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Exposure to COVID-19 Misinformation Across Instant Messaging Apps: Moderating Roles of News Media and Interpersonal Communication

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Given that instant messaging apps have been identified as a new conduit of coronavirus disease (COVID-19) misinformation, this study pursues two goals. The first is to examine the associations between exposure to COVID-19 misinformation through instant messaging apps on the one hand and knowledge and preventive behavioral intention, on the other. The second is to test whether news media and interpersonal communication moderate these relationships. By analyzing survey data from 1,209 adults from the general population of South Korea during the COVID-19 pandemic, we found that exposure to COVID-19 misinformation across instant messaging apps was negatively related to COVID-19 knowledge and COVID-19–preventive behavioral intention. However, the negative link between misinformation exposure and preventive behavioral intention differed depending on the level of news media exposure and interpersonal communication. Specifically, the negative association between COVID-19 misinformation exposure and preventive behavioral intention was weaker among individuals who were exposed to more COVID-19 news media and participated in more interpersonal communication about COVID-19.

Keywords: COVID-19, misinformation, instant messaging apps, news media, interpersonal communication, social media

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During a pandemic, individuals may face another epidemic called an infodemic—an over-abundance of information—some accurate and some not—that makes it hard for people to find trustworthy sources and reliable guidance when they need it (World Health Organization [WHO], 2020a). The infodemic contributes to misinformation, making the pandemic worse. The spread of misinformation can undermine public health officials' recommendations, for example, by diminishing people's trust in expert guidance, making them less likely to take science-based precautions that protect their health.

Outbreaks of misinformation have been common during the coronavirus disease (COVID-19) pandemic (Islam et al., 2020; Kouzy et al., 2020). Misinformation about COVID-19 has spread quickly, widely, and inexpensively through social media platforms, endangering lives and hampering recovery. Instant messaging applications (apps) within social media have a powerful potential to easily promote the worldwide flourishing of misinformation in global public health crises. Because these are private spaces where users share messages encrypted with a key, it is much more difficult to identify, flag, or remove misinformation and trace its origin. A project of the International Fact-Checking Network (IFCN) at Poynter, composed of fact-check organizations from more than 70 countries, examined 10,742 COVID-19–related misinformation communicated as of January 26, 2021, and about 13% were found to have been spread from instant messaging apps (Tantuco, 2021).

South Korea has experienced four waves of COVID-19 outbreaks, totaling 191,531 cases, including 2,079 deaths, as of July 27, 2021 (Korea Disease Control and Prevention Agency, 2021). This study was conducted during the first wave, from February to April 2020. During the epidemic's first peak in South Korea, 42.1% of adults had seen false or misleading news about COVID-19 within the previous week, and 94.7% agreed that substantial punishment was appropriate for those who spread COVID-19 misinformation (Lee, 2020). Because South Koreans are extensive users of smartphones and rely heavily on instant messaging apps for real-time chat (Gill & Rojas, 2020), instant messaging apps were undoubtedly a source of COVID-19 misinformation (Lee et al., 2020). Nevertheless, relatively little research has been conducted on this issue. The purpose of this research is twofold: to examine the associations between misinformation exposure through instant messaging apps on the one hand and knowledge and preventive behavioral intention on the other, and to test whether news media and interpersonal communication moderate the relationships.

Infectious Disease Outbreaks and Misinformation

Misinformation is a serious threat in the public health domain. Misinformation during infectious disease outbreaks can be particularly dangerous because people easily accept or share pseudo-scientific claims without evidence. If unsubstantiated claims mislead individuals about the symptoms, treatment, and prevention of disease, they are less likely to comply with official health advice and may thus contribute to disease spread, posing significant challenges to public health (Evanega, Lynas, Adams, & Smolenyak, 2020). Most health professionals do not consider that genetically modified (GM) mosquitoes spread the Zika virus in 2016, but more than one-third of U.S. adults believed that this was true. According to the Annenberg Public Policy Center study (2016), "a British biotechnology company genetically engineered mosquitoes to create short-lived offspring, a move that has been shown to reduce mosquito populations by 95% in some areas" (Mitchell, 2019, p. 212). Although this

initiative significantly lessened Zika transmission, the false belief persisted. Such misunderstanding prompted a prohibition on pesticides, a move that hindered efforts to control the spread of the virus (Sharma, Yadav, Yadav, & Ferdinand, 2017). In another example, during the COVID-19 pandemic, almost 300 individuals died in Iran because they ingested methanol, which was incorrectly recommended for COVID-19 treatment (Kim, Ahn, Atkinson, & Kahlor, 2020). In addition, U.S. adults with stronger beliefs in COVID-19 misinformation were less likely to wear face masks or engage in social distancing (Hornik et al., 2021).

Misinformation has been defined in different ways (Krause, Freiling, Beets, & Brossard, 2020; Scheufele & Krause 2019). Although early work in misinformation literature encompassed two facets of misinformation—inaccurate information itself and the inaccurate beliefs shaped by that inaccurate information—later literature differentiated between the two (Vraga & Bode, 2020). Nyhan and Reifler (2010) distinguished between inaccurate information (or true misinformation) and misperceptions (or the beliefs that individuals hold). Krause et al. (2020) clarified the concept of misinformation by differentiating between "(a) incorrect information that a communicator believes true and (b) information that a communicator knows is false but purveys as true (sometimes referred to as disinformation)" (p. 2). According to Vraga and Bode (2020), in the COVID-19 pandemic, misinformation can be defined generally as any messages that are against the best available evidence pertaining COVID-19 and that would unlikely be altered. In short, misinformation can be defined as inaccurate information unproven by clear evidence or expert opinion (Nyhan & Reifler, 2010; Tan, Lee, & Chae, 2015; Vraga & Bode, 2020). This indicates a relatively narrow definition, excluding information that is putative, unproven, vague, or conflicting (Bode & Vraga, 2018; Tan et al., 2015).

This limited definition is particularly useful in public health crises, where expert consensus marks a clear division between accurate and inaccurate information (Vraga & Bode, 2017). Nevertheless, during infectious disease outbreaks, expert consensus is often subject to change, and uncertainty about relatively unknown diseases inevitably leads to the production of new evidence (Vraga & Bode, 2020). Therefore, in epidemics, claims that are currently rated false can become true because of emerging evidence (Chou, Oh, & Klein, 2018; Vraga & Bode, 2020). For example, in 2016, the U.S. Centers for Disease Control and Prevention initially did not report that Zika could be spread through sexual intercourse but later acknowledged that it could be sexually transmitted. It is essential to verify claims by accessing a flow of correct information when assessing claims on infectious diseases (Tasnim, Hossain, & Mazumder, 2020). For this reason, public health organizations attend misinformation during infectious disease outbreaks and update the most recent correct information to rapidly curb disease spread. Thus, in this study, misinformation is defined as claims that the World Health Organization (WHO) has officially reported false at the time of the investigation.

The Emergence of Instant Messaging Apps as a Key Source of Misinformation

In recent years, with the spread of mobile technology, the popularity of using instant messaging apps has rapidly increased. Instant messaging apps are online platforms that provide wide functionality for social networking and multimodal communication (Huang & Zhang, 2019). Many instant messaging apps provide chat rooms whereby a user can communicate with individuals or groups, allowing

synchronous and asynchronous interactions and exchange of information (Dhir, Kaur, & Rajala, 2020; Valenzuela, Bachmann, & Bargsted, 2021). This technological feature allows information to be widely and quickly disseminated through instant messaging apps. During the COVID-19 pandemic, some countries, including Australia, Singapore, and the United Kingdom, have utilized the platform WhatsApp to provide COVID-19 updates (Liu & Tong, 2020).

Although some people share public health information with instant messaging apps, there are increasing concerns about the spread of misinformation, including rumors and fake news. For example, in Bahrain, most drug-related information about COVID-19 circulated on the WhatsApp platform, included potentially misleading or false claims without credible evidence (Al Khaja, AlKhaja, & Sequeira, 2018). In addition, nearly one in five adults in Hong Kong saw or read the misinformation that smoking or alcohol drinking can protect against COVID-19 via instant messaging apps (Luk et al., 2020). There are two characteristics of the misinformation spread through instant messaging apps that demonstrate their relative deficiencies in the gatekeeping role. First, misinformation tends to be spread more rapidly than truthful information, and ordinary users often spread such misinformation through instant messaging apps (Rossini, Stromer-Galley, Baptista, & Veiga de Oliveira, 2021). Second, ordinary people are more likely to be misinformed when misinformation is shared by people they know than by anonymous social media users because of the influence of social ties (Anspach, 2017; Rossini et al., 2021). Instant messaging apps are optimized to increase the influence of social networks via the functions that enable sharing, endorsement, and discussion of information, and people more easily accept information regardless of its veracity because of the increased personal influence (Anspach, 2017). It has recently been observed that instant messaging apps are emerging as a media misinformation source (e.g., Reis, Melo, Garimella, & Benevenuto, 2020).

People increasingly utilize instant messaging apps to consume news and information, not just for casual conversations (Rossini et al., 2021), which may increase the users' opportunities to encounter misinformation. Recent data collected by the Reuters Institute show that about a third of respondents in six countries (the United Kingdom, the United States, Germany, Spain, South Korea, and Argentina) have seen much or a great deal of false or misleading information about COVID-19 via instant messaging apps in the last week (Nielsen, Fletcher, Newman, Brennen, & Howard, 2020). Specifically, South Korea presents an ideal national context for exploring misinformation about COVID-19 via instant messaging apps. According to a survey conducted by the Korea Press Foundation, almost 40% of South Korean survey respondents have encountered fake news via instant messaging apps, compared with 27% of the respondents via Facebook and Twitter (Park & Youm, 2019). It is also important to note that South Koreans are much more likely to trust news or information from people they know personally (Nielsen et al., 2020). Because instant messaging apps are designed to allow private communication among close people and those who participate in specific groups, misinformation exposure via instant messaging apps can drive perceptions, beliefs, and behaviors. If individuals are repeatedly exposed to misinformation, they tend to believe it to be accurate. This has been termed the illusory truth effect, or the phenomenon whereby the repetition of information increases the likelihood that it will be judged true (Dechêne, Stahl, Hansen, & Wänke, 2010). Exposure to health-related misinformation can be a detriment to public health, such as by altering health-related cognition and behavior (Tan et al., 2015). For example, in Hong Kong, alcohol drinkers and smokers exposed to the information that alcohol drinking and smoking can protect

against COVID-19 from WhatsApp/WeChat, Facebook, Instagram, and Twitter showed increased alcohol and tobacco consumption (Luk et al., 2020). Likewise, worldwide, COVID-19 misinformation has been spread through instant messaging apps, such as WhatsApp, WeChat, and Telegram (Davis, 2020; Luk et al., 2020).

A theoretical approach could also help explain how exposure to COVID-19 misinformation through instant messaging apps affects COVID-19 knowledge and preventive behavioral intention. For example, the risk information seeking and processing (RISP) model (Griffin, Dunwoody, & Neuwirth, 1999) explains which factor affects individuals' information seeking and information processing. The RISP model suggests that information insufficiency, the difference between current knowledge (i.e., what people know) and sufficiency threshold (i.e., what people need to know), plays a large role in promoting information seeking and systematic processing (Hwang & Jeong, 2016), so higher levels of exposure to COVID-19 misinformation through instant messaging apps can decrease users' sense of information insufficiency, which is negatively associated with knowledge and preventive behavior. Moreover, media dependency theory proposes that people tend to depend on the media to meet their needs, and the impact of media is heightened as they fulfill their needs (Ball-Rokeach & DeFleur, 1976). Media richness theory suggests four aspects of media richness in delivering rich information, such as immediate feedback (i.e., rapid two-way communication and immediate response to messages), multiple cues (i.e., various information channels, including texts, voices, audios, images, or videos), personal focus (i.e., expressing or delivering users' personal feelings or tailored messages), and language variety (i.e., delivering a wide range of meaning by using various symbols in a language) (Tseng, Cheng, Yu, Huang, & Teng, 2019). Using media dependency theory and media richness theory, we suggest that media richness and media dependency in instant messaging apps can heighten the negative effect of exposure to COVID-19 misinformation on COVID-19 knowledge and preventive behavioral intentions. These theoretical foundations and previous findings indicate that greater exposure to misinformation is associated with lower levels of knowledge and preventive behavior about infectious diseases. From these considerations, this study adopts the following research hypothesis:

H1: Exposure to COVID-19 misinformation via instant messaging apps will be negatively related to COVID-19 knowledge (H1a) and COVID-19–preventive behavioral intention (H1b).

Moderating Roles of News Media and Interpersonal Communication in Message Exposure Effects

Media message research has found that message effects are often underestimated or exaggerated by individual differences (Oliver & Krakowiak, 2009). Dual-processing models of persuasion, for example, such as the elaboration-likelihood model and the heuristic-systematic model, support the idea that individual difference variables can play a critical moderating role in attitude change (e.g., Cacioppo & Petty, 1984; Eagly & Chaiken, 1993). These variables include intelligence, self-esteem, self-monitoring, and the need for cognition that results from message exposure (Petty & Wegener, 1998). In addition to moderating the direction and nature of message influence, individual characteristics may also heighten or lower message influences or may even provide a necessary condition for message influences to occur (Oliver & Krakowiak, 2009).

Individual differences include various structural, cultural, cognitive, and motivational characteristics that affect messages' impact. We focus on two individual difference variables as potential moderators of the health risks posed by health misinformation: news media exposure and interpersonal communication. During public health crises, people are likely to use news media for acquiring information to deal with uncertain situations. South Korean's news media use particularly increased at the first peak of the COVID-19 pandemic. According to a survey from the Reuters Institute conducted in six countries in early April 2020 (the United Kingdom, the United States, Germany, Spain, South Korea, and Argentina), 77% of South Koreans received information on COVID-19 from news organizations, was the highest rate in the survey (Nielsen et al., 2020). In addition, South Koreans exhibited the highest degree of trust in news and information about COVID-19 from news organizations (Nielsen et al., 2020). With traditional news media, such as television, newspapers, and radio, online news media serve as a reliable channel providing prompt and diverse information content, especially during public health crises. By providing various news content generated by mainstream news media in both the web and mobile environment, online news media have a noticeable advantage concerning its accessibility and the diversity of its sources (Lee, Kim, Park, & Cha, 2021).

Considering the increased use of and high public trust in news media during a pandemic, news media use may influence people's knowledge, attitudes, and preventive behavior related to pandemics, although evidence for this is often inconsistent (Ho, Peh, & Soh, 2013; Melki et al., 2020; Nazione, Perrault, & Pace, 2021). In addition, news media serve as gatekeepers for filtering misinformation and inspecting information quality (Vraga, Bode, & Tully, 2020). News media attempt to deliver high-quality information, using expert or reliable sources, making people expect high-quality information. News media use may encourage audiences to question misinformation (Vraga et al., 2020). Adequate information exposure to news media, such as that provided by journalists, is likely to mitigate the negative impact of misinformation through the correction of misinformation (Southwell & Thorson, 2015). The presence of journalistic gatekeepers for news media can make it easier for individuals to distinguish fact from fiction and, as a result, may neutralize the potential negative effect of misinformation exposure through instant messaging apps. Supporting this expectation, in the United States, it was found that more exposure to information on Twitter was associated with more misperceptions and less social distancing compliance during the COVID-19 pandemic, whereas conversely, more exposure to information on traditional media was associated with fewer misperceptions and more social distancing compliance (Bridgman et al., 2020).

The public prefers to use interpersonal channels for information acquisition in times of uncertainty. Information obtained through interpersonal networks helps people recognize the severity of a risk and appropriately respond to the risk situation (Spence, Lachlan, & Griffin, 2007). Discussions with family members, friends, and coworkers provide individuals with greater social opportunities to understand information about risk situation (Ho, 2012). Previous studies have consistently indicated that interpersonal communication contributes to improved knowledge and promotes adherence to preventive practices during infectious disease outbreaks (Cho, Lee, & Lee, 2013; Ho, 2012; Ho et al., 2013). Some recent studies have shown that interpersonal communication is effective in improving awareness and knowledge level of COVID-19 (Ezeah, Ogechi, Ohia, & Celestine, 2020) and promoting COVID-19-protective behaviors (Ju, Ohs, Park, & Hinsley, 2021). Considering the direct and substantive

role of interpersonal communication in influencing individuals' cognitive and behavioral changes, it is possible that interpersonal communication can moderate the negative associations between misinformation exposure and public health emergency outcomes.

Interpersonal communication has a deliberative nature that entails elaborative and collective thinking. When engaging in interactive communication, individuals make significant efforts to understand topics of conversation, articulate their thoughts for expressions, and determine the pros and cons of various opinions provided by diverse conversation participants (Benhabib, 1996). Furthermore, in interpersonal conversation, one can learn about what others know and think, and engage in collective consideration (Cho et al., 2009). This deliberation through interpersonal communication has been found to increase knowledge and participation in the field of political communication (Cho et al., 2009; Shah et al., 2007). The deliberative merit of interpersonal communication can counteract misinformation in two ways (Hardy & Scheufele, 2005). First, individuals become better able to process misinformation if they talk it over with other people. These conversations motivate relational correction, such as in correcting family members and friends who share misinformation (Malhotra, 2020). Second, people might use misinformation more carefully because they expect to have discussions about it. More frequent discussions, therefore, trigger more careful misinformation processing and reduce the adverse consequences of misinformation exposure.

For these reasons, access to news media and interpersonal communication can potentially moderate the relationship between COVID-19 misinformation exposure through instant messaging apps and knowledge or preventive behavior. Specifically, news media messages and interpersonal communication attenuate rather than amplify the negative consequences of unfiltered misinformation exposure. For example, interactions between news media use and COVID-19 misinformation through instant messaging apps produce different levels of knowledge and preventive behaviors. Similarly, interpersonal communication inhibits the effect of misinformation through instant messaging apps on decreasing knowledge and preventive behavior. In this study, interpersonal communication is conceptualized as face-to-face communication, although it is possible for interpersonal communication to take place in online contexts. Face-to-face interpersonal communication includes both verbal and nonverbal communication but computer-mediated communication lacks traditional nonverbal cures, which may cause misunderstanding, and interrupting meaningful interpersonal communication (Lo, 2008; Olaniran, 2002). Based on the above discussion, we explore the moderating mechanism of news media exposure and interpersonal discussions in the relationship between misinformation exposure via instant messaging apps and knowledge or the intention to engage in preventive behaviors as follows:

H2: The negative association between exposure to COVID-19 misinformation via instant messaging apps and COVID-19 knowledge will be weaker for those exposed to more COVID-19 news media.

H3: The negative association between exposure to COVID-19 misinformation via instant messaging apps and COVID-19 knowledge will be weaker for those who participate in more interpersonal communication about COVID-19.

H4: *The negative association between exposure to COVID-19 misinformation via instant messaging apps and COVID-19-preventive behavioral intention will be weaker for those exposed to more COVID-19 news media.*

H5: *The negative association between exposure to COVID-19 misinformation via instant messaging apps and COVID-19-preventive behavioral intention will be weaker for those who participate in more interpersonal communication about COVID-19.*

Method

Data Collection and Procedure

After obtaining IRB approval from Incheon National University, we collected data from February 17 to 25, 2020. As the number of COVID-19 cases continued to increase, the South Korean government raised its alert level for COVID-19 virus to the highest level on February 23. After this point, people were required to report any symptoms related to COVID-19 for further testing, contact tracing, isolation, and treatment. Individuals were also asked to leave their homes only for daily necessities, healthcare, and commuting to work, and many community spaces were closed with the potential for noncompliant facilities to be handed administrative orders.

The survey was conducted via an online platform by a professional research agency in South Korea. The agency retains a panel of over 1.3 million people representing the Korean population in terms of age, gender, and residential area. An invitation email was sent to 7,529 panel members randomly selected by a computer algorithm to recruit the study participants. Of these, 1,831 individuals accessed the web survey, and 1,219 completed it. After completing the survey, all participants were directed to a debriefing page that indicated what was fact and what was misinformation on the COVID-19 information presented in the questionnaire. A link to the WHO's website for more information about the misinformation was provided. The final sample size was 1,209 after ten insincere responses were removed. The respondents' average age was 44.1 years (*SD* = 12.7, range: 20–69), and 50.0% were male. Most respondents (78.2%) had a college degree or higher, 21.3% had graduated from high school, and 0.6% had a middle school education or lower. The median monthly household income ranged from 4 to 5 million Korean won (equivalent to approximately U.S. $3,300–$4,100), and 7.3% of the participants had been diagnosed with pulmonary disease.

Measures

Exposure to COVID-19 misinformation via instant messaging apps was measured by asking respondents how frequently they had seen or heard the following information about COVID-19 across instant messaging apps (e.g., Facebook Messenger, WeChat, WhatsApp, WeChat, LINE, or KakaoTalk) in the past 30 days: "(1) Vaccines against pneumonia protect against COVID-19, (2) People receiving packages from China are at risk of contracting COVID-19, (3) Pets at home can spread COVID-19, and (4) Hand dryers are effective in killing COVID-19." The WHO (2020b) has identified each of these

assertion as COVID-19-related misinformation. Responses ranged along a 5-point Likert scale (1 = never to 5 = very often; α = .86).

Exposure to COVID-19 news media was distinguished between two types of news media: traditional and online news media. Exposure to traditional news media was assessed with the following three items on a 5-point Likert scale (1 = never to 5 = very often): "In the past 30 days, how frequently have you seen or heard information about COVID-19 on (1) television news, (2) newspaper news, and (3) radio news?" (α = .85). Exposure to online news media was measured with the following two items on a 5-point Likert scale (1 = never to 5 = very often): "In the past 30 days, how frequently have you seen or heard information about COVID-19 on (1) online news portals and (2) mainstream news websites?" (Inter-item r = .63).

Interpersonal communication about COVID-19 was measured using the following three items (Ho et al., 2013): "In the past 30 days, how frequently have you talked about COVID-19 in face-to-face settings with (1) family, (2) friends, and (3) coworkers?" Responses ranged along a 5-point scale (1 = never to 5 = very often; α = .64).

COVID-19 knowledge was measured by asking respondents to state whether the following sentences about COVID-19 were true or false (WHO, 2020b): "(1) People can catch COVID-19 if they breathe in droplets from a person with COVID-19 who coughs or exhales droplets, (2) Vaccines against pneumonia protect against COVID-19, (3) Eating garlic helps prevent COVID-19 infection, (4) COVID-19 can spread from person to person, (5) Putting on sesame oil blocks COVID-19 from entering the body, (6) People receiving packages from China are not at risk of contracting COVID-19, (7) Pets at home can spread COVID-19, (8) Antibiotics are effective in preventing and treating COVID-19, (9) Thermal scanners are effective in detecting people with COVID-19, and (10) Hand dryers are effective in killing COVID-19." Responses were recorded as 0 (incorrect or do not know) or 1 (correct) and summed into a combined scale in which higher scores indicated higher levels of knowledge about COVID-19 (range: 0–10).

COVID-19-preventive behavioral intention was measured with the following three items (Korea Disease Control and Prevention Agency, 2020): "(1) I will wash my hands often with soap and water for at least 20 seconds, (2) I will cover my mouth and nose with my sleeve when coughing, and (3) I will wear a face mask when I am around other people." Responses were assessed on a 5-point Likert scale (1 = not at all to 5 = very much; α = .88). Table 1 presents descriptive statistics and correlation coefficients among the variables.

Table 1. Descriptive Statistics and Bivariate Correlations Between Key Variables.

	1	2	3	4	5	6	7	8	9	10	11
1	1.00										
2	.31***	1.00									
3	.14***	.47***	1.00								
4	.16***	.26***	.23***	1.00							
5	−.20***	.05	.09**	.08**	1.00						
6	−.10***	.15***	.22***	.20***	.18***	1.00					
7	.03	.10**	−.16***	−.08**	−.01	.01	1.00				
8	−.09**	−.09**	.03	.06*	−.02	.31***	−.01	1.00			
9	−.06*	.09**	.09**	.10***	.10**	.05	−.04	−.09**	1.00		
10	−.01	.14***	.07*	.26***	.07*	.12***	.02	.06*	.25***	1.00	
11	.01	.03	.02	.04	.00	.01	.03	.06*	.03	.05	1.00
M	2.05	3.40	4.02	3.57	5.22	4.44	1.50	5.50	1.50	6.18	1.93
SD	0.92	0.95	0.87	0.87	2.20	0.65	0.50	0.98	0.50	2.28	0.26

Note. 1. Exposure to COVID-19 misinformation via instant messaging apps; 2. Exposure to COVID-19 traditional news media; 3. Exposure to COVID-19 online news media; 4. Interpersonal communication about COVID-19; 5. COVID-19 knowledge; 6. COVID-19–preventive behavioral intention; 7. Age; 8. Gender; 9. Education; 10. Monthly household income; 11. Pulmonary disease diagnosis
*$p < .05$, **$p < .01$, ***$p < .001$.

Analytic Procedure

We performed two sets of hierarchical ordinary least squares regression analyses for the two dependent variables: COVID-19 knowledge and COVID-19–preventive behavioral intention. Before testing the regression models, screening revealed that exposure to COVID-19 misinformation was not normally distributed. To address this, the variable was log-transformed, a standard practice used to normalize a skewed distribution of data. In each regression model, sociodemographics were set as the control variables in the first block, followed by the independent variable, namely, exposure to misinformation, in the second block, and moderators, such as exposure to news media and interpersonal communication, in the third block. Finally, four interaction terms were created and entered in the final block. Each interaction term was created by multiplying the standardized scores for independent and moderating variables to avoid possible multicollinearity discrepancies between the interaction term and its components.

Results

H1 predicted that exposure to COVID-19 misinformation via instant messaging apps would be negatively associated with COVID-19 knowledge and COVID-19–preventive behavioral intention. As shown in Table 2, misinformation exposure was negatively related to knowledge ($\beta = -.20$, $p < .001$) and preventive behavioral intention ($\beta = -.07$, $p < .01$). Thus, H1a and H1b were supported.

H2 posited that the negative association between exposure to COVID-19 misinformation via instant messaging apps and COVID-19 knowledge would be moderated by exposure to COVID-19 news media. H3 proposed that interpersonal conversations about COVID-19 would moderate the negative relationship between exposure to COVID-19 misinformation via instant messaging apps and COVID-19 knowledge. Contrary to expectations, however, neither exposure to news media nor interpersonal communication moderated the negative association between misinformation exposure and knowledge. Thus, H2 and H3 were not supported.

Table 2. Hierarchical Regression Predicting Hypothesized Dependent Variables.

	COVID-19 knowledge		COVID-19–preventive behavioral intention	
	Beta	Sig	Beta	Sig
Block 1. Controls				
Age	−.01	.658	.31	.000
Gender (Male = 0)	−.01	.727	.01	.627
Education	.08	.005	.06	.050
Monthly household income	.06	.065	.09	.001
Pulmonary disease diagnosis (No = 0)	−.001	.967	−.02	.533
ΔR^2 (%)	.01	.009	.11	.000
Block 2. Exposure to misinformation				
Exposure to COVID-19 misinformation on instant messaging apps	−.20	.000	−.07	.007
ΔR^2 (%)	.04	.000	.01	.007
Block 3. Exposure to news media and interpersonal communication				
Exposure to COVID-19 traditional news media	.06	.068	.11	.001
Exposure to COVID-19 online news media	.07	.039	.15	.000
Interpersonal communication about COVID-19	.07	.017	.13	.000
ΔR^2 (%)	.02	.000	.07	.000
Block 4. Interactions				
Exposure to misinformation × Exposure to traditional news media	−.02	.604	.08	.005
Exposure to misinformation × Exposure to online news media	.004	.884	.08	.004
Exposure to misinformation × Interpersonal communication	−.01	.874	.08	.003
ΔR^2 (%)	.00	.938	.01	.003
Total ΔR^2 (%)	.07	.000	.20	.000

Note. N = 1,209. Cell entries are final standardized Beta (β) for Blocks 1, 2, and 3, whereas cell entries are before-entry standardized Beta (β) for Block 4. p Values for "ΔR^2" and "Total R^2" statistics are based on F-change and F-test, respectively.

H4 and H5 hypothesized that the negative relationship between exposure to COVID-19 misinformation via instant messaging apps and COVID-19–preventive behavioral intention would be moderated by exposure to COVID-19 news media and interpersonal communication about COVID-19, respectively. As shown in Table 2, three interactions were found to be significant. Figures 1 and 2 indicate the negative association between exposure to COVID-19 misinformation and COVID-19–preventive behavioral intentions was weaker among individuals who were exposed to more COVID-19 news media (β = .08, p < .01 for exposure to misinformation × exposure to traditional news media; β = .08, p < .01 for exposure to misinformation × exposure to online news media). Thus, H4 was supported.

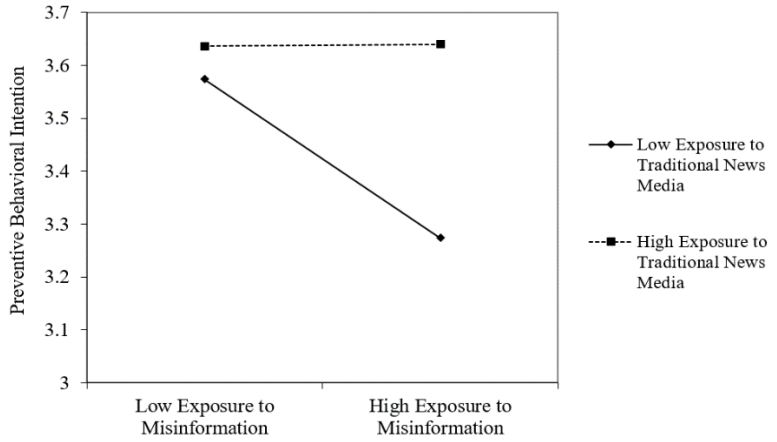

Figure 1. Interaction between exposure to misinformation and exposure to traditional news media on preventive behavioral intention.

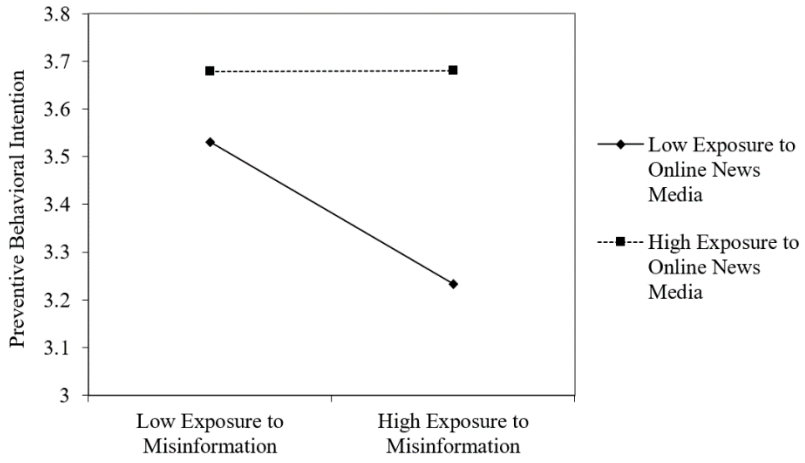

Figure 2. Interaction between exposure to misinformation and exposure to online news media on preventive behavioral intention.

In addition, exposure to COVID-19 misinformation had a less negative relationship with COVID-19–preventive behavioral intention for those who engaged in more interpersonal conversations about COVID-19 (β = .08, p < .01, see Figure 3). Therefore, H5 was supported.

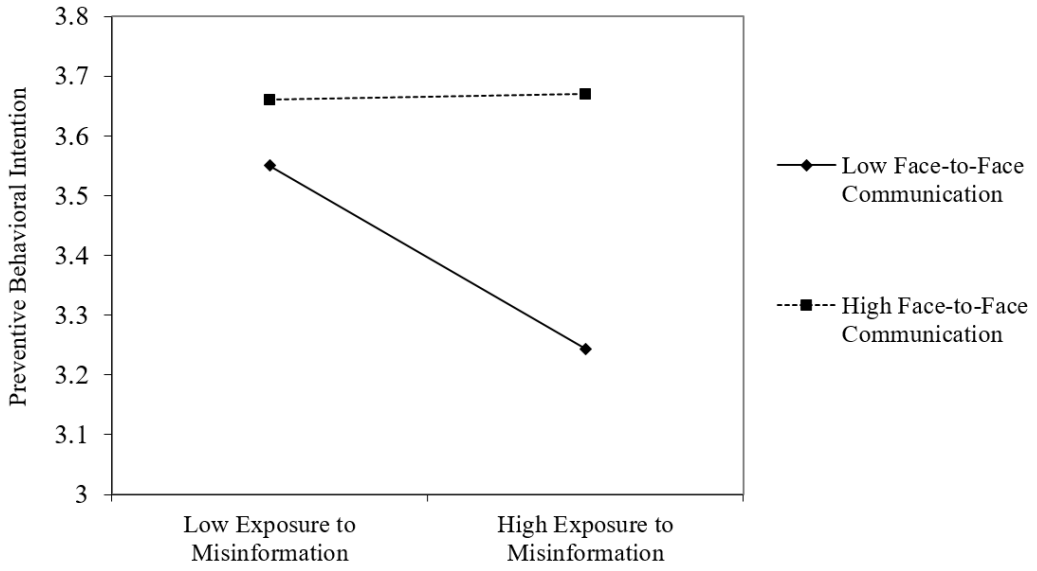

Figure 3. Interaction between exposure to misinformation and interpersonal communication on preventive behavioral intention.

Discussion

This study examined whether instant messaging apps enabled the propagation of misinformation that was significantly linked to poor knowledge and low preventive behavioral intention in the early stages of the COVID-19 pandemic in South Korea. We also investigated how the negative association between misinformation exposure and preventive behavioral intention could be mitigated using news media and interpersonal communication.

Consistent with prior evidence (e.g., Hornik et al., 2021; Lee et al., 2020; Luk et al., 2020), exposure to misinformation across instant messaging apps was negatively related to knowledge and preventive behavioral intention. According to the RISP model (Griffin et al., 1999), information seeking and processing are driven by information insufficiency, which refers to the gap between the knowledge one has and the knowledge one desires. COVID-19–related misinformation can reduce the sense of information insufficiency, or recognition of a knowledge gap, by overwhelming individuals with many pieces of knowledge and inconsistent recommendations on what prevents and cures the disease (Kim et al., 2020; Pentina & Tarafdar, 2014). Thus, varied and unverified COVID-19 misinformation circulating across instant messaging apps might reduce individuals' perception of their need for information on prevention of and treatment for COVID-19. This could decrease information seeking and increase superficial information processing, resulting in lowered knowledge and preventive measures pertaining to COVID-19.

Another potential explanation is derived from the communicative affordance of instant messaging apps that are primarily used for information interactions among close ties such as those with friends, family, and coworkers (Kwak, Lane, Zhu, Lee, & Weeks, 2020). Instant messaging apps serve as a more intimate setting for interaction than other social media platforms such as Facebook and Twitter, with users interacting privately with personal contacts or clearly defined groups (Valeriani & Vaccari, 2018; Yamamoto, Kushin, & Dalisay, 2018). Because of the influence of personal relationships, information (even if it is false) shared by close networks may be more effective in changing recipients' attitudes, beliefs, and behaviors (Anspach, 2017). In addition, messages circulating via instant messaging apps are generally sent from trusted, reliable, and known sources, and thus exposure to them may have a greater impact (Mosca & Quaranta, 2021). For those reasons, misinformation from close ties is perceived as more trustworthy and believable, which may be related to poor knowledge and low preventive behavioral intentions.

The findings shed light on the critical roles of news media and interpersonal communication in the relationship between misinformation and health-related measures in public health emergencies. Specifically, the relationship between exposure to COVID-19 misinformation and COVID-19–preventive behavioral intention was moderated by exposure to COVID-19 news media and interpersonal communication about COVID-19, suggesting that news media and interpersonal discussions could alleviate the negative association between misinformation exposure and infection preventive behavioral intention.

Particularly noteworthy is the moderating role of news media in offline and online contexts. Traditional news media are the primary communication channels between the general public and public health officials during public health crises. These platforms are the most common gateways for the public to access reliable news and information that manage uncertainty and promote adaptive behaviors against threats (Reynolds & Seeger, 2005). Prior research on public responses to recent epidemics has shown that overall traditional news exposure promotes participation in various protective measures (Choi, Shin, Park, & Yoo, 2018; Harper, Satchell, Fido, & Latzman, 2021; Jin, Chung, & Byeon, 2018). Given that people use online news most frequently for acquiring information during pandemics, online news media also have tremendous potential to continue and expand public health efforts. Online news outlets, such as online news portals and mainstream news websites, are affiliated with professional journalists, so they have much higher credibility than online independent media (Chung, Nam, & Stefanone, 2012). The perceived credibility of the information source acts as an important contributor to the adoption of the presented content (Grosser, 2016). Both traditional news media and online news media are widely recognized as powerful drives that increase the public's adherence to the safety measures recommended by public health organizations to combat the spread of epidemics. Thus, they might meaningfully attenuate the negative association between misinformation exposure and preventive behavioral intentions.

Like mass-mediated communication, interpersonal health communication about COVID-19 also played an important role in weakening or diminishing the negative relationship between misinformation exposure and health-protective behavioral intentions in the context of COVID-19. Interpersonal communication and media exposure function as substitutes for one another (Lee, 2009). From this perspective, COVID-19 misinformation from instant messaging apps may reach individuals and discourage them from engage in preventive behaviors about COVID-19 to a greater degree when there is less exposure to a variety of information from interpersonal networks. By contrast, those who already receive enough

information about COVID-19 from their interpersonal communication network are less likely to pay attention to and actively process COVID-19 misinformation on instant messaging apps.

Interestingly, exposure to COVID-19 news media and interpersonal communication on COVID-19 moderated the negative association between exposure to COVID-19 misinformation and COVID-19–preventive behavioral intention, but not COVID-19 knowledge. One possible reason for this could be that positive associations between news media, interpersonal communication, and knowledge were statistically nonsignificant or weak. However, the negative relationship between misinformation exposure and knowledge was statistically significant and strong. Accordingly, news media and interpersonal communication might have limited ability to change the negative connection.

The current study has important implications. First, this study provides evidence that news media, through its traditional and online platforms, can play a vital role in prompting preventive behaviors either directly or indirectly in the face of the pandemic. In particular, the negative association between misinformation exposure via instant messaging apps and people's compliance with recommended behaviors can vary across news media consumption. Thus, government or public health authorities should actively leverage news media to curb the spread of infectious diseases during pandemics. It is also imperative that government health organizations monitor how news media present epidemics and provide the media with clear guidelines to follow during outbreaks. Second, our findings demonstrate that interactive, two-way communication with close people can be effective in alleviating the negative association between misinformation and health-related behaviors. Health promotion planners should therefore develop and advertise public health campaigns to encourage the public to engage in interactive conversations during public health crises. In addition, it should be considered that information seeking via news media or interpersonal networks during public health crises can vary by socioeconomic status (SES). In previous studies, it has been suggested that more educated people tend to seek out health information more actively in various health contexts (i.e., Lee, Ramirez, Lewis, Gray, & Hornik, 2012). Accordingly, public health officials and policy makers should design and implement educational programs to improve health literacy among low-SES individuals to increase their information seeking from news media and interpersonal networks during infectious disease outbreaks.

Regarding the theoretical implications, this study supports the key claims of existing theories of media dependency and media richness that the use of instant messaging apps can intensify the negative association between misinformation on COVID-19 knowledge and preventive behavioral intentions. Moreover, this study suggests a conceptual framework to correct the adverse impact of exposure to misinformation via instant messaging apps by proving the moderating roles of news media and interpersonal communication.

It is necessary to note this study's limitations. First, it used cross-sectional data. Thus, the results did not reveal any causal direction. Although we did not test any causal relationships, future exploration should use longitudinal data or experimental methods to explore causality for identifying the dangers of misinformation and developing how to prevent the public from misinformation during a pandemic. Second, this study treated all messaging apps together despite their widely varying characteristics. Future studies should consider the diversity of these apps in terms of their functions and content. Finally, we measured

misinformation exposure via instant messaging apps relying on self-reports, and thus, it is hard to gauge the tone, theme, or nature of misinformation. Future research will benefit from investigations of misinformation in a more precise way.

Despite these limitations, this research contributes to communication research and practices for confronting misinformation in times of public health crisis. Because of the widespread use of instant messaging apps, individuals from all over the world can share misinformation more easily and rapidly than ever. Thus, understanding the factors that reduce the danger of misinformation in instant messaging apps provides promising new insights and opportunities for future communication scholars and practitioners interested in developing theory and designing interventions for addressing health misinformation.

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