misinformation harms and examined the level of harms in natural and manmade crises. This taxonomy of misinformation harms from social media includes physical harms (such as life and injury), psychological harms (such as emotion, trust, discrimination), financial harms (related to income), and other harms (like privacy harms or confusion harms). To summarize, in this study we consider the context of COVID-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: the contextual harms. When examining misinformation harms, people perceive the harms based on their beliefs or opinions regarding the context (Vassie et al., 2005). Some researchers have conceptualized harm perceptions based on the perceived severity of harms in relation to the specific context of misinformation (Tran et al., 2020). In the research on online privacy issues, Nissenbaum (2011) has utilized the theory of contextual integrity to consider “context-specific substantive norms” (p.32). In a similar vein, this research investigates harm by treating misinformation as the result of context, and thus harm arising from it can be considered as a “*contextual harm*”. This type of considered harm is measured based on perceptions of severity of harms given the specific context<sup>3</sup>. This type of harm is different from the component harms in terms of considering the overall harms from the context rather than various types of harms related to the components.

Specifically, regarding the harms from actual context, literature has conceptualized them to focus on the seriousness of the consequences (Slovic et al., 1987; Tran et al., 2020; Vassie et al., 2005; Wang et al., 2015). Prior studies have utilized various terms to reflect the consideration of seriousness, either stated as “severity” (Slovic et al., 1987; Vassie et al., 2005) or as the “dread” characteristic of risk perceptions (Slovic et al., 1987; Vassie et al., 2005; Wang et al., 2015). Moreover, several other scholars have also considered the possibility of individuals becoming victims when facing risky contexts, which might be applicable to various types of threats (Vassie et al., 2005) or to activities handling crisis misinformation flows (Tran et al., 2019). In the context of COVID-19 health-related misinformation, we argue that misinformation harms can also be reflected by the possibility that the audience or receiver of misinformation can become either a direct or indirect (where a friend or family member gets COVID) victim and suffer harms. Accordingly, we propose in this paper, “contextual harms” will be addressed in terms of both “severity” and “victimization”.

### 2.2.2 Corrective Actions and Comparative harm perceptions

Realizing the severity of harm from widespread misinformation, social media companies like Facebook or Twitter have employed various “corrective actions” to correct misinformation (Rosenberg et al., 2020). For instance, Facebook community policy has enforced “remove, reduce and inform” actions toward content with harmful consequences toward the community of users (Rosen and Lyons, 2019). In the same vein, Nyilasy (2020) also stated that governments and social media platforms need to collaborate efforts in three ways: cutting fake news supplies (similar to removing misinformation), blocking the community access to view fake news (similar to reducing misinformation diffusion), and encouraging internet or social media users to practice vigilance (similar to informing about debunked misinformation). In addition, Miner et al. (2020) has 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

<sup>3</sup> This harm does not reflect the beliefs on the falsity of the misinformation from readers, and it reflects the resulting harms from given situation without any imagination of possible changes (which will be indicated in the discussion on “counter-contextual harm” later).

misinformation and misinformation diffusion, which involve removing and reducing actions, rather than informing efforts. Despite their importance, no studies that we know 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 are presented with 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 the suggestions of Bradley (2012) about the use of counterfactual contexts as comparative consideration, Holtug (2002) also stated that “counterfactual baseline” should be employed when investigating features of harms (p. 369). For the purposes of our paper, we rename counter *factual* as counter-*contextual* since we consider the specific context in which the misinformation is spread, rather than in general. It allows us to estimate misinformation harms in a condition where a corrective action is available in the future. In this paper, we utilize Facebook’s corrective actions of remove and reduce<sup>4</sup>, where (a) remove action involves deleting the contents that go against the community standards of permitted contents or threaten people’s safety, and (b) reduce action down-ranks the contents that are problematic but still newsworthy and in the public interest. Since, counter-*contextual* thinking involves perception of harm in a futuristic condition of corrective action that is yet to happen, thus harm in such a context can be considered as a “*counter-contextual harm*”. Thus, in this paper, comparative harms, that is the “*counter-contextual harms*”, are measured in the context of two corrective actions: immediately *removing* misinformation and immediately *reducing* misinformation diffusion.

While non-comparative harms (including component harm and contextual harm) directly reflect how severe the harm from actual contextual health-related misinformation is, comparative harms (reflected by counter-*contextual* harm related to corrective actions) is associated with severity of harm from a counter-*contextual* situation, which in our case is based on the corrective actions aimed at removing or reducing health-related misinformation.

### 3 Methodology

In this section, we discuss the details of the methodology, consisting of data collection, survey design, measures and descriptive statistics.

#### 3.1 COVID-19 misinformation scenarios

Our study was designed as a scenario-based survey to better capture different aspects of the perceived COVID-19 misinformation harms as described above. Scenarios have been used by various scholars when examining “information security contexts” (Effron, 2018; Siciliani et al., 2019; Vassie et al., 2005). Utilizing scenario-based surveys in our context of examining perceived misinformation harms is particularly relevant due to several reasons. First, scenarios help participants focus their thoughts on a specific context as real life misinformation examples (such as the claim of drinking bleach), which can give rise to both types of non-comparative harms, i.e., component harms and contextual harms. Second, scenario-based self-reporting surveys establish the condition that participants can narrow down and compare relevant thoughts on counter-*contextual* harms (such as harms from counter-*contextual* conditions of timely removal of drinking bleach claims), as needed for effective comparative harm judgements. Finally, contextual scenarios and counter-*contextual* instructions act as experiments to stimulate participants’ thinking process, which both enrich the relevancy and optimize practical implications from the obtained data.

The health-related misinformation scenarios used in this paper were chosen based on the following criteria: (1) The scenarios must be popular so that people have sufficient understanding; and (2) They should cover a wide range of topics within the context of COVID-19 pandemic. Based on prior literature, we chose six health-related misinformation scenarios as shown in Table 2.

**Table 2. Six chosen COVID-19 Health-related misinformation scenarios**

Scenarios	Summary of misinformation messages	References
S1: Wearing masks	Initial guidelines from CDC asked people to wear masks only if they have some symptoms, and wearing masks in public was not encouraged.	Achenbach et al., 2020

<sup>4</sup> <https://about.fb.com/news/2018/05/hard-questions-false-news/>

S2: Bioweapon	A Chinese lab created Coronavirus 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 is not effective in killing 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	Children cannot be infected by Coronavirus and are “essentially immune”.	Phillips, 2020

Accordingly, the six chosen scenarios cover various topics of health related misinformation. While S1 – Wearing masks and S4 – Hand sanitizer refer to the effectiveness and necessity of prevention methods, S3 – Natural treatments and S5 – Toxic treatments refer to claims of the virus cures. In addition, S2 – Bioweapon relates to the source of the virus and health risk whereas S6 – Immune children concerns about the overall spread and severity of the virus infection. Thus, these health-related misinformation scenarios are expected to cover different concerns and perceptions from the public surrounding the pandemic characteristics.

### 3.2 Participant recruitment and data collection

We collected data from the United States (US) residents who were 18 years or older. According to Coronavirus Misinformation Tracking Center<sup>5</sup>, 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 40 million users from more than 80 countries (Soumya, 2018). Using Cint to obtain responses offers several benefits. Cint provides high quality data. The COVID-19 victimization experience was captured. We requested the following target groups from Cint for this study: (a) participants that were direct victims (i.e. they were directly infected by COVID-19 virus) or indirect victims (i.e. they knew someone in their social media network who was infected by COVID-19), and (b) participants that were not affected by COVID-19 (classified as non-victims).

Survey links were distributed, and responses were collected in May 2020, right at the highest surge of COVID-19 pandemic (from around 100 cases in March 2020 to more than 30,000 cases at the beginning of April 2020)<sup>6</sup>, to ensure up-to-date and fresh knowledge, experience and perceptions from participants. Participants were recruited with the incentive of \$3.0 payment per completed and qualified response (not violating attention check questions) for from 5 to 10 minutes of answering questions (based on a pilot test result conducted by the members of the research team).

### 3.3 Survey design

As the main purpose of this research is to examine perceptions of health-related misinformation harms in the COVID-19 context, obtaining people’s judgments through vignette studies using surveys is 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 provide judgments of how they felt about harm from the scenarios.

The survey was designed on Qualtrics platform (<https://www.qualtrics.com>). Then the survey link was sent to participants. Each participant answered questions regarding 6 health-related misinformation scenarios. The health-related misinformation scenarios were randomized. The survey also captured the basic demographics information, including whether the participant or someone in their network was infected by COVID-19. To ensure quality of responses, we added attention check questions.

<sup>5</sup> <https://www.newsguardtech.com/coronavirus-misinformation-tracking-center/>

<sup>6</sup> <https://www.nytimes.com/interactive/2021/us/COVID-cases.html>

### 3.4 Measures of harm perceptions

Borrowing from Vassie et al. (2005), we utilize severity and victimization as two items to capture perceptions of contextual harms. In the context of COVID-19 health-related misinformation scenarios, we asked questions about severity and victimization from health-related misinformation in the surveys. The entire survey and sections regarding the types of harms can be found in the Appendix.

Also, adapting from the literature on counter factual thinking (Siciliani et al., 2019) and utilizing Facebook's corrective actions<sup>7</sup> of removal of misinformation and reduction of misinformation (Rosen and 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. (2020), we measured the likelihood of occurrence and level of impact (Tran et al., 2019) of 11 component harms that were applicable to the COVID-19 pandemic context. We measured these harms on a scale of 1 (low) to 10 (high) or 0 (if harms cannot 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, of whom 200 (58.31%) were affected by COVID-19 either directly (direct patients: they have been infected by the virus) or indirectly (they have family members, relatives or close friends that are COVID-19 direct patients), and 143 (41.69%) were not. There were 53 participants with healthcare working experience (15.45%). These are summarized in Table 3.

**Table 3. Summary of the US participants**

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

## 4 Analysis and Results

In this section, we discuss the analysis of contextual and counter-contextual harms. Subsequently, we provide a comparison of scenarios with varying levels of counter-contextual harms.

### 4.1 Visualization of contextual and counter-contextual harms

We examined the differences among 6 COVID health-related misinformation scenarios based on the two factors, contextual harms and counter-contextual harms. This is displayed in Figure 1. It is clear that three scenarios S1 – Facemask, S5 – Toxic treatment and S6 – Immune Children result in higher values on both contextual and counter-contextual harms. This means participants estimated higher harm from these COVID-19 health-related misinformation scenarios as well as higher harm after corrective efforts such as removing and reducing the health-related misinformation. This is in line with the literature wherein misinformation about the preventive methods (S1 – Facemasks), consumption of toxic substances such as bleach (S5 – Toxic treatment) and the spread of the virus in children (S6 – Immune Children) has been shown to result in large-scale physical harms (Phillips, 2020; Rosenbloom, 2020).

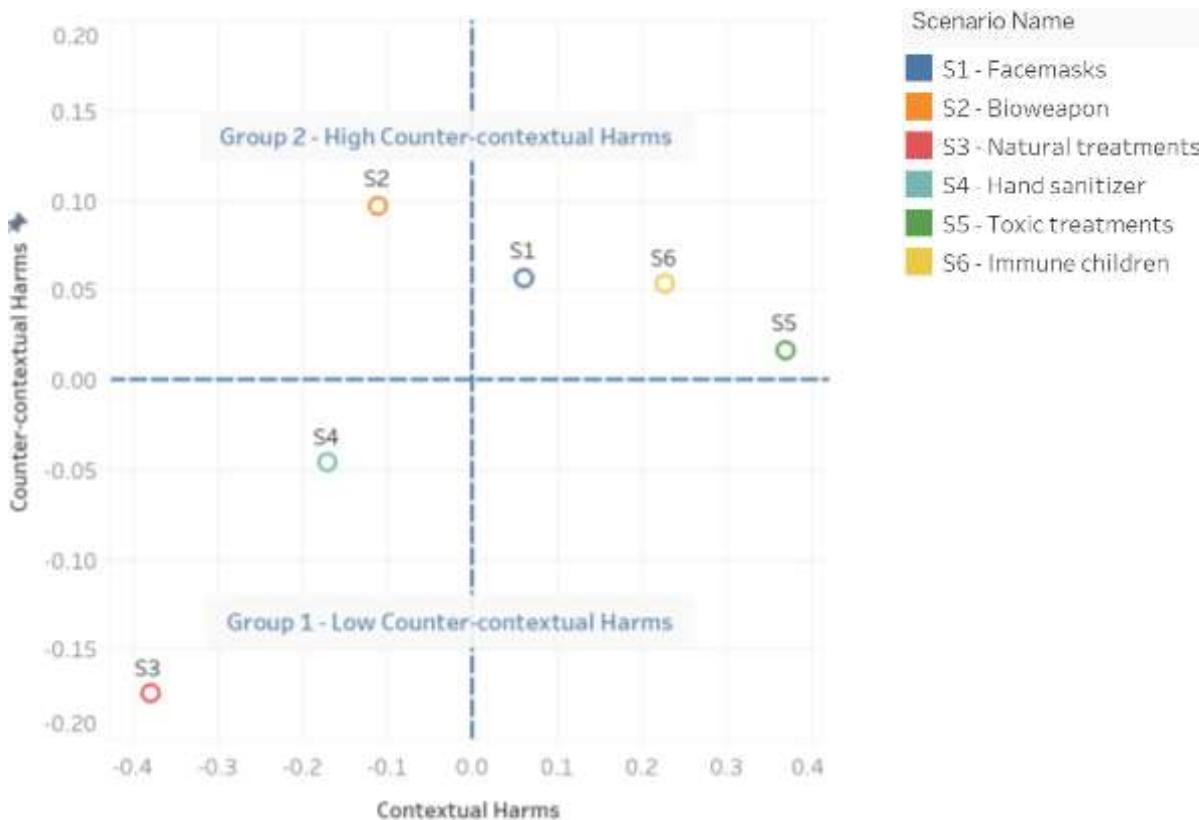
In addition, S3 – Natural treatments and S4 – Hand sanitizer have lower scores on contextual and counter-contextual harms. This indicates that the perceived harms from these scenarios are low compared to other scenarios, as well as perceived harm after removing or reducing the spread of health-related misinformation messages is lower. Interestingly, while both S3 – Natural treatments and S5 – Toxic treatments are related to treating the virus infections, harm perceptions are different: high perceived harm for S5 compared to low perceived harm for S3. This finding indicates that certain characteristics related to consumption (such as consuming vitamin C compared to bleach) can shape people's perceptions of harms.

<sup>7</sup> <https://about.fb.com/news/2018/05/hard-questions-false-news/>

S2 – Bioweapon was rated low on contextual harms but higher on counter-contextual harms. This implies that participants think applying corrective actions such as removing or reducing the health-related misinformation will result in higher harms. This is perhaps because the topic of bioweapon is deeply rooted in the long-term conflicts between the US and China at both governmental and societal levels (Chen et al., 2020). Chen et al. (2020) states 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 will not be sufficient to fix the issues, but social media companies need a collaborative effort involving “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 the six COVID-19 health-related misinformation scenarios can be classified 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, including S3 – Natural treatments and S4 – Hand sanitizer.
- **Group 2:** High counter-contextual harms: This group contains scenarios that have higher counter-contextual harm scores, including S1 – Facemask, S2 – Bioweapon, S5 – Toxic treatments, and S6 – Immune children.

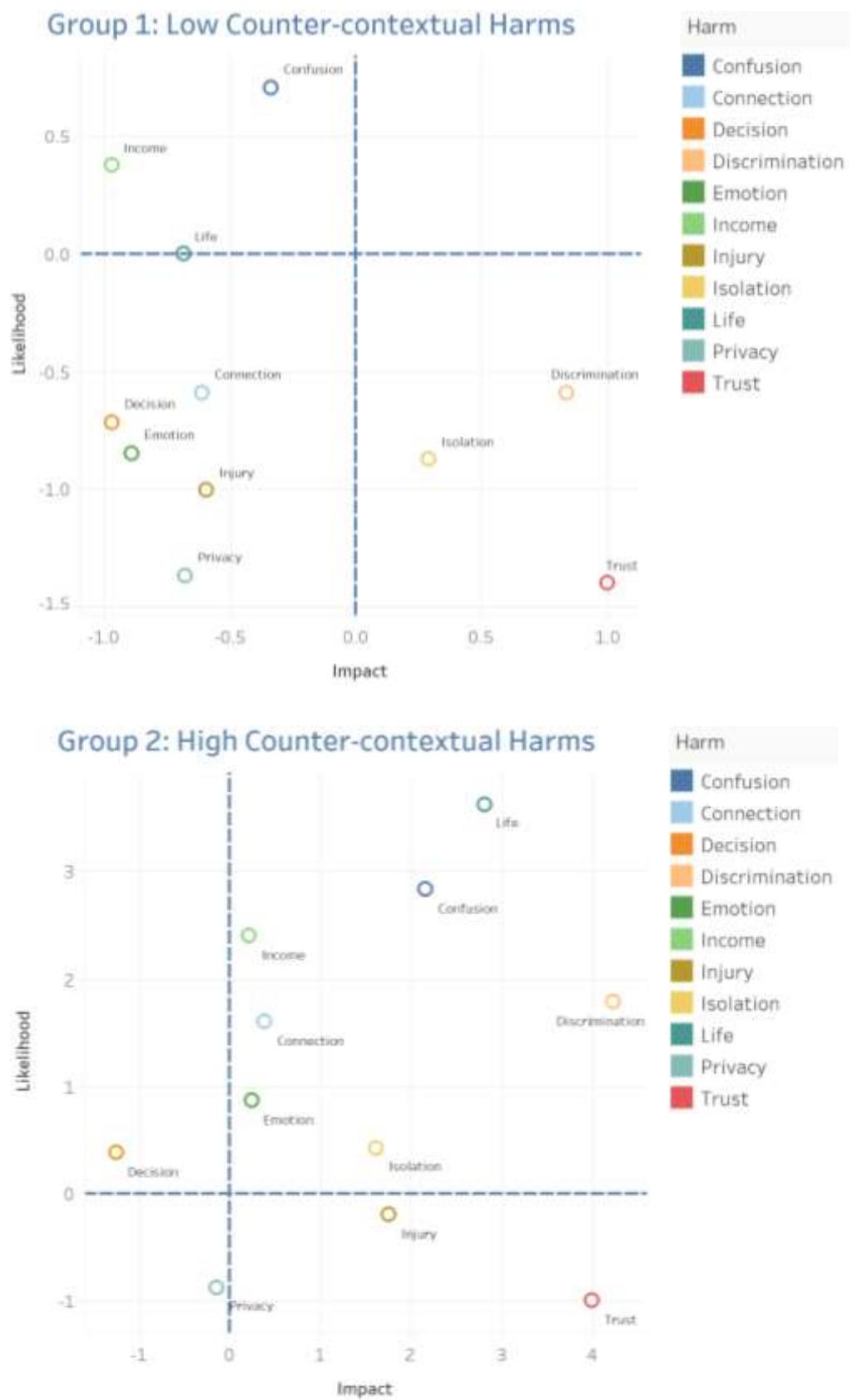


**Figure 1. Perceived contextual harms and counter-contextual harms of COVID-19 scenarios.**

For validation purposes, we used ANOVA in order to examine the mean difference of counter-contextual harm between the two groups, Group 1 and Group 2. The result confirms the significant mean difference of counter-contextual harm between Group 1 and Group 2 ( $F = 12.752$ ;  $p < 0.05$ ). This result sets the base for the following examination of component harms based on the two defined groups (Group 1 – High counter-contextual harms and Group 2 – Low counter-contextual harms).

## 4.2 Visualization of Component and Counter-contextual harms

The result of the analysis of component harms for low and high counter-contextual harms based on likelihood and impact is shown in Figure 2.



**Figure 2. Comparison of component harms for Groups 1 and 2 (of Figure 1)**

We can see that from Group 1 – Low counter-contextual harms to Group 2 – High counter-contextual harms, most of the component harms shift from lower left to upper right quadrant, indicating a shift from lower to higher values for likelihood and impact. Note: The mean has been set to 0. For interpretation, we compare the values of the harms and the horizontal or vertical axes (the zero values) to classify as “higher” ( $\geq 0$ ) or “lower” ( $< 0$ ).

Group 1 has 3 higher likelihood harms and 8 lower likelihood harms, while Group 2 has 8 higher likelihood harms and 3 lower likelihood harms. Similarly, Group 1 has 3 higher impact harms and 8 lower impact harms, while Group 2 has 9 higher impact harms and 2 lower impact harms. In addition, Group 1 has 5 harms that have lower values of likelihood and impacts (45.45%) while Group 2 has 7 harms that have higher values of likelihood and impacts (63.64%). These findings suggest that when people believe that the corrective actions such as removing or reducing health-related misinformation messages will not be effective in lowering the harms, they perceive higher likelihood and impact of component harms. Similarly, when people believe that the corrective actions are effective in lowering the harms, they perceive lower likelihood and impact of component harms.

## 5 Post hoc analysis

In this section, we investigate whether victimization experience can shape the differences in people’s perceptions of harms. For this purpose, we compare between COVID-19 victims and non-victims. COVID 19 victims are defined as participants that were either directly infected by COVID-19 or they had family members, relatives or close friends that were infected by COVID-19. Similarly, COVID-19 non-victims are defined as participants that had neither been infected by the virus nor had family members, relatives or close friends infected by COVID-19. Note: Here 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 have a generic view of harm perceptions, we compared the mean of harms between the COVID-19 victim and non-victim group by using ANOVA test. Table 4 presents results of the ANOVA test. Results show that victims and non-victims have significant differences in their perceptions of contextual harms, counter-contextual harms and component harms except for the counter-contextual harm after reducing health-related misinformation.

**Table 4: Differences of harm perceptions between victims and non-victims in 3 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  $\leq 0.05$ ; \*\*: p-value  $\leq 0.01$ ; \*\*\*: p-value  $\leq 0.001$

Specifically, victims rated significantly higher contextual harms (differences are 0.285 and 0.298) and component harms (differences are 0.208 and 0.228) compared to non-victims. On the other hand, victims rated significantly lower counter-contextual harms (significant difference of harm after removal action is -0.185) compared to non-victims. The lower scores on counter-contextual harms indicate lower perceived harms after corrective actions. This means that the victims perceive lesser harm in the aftermath of corrective actions compared to the non-victims.

## 5.2 Harm perceptions of victims and non-victims by scenarios

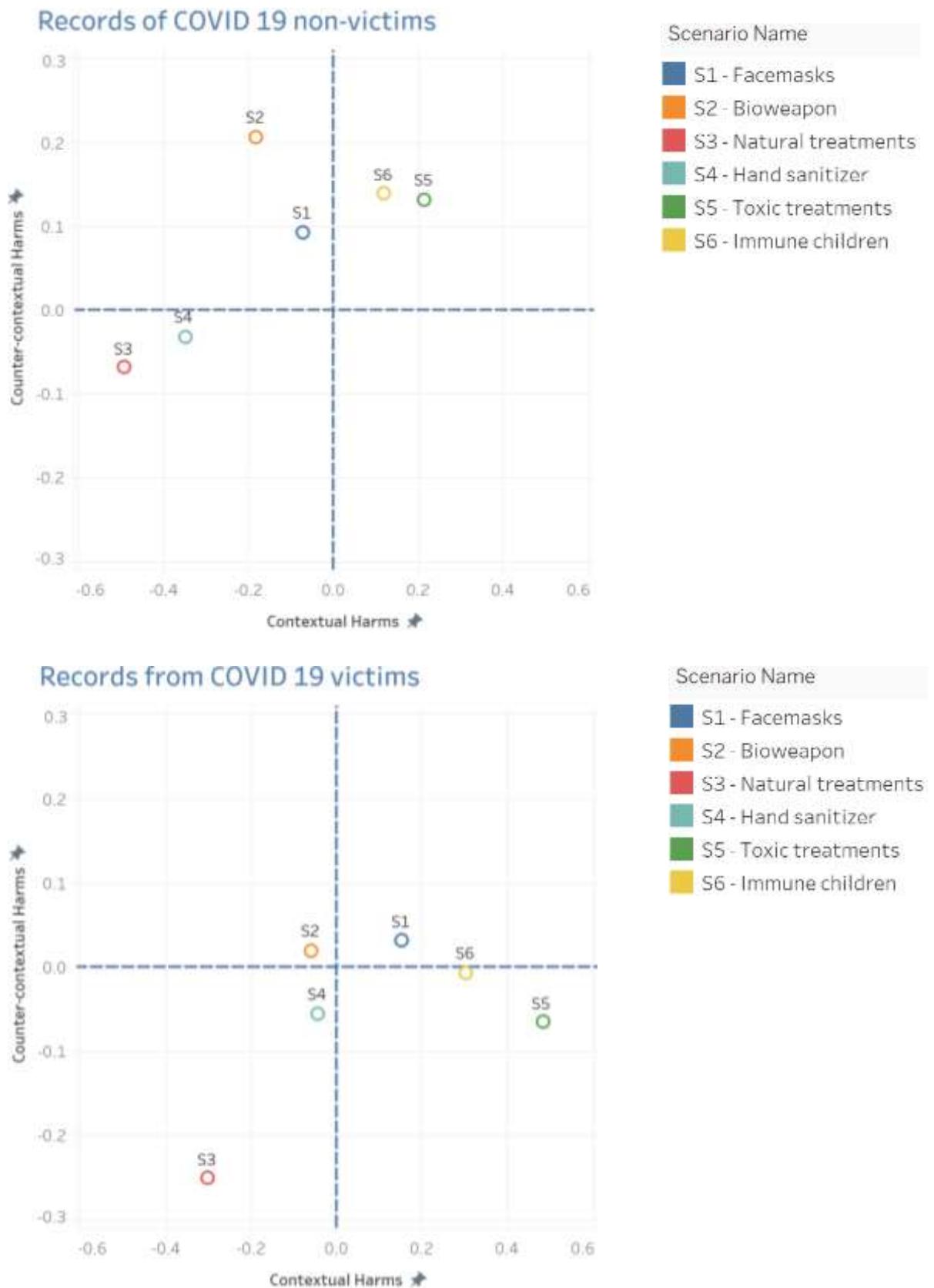


Figure 3. Comparison of victims and non-victims.

Figure 3 shows the differences in contextual and counter-contextual harms between victim and non-victim groups for 6 scenarios. From the results, we see that contextual and counter-contextual harm regarding S2 – Bioweapon, S3 – Natural treatments and S4 – Hand sanitizer are similar for both victims and non-victims. In addition, S5 – Toxic treatments and S6 – Immune children both have higher contextual harms for victims and non-victims, however, counter-contextual harms are higher for non-victims compared to victims. This means that while both victims and non-victims agree on the contextual harms from these scenarios, the victims expect that corrective actions are more effective in mitigating health-related misinformation harms compared to the non-victims. Furthermore, S1 – Facemasks have higher counter-contextual harms for victims and non-victims, however, contextual harms are higher for victims compared to non-victims. This implies that the victims rate higher harms on health-related misinformation regarding facemasks as opposed to the non-victims.

## 6 Discussion

In this paper, we extract several key findings related to harm perceptions to answer specific research questions. First, to answer RQ1 about measuring harm perceptions, we have conceptualized health-related misinformation harm using perceived contextual harms and counter-contextual harms, which can be used as a mechanism to quantify misinformation harms. We have 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 have extracted insights about corrective actions (e.g., remove or reduce) as well as contextual characteristics (e.g., natural treatments or toxic substances) that shape harm perceptions. Third, to answer RQ3 about the role of victimization experience on harms, we have identified that COVID-19 victims have significantly higher perceptions of harms compared to non-victims. We have also identified that victims have rated lower perceived counter-contextual harms from corrective actions of removing or reducing health-related misinformation messages compared to non-victims.

There are several implications of these findings. First, significant differences in harm perceptions between victims and non-victims show that personal factors as well as background/experience of misinformation receivers (such as, victimization experience, prior exposure to digital crimes, cyber security training, or the awareness of information quality and information threats) can shape harm perceptions. The investigation of personal factors affecting people's perceptions can be useful in training people to be prepared to manage health-related misinformation. Second, in addition to personal factors, contextual factors and features of scenarios can also shape perceptions of health-related misinformation harms. This understanding can be useful in affording social media companies target features of the health-related misinformation in order to mitigate harm from the health-related misinformation. Third, corrective actions might be effective in mitigating health-related misinformation harm perceptions. This examination can help social media companies unfold different types of corrective actions against health-related misinformation messages.

## 7 Conclusion

In a large-scale crisis, such as the COVID-19 pandemic, people can easily become the victims of widespread health-related misinformation. While several scholars have examined misinformation in crisis context, research on perceptions of health-related misinformation harm with the consideration of corrective action effects is scarce. This paper is one of the very first efforts examining people's harm perceptions from health-related misinformation scenarios (contextual harms) as well as harm perceptions after corrective actions against health-related misinformation (counter-contextual harms).

This study contributes to literature addressing the role of corrective actions within health-related misinformation contexts. In addition, it provides directions in quantifying misinformation harms utilizing the combination of three types of harms: component harms, contextual harms and counter-contextual harms. Being built from the literature of perceptions facing threats, such a combination of harm measurements can be replicated in similar contexts outside the health-related misinformation scope, such as misinformation harms during natural disasters, manmade crises and other types of health crises (like the vaccine hesitancy resulting from anti-vaccination movements) (Tran et al., 2019; Tran et al., 2020). Consequently, the research findings not only contribute to the literature of emergency responses but also to the theoretical understanding of psychological mechanisms of harm perceptions when people face such a risky context like COVID-19 pandemic and its by-product threats as different misinformation scenarios. Moreover, considering health related crisis misinformation that spread on social media environment where unverified

claims with interactions from social media users can be quickly circulated and cause harms during crises, the proposed perceived harm measurement (comprising of component harm, contextual harm and counter-contextual harm) can broaden the understanding of misinformation harm perceptions that are uniquely associated with the natures of social media conversations as well as derive valuable insights for involved stakeholders in efforts to minimize or mitigate harms to the community of victims. For instance, it can provide insights as practical contributions for social media companies for quantifying harms, for predicting the effectiveness of corrective actions based on the examination of component harms, for defining strategic action plans that can lead to mitigation of harm perceptions, and for prioritizing limited resources to certain types of health-related misinformation scenarios.

This study has some limitations. First, due to the nature of our chosen scenarios and the context of COVID-19 health-related misinformation, we only obtained responses from US participants. Second, while we choose six health-related misinformation scenarios due to the availability of resources, there are several other misinformation scenarios spanning different stages of crisis response and recovery. Third, in the chosen context of COVID-19 pandemic, we only considered health-related misinformation harms despite there are other types of misinformation messages related to other topics such as political or racial tensions.

Accordingly, we suggest several future research directions as the expansion of our study. First, future research can examine other factors (such as predictability) that can be used to conceptualize health-related misinformation harms, or misinformation harms in general. Second, researchers can consider other forms of corrective actions (such as, informing about the false claim 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 people's perceptions of misinformation harms. Fourth, other types of misinformation messages surrounding the COVID-19 pandemic or similar contexts can be considered. Fifth, replications of our study in other crisis contexts such as natural disasters (like earthquakes, floods or wildfires), manmade crises (like gunshots or terrorisms) and other health crises (like other disease outbreaks or vaccine hesitancy as a result of anti-vaccination movements) (Tran et al., 2020) can significantly enrich our findings. Sixth, other factors (such as political biases and beliefs on misinformation sources) affecting harm perceptions might be also considered to enrich future research. Finally, further studies may deepen our findings of differences in harm perceptions between victims and nonvictims by utilizing appropriate theoretical backgrounds such as maladaptive fear responses (Buss and 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

### Descriptions of scenarios:

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 contents.

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: Not effective 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 a review of the related literature, we pre-identified a list of 11 harms derived from misinformation in social media during humanitarian crises. 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 are defined as affected individuals or communities during the considered situations. Your answer can range from 1 as lowest level to 10 as highest level for each of the characteristics. 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 (column 2), 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 (Column 3), 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, there was a misinformation circulating on social media about sharks on streets. This misinformation created unnecessary panic amongst many New York City residents. Therefore, for example, though likelihood of occurrence of loss of life would be low, likelihood of occurrence of emotional sufferings would be high).

Very Unlikely / Low Impact					↔	Very Likely / High Impact				
0	1	2	3	4	5	6	7	8	9	10
<b>Misinformation Harm: Misinformation can result in:</b>					Likelihood of Occurrence (0,1, 2, ...,10)			Degree of Impact (0,1, 2, ...,10)		
Loss of life.										

Loss due to bodily injury.		
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 staffs, healthcare researchers, hospitals staffs.

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

## About the Authors

**Thi Tran.** Thi Tran is a PhD in Information Technology Candidate in the Department of Information Systems and Cyber Security at The University of Texas at San Antonio. His research interest is investigating misinformation harms and designing misinformation handling systems.

**Rohit Valecha.** Rohit Valecha is an Associate Professor in the Department of Information Systems and Cyber Security at The University of Texas at San Antonio.

**H. Raghav Rao.** H. Raghav Rao is AT&T Chair Professor of the Department of Information Systems and Cyber Security at the University of Texas at San Antonio. He has a courtesy appointment in the Department of Computer Science.

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