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# The direct effects of media exposure on behaviors aimed at preventing COVID-19 and its indirect effects as mediated by interpersonal communication: a longitudinal study in Japan

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**Objective:** We aimed to examine the direct effects of exposure to media information about infection-preventing behavior and its indirect effects via interpersonal communication at two time points during the pandemic.

**Methods:** In August 2020 and August 2021, a web-based survey of Japanese people under a declared state of emergency was conducted. We collected sociodemographic data and data on seven types of exposure to media information, three types of exposure to interpersonal communication, and six types of infection-preventing behavior.

**Results:** A total of 784 participants completed both surveys. Exposure to information in the mass media decreased over the year, while interpersonal communication about COVID-19-related topics increased. The direct effect of exposure to information in the media about preventive behaviors was statistically significant in the pandemic's early stages, but this was no longer true after 1 year. The indirect effect via interpersonal communication was statistically significant at both time points.

**Conclusion:** Our results suggest that the influence of media information on infection-preventing behavior during the pandemic was maintained over time as an indirect effect via interpersonal communication. For risk communication media strategies during pandemics, adopting strategies to generate interpersonal communication will have a sustained effect on preventive behavior.

KEYWORDS

**COVID-19, pandemic, preventive behavior, media information, risk communication**

## 1 Introduction

Due to its prolonged duration, the COVID-19 pandemic seriously affected human health and society (1). In the absence of a cure, the only way to protect oneself was to combine vaccination, which has a limited duration of efficacy, with preventive behaviors such as wearing masks and social distancing (2, 3). As time went on, people experienced "pandemic fatigue" and became less willing to engage in infection-preventing behaviors (4–6). During a pandemic,

such decreased individual engagement in preventive behaviors poses a serious threat to public health.

The media is a major source of information in a pandemic because of its access to expert information and ability to disseminate large amounts of information quickly and widely (7–9). In the pandemic's early stages, many Japanese people paid attention to TV news, web-based news sites, and tabloid TV shows as sources of information (10, 11). When the media communicates effectively and informs the public about facts, people can form accurate risk assessments (12–14). A study conducted during the H1N1 pandemic suggested that attention to the news influences individuals' likelihood of engaging in preventive behaviors (15). However, some studies support the limited effects theory of the media, which suggests that the direct effects of exposure to media information on individual behavior are limited (16–18). A meta-analysis examining the effects of media campaigns on individual health behaviors suggested that the effects are short term and minor, and that it is unfeasible to try to use media campaigns to change population behavior by as much as 20% (17).

Research on media communication suggests that interpersonal communication mediates the effects of media information on individual behavior (19, 20). For example, the two-step flow model describes a combination of one-to-many communication (e.g., mass media) and one-to-one communication (e.g., interpersonal communication) as changing an individual's behavior. These mediation models are based on interpersonal communication's functions for media information of relaying media information to others (social diffusion), providing opportunities to discuss media content in detail, and reinforcing social norms (21). In previous studies on skin cancer and HIV prevention, interpersonal communication was found to mediate the direct effects of exposure to media information on individuals' perceptions of risk and attitudes toward preventive behavior (17). Another study of a smoking cessation campaign showed that interpersonal discussion after exposure to the media campaign mediated the direct effect of exposure to the media campaign (19). Importantly, previous studies have suggested that the mediated effects of interpersonal communication are greater than the direct effects of exposure to media information in promoting health behaviors. For example, a study during the H1N1 influenza pandemic reported that the mediated effect of personal discussions with family and friends on vaccination intention was greater than the direct effect of exposure to mass media messaging about vaccination (22). Another study of Hong Kong residents during the MERS outbreak reported no direct effect of mass media messaging on preventive behavior and detected only fully mediated indirect effects of interpersonal communication (23). A meta-analysis of media health campaigns found that the odds of achieving health goals were significantly better when there was some interpersonal communication compared to when there was only media campaign exposure (17, 21). Additionally, interpersonal sources of information influence behavioral change relatively quickly, whereas the mass media influences the perceptual and attitudinal aspects of responses more gradually (21).

Therefore, previous studies have suggested that effectively combining information spread by the media and interpersonal communication is the key to encouraging people to engage in necessary health behaviors during prolonged health crises. However, no longitudinal study has examined the long-term effect of exposure to media information on adopting infection-prevention behavior during a prolonged pandemic or looked at how interpersonal communication mediates that effect. This study seeks to examine the direct effects of exposure to media information about COVID-19 prevention behavior and the mediating effects of interpersonal communication regarding such behavior during the COVID-19 pandemic in Japan longitudinally over the one-year period from the time the pandemic was declared. Based on the results, we discuss strategies for increasing the effectiveness of media communication on infection-prevention behaviors by combining them with interpersonal communication.

# 2 Methods

## 2.1 Study design

A longitudinal study was conducted in Japan using a web-based survey administered at two time points: immediately after the declaration of the COVID-19 pandemic in August 2020 and 1 year later in August 2021. The state of emergency declared by the Japanese government was in effect at both times.

## 2.2 Data collection

Based on the platform of Rakuten Insight, Inc., the sample was drawn from a sample of 2.2 million Japanese residents. We used non-probabilistic quota sampling to ensure that the sample was representative of the whole population of Japan. The sample had the same proportions for gender, age, and prefecture as the general Japanese population. Those eligible to participate in the study were (1) people living in areas where a state of emergency had been declared, (2) not infected with COVID-19 themselves and with no family members who were infected, and (3) 18 years of age or older.

We conducted the first survey on 15–16 August 2020 and the second on 15–17 August 2021. Members of the survey panel who met the inclusion criteria were invited via email to respond to the screening questions. As part of the screening process, the participants were required to read a web page outlining our research. Participants were randomly sampled from among those who responded to the screening questions with the same distribution of age group, gender, and place of residence as the general population in Japan. After agreeing to participate, the participants completed an online questionnaire. Before the survey, a pre-survey was conducted on 10 people recruited through snowball sampling to verify the face validity of the questionnaire. Interviews were conducted with the participants of the pre-survey regarding the ease of understanding the questions, the invasiveness of the questions, and the lack of options, and some of the wording of the questionnaire was revised. After the questions were fixed, the first survey was completed by 1,000 participants from eight prefectures that were then in a state of emergency. The second survey was conducted with participants recruited from the first survey. The areas surveyed were under a state of emergency at both times. The data, separated from personal information by the research firm, was provided to the researchers for analysis. An analysis was conducted on the 784 participants who completed both surveys. The follow-up rate was 78.4%.

## 2.3 Measurements

Sociodemographic data (e.g., gender, age, level of education, household income, place of residence, employment status, history of chronic disease, and co-residence) were collected in the first survey. As part of the first survey, health literacy was also assessed. This is because health literacy is associated with seeking information about health and with preventive behavior against infection. We analyzed health literacy using a five-item version of Ishikawa et al.'s (24) Communicative, Critical Health Literacy.

### 2.3.1 Exposure to media information about COVID-19

The first and second surveys assessed the frequency of exposure to six types of media information channels: newspapers, news websites, non-news websites, social media, TV news, and tabloid TV shows. We asked about the level of attention to COVID-19-related information on each channel in the past week, using a single question adopted from previous studies (e.g., "How much attention did you pay to information about COVID-19 in newspapers?") (25). Based on a 10-point scale, we rated each item from 1 (paid no attention at all) to 10 (paid a great deal of attention). Cronbach's alpha for the combined scores was T1 = 0.77, T2 = 0.74.

### 2.3.2 Interpersonal communication about COVID-19

The frequency of interpersonal communication about COVID-19 with family, friends, and physicians was assessed in the first and second surveys. We asked each subject how often they exchanged COVID-19-related information with each type of person over the past week (e.g., "How often did you exchange information about COVID-19 with your family?"). Based on a 10-point scale, we rated each item from 1 (not at all) to 10 (very often). This question was adopted from previous studies (25). Cronbach's alpha for the combined scores was T1 = 0.67, T2 = 0.69.

### 2.3.3 COVID-19 preventive behaviors

The Japanese government recommended preventive behaviors for COVID-19 similar to those endorsed by the World Health Organization (26). Participants in the first and second surveys were asked whether they had engaged in six preventive behaviors recommended by the Japanese government (social distancing, avoiding closed spaces, utilizing ventilation, wearing masks, using hand sanitizer, and washing their hands with soap) (26). Specifically, through a single question, the participants were asked how often they engaged in each of the six COVID-19 prevention behaviors over the past 7 days (e.g., "How often did you wear a mask to prevent COVID-19 over the past 7 days?"). Based on a previous study, items were scored on a 5-point scale ranging from 1 (never) t to 5 (always) (27). For the scaled overall scores, Cronbach's alpha was T1 = 0.88, T2 = 0.86.

## 2.4 Ethical considerations

A protocol for this study was approved by the Ethics Review Committee at the Graduate School of Medicine, The University of Tokyo (number 11270). A web-based informed consent form was completed by all participants in accordance with the Helsinki Declaration.

## 2.5 Statistical analysis

Descriptive statistics were computed for each sociodemographic variable. Cronbach's alpha was calculated for all measures. A *t*-test was conducted to examine the changes between the time points for each type of media information exposure and interpersonal communication.

We examined the direct effects of media exposure on prevention behavior and the indirect effects via interpersonal communication using mediation analysis. A mediating analysis is a method for examining the effect of an explanatory variable ($X$) on a outcome variable ($Y$) via a mediating variable ($M$). In this study, mediation analysis was conducted using the procedure proposed by Hayes (28) and the PROCESS macro in SPSS (29). Ordinary least squares path analysis was used to estimate the coefficients of the direct and indirect effects of media exposure on COVID-19 preventive behavior mediated via interpersonal communication. In estimating the coefficients, we adjusted for variables that have been shown in previous studies to influence infection prevention behavior. These covariates included in the analysis were age, gender, level of education, household income, area of residence, employment status, co-residence with family, chronic disease status, and health literacy at Time 1 (T1). We found no interaction between exposure to media information and interpersonal communication on preventive behaviors. The bias-corrected bootstrap method (5,000 random samples) was used to calculate the 95% confidence intervals for the test of indirect effects. This analysis was conducted first cross-sectionally using data from time points T1 and T2, respectively, and then longitudinally using data from T1 for exposure to media information and interpersonal communication and T2 for preventive behavior.

Because of the online survey's specifications, there were no missing values. Our analysis excluded participants who only responded to the first survey. We conducted all tests on a two-sided basis with a 5% significance level. The data were analyzed using IBM SPSS version 25 (IBM Corp., Armonk, NY, United States).

# 3 Results

## 3.1 Participant characteristics

The participants' characteristics are presented in Table 1. As stated in the method section, their gender, age, and prefecture of residence were similar to those of the general Japanese population. The proportions of participants with a level of education lower than a university degree and those with a university degree or higher were similar. Approximately half of the participants were full-time employees. Those who were included in the analysis and those who were excluded because they did not take the second survey did not differ statistically significantly in their demographic characteristics.

## 3.2 Exposure to media information and interpersonal communication about COVID-19

Table 2 shows the changes in exposure to media information and frequency of interpersonal communication over the year. Exposure to media information tended to decrease over the year. The types of media information to which the participants had the highest degree

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TABLE 1 Sociodemographic characteristics of participants ($n = 784$).

| | n | % |
|---|---|---|
| Age (Mean, SD) | 47.14 | 12.8 |
| **Gender** | | |
| Female | 388 | 49.5 |
| Male | 396 | 50.5 |
| **Educational level** | | |
| Less than high school | 12 | 1.5 |
| High school graduate | 156 | 19.9 |
| Vocational school/Junior collage | 175 | 22.3 |
| Bachelor's degree | 379 | 48.3 |
| Post baccalaureate degree | 62 | 7.9 |
| **Income (US $)** | | |
| Less than $15,000 | 64 | 8.2 |
| $15,000 to <$43,500 | 320 | 49.0 |
| $43,500 or more | 334 | 42.6 |
| Unclear | 66 | 8.4 |
| **Employment status** | | |
| Employed full-time | 415 | 52.9 |
| Employed part-time | 179 | 22.8 |
| Retired/unemployed | 190 | 24.2 |
| Chronic disease | 149 | 19 |
| Co-residence with family | 613 | 78.2 |
| Health Literacy† (Mean, SD) | 3.822 | 0.6 |

SD, standard deviation. †Health literacy was measured by the CCHL.

of exposure were news information obtained from TV and websites for both T1 and T2. Exposure to old media (TV and newspapers) showed a statistically significant decrease over the year ($p < 0.001$ respectively). On the other hand, exposure to new media such as social media and video sharing sites showed a statistically significant increase over the year ($p = 0.02$, $p < 0.001$ respectively). There was a statistically significant increase in the frequency of interpersonal communication about COVID-19-related topics among all subjects with their physicians, family, and friends over the year ($p < 0.001$ respectively).

Figure 1 shows the results of the mediation analysis in which the outcome variable was preventive behavior, the explanatory variable was exposure to media information, and interpersonal communication was the mediating variable in the first survey. There was a significant direct effect of media information exposure on preventive behavior (0.061, 95% CI = 0.025–0.096). Media information exposure was also shown to be significantly associated with preventive behavior indirectly through interpersonal communication (0.038, 95% CI = 0.017–0.06). The effect of media information exposure on the interpersonal communication was also significant (0.505, 95% CI = 0.437–0.572).

Figure 2 shows the results of the mediation analysis in which the outcome variable was preventive behavior, the explanatory variable was exposure to media information, and interpersonal communication was the mediating variable in the second survey. There was no significant direct effect of media information exposure on preventive behavior (0.009, 95% CI = −0.026–0.045). On the other hand, media information exposure was found to be significantly associated with preventive behavior, indirectly through interpersonal communication (0.03, 95% CI = 0.009–0.052). The effect of media information exposure on the interpersonal communication was also significant (0.554, 95% CI = 0. 476–0.632).

# 4 Discussion and conclusion

## 4.1 Discussion

This study examined the direct effects of exposure to media information about COVID-19 on engagement in infection-prevention behavior and the indirect effects mediated through interpersonal communication at two time points among residents of Japan under the COVID-19 state of emergency. Understanding longitudinal changes in the effects of people's exposure to information on their infection-prevention behavior will enhance communication strategies to maintain and promote public health compliance during prolonged pandemics.

Regarding exposure to media information about COVID-19 during the first year of the pandemic, there was a high level of exposure, particularly to news information on TV and on the web. This result supported previous studies indicating that people consider the news an important source of information during disease outbreaks (9, 15). During the following year, exposure to information about COVID-19 in the mass media decreased. This may be partly due to a decrease in the frequency of media coverage over time. On the other hand, interpersonal communication on topics related to COVID-19 increased over the year for all targets. This suggests that in a pandemic lasting longer than a year, people's information-seeking behavior may change between the start of the pandemic and 1 year later. One previous qualitative study reported that over the course of the pandemic, the content of people's interpersonal communication shifted from content based on media reports to content based on personal experience (30). In a pandemic's early stages, people communicate about the unknown disease and base their communication on proxy experiences through the media. However, as the number of infected people increases, these proxy experiences are likely to be replaced, or at least supplemented, by direct experiences. In other words, when people do not have access to the experiences of those close to them, they will obtain more information from the media, but when they have access to the experiences of those close to them, they may seek more exposure to personal information. This may explain why exposure to media information about COVID-19 decreased over the year, while exposure to interpersonal communication and new media that allow people to share personal information about COVID-19 increased.

Regarding the direct effect of exposure to information in the media on preventive behavior, a significant effect was detected at T1 but not at T2. Based on cultivation theory, which states that the media cultivates social reality, norms, and values, frequent media users interpret the presumed frequency, likelihood, and characteristics of events described in the media as reality, thus influencing norms (e.g., descriptive norms). Moreover, previous studies have reported that risk emotions such as fear and anxiety motivate information-seeking and

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TABLE 2 Changes in exposure to each type of COVID-19 media information and interpersonal communication ($n = 784$).

| | T1 | | T2 | | Differences | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | 95%CI | | *p** |
| **Media information** | | | | | | | | | |
| Newspaper | 5.25 | 3.373 | 4.82 | 3.329 | −0.432 | 2.825 | −0.630 | −0.234 | <0.001 |
| TV news | 7.33 | 2.898 | 7.00 | 2.801 | −0.325 | 2.379 | −0.492 | −0.158 | <0.001 |
| TV tabloid shows | 6.02 | 2.996 | 5.67 | 2.910 | −0.352 | 2.458 | −0.524 | −0.180 | <0.001 |
| News websites | 6.78 | 2.609 | 6.68 | 2.528 | −0.092 | 2.606 | −0.275 | 0.091 | 0.324 |
| Government and medical professional official websites | 5.61 | 3.154 | 4.79 | 2.857 | −0.813 | 3.371 | −1.049 | −0.576 | <0.001 |
| Video sharing sites | 3.52 | 2.700 | 4.16 | 3.025 | 0.649 | 3.022 | 0.437 | 0.861 | <0.001 |
| Social media | 3.68 | 2.784 | 3.92 | 2.962 | 0.239 | 2.874 | 0.037 | 0.440 | 0.020 |
| **Interpersonal communication** | | | | | | | | | |
| Physicians | 3.18 | 2.527 | 4.01 | 3.020 | 0.825 | 3.073 | 0.610 | 1.041 | <0.001 |
| Family | 6.67 | 2.452 | 7.24 | 2.648 | 0.570 | 2.309 | 0.408 | 0.732 | <0.001 |
| Friends | 5.40 | 2.493 | 5.91 | 2.638 | 0.506 | 2.502 | 0.331 | 0.682 | <0.001 |

*Paired *t*-test.

protective behaviors (31, 32). For example, a previous study on H1N1 reported that media reports evoking fear tended to draw increased public attention to the media (15). COVID-19 spread rapidly, and the numbers of deaths and severe cases were reported daily in the media (9). In the early stages of the pandemic, the high exposure of many people to such information may have led to fear and a high estimate of their own likelihood of infection, which may have led to increased monitoring of media information and protective action (33). However, contrary to these predictions, the present study showed that even during the pandemic, the direct effect of the media decreased over time. The following reasons may explain why the direct effect of the media on public preventive behavior was not sustained for long. First, during the pandemic, the public was exposed to a high frequency of messages promoting preventive behavior disseminated through the media. However, it is known that a higher frequency of exposure to persuasive messages does not necessarily produce good persuasive effects (34). When individuals are exposed to similar messages beyond the desired frequency, the result can be message fatigue (35). Studies on issues such as smoking cessation, dental floss use, and disease prevention programs have reported that such fatigue can lead to non-compliance with recommended behavior through both active resistance (reactance) and passive resistance (neglect) (36–38). A study conducted during the COVID-19 pandemic indicated that people exposed to a high volume of messages may have developed message fatigue, leading them to disregard this information and reduce their infection-prevention behaviors (39, 40). Second, media reports of the rapidly increasing number of infections and deaths unintentionally appealed to the public's fear of this infectious disease. In the early stages of the pandemic, this may have encouraged public preventive behavior, but studies of emotions and coping strategies suggest that people adapt to these emotions through defiance mechanisms such as reframing and denial (41). This study's results may reflect the characteristics of a prolonged pandemic in which the direct effect of media information on public preventive behavior was reduced by continuing to monotonously repeat data reporting and persuasive messages.

However, regarding the indirect effect of exposure to media information on prevention behavior mediated by interpersonal communication, statistically significant effects were found for both T1 and T2. Combined with the result that the direct effect of media information exposure detected in T1 was not detected in T2, this suggests that the effect of exposure to information in the media on preventive behavior shifted from a direct effect to an indirect effect through fully mediated interpersonal communication during the year of the pandemic. Based on the two-step flow model, media messages are spread by opinion leaders who are more exposed to the media; through their relationships, these opinion leaders spread the message to groups that were not exposed to the original message (42). In the early stages of the pandemic, most people were actively exposed to media information, including those who do not actively collect health information in normal times. In a situation in which the public was faced with a crisis, the number of people directly exposed to media information increased, which may have resulted in a situation in which the one-step flow (direct influence by media information) and the two-step flow (influence via interpersonal communication) coexisted. Over time, the information-seeking behavior of non-opinion leaders may have calmed down, resulting in the media information flow shifting to a complete two-step flow. In other words, media information has the potential to continue to influence preventive behavior over time; even if its direct effect diminishes, if it can be mediated through interpersonal communication. Previous studies of health campaigns have reported that the effect on individual behavior was greater when interpersonal communication was generated from the campaign in addition to direct exposure to information from the campaign (21). To sustain the long-term effects of media information on individual preventive behavior, including content that triggers interpersonal communication may be an effective approach.

Previous studies have suggested that several public health communication strategies are effective in generating interpersonal

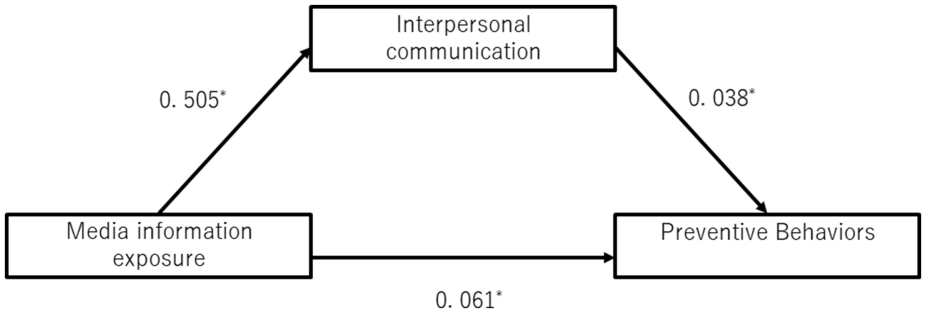


FIGURE 1
The direct effect of exposure to media information on prevention behavior and indirect effect mediated by interpersonal communication at the first survey. *$p < 0.05$ adjusted for age, gender, education, income, area of residence, employment status, co-residence with family, chronic disease status, and health literacy by multiple regression analysis.

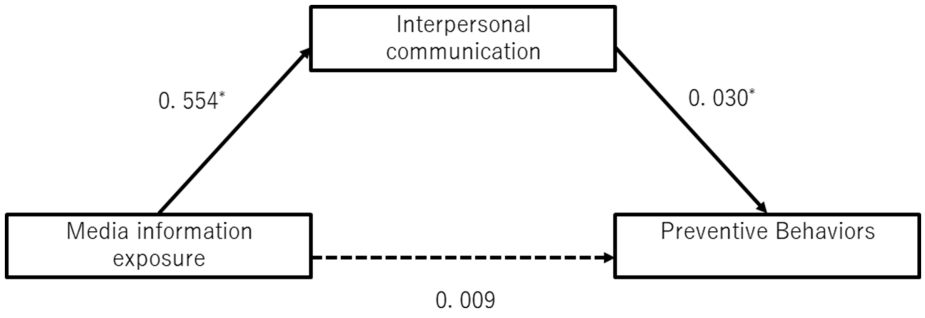


FIGURE 2
The direct effect of exposure to media information on prevention behavior and indirect effect mediated by interpersonal communication at the second survey. *$p < 0.05$ adjusted for age, gender, education, income, area of residence, employment status, co-residence with family, chronic disease status, and health literacy by multiple regression analysis.

communication through the media. The first is to provide explicit discussion prompts that encourage discussion with individuals close to the recipient of the message. For example, the National Youth Anti-Drug Media Campaign encouraged parents to talk with their children in the expectation that increased parent–child communication about drugs would stop drug use (43). This triggered more frequent parent–child conversations. Presenting messages that explicitly include the target and content of the conversation to be generated has the potential to increase conversations about media information. Second, many studies have shown that emotionally stimulating content stimulates interpersonal communication (44). People often talk with others about emotional events (45). Emotion has been reported to trigger evaluation and diffusion of health topics in campaigns (46). Topics with the ability to evoke emotions have the potential to create public buzz and communication opportunities. Third, the use of narratives in public health messages may also be effective. Previous studies examining the effectiveness of public health messages in social media have reported that narrative messages directly influence intentions to share in interpersonal communication (47). At the same time, it has been reported that narrative messages are less likely to generate psychological reactance because it is difficult to perceive the sender's persuasive intentions. Narratives may be more easily accepted and spread more readily under pandemics, where psychological reactance to persuasive messages is more likely to develop.

In summary, the results of this study suggest that the influence of media exposure on preventive behavior during a pandemic may shift from a direct effect in the early stages to an indirect effect mediated by interpersonal communication as the pandemic becomes more prolonged. To promote infection-prevention behavior for a prolonged duration using the media, including content that leads to the generation of interpersonal communication may be an effective strategy.

Several limitations should be considered when interpreting this study's results. First, because this is an observational study, a causal relationship between exposure to media information and interpersonal communication and infection-prevention behavior cannot be established based on its results. Furthermore, because non-probability sampling was adopted, there are limitations to the representativeness of the sample. Therefore, we relied on previous studies and existing theories in our discussion. However, considering that it is quite difficult to conduct a randomized controlled trial in a crisis situation, the results of this study represent important findings. Second, the participants all had to have access to the internet survey form to complete the survey, and their level of education was likely to be higher than that of the general Japanese public. Additionally, as the data was collected through questionnaires, there is a possibility of self-reporting bias. Finally, single-item, unvalidated scales were used in this study for exposure to media information, frequency of interpersonal communication, and engagement in preventive behaviors. We adopted items commonly used in previous studies to enable comparisons with the results of other infectious disease pandemics and with results from other countries. In the future, it is expected that scales measuring these factors will be developed. Despite these limitations, this is the first study to report

changes between two time points during the pandemic in the direct effects of information in the media on COVID-19 prevention behavior and the indirect effects mediated by interpersonal communication. The conflict between humanity and emerging infectious diseases will continue in the future. And in the case of a future pandemic, new information media will become more widespread, and the infodemic may become an even more serious problem. This study will provide a perspective and the importance of utilizing interpersonal communication, which is the basis of communication, in public health communication strategies in the event of a future pandemic.

### 4.2 Conclusion

In the early stages of a pandemic, the media had a direct effect on people's preventive behaviors. However, when a pandemic becomes prolonged, the effect is maintained only as an indirect effect, fully mediated by interpersonal communication.

Mass media is one of the most useful tools for rapidly providing information to large numbers of people. As observed during the COVID-19 pandemic, risk communication via the mass media is a major channel for governments and other risk communicators. The results of exposure to the media for the participants in this study also suggest that the general public attempted to access information about COVID-19 through the mass media in the early stages of the pandemic. The media is an important channel for risk communicators to promote infection-prevention behavior during a pandemic. This study suggests a possible strategy for sustaining the effectiveness of risk communication through the media over a long period of time during a pandemic. This means generating interpersonal communication among the public on health topics through media information. To sustain the effectiveness of risk communication through the media, it may be useful to incorporate triggers that generate interpersonal communication, such as explicit prompts to communicate with people close to the message recipients, including emotionally evocative content, and incorporating narrative messages. Risk communicators have been able to take advantage of the media's ability to communicate immediately with huge numbers of people during pandemics to rapidly disseminate accurate information. In addition, if the "emotionality" of the media can be leveraged, risk communications will continue to influence the behavior of greater numbers of people for longer periods.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving humans were approved by Ethics Review Committee at the Graduate School of Medicine, The University of Tokyo. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

HO: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. TO: Conceptualization, Methodology, Writing – review & editing. TK: Supervision, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## References

1. WHO (World Health Organization). WHO coronavirus (COVID-19) dashboard. (2022). Available at: https://covid19.who.int/ (accessed April 24, 2023)

2. Rosenberg ES, Dorabawila V, Easton D, Bauer UE, Kumar J, Hoen R, et al. COVID-19 vaccine effectiveness in New York state. *N Engl J Med*. (2022) 386:116–27. doi: 10.1056/nejmoa2116063

3. Feikin DR, Higdon MM, Abu-Raddad LJ, Andrews N, Araos R, Goldberg Y, et al. Duration of effectiveness of vaccines against SARS-CoV-2 infection and COVID-19 disease: results of a systematic review and meta-regression. *Lancet*. (2022) 399:924–44. doi: 10.1016/S0140-6736(22)00152-0

4. Al-Tammemi AB, Tarhini Z, Akour A. A swaying between successive pandemic waves and pandemic fatigue: where does Jordan stand? *Ann Med Surg*. (2021) 65:102298. doi: 10.1016/j.amsu.2021.102298

5. Ilesanmi OS, Bello AE, Afolabi AA. COVID-19 pandemic response fatigue in Africa: causes, consequences, and counter-measures. *Pan Afr Med J*. (2020) 37:37. doi: 10.11604/pamj.supp.2020.37.37.26742

6. Reicher S, Drury J. Pandemic fatigue? How adherence to COVID-19 regulations has been misrepresented and why it matters. *BMJ*. (2021) 372:1–2. doi: 10.1136/bmj.n137

7. Shih T-J, Wijaya R, Brossard D. Media coverage of public health epidemics: linking framing and issue attention cycle toward an integrated theory of print news coverage of epidemics. *Mass Commun Soc*. (2008) 11:141–60. doi: 10.1080/15205430701668121

8. Anwar A, Malik M, Raees V, Anwar A. Role of mass media and public health communications in the COVID-19 pandemic. *Cureus*. (2020) 12:e10453. doi: 10.7759/cureus.10453

9. Zhang L, Kong Y, Chang H. Media use and health behavior in H1N1 flu crisis: the mediating role of perceived knowledge and fear. *Atl J Commun*. (2015) 23:67–80. doi: 10.1080/15456870.2015.1013101

10. Kusama T, Kiuchi S, Takeuchi K, Ikeda T, Nakazawa N, Kinugawa A, et al. Information usage and compliance with preventive behaviors for COVID-19: a longitudinal study with data from the JACSIS 2020/JASTIS 2021. *Healthc*. (2022) 10:521. doi: 10.3390/healthcare10030521

11. Uchibori M, Ghaznavi C, Murakami M, Eguchi A, Kunishima H, Kaneko S, et al. Preventive behaviors and information sources during COVID-19 pandemic: a cross-sectional study in Japan. *Int J Environ Res Public Health*. (2022) 19:14511. doi: 10.3390/ijerph192114511

12. Garfin DR, Silver RC, Holman EA. The novel coronavirus (COVID-2019) outbreak: amplification of public health consequences by media exposure. *Health Psychol*. (2020) 39:355–7. doi: 10.1037/hea0000875

13. Fischhoff B, Wong-Parodi G, Garfin DR, Holman EA, Silver RC. Public understanding of Ebola risks: mastering an unfamiliar threat. *Risk Anal*. (2018) 38:71–83. doi: 10.1111/risa.12794

14. Ning C, Guo D, Wu J, Gao H. Media exposure and media credibility influencing public intentions for influenza vaccination. *Vaccine*. (2022) 10:526. doi: 10.3390/vaccines10040526

15. Chen NN, Mstpma BA. Examining the role of media coverage and trust in public health agencies in H1N1 influenza prevention. *Int Public Heal J*. (2011) 3:45–52.

16. Noar SM. A 10-year retrospective of research in health mass media campaigns: where do we go from Here? *J Health Commun*. (2006) 11:21–42. doi: 10.1080/10810730500461059

17. LB S, MA H, EW M, Kiwanuka-Tondo J, Fleming-Milici F, Proctor D. A meta-analysis of the effect of mediated health communication campaigns on behavior change in the United States. *J Health Commun*. (2004) 9:71–96. doi: 10.1080/10810730490271548

18. Geary CW, Burke HM, Castelnau L, Neupane S, Sall YB, Wong E, et al. MTV's "staying alive" global campaign promoted interpersonal communication about HIV and positive beliefs about HIV prevention. *AIDS Educ Prev*. (2007) 19:51–67. doi: 10.1521/aeap.2007.19.1.51

19. Jensen KB. Two-step and multistep flows of communication In: The international encyclopedia of communication theory and philosophy. Eds. KB Jensen, EW Rothenbuhler, JD Pooley and RT Craig (Hoboken, NJ, USA: John Wiley & Sons, Inc.). (2016) 1–11. doi: 10.1002/9781118766804.wbiect186

20. Weimann G. Multistep flow of communication: evolution of the paradigm In: The international encyclopedia of media effects Eds. P Rössler, CA Hoffner and L Zoonen (Hoboken, NJ, USA: John Wiley & Sons, Inc.). (2017) 1–10. doi: 10.1002/9781118783764.wbieme0055

21. Jeong M, Bae RE. The effect of campaign-generated interpersonal communication on campaign-targeted health outcomes: a meta-analysis. *Health Commun*. (2018) 33:988–1003. doi: 10.1080/10410236.2017.1331184

22. Yang ZJ. Predicting young adults' intentions to get the H1N1 vaccine: an integrated model. *J Health Commun*. (2015) 20:69–79. doi: 10.1080/10810730.2014.904023

23. Ludolph R, Schulz PJ, Chen L. Investigating the effects of mass media exposure on the uptake of preventive measures by Hong Kong residents during the 2015 MERS outbreak: the mediating role of interpersonal communication and the perception of concern. *J Health Commun*. (2018) 23:1–8. doi: 10.1080/10810730.2017.1388455

24. Ishikawa H, Nomura K, Sato M, Yano E. Developing a measure of communicative and critical health literacy: a pilot study of Japanese office workers. *Health Promot Int*. (2008) 23:269–74. doi: 10.1093/heapro/dan017

25. Ho SS, Peh X, Soh VWL. The cognitive mediation model: factors influencing public knowledge of the H1N1 pandemic and intention to take precautionary behaviors. *J Health Commun*. (2013) 18:773–94. doi: 10.1080/10810730.2012.743624

26. Ministry of Health L and W. Practical examples of new lifestyle in anticipation of COVID-19. (2020). Available at: https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000121431_newlifestyle.htm (accessed September 19, 2023)

27. Han Q, Zheng B, Cristea M, Agostini M, Belanger JJ, Gutzkow B, et al. Trust in government regarding COVID-19 and its associations with preventive health behaviour and prosocial behaviour during the pandemic: a cross-sectional and longitudinal study. *Psychol Med*. (2021) 53:149–59. doi: 10.1017/S0033291721001306

28. Hayes AF. An Index and Test of Linear Moderated Mediation. *Multivar. Behav. Res*. (2015) 50:1–12. doi: 10.1080/00273171.2014.962683

29. Hayes AF. Introduction to mediation, moderation, and conditional process analysis: a regression-based approach. New York, NY: Guilford Press (2013).

30. Wagner A, Reifegerste D. "The part played by people" in times of COVID-19: interpersonal communication about media coverage in a pandemic crisis. *Health Commun*. (2023) 38:1014–21. doi: 10.1080/10410236.2021.1989786

31. So J, Kuang K, Cho H. Information seeking upon exposure to risk messages: predictors, outcomes, and mediating roles of health information seeking. *Communic Res*. (2019) 46:663–87. doi: 10.1177/0093650216679536

32. Lee SY, Hwang H, Hawkins R, Pingree S. Interplay of negative emotion and health self-efficacy on the use of health information and its outcomes. *Communic Res*. (2008) 35:358–81. doi: 10.1177/0093650208315962

33. Gerbner G, Gross L. Living with television: the violence profile. *J Commun*. (1976) 26:172–99. doi: 10.1111/j.1460-2466.1976.tb01397.x

34. Kim S, So J. How message fatigue toward health messages leads to ineffective persuasive outcomes: examining the mediating roles of reactance and inattention. *J Health Commun*. (2018) 23:109–16. doi: 10.1080/10810730.2017.1414900

35. So J, Kim S, Cohen H. Message fatigue: conceptual definition, operationalization, and correlates. *Commun Monogr*. (2017) 84:5–29. doi: 10.1080/03637751.2016.1250429

36. Rhodes N, Roskos-Ewoldsen DR, Edison A, Bradford MB. Attitude and norm accessibility affect processing of anti-smoking messages. *Health Psychol*. (2008) 27:S224–32. doi: 10.1037/0278-6133.27.3(suppl.).s224

37. Dillard JP, Shen L. On the nature of reactance and its role in persuasive health communication. *Commun Monogr*. (2005) 72:144–68. doi: 10.1080/03637750500111815

38. Rains SA, Turner MM. Psychological reactance and persuasive health communication: a test and extension of the intertwined model. *Hum Commun Res*. (2007) 33:241–69. doi: 10.1111/j.1468-2958.2007.00298.x

39. Guan M, Li Y, Scoles JD, Zhu Y. COVID-19 message fatigue: how does it predict preventive behavioral intentions and what types of information are people tired of hearing about? *Health Commun*. (2023) 38:1631–40. doi: 10.1080/10410236.2021.2023385

40. Ball H, Wozniak TR. Why do some Americans resist COVID-19 prevention behavior? An analysis of issue importance, message fatigue, and reactance regarding COVID-19 messaging. *Health Commun*. (2021) 37:1812–9. doi: 10.1080/10410236.2021.1920717

41. Lazarus RS. The psychology of stress and coping. *Issues Ment Health Nurs*. (1985) 7:399–418. doi: 10.3109/01612848509009463

42. Soffer O. Algorithmic personalization and the two-step flow of communication. *Commun Theory*. (2021) 31:297–315. doi: 10.1093/ct/qtz008

43. Kam JA, Lee C. Examining the effects of mass media campaign exposure and interpersonal discussions on Youth's drug use: the mediating role of visiting pro-drug websites. *Health Commun*. (2013) 28:473–85. doi: 10.1080/10410236.2012.699873

44. Hafstad A, Aaro LE. Activating interpersonal influence through provocative appeals: evaluation of a mass media-based antismoking campaign targeting adolescents. *Health Commun*. (1997) 9:253–72. doi: 10.1207/s15327027hc0903_4

45. Rimé B. Emotion elicits the social sharing of emotion: theory and empirical review. *Emot Rev*. (2009) 1:60–85. doi: 10.1177/1754073908097189

46. Pfau M.. The persuasion handbook: developments in theory and practice. Thousand Oaks, CA: Sage. (2002). 289–308.

47. Barbour JB, Doshi MJ, Hernández LH. Telling global public health stories. *Communic Res*. (2016) 43:810–43. doi: 10.1177/0093650215579224