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The Effects of Social Media Use on Preventive Behaviors during Infectious Disease Outbreaks: The Mediating Role of Self-relevant Emotions and Public Risk Perception

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ABSTRACT

While there has been increasing attention to the role of social media during infectious disease outbreaks, relatively little is known about the underlying mechanisms by which social media use affects risk perception and preventive behaviors during such outbreaks. Using data collected during the 2015 Middle East Respiratory Syndrome coronavirus (MERS-CoV) outbreak in South Korea, this study explores the relationships among social media use, risk perception, and preventive behaviors by examining the mediating role of two self-relevant emotions: fear and anger. The findings demonstrate that social media use is positively related to both of these emotions, which are also positively related to the public's risk perception. The findings also indicate that social media use can significantly increase preventive behaviors via the two self-relevant emotions and the public's risk perception.

In recent years, a series of infectious disease outbreaks such as Ebola, Zika, influenza, and Dengue fever around the world have shed light on the significance of effective communication strategies regarding such diseases (Parmer et al., 2016). An outbreak of infectious disease is the occurrence of a disease that is not usually anticipated in a particular community, geographical region, or time period (Oh, Paek, & Hove, 2015). Typically, an emerging infectious disease involves rapid spreading, threatening the health of large numbers of people, and thus requires urgent action to stop the disease at the community level (Wurz, Nurn, & Ekdahl, 2013). Infectious disease communication is a type of emergency risk communication that is vital to public health and safety (Toppenberg-Pejcic et al., 2019). The difficulty of infectious disease communication arises mainly from the high uncertainty about the exact route of contamination, treatment, and recovery in an outbreak's initial stage (Lin, McCloud, Bigman, & Viswanath, 2016). Accurate information about risk and treatment may not be readily available (Reynolds & Seeger, 2005).

During recent infectious disease outbreaks, social media networking sites (hereafter social media) have functioned as firsthand information channels from which the public can obtain disease-related information and exchange it with their family, friends, and neighbors in real time (Jang & Paek, 2019). For example, Ding and Zhang (2010) found that the outbreak of the H1N1 flu was first reported via social media. For this reason, government agencies such as the Centers for Disease Control and Prevention (CDC) have started to use social media to inform the public of emerging infectious diseases such as the Zika and Ebola outbreaks (Chan et al., 2018; Lazard, Scheinfeld, Bernhardt, Wilcox, & Suran, 2015). Particularly when traditional media do not provide relevant, timely information for the public, social media serve as a major, immediate information source (Jang & Paek, 2019; Yoo, Chio, & Park, 2016).

While scholars have increasingly attended to the role of social media during infectious disease outbreaks, the question of how social media use might affect the public's affective responses, risk perception, and preventive behaviors has yet to be fully explored. Furthermore, theoretical studies investigating the public's reactions to infectious disease outbreaks are limited. To fill this gap, this study examines how social media use is related to emotional responses and risk perception, which in turn predict preventive behaviors. Using data collected during the 2015 outbreak of Middle East Respiratory Syndrome coronavirus (MERS-CoV, hereafter MERS) in South Korea, the study explores underlying mechanisms by examining the roles of two self-relevant emotions: fear and anger. Specifically, the study investigates three issues: (1) how social media use relates to the two self-relevant emotions, (2) the extent to which the self-relevant emotions predict public risk perception, and (3) how social media use affects preventive behaviors through psychological and cognitive mechanisms.

Background: The 2015 MERS outbreak in South Korea

Middle East respiratory syndrome is a viral respiratory disease caused by a coronavirus. MERS can cause a fever, cough, breathing difficulties, pneumonia, kidney failure, and even death, especially among elderly people. The first case of MERS was identified in Saudi Arabia in 2012, and the first death was reported in that year (WHO, 2018). MERS was identified in South Korea on May 20, 2015, when it was

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brought by a traveler who had visited the Middle East. During the next two months, the virus spread rapidly among health professionals and patients in health centers where MERS patients were being treated, resulting in 186 confirmed cases, including 38 deaths (Korean Ministry of Health and Welfare, 2016). It was the largest outbreak of MERS outside of Saudi Arabia (Choe, 2015). The outbreak triggered widespread public panic and took a heavy toll on South Korea's economy.

The South Korean government was heavily criticized for its initial response to the epidemic. The government did not initially reveal the names of the hospitals treating MERS patients, and all subsequent infections occurred in these hospitals. The government was accused of being insufficiently trustworthy in communicating with the public and was denounced as slow and inappropriate in its provision of accurate information about the disease. Because the government withheld necessary information, the public did seek and share MERS-related information primarily via social media (Jang & Paek, 2019). According to a survey conducted during the outbreak (Kim & Yang, 2015), 71.5% of respondents reported having obtained MERS-related information primarily via social media. MERS was mentioned in tweets more than 392 million times during the outbreak and ranked as Koreans' most used keyword in their searches that year (Kim, 2015). This unique situation provided an opportunity to examine the effects of social media use on people's risk perception and their subsequent behaviors during an infectious disease outbreak in real time.

The effect of media on risk perception

Mass media have long been considered to be vital shapers of the public's risk perceptions (Snyder & Rouse, 1995). Particularly when individuals do not have first-hand experience or knowledge of a health hazard, for instance, during an infectious disease outbreak, they are more likely to rely on mass media to learn about the hazards (Oh et al., 2015). Previous literature has demonstrated that the media can substantially influence public perceptions of risk issues such as H1N1 flu (Oh et al., 2015), Avian flu (Fung, Namkoong, & Brossard, 2011), or bovine spongiform encephalopathy (Paek, Oh, & Hove, 2016).

According to the Social Amplification of Risk Framework (SARF), the media can function as a "social amplification station" to form the social experience of risk, by either amplifying or attenuating public risk perception (Kasperson et al., 1988). Individuals learn about a risk through the media that not only provide the risk messages but also interpret the risk issues. The risk information is processed in a way that forms the salience of the risk, which in turn affects people's risk perception (Chong & Choy, 2018). For example, sensational media coverage of an infectious disease outbreak can amplify or height public risk perception of the disease (Ali et al., 2019).

In elaborating the influence of the media on risk perception, the differential-impact hypothesis suggests that the media can affect the public's perceptions of risks when the media arouse self-relevant emotions through vivid depictions of the risk issues (Snyder & Rouse, 1995). Self-relevant emotions are transient feelings that arise from thoughts about one's life and self (Dunlop, Wakefield, & Kashima, 2008). Self-relevant emotions such as fear or anger can strongly shape people's beliefs about how risks influence them, known as *personal-level risk perception*, and their behaviors to control the risk (Dunlop et al., 2008; Paek et al., 2016). Specifically, self-relevant emotions are assumed to mediate the influence of media exposure on personal-level risk perception (Oh et al., 2015) and, in turn, to increase desirable preventive behaviors (Paek et al., 2016). For example, Paek et al. (2016) demonstrated that fear elicited by reading news stories about carcinogen was positively associated with personal-level risk perception of the hazard, and personal-level risk perception was related to a desired behavioral outcome, intention to talk about the risk. Myrick and Oliver (2015) found that when people saw a sad video related to cancer, they felt compassion, which, in turn, increased their levels of risk perception.

The effects of social media exposure on self-relevant emotions

Guided by the previous accounts regarding the role of self-relevant emotions in the relationship among media use, risk perception, and behavioral outcomes, this study proposes that self-relevant emotions relate to how social media use would affect personal-level risk perception and preventive behaviors regarding an infectious disease. Public health-crisis information on social media is often framed in emotional terms (Do, Lim, Kim, & Choi, 2016). An infectious disease outbreak is a negative event and results in an unpredictably large number of infections and mortalities (You, Joo, Park, Noh, & Ju, 2017), which elicits the public's negative self-relevant emotions. In such a situation, an infectious disease outbreak can trigger the ordinary public's expression of their concerns about the outbreak, particularly through social media (Ofoghi, Mann, & Verspoor, 2016). For example, self-relevant emotions such as fear and anger were prevalent when people talked about the 2015 MERS outbreak on social media (Song, Song, Seo, Jin, & Kim, 2017). A recent study revealed that fear and anger were consistently expressed in tweets during the Ebola outbreak (Ofoghi et al., 2016). It is likely that social media users are exposed to emotional contents when they receive and share infectious disease-related information, which is resulting in intense emotional responses. In particular, fear and anger were the two most salient emotions on Twitter during the MERS outbreak (Do et al., 2016). This study, therefore, proposes that fear and anger can be elicited as a result of exposing MERS-related information on social media. At present, however, little is known about how self-relevant emotions such as fear and anger elicited by social media use can affect risk perception and preventive behaviors during an infectious disease outbreak. Therefore, we examine how fear and anger elicited by social media use regarding an infectious disease affect risk perception and preventive behaviors related to the disease.

The differential roles of fear and anger in shaping risk perception

Several conceptualizations exist regarding the role of emotion in risk perception and acting on those perceptions, such as the risk-as-feeling hypothesis (Loewenstein, Weber, Hsee, & Welch, 2001), the affect heuristic (Slovic, Finucane, Peters, & MacGregor, 2007),

and a model of affect-as-information (Schwarz & Clore, 1983). All incorporate the view that the representation of events in our minds is inextricably associated with feelings and that individuals refer to the associated feelings when they make judgments (Popova, So, Sangalang, Neilands, & Ling, 2017). For instance, the model of affect-as-information (Schwarz & Clore, 1983) suggests that individuals rely on their current emotional state in a heuristic way to make complicated assessments as long as the experienced emotional states are considered relevant to the assessment target. Lerner and colleagues also pointed out that "appraisal theory assumes that emotions not only arise from, but also elicit specific cognitive appraisals" (Lerner, Gonzalez, Small, & Fischhoff, 2003, p. 144). Furthermore, according to the Integrated Crisis Mapping (ICM) model (Jin, Pang, & Cameron, 2012), during a crisis emotions can function as an anchor of the public's interpretation of the crisis event. All these theoretical accounts point to causal relationships whereby emotions can affect risk perception.

Lerner and Keltner (2000) proposed the Appraisal Tendency Framework (ATF) to provide a more nuanced explanation of the differential roles of discrete emotions in shaping perceptions and behavioral outcomes. According to the ATF (Lerner & Keltner, 2000), each emotion is associated with specific appraisal dimensions. Appraisal theories suggested six appraisal dimensions for a specific emotion: anticipated effort, attention activity, certainty, control, pleasantness, and responsibility (Smith & Ellsworth, 1985). Previous literature has suggested that each emotion involves the six appraisal dimensions distinctively (Smith & Ellsworth, 1985), which leads to differential risk perceptions (Lerner & Keltner, 2000, 2001) and behavioral consequences (Izard, 1977). In other words, each emotion stimulates a tendency to estimate future events in a way consistent with the appraisal dimensions that generated the emotion (Lerner & Keltner, 2000, 2001). This process is called an *appraisal tendency* (Lerner & Keltner, 2000).

Scholars have suggested that fear and anger differ on the appraisal dimensions of certainty and control in particular, which are similar to cognitive meta-factors that shape risk perception, namely *unknown risk* (labeled at the high end by risk assessed to be uncertain) and *dread risk* (labeled at the high end by recognized lack of individual control: Lerner & Keltner, 2001). According to the ATF, fear, on the one hand, is associated with a tendency to perceive a situation as unclear and less controllable in situations (Lerner & Keltner, 2000). Anger, on the other hand, is associated with a tendency to perceive a situation as certain and controllable (Lerner & Keltner, 2000).

Scholars have documented that fearful people tend to perceive greater risk because they have a sense of uncertainty and little control over their situations (Lerner et al., 2003; Lerner & Keltner, 2000, 2001). In contrast, angry people tend to be optimistic regarding potential risk because they are confident in the likelihood of restraining a risk situation (Lerner et al., 2003). Lerner and Keltner (2000, 2001) conducted a series of experiments demonstrating that fear is positively associated with pessimistic risk judgments and anger is positively associated with optimistic risk judgments regarding possible future life events such as contracting a sexually transmitted disease, developing cancer, getting divorced, and so on. In Lerner and colleagues' study (2003), participants were randomly assigned to see a picture and hear an audio clip about terrorism, which evoked either fear or anger. The findings indicated that compared to the average American, more fearful people tended to see themselves as more vulnerable to the risk of terrorism, whereas angrier people tended to perceive themselves as less vulnerable. The findings lead us to assume that fear would be positively associated with personal-level risk perception, whereas anger would be negatively associated with personal-level risk perception. Guided by theoretical accounts of the ATF and the differential-impact hypothesis, this study attempts to extend the theoretical connections among social media use, personal-risk perception, and preventive behaviors through self-relevant emotions.

Emotions and personal-level risk perception as antecedents to preventive behaviors

When people recognize that they are vulnerable to a risk, they become motivated to engage in preventive health behaviors (Rimal, Flora, & Schooler, 1999). Health behavior models, such as Health Belief Model (Rosenstock, 1974), Protection Motivation Theory (Rogers, 1975), and Precaution Adaption Process Model (Weinstein, 1987) have theorized that one's perceived risk of a particular health hazard motivates the person to engage in preventive behaviors as a way to reduce the risk (for an overview, see Van der Pligt, 1996). Based on the theoretical accounts noted above, previous research has found that perceived personal risk promotes preventive behaviors in various health contexts (e.g., Paek, Oh, & Hove, 2016; Yoo, Paek, & Hove, 2018).

Emotions can not only affect behavioral outcomes via risk perception, but emotions can also directly motivate preventive behaviors (Turner & Underhill, 2012). Furthermore, discrete emotions generate different types of *action tendencies* (Lazarus, 1991). An action tendency indicates the ability of each emotion to predispose people to act in a particular way to solve the problem that generates the emotion (Frijda, 1986). Fear, for example, can trigger problem-solving or problem-avoiding behaviors to preclude the feared incident or situation from happening (Frijda, 1986; Lazarus, 1991). While fear may increase people's alertness to the severity and likelihood of risks, which would accordingly elicit stronger intentions to control it, fear might also hinder engagement in such behavior, particularly when the fear is strong (Yang & Chu, 2018).

In explaining people's different responses to fear, Janis (1967) proposed the inverted U-shaped Fear Drive Model. The inverted U-shaped Fear Drive Model demonstrates that a moderate level of fear can engender a motivational state for adaptive coping behaviors, but when fear levels are too low or high, individuals may not attend to or avoid such behaviors (Janis, 1967). While many experimental studies have supported the original Fear Drive Model, other convincing literature has presented a linier effect of fear on preventive health behaviors (e.g., Ali et al., 2019; Hartmann, Apaolaza, D'Souza, Barrutia, & Echebarria, 2014; LaTour & Tanner, 2003). For example, Hartmann et al. (2014) found that as individuals perceived more fear due to environmental threats, they were more likely to engage in pro-environmental behaviors. LaTour and Tanner (2003) also showed a positive and liner relationship between fear and preventive behaviors in the context of radioactive radon gas contamination.

The relationship between fear and preventive behaviors can be contingent upon the context in which fear is experienced. The inverted U-shaped Fear Drive Model assumes that a high level of fear can cause fleeing, thereby promoting survival (Ali et al., 2019). However, a high level of fear can promote preventive behaviors in a situation in which people do have no choice but to take such behaviors for their survivals as it encourages systematic information processing such as considering various factors related to the situation that evokes fear (Tiedens & Linton, 2001). Won, Bae, and Yoo (2015) reported that specific preventive behavior-related terms (e.g., wearing masks, hand sanitizer, and avoiding crowed places) were the most frequently mentioned words on social media during the MERS outbreak. It might be because such an infectious disease can fatally affect people's lives unless they engage in preventive behaviors immediately during the outbreak. Therefore, we assume that people are more likely to take precautionary behaviors when they feel greater fear during the MERS outbreak.

Anger, on the other hand, can initiate problem-solving behaviors intended to eliminate impediments (Nabi, 1999, 2002; Smith et al., 2010). Anger is induced when one's goals are thwarted (Lazarus & Lazarus, 1994; Turner, 2007). Anger, therefore, functions to remove impediments that hinder goal attainment or well-being (Lazarus, 1991). For example, Turner and Underhill (2012) found that angrier individuals were more likely to prepare for terrorism in the future. We expect that during the MERS outbreak, angrier people are more likely to engage in preventive behaviors to remove the immediate obstacle that threatens their lives.

Based on the theoretical accounts and previous findings above, self-relevant emotions and personal-level risk perception are expected to be the psychological mechanism through which social media exposure promotes preventive behaviors. Specifically, we propose six hypotheses in order to examine the process whereby risk information exposure via social media affects personal-level risk perception and preventive behaviors through two self-relevant emotions: fear and anger.

H1-1: Social media risk information exposure will be positively associated with fear.

H1-2: Social media risk information exposure will be positively associated with anger.

H2-1: Fear will be positively associated with personal-level risk perception.

H2-2: Anger will be negatively associated with personal-level risk perception.

Based on the hypotheses proposed thus far, there would be an indirect effect of social media risk information exposure on personal-level risk perception through fear and anger.

H3-1: Social media risk information exposure will have an indirect effect on personal-level risk perception through fear.

H3-2: Social media risk information exposure will have an indirect effect on personal-level risk perception through anger.

Next, consistent with extant literature, self-relevant emotions and personal-level risk perception are hypothesized to be directly associated with preventive behaviors.

H4-1: Fear will be directly and positively associated with preventive behaviors.

H4-2: Anger will be directly and positively associated with preventive behaviors.

H5: Personal-level risk perception will be directly and positively associated with preventive behaviors.

Finally, the above hypotheses collectively propose serial mediation models. The serial mediation comprises multiple mediators ordered in an identified causal sequence in which an assumed Cause X influences a Mediator M_1, which in turn influences another Mediator M_2, and so forth, resulting in an assumed final outcome (Hayes, 2013). This study suggests a two-mediator model in which social media exposure is modeled as affecting preventive behaviors through two self-relevant emotions and personal-level risk perception sequentially.

H6-1: Social media risk information exposure will have an indirect effect on preventive behaviors through fear and personal-level risk perception in serial.

H6-2: Social media risk information exposure will have an indirect effect on preventive behaviors through anger and personal-level risk perception in serial.

A summary of the hypotheses is described in Figure 1.

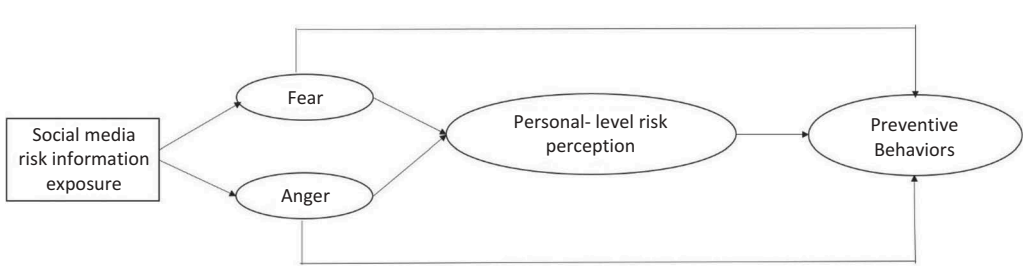

Figure 1. Hypothesized model.

Method

Sample

We conducted an online survey in July 2015 during the MERS outbreak. The data was collected via a leading online survey firm in Korea to ensure the representativeness of the data. The firm provided a panel of nationally representative respondents in South Korea. The panel comprised individuals who indicated willingness to complete the survey. A total of 6,973 individuals from the panel were extracted via quota sampling based on age, gender, and region. A survey link was distributed to all of them, and 667 individuals responded. After excluding participants who provided incomplete data, for instance, people who started the survey but did not finish it, we used a total sample of 400 for the analysis. The average age of the participants was 38.07 (*SD* = 10.33), and there were 200 female participants and 200 male participants.

Measures

Social media risk information exposure (hereafter, social media exposure)

We included the following question to assess the participants' exposure to MERS-related risk information via social media during the MERS outbreak, using a 7-point Likert scale (1 = not at all, to 7 = to a great extent): "How much have you seen information about MERS on social media such as blogs, Facebook, Twitter or YouTube?" Higher scores indicated greater exposure to MERS-related risk information via social media (*M* = 3.94, *SD* = 1.47).

Personal-level risk perception

We measured personal-level risk perception by using the following four items on a 7-point scale ranging from 1 = strongly disagree to 7 = strongly agree (Oh et al., 2015): "(1) The problem of MERS is serious to me; (2) I am worried that I would be affected by MERS; (3) It is likely that I would be affected by MERS; (4) I have felt that MERS is dangerous." The responses were averaged to construct an index of personal-level risk perception, and higher scores indicated greater personal-level risk perception (*M* = 4.58, *SD* = 1.40, Cronbach's α = .92).

Fear

We used two items to measure participants' levels of fear of MERS on a 7-point scale ranging from 1 = not at all to 7 = to a great extent (Yang & Chu, 2018). The statements included "I am fearful of MERS" and "I am frightened by MERS" (*M* = 4.52, *SD* = 1.47, r = .90).

Anger

To assess anger about MERS, we used the following two items on a 7-point scale ranging from 1 = not at all to 7 = to a great extent (e.g., Griffin et al., 2008). The items included "I am angry with MERS" and "I am irritated at MERS." The responses were averaged to construct an index of anger, and higher scores indicated greater levels of anger (*M* = 5.08, *SD* = 1.52, r = .86).

Preventive behaviors

We assessed preventive behaviors on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree) in which respondents were asked how frequently they engaged in the following preventive behaviors since the first MERS patient was confirmed: "(1) I have worn a mask to reduce the risk of MERS infection; (2) I have tried not to go to public spaces, such as restaurants or department stores; (3) I have tried not to go to hospitals; and (4) I have tried to wash my hands or used hand sanitizer more often to prevent the risk of MERS infection." We averaged the four items to create an index of preventive behaviors (*M* = 4.47, *SD* = 1.47, Cronbach's α = .82).

Data analysis

For the preliminary analysis, we used SPSS 24.0 to conduct a series of descriptive analyses of all key variables and bivariate correlation analyses between them (see Table 1). To examine the hypothesized relationships in the proposed model, we used the R package lavaan (Rosseel, 2012) to perform Structural Equation Modeling (SEM). We used Maximum Likelihood Estimation (MLE) to estimate the coefficients and test the significance of the hypothesized relationship, since MLE gives the least-biased parameter estimates (Johnson & Wichern, 2007). We used the following criteria for the model fit evaluation: a model with root-mean-square error of approximation (RMSEA) ≤ .06, comparative-fit-index (CFI) ≥ .95, and standardized root-mean-square residual (SRMR) ≤ .05 was considered to be well-fitted (Hu & Bentler, 1999). For control purposes, we linked demographic variables, such as age, gender, education level, income, and health status, to all the endogenous variables. Lastly, we employed a bootstrapping approach to test the mediation effects. We used 1,000 bootstrap samples, which were randomly selected from the sample, to calculate the indirect effects and confidence intervals.

Table 1. Descriptive statistics and bivariate correlations between key variables.

	Mean	SD	1.	2.	3.	4.
1.SNS exposure	3.94	1.47				
2.Fear	4.52	1.47	.26**			
3.Anger	5.08	1.52	.19**	.53**		
4.Personal-level risk perception	4.58	1.40	.23**	.65**	.46**	
5.Preventive behaviors	4.47	1.47	.23**	.53**	.43**	.62**

**p < .01.

Based on the model fit criteria, the proposed structural model indicated a good fit with the data: X^2 (105, N = 400) = 272.73 (p = .000); RMSEA = .06 (90% CI: .05 to .07); CFI = .96, SRMR = .04. Overall, the proposed model explained 13.8% of the total variance in the fear construct, 8.3% in the anger construct, 49% in the personal-level risk perception construct, and 52.6% in the preventive behaviors construct.

Results

Effects of social media exposure on self-relevant emotions

H1 tested whether social media exposure would be positively associated with fear (H1-1) and anger (H1-2). The results showed that social media exposure was positively related to fear (β = .26, p < .001) and anger (β = .21, p < .001).

Effects of self-relevant emotions on personal-level risk perception

H2 explored the relationships between two self-relevant emotions and personal-level risk perception. Specifically, we examined whether fear would be positively related to personal-level risk perception (H2-1) and anger would be negatively associated with personal-level risk perception (H2-2). The results demonstrated that both of fear (β = .60, p < .001) and anger (β = .15, p < .01) were positively associated with personal-level risk perception. Thus, the results only supported H2-1.

Mediating roles of self-relevant emotions in the relationship between social media exposure and personal-level risk perception

H3 predicted significant indirect links, via two self-relevant emotions, between social media exposure and personal-level risk perception. Specifically, H3-1 predicted that social media exposure would have an indirect effect on personal-level risk perception through fear. The indirect effect of social media exposure on personal-level risk perception, via fear, was significant (*indirect effect* = .15; CI = .09 to .21). Thus, the finding supports H3-1.

H3-2 examined the indirect effect of social media exposure on personal-level risk perception through anger. The significance of the mediating role of anger between social media exposure and personal-level risk perception also manifest (*indirect effect* = .03; CI = .004 to .052), supporting H3-2.

Effects of self-relevant emotions and personal-level risk perception on preventive behaviors

H4 tested whether two self-relevant emotions, fear (H4-1) and anger (H4-2), would be positively related to preventive behaviors. The results showed that both fear (β = .13, p = .05) and anger (β = .16, p < .01) were positively associated with preventive behaviors. Therefore, H4 was supported.

Also, H5 postulated that personal-level risk perception would have a positive, and significant influence on preventive behaviors. As seen from Figure 2, personal-level risk perception was positively associated with preventive behaviors (β = .51, p < .001). Hence, the result supports H5.

The serial mediation effect of self-relevant emotions and personal-level risk perception on the path between social media exposure and preventive behaviors

H6 investigated the indirect effects of social media exposure on preventive behaviors through two self-relevant emotions and personal-level risk perception. Table 2 summarizes the indirect effects of the hypothesized mediators. Specifically, H6-1 examined whether fear and personal-level risk perception sequentially mediate the path between social media exposure and preventive behaviors. As seen in Table 2, the findings demonstrated that social media exposure significantly and

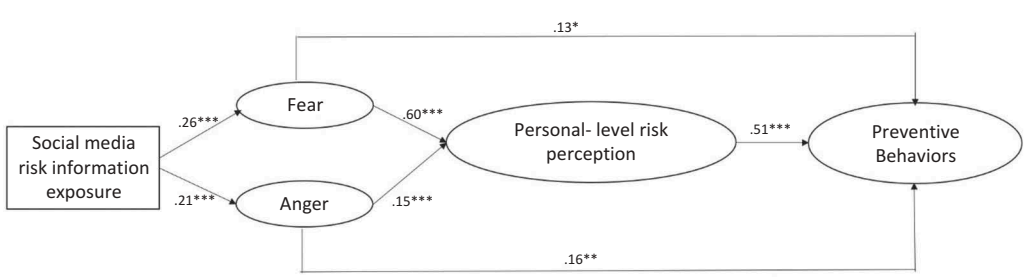

Figure 2. Results of hypothesized model.
Note. *p = .05, **p < .01, *** p < .001.

Table 2. Indirect effects of social media exposure on preventive behavior through discrete emotions and risk perception.

		Point estimation (SE)	CI
Mediators:	Indirect effects		
Fear, Anger and personal-level risk perception	Via M1	.15(.03)[a]	.090 to .210
	Via M2	.03(.01)[a]	.004 to .052
	Via M1, M3	.06(.02)[a]	.032 to .092
	Via M2, M3	.01(.01)[a]	.002 to .026

M1 = Fear, M2 = Anger, M3 = Personal-level risk perception; CIs are bias-corrected 95% confidence intervals based on 1,000 bootstrap samples.
[a]Indicates significant effects.

indirectly influenced preventive behaviors through fear and personal-level risk perception (*indirect effect* = .06; CI = .03 to .09). Thus, the results support H6-1.

H6-2 tested the serial mediation model, the indirect effect of social media exposure and preventive behaviors through anger and personal-level risk perception. As Table 2 shows, social media exposure had statistically significant indirect effects on preventive behaviors through anger and personal-level risk perception (*indirect effect* = .01; CI = .002 to .026). Thus, the results support H6-2.

Discussion

Analyzing data collected during the 2015 MERS outbreak in South Korea, this study attempts to advance knowledge of how social media shape public risk perception and engagement in preventive behaviors. The findings indicate that social media exposure is related to the two self-relevant emotions, fear and anger, and these emotions mediate the relationships between social media exposure and personal-level risk perception as well as preventive behaviors related to MERS.

In recent years, social media have become an increasingly important information source for risk and crisis communication, particularly during infectious disease outbreaks. Information acquisition and exchange via social media during an infectious disease outbreak can complicate communication about the disease, as emotions can play a significant role in shaping public risk perception or subsequent behaviors. The literature on risk communication has yet to disentangle the dynamics among social media use, affective responses, risk perceptions, and behavioral outcomes. This study explicates the emotional and cognitive mechanisms underlying the process through which exposure to risk information on social media shapes people's risk perceptions and preventive behaviors.

As we expected, the findings demonstrate that two self-relevant emotions, fear and anger, mediate the relationship between social media exposure, personal-level risk perception, and preventive behaviors. The findings extend the differential-impact hypothesis, which suggests that social media exposure during an infectious disease outbreak can elicit intense self-relevant emotions and, in turn, increase personal-level risk perception and preventive behaviors. Some scholars have suggested that self-relevant emotions mediate the relationship between mass media and risk perception (e.g., Oh et al., 2015; Snyder & Rouse, 1995). However, the role of self-relevant emotions in social media has not been investigated. By incorporating the roles of self-relevant emotions, this study extends the differential-impact hypothesis on the roles of media genres (e.g., news vs. entertainment) in risk perception beyond traditional media and into the realm of social media.

Guided by the ATF, we assumed that fear would be positively associated with personal-level risk perception, whereas anger would be negatively associated with it. However, the findings of this study demonstrated that both fear and anger were positively associated with personal-level risk perception. The results might stem from the fact that the MERS outbreak was obviously an uncertain and uncontrollable event for the public. Lerner and Keltner (2001) pointed out that the differential appraisal tendencies of fear and anger should emerge most remarkably when a target event is ambiguous regarding controllability and certainty. That is, if an event can be clearly defined in terms of certainty and controllability, individuals' perceived risks of the event might be subject to the effects of the emotional valence. Some studies also showed the same pattern as ours when the risk events were obviously uncertain and uncontrollable, such as a flood (Griffin et al., 2008) or the Ebola outbreak (Yang & Chu, 2018). Exploring a broader range of risk issues can advance our understanding of how different self-relevant emotions affect the public's risk perception and subsequent behaviors.

Although both fear and anger appeared to be positively associated with personal-level risk perception, the association with anger was weaker than that with fear. In the SEM model, although the total effect of anger was significant and positive, it was smaller (β = .15, p < .001) than that of fear (β = .60, p < .001). In addition, we conducted a post-hoc analysis to demonstrate the role of each emotion in the relationship between social media exposure and preventive behaviors. The findings revealed that the relationship between social media exposure and preventive behaviors was significantly mediated by personal-level risk perception when controlling for anger (*indirect effect* = *.07;* CI = .02 to .12) but not for fear (*indirect effect* = .03; CI = −.01 to .07). When fear is controlled, the relationship between social media exposure and preventive behaviors became insignificant because the influence of fear on personal-level risk perception was controlled. In other words, without the explanatory variance of fear in personal-level risk perception, the relationship between social media exposure and personal-level risk perception was not significant; thus, the mediating effect of personal-level risk perception on the relationship between social media exposure and preventive behavior could not be established. The results indicated that fear fully mediated the relationship between social media exposure and personal-level risk perception. In contrast, when anger was controlled, the mediation effect of personal-level risk perception was still significant, indicating that anger explained personal-level risk perception to a lesser extent than did fear. In other words, even if exposure to MERS-related information on social media did not trigger anger, people tended to believe that the outbreak would affect them. Taken together, our findings support previous literature demonstrating that fear plays a stronger role than anger in shaping risk perception (Lerner et al., 2003).

For future research, in addition to investigating the two self-relevant emotions examined in this study, it will be worthwhile to examine other types of self-relevant emotions that can affect risk perception and behaviors during infectious disease outbreaks. For example, anxiety is associated with the appraisal tendency of facing uncertain existential threats (Lazarus, 1991) and accompanies the action tendency of reducing uncertainty (Raghunathan & Pham, 1999). As a highly relevant negative emotion in infectious disease outbreaks, anxiety is one of the emotions people can express prevalently on social media. Although the operationalization of fear often incorporated anxiety (e.g., anxious or worried) in previous studies on fear appeal, fear and anxiety are distinct emotions and, thus, can differentially affect risk perceptions (So, Kuang, & Cho, 2016). As El-Toukhy (2015) elucidated, susceptibility (the possibility of experiencing a health hazard) and severity

(the seriousness of the hazard) are two components of risk perception. So et al. (2016) found that perceived susceptibility was a stronger predictor of anxiety than of fear, whereas perceived severity was a stronger predictor of fear than of anxiety. Furthermore, the scholars demonstrated that anxiety played a stronger role than fear in increasing preventive behavioral intentions related to meningitis. Therefore, an exploration of how other self-relevant emotions such as anxiety influence preventive behaviors would more effectively demonstrate how different emotions can play qualitatively different roles in promoting preventive behaviors.

Before we further discuss the findings, it is necessary to mention this study's limitations. First, the cross-sectional nature of the data limits our ability to make a strong inference about causal direction. For example, even though our findings indicated significant correlations between the two self-relevant emotions and personal-level risk perception, these correlations alone do not establish any direction of influence. One could interpret the hypothesized correlations as indicating that fear and anger provoked by exposure to risk information about MERS on social media may increase personal-level risk perception of the disease. At the same time, however, it is equally plausible that those who perceive greater risk are likely to be highly fearful or angry. Researchers have pointed out the difficulty of establishing whether emotion or cognition comes first. A causal relationship between emotion and cognition is hard to generalize. Studies on fear appeal, such as those on the extended parallel process model (EPPM; Witte, 1992), posit that risk perception (cognition) induces fear (emotion). For this reason, research guided by EPPM has used risk perception, not fear, in models (Chae & Lee, 2019). However, fear in the fear appeal literature is different from fear examined in this study given that most fear appeal studies have focused on emotional states induced by a single message. Fear in this study is an emotional state elicited by repeated exposure to MERS-related information on social media. As Chae and Lee (2019) indicated, if fear exists only as a consequence of risk perception, both should have the same effects on subsequent behaviors. However, evidence shows that they have different effects. For example, increased risk perception of breast cancer is positively related to cancer screening (Katapodi, Lee, Facione, & Dodd, 2004), whereas cancer-related fear can reduce that behavior (Miles, Voorwinden, Chapman, & Wardle, 2008). Future investigations employing an experimental or longitudinal design would better demonstrate the causal directions hypothesized in this study.

Another shortcoming of this study is that we used a single item to measure social media exposure. A single measure of social media may not completely capture its effect because social media can take various forms (e.g., content oriented vs. user oriented); depending on the form, the media can have differential effects (e.g., Yoo et al., 2018). While various social media platforms have distinctive features, they share common basic operations, allowing users to create or distribute content (Westerman, Spence, & Van Der Heide, 2014) and to obtain additional information on specific issues via users' comments (Lee & Chun, 2016). For this reason, some previous studies also used a single item to examine the effects of social media in risk communication (e.g., Choi, Yoo, Noh, & Park, 2017; Yoo et al., 2016). Furthermore, people do not use a single social media platform exclusively; rather, they use more than one platform to obtain information. For example, a recent survey (Pew Research Center, 2018) shows that more than 90% of Twitter users also use Facebook and YouTube. Therefore, it is worthwhile to examine the effects of social media as an information source as a whole during infectious disease outbreaks, rather than focusing on the different effects of specific platforms. With regard to the strategic use of various social media platforms, however, it will be worthwhile to investigate the different impacts of different social media platforms in future research (e.g., Facebook vs. Twitter).

Lastly, we did not investigate the sources of risk information on social media. Social media exposure may occur via various information sources, such as government agencies, the media, friends, and family (Choi et al., 2017). In particular, because social media users build their online networks to include mainly their acquaintances, these users seem more likely to vividly sympathize with the emotions of others in their networks, which, in turn, may increase the users' self-relevant emotions. To better understand the effect of social media during infectious disease outbreaks, it would be interesting to explore how various types of information sources influence emotional responses and how such responses shape risk perception and preventive behaviors.

In terms of practical implications, our findings suggest that public health communicators and policymakers should pay more attention to the roles of emotions during infectious disease outbreaks. The findings of this study support the idea that people use social media to express not only factual information but also emotion-filled dialogue about public health crises (Do et al., 2016; Ofoghi et al., 2016), and this dialogue can influence how they perceive and behave in response to the crisis. Studies have found that members of the public may not tolerate situations with even insignificant levels of risk if they believe that government agencies are unconcerned and unresponsive to their well-being (Maxwell, 2003). Our findings indicate that it may not be effective crisis management to disregard the public's emotional responses as irrational overreactions during a public health crisis. Tracking public emotions through social media monitoring could be used to better communicate with ordinary citizens during an infectious disease outbreak.

Effective communication with the public by public health agencies and governments is among the most important components of successful pandemic responses (Lee & Basnyat, 2013). Successful communication can help the public adopt appropriate behaviors to stop the spread of an outbreak (Reynolds & Seeger, 2005). In contrast, unsuccessful communication can ignite community outrage and hinder risk mitigation (Maxwell, 2003). This study's findings can help policymakers and communicators better understand the complex process of emotions and cognition provoked by infectious disease outbreaks and develop better communication strategies.

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