언론정보학석사학위논문

# Is air pollution a serious threat to me or society?

Information sources as explanatory variables for different risk perceptions and behaviors

대기오염은 나에게 위험한가 사회에 위험한가:

메시지 접촉 경로에 따른 위험 인식 및 행동 차이

August 2018


서울대학교 대학원

언론정보학과

박 준 모

# Abstract

Air pollution information has been made available to the public in South Korea. However, relatively little work has been done to explore the impact of this information and the ways in which it is interpreted by the members of the public. In this study, we examined the mechanism by which the media affects individuals' social/personal risk perceptions and behavior by observing the through utilization of the portal website content analysis and a nationally representative survey.

Study 1 included a content analysis of air pollution buzz data in Naver and Daum, which are the two most visited websites in South Korea. Data included fine particulate matter related documents from microblogs, communities, and Q&A of portal websites between August 7 and September 6, 2017. A content analysis of fine PM related documents was conducted with hierarchical clustering analysis(HCA) and multi-dimensional scaling(MDS). A total of 5,808 documents were crawled. The content analysis using semantic network analysis followed by hierarchical clustering and multidimensional scaling revealed the frames and their closeness in the context of the fine particulate pollution issue. We could notice many discussions were personal frames which contained personal

countermeasures or causes. Especially, personal counteractions such as ventilation, cleaning, or facial mask were pointed out as the reaction to the air pollution problem as well as physical symptoms such as rhinitis, eye, skin, and concern. Therefore, we could conclude that air pollution information on the Internet is mostly composed of personal framed messages rather than focusing on social causes or effects.

In study 2, this study aimed to empirically test the relationship between the media contents, risk perception and behavioral intentions by conducting a nationally representative survey between September 7 to 19, 2017. Study participants consisted of 981 adults. The survey results showed that the mass media exposure is not related to both perception of social risk and personal risk, after controlling for sociodemographic and scientific knowledge. However, interpersonal communication was positively related to both perceptions of social risk and personal risk. Internet only led to increased level of personal risk perception.

The cross-sectional test was examined through hierarchical multiple regression predicting pro-environmental behavior and self-protective behavior intention. After controlling other variables, the significant final beta of all kinds of risk were each positively related to pro-environmental behavior and self-protective behavior intention. Results indicated some support for predictions derived from the impersonal impact hypothesis,

however, the impact of mass media was found not to have significant impact on audiences' perceptions of air pollution risk to self or to the others. Instead, interpersonal communication was found to have an impact on both personal and society-level risk. In addition, the Internet had an impact on personal risk only. This may have caused by traits of messages on the Internet, which is seen in content analysis that many fine particulate matter-related discussions are personal-framed. On the basis of our findings, we make some suggestions regarding ways of developing air pollution campaigns that are more responsive to the public.

**Keyword : Air pollution, Behavior change, Frame, Health Communication, Impersonal effect, Media Effect, Media Psychology, Risk Perception**
**Student Number :** 2016-20220

# Table of Contents

# List of Tables



# List of Figures

# 1. Introduction

Air pollution became the biggest environmental risk to health both in developed countries and developing countries (WHO, 2016a). Especially people living in Asia, Africa, and Middle East breathe much higher levels of air pollutants than those in living other parts of the world (WHO, 2016a). Air pollutant level is increasing and causing a large number of mortalities in the world (North, 2016). Considering harmful impacts of the air pollution, World Health Organization (WHO) classified air pollution as a group 1 human carcinogen in October 2013 by the International Agency for Research on Cancer (WHO, 2013). Among the components of air pollution, fine particulate matter (PM) is a primary concern. Fine PM is suspected of leading to various health diseases, especially respiratory diseases and cardiovascular diseases (WHO, 2016a).

Although public agencies, media and citizens all consider air pollution as harmful to health, the communication strategies traditionally developed by public agencies and the media are not often based on a careful consideration of how the public reacts to information about air pollution levels and possible risks (Oltra & Sala, 2014). Public agencies often aim at informing citizens about air pollution levels and motivating actions to reduce air pollution levels. They expect to modify public behavior through

information transfer, but in fact, little is known about the effect of advisories in altering public behavior (Semenza et al., 2008). As Scov et al (1991) argued, it is questionable whether air quality information which relies on modification of individual health behavior through information transfer will have any direct effect.

Previous researches on this topic often have focused on the way of media portrayal or different risk perceptions between expert and citizens. For example, some studies analyzed news coverage (Kim et al., 2015; Mayer, 2012), social media portrayal (Key, Zhao & Sui, 2015) of fine particulate matter and revealed that social or international factors (i.e. aged fossil-fuel plant, pollutant from China) were often described as responsible for the air pollution problem while the possible countermeasures were mainly focused on personal behaviors (i.e. wear on face masks, stay indoors, drink more water). However, few studies have examined the association between media exposure, risk perception and possible coping behaviors. To expand risk perception research based on media effect approach, different communication sources, different types of risks, and different types of possible behaviors should be considered all together in the context of air pollution.

In this sense, the impersonal impact hypothesis can be applied to fill

the need of vigorous attempts to better understand the determinant of air pollution-relevant behavior changes. Impersonal impact hypothesis assumes that people distinguish between two different levels of risk judgment: personal and societal (Tyler, 1980; Tyler & Cook, 1984). Despite the fact that 90.8% of the Korean populations are concerned of air pollution, (KEI, 2016) individuals often incorrectly assess their own personal risk as low. Thus it may be crucial for public health agencies or campaign managers to know which communication channels help individuals to rate themselves at the appropriate risk level, and to act accordingly.

Equally important is considering pro-environment behaviors as dependent variable in addition to self-protective behaviors. Large numbers of health communication studies have primarily focused on self-protective behaviors such as cancer screening (Zhao & Nan, 2016), getting HPV vaccination (Carcioppolo et al, 2017), or condom usage (Guan et al., 2017) as a dependent variable. However, health risks caused by environmental factors may lead to two different coping behaviors (WHO, 2016b). For example, in order to prevent Zika virus, which is transmitted by mosquitos, people might wear long sleeves or sleep under a mosquito net to avoid oneself from mosquito bites while cleaning potential mosquito breeding sites in one's neighborhood (WHO, 2016c). Likewise, two kinds of coping behaviors on air pollution are available– one is action to minimize exposure

to pollutant such as wearing face masks or staying indoors which is beneficial for personal health but does not help solving air pollution problem. The other is action to reduce air pollution itself such as supporting restrictions on pollutant emission or participating in clean air campaign; it can be helpful for solving air pollution itself but not for immediate personal health.

In sum, the literature attributes risk perception and behavior differences to a variety of personal, impersonal, and intrapersonal factors, where the role of mass media have been traditionally highlighted. With internet and social media emerging as important sources of health and environment information, this study intends to expand the scope of impersonal influence research by incorporating social media into the traditional model to explain new variances in health risk perception. In this study, we analyzed air pollution risk perception in two levels – personal, and society. Then we assessed the influences of communication on two different behavior intentions - intention to reduce air pollution (pro-environment behavior intention) and intention to minimize exposure to air pollution (self-protective behavior intention). Here, we focus on implications for environmental and health behavior intention of the impersonal impact hypothesis (Tyler & Cook, 1984), which argues that media coverage typically impacts societal risk perceptions in general but not personal risks.

Impersonal impact hypothesis implicates that media coverage does not really matter with respect to health outcomes, given that perceptions of personal risk are more likely to motivate behavior change. However, we propose that concern about health risks at the society-level may significantly matter to environmental behaviors which are beneficial to the general others rather than one's own.

Considering little is known about how the public perceive the air pollution risk and the impact of self-other risk perceptions on two different behaviors, analyzing the air pollution risk can lead to the expanded understanding of impersonal impact hypothesis. In addition, cross-sectional survey combined with computational content analysis enabled us to examine frame effect in society-level. Most frame effect studies had been mostly conducted with message experiment in order to examine the effect of differently framed messages. Meanwhile, by applying computational method followed by survey, it is feasible to see whether social or personal portrayal of risk really impact on each risk perceptions in the whole population level. This may lead us to the new approach to study message effect on self-other risk perception and behaviors.

# 2. Literature Review

## 2.1.Communication effects on risk perception

Media effect studies generally have defined risk perception as perceived probability or likelihood of risky events and their negative consequences occurring to the ordinary people (Knuth et al., 2014; So, 2012). Given the overarching definition of risk perception, this study further divides into three types of risk perception: societal, personal level risk perception (e.g. Tyler, 1980; Weinstein, 1987) and neighborhood level risk perception. The following sections describe how the mass media, social media and interpersonal discussion influence each dimension of risks and explain the possible underlying reason why those impacts systematically differ.

## 2.2. Public Risk Perception: Society, and Personal level

According to the impersonal impact hypothesis (Tyler, 1980), individuals tend to estimate a health risk at two separate levels: risk for themselves (personal-level risk perception) and risk for general others (societal-level risk perception). Societal-level risk is defined as a person's estimation of the generalized level of risk to society, whereas personal-level risk refers to one's consideration of something as a risk to him or herself (Snyder & Rouse, 1995; Tyler, 1980). Prior studies consistently demonstrated that these two levels of judgment are usually independent, and individuals do not

necessarily draw implications about themselves from the information about the frequency or seriousness of a problem within the society (So, 2012; Tyler & Cook, 1984). In short, it is likely that people may not perceive a health or environmental risk as dangerous to themselves even though they perceive the risk as harmful to other people in society (Han et al, 2013; Oh, 2014).

The two types of risk judgments are not only conceptually distinct but also differ systematically. Third-person effect and optimistic bias have been attributed to the reason why there is difference in risk perception of the self and others (Chapin, 2000; Weinstein, 1987). Some risk perception studies have empirically demonstrated that individuals tend to judge themselves to be less likely to be affected by risk factors while judging others to be more vulnerable to the risks (Davison, 1983; Gunther, 1991; Weinstein, 1987). Optimistic bias has been revealed in various health and environment issues like H1N1 flu (Cho et al., 2013), natural disasters (Trumbo et al., 2014) and smoking (Dillard, McCaul & Klen, 2006). Another important difference lies in their behavioral implications: personal-risk perceptions have the capacity to motivate self-preventive behaviors while societal-level risk perceptions are less likely to have a direct impact on self-preventive behaviors (Oh et al., 2014; Snyder & Rouse, 1995).

### 2.2.1 Traditional Media Effects on Risk Perceptions

Mass media have been widely considered as an influential source of public's risk perception in communication research. This area of research has received concentrated attention since the media researchers began to examine the relationship between television viewing and violence rate estimates. As the body of literature on media's influence on social risk perception began to grow, two major theories – cultivation theory and impersonal impact hypothesis – have emerged in this area of research.

Although rarely stated explicitly as a theory about media's influence on risk perceptions, cultivation theory (Gerbner, 1969) is one of the theoretical basis for a large body of media effect researches on the topic (Lee & Niederdeppe, 2011). In essence, cultivation theory postulates that long-term exposure to the media lead to the perceptions and beliefs about the world that are consistent with the media's portrayals. Cultivation theory primarily focused on the social reality concerning violent crimes and proponents of cultivation theory contend that heavy television viewers show tendencies to overestimate the incidence of serious crime in society and believe that the world is a mean place where people cannot be trusted (Nabi & Sullivan, 2001). In addition, viewing local television news was associated with increased estimate of regional and neighborhood crime rates (Romer, Jamieson & Aday, 2003). Thus it can be inferred from cultivation studies

that viewing mass media may predict higher estimation of susceptibility of general others and neighborhood

Distinct from cultivation theory, impersonal impact hypothesis (Tyler, 1980; Tyler & Cook, 1984) distinguishes between societal and personal-level risk perceptions. It posits that the mass media predominantly influence social risk perceptions and tend to have less impact on personal risk perceptions. Within the area of crime, numerous studies have supported this hypothesis (Tyler & Cook, 1984). A number of studies indicate that exposure to the crime news in the mass media is unrelated to personal risk perception (i.e. fear of crime victimization), while showing positive correlation with social risk perception (i.e. judgments about the crime rates in society; Tyler, 1980, 1984). Many health research also indicate that mass media predominantly influence people's risk perception on the society while imposing relatively little effect on personal-level risk. Masiero and colleagues (2016), for example, found that the smokers and drinkers tend to underestimate cancer risk when it pertains to themselves compared with risk pertaining to general others. They revealed that as people rely heavily on media coverage for a picture of society as a whole, they tend to perceive other's cancer risk high. On the contrary, they draw primarily not on mass media but on personal experience when considering their own cancer risk.

Contrary to the impersonal impact hypothesis, however, some studies have reported that the media can significantly increase not only societal but also personal-level risk perception under certain conditions. Media System Dependency (MSD) theory, which posits that the effect of media may be most prominent when audiences depend on the media for the purpose of satisfying personal goals, proposes the significant effect of newspaper exposure on personal risk perception (Ball-Rokeach, 1985; Ho, Liao & Rosenthal, 2015). In addition, the differential-impact hypothesis suggests that media may have different impact on risk perception depending on the formats in which messages are delivered (So, Cho & Lee, 2011). For instance, entertainment media may lead people to perceive higher personal-level risk given their image-oriented and dramatic depiction make the risk more associated with the self (Paek, Oh & Hove, 2016; Snyder & Rouse, 1995).

Although it is difficult to draw a firm conclusion about media's influence on social and personal risk perceptions from these studies, the results point to the same conclusion: the mass media influence society-level risk perception and it may also impact on personal risk perception when people highly depend on media as an information source. Thus, one of the aims of this study is to examine the impact of mass media on shaping people's risk perception.

### 2.2.2 Interpersonal Communication Effects on Risk Perceptions

Many health and risk communication literatures have examined that interpersonal communication also play an important role in shaping societal and personal-level risk perceptions (Cho et al, 2013; Ho, Scheufele & Corley, 2011; Snyder & Rouse, 1995). In the area of risk communication, interpersonal communication heightened personal-level risk perceptions (Griffen & Dunwoody, 2000; Morton & Duck, 2001). For instance, Snyder and Rouse (1995) noted that interpersonal discussion influence personal risk judgments of AIDS. Morton and Duck (2001) also found that people who often talked about skin cancer with others perceived themselves to be vulnerable to skin cancer.

One probable cause for interpersonal communication impacting on personal risk is the message trait of conversations and psychological proximity. Ordinary talk often focuses on personal stories – stories of personal experiences about risk and it may lead individual to imagine risk more concretely. Also, interpersonal communication generally occurs between socially proximal others (e.g. family, friends, co-workers). As information acquired from proximal others is perceived as more self-relevant as psychological distance between self and others decreases (Cho et al., 2013; Liberman et al., 2007), it is likely to impact on personal risk rather than societal-level.

In sum, interpersonal communication is more significantly correlated with perception of personal risk rather than with societal risk. The findings of prior studies imply that conversational interaction, which seems to be difficult to ignore by nature, may effectively lead people to consider risks associated with self.

### 2.2.3. Internet and Risk Perceptions

In recent years, as internet such as online communities and social media had become popular, the use of internet as health information source can influence people's cognition or behavior related to health issues (Chew & Eysenbach, 2010). Internet has both traits of interpersonal communication and mass media (Lee, 2011), thus it is likely to impact both on personal and societal risk. First of all, it can influence personal risk perceptions of the public health issues (Chung, 2016). A specific characteristic of online environment is that many users tend to express their emotional responses, such as fear, worry, or anxiety on health issues (Chew & Eyesenbach, 2010). Thus, negative personal experiences or messages spread largely through online networks are likely to impact on personal vulnerability. Moreover, as internet users tend to share information and affection with their acquaintance, such as colleagues, friends, and family members, they are likely to respond seriously to their online contacts' information or opinions on the health issues.

On the other hand, internet functions like traditional media in some way. Twitter, which is a micro-blogging service that enables its millions of users to send and read messages, tend to make the content of the traditional mass media more widely distributed (Mondragon, Montes & Valencia, 2017). Several studies have found that people used social media, to disseminate health information from traditional institutional sources (Chew & Eysenbach, 2010). This means that traditional institutional sources (such as traditional mass media, government information services) use new media platforms for information dissemination rather than engagement (Lee & VanDyke, 2015).

In sum, we can expect that health information on the Internet may have combined impact on both personal and societal risk perception. In one way, the Internet conveys the content of the traditional mass media more widely known, while others share personal experiences. If internet posts tend to portray air pollution as more associated with society (societal frame), then exposure to social media may lead to higher societal-level risk perception. However, if internet portrayal of air pollution is more concentrating on individual responsibilities or consequences (individual frame), then exposure to internet may be associated with personal risk perception.

### 2.3. Mechanism Underlying Different Information Sources Impact Different Risk Perceptions

The Construal Level Theory (Trope, Liberman & Wakslak, 2007) is a possible explanation of psychological mechanism underlying mass media primarily influences societal-level risk and interpersonal communication lead higher personal-level risk. By definition, construal refers to representations of information in people's minds (Kahneman & Tversky, 1979). Researchers have expanded the range of construal levels to encompass information that exists outside of people's minds when societal-individual framings are associated with construal levels (Nan, 2007). Therefore, construal levels are used here to refer not only to representations of information in people's minds but also to information external to people's minds (e.g. the content of news coverage, social media posts). A major idea of CLT (Construal Level Theory) is that temporal distance influences the way people perceive the same information (Nan, 2007). According to CLT, temporal distance is one dimension of psychological distance, which includes the so-called social distance (Trope & Liberman, 2003) and social distance would influence the way people interpret the information. The psychological distance is caused by the way of an event portrayal and it determines the interpretation level.

Societal and individual framing refer to the way portraying the cause and consequence of risks (Kim & Willis, 2007; Nan, 2007). Social-framed messages tend to emphasize societal responsibilities and solutions so the message is perceived as relatively abstract and decontextualized. For instance, messages portraying social structure or China as the culprit of air pollution can be regarded as societal frame (Kim et al., 2015) and it may lead people to understand air pollution risk in perceptually abstract way. On the other hand, an individual-frame message underlines personal responsibilities or solutions so that it appears concrete and contextualized. To be specific, messages emphasizing individual responsibility and action may be considered as individual frame (Kim et al., 2015), leading readers to imagine air pollution risk in more concrete way.

Based on the literature reviewed, the current study expects that a social frame would affect general other's risk while individual frame affect risk on oneself. To apply construal level theory to impersonal impact hypothesis, mass media tend to highlight the social responsibility of risk and describe risk in terms of abstract and decontextualized features. Then, we can expect perceptual distance between the risk and oneself to be farther, thus people are more likely to interpret risk information in high construal level leading to judge risk as others' problem rather than of oneself. Interpersonal communication, on the other hand, tends to focus on

individual result or actions by sharing personal experiences or anecdote of surrounding people. As air pollution risks are represented in terms of concrete, contextualized features, it may decrease the interpretive distance and induce people to perceive information in low construal level. Then we can anticipate that people who frequently have conversation about air pollution risk would perceive air pollution risk related to oneself rather than the general others. Based on these assumptions, hypotheses and research questions are followed.

*Hypothesis 1 (H1)*: Exposure to air pollution information in mass media will increase society-level risk perception.

*Hypothesis 2 (H2)*: Exposure to air pollution information in mass media will not increase personal-level risk perception.

*Research Question* 1 *(RQ1)*: Does exposure to air pollution information on the Internet will increase society-level risk perception?

*Research Question* 2 *(RQ2)*: Does exposure to air pollution information on the Internet increase personal-level risk perception?

*Hypothesis 3 (H3)*: Interpersonal communication about air pollution will not increase society-level risk perception.

*Hypothesis 4 (H4)*: Interpersonal communication about air pollution will increase personal-level risk perception.

## 2.4. Responsive Actions on air pollution

Research on the epidemiological efforts of air pollution has mainly documented how pollutant particles can damage both physical and mental health of exposed individuals (WHO, 2013; WHO, 2016b). According to Health Belief Model (Rosenstock, 1974; Rosenstock, Strecher & Becker, 1988) we can expect that increase of air pollution risk perception may alter individual behavior intentions. However, less attention has been paid to the individual and public responses to this environment hazard.

As mentioned by previous studies (Bickerstaff & Walker, 1999; Oltra & Sala, 2014; Skov et al., 1991), people have multiple ways in order to deal with air pollution; for example, some would take self-protective actions to minimize air pollutant exposure but others would take part in pro-environmental behaviors to reduce air pollutant emissions (Skov et al., 1991; Xu, Chi & Zhu, 2017). Many studies have mainly investigated self-protective behaviors in public health domains (Cho, Lee & Lee, 2013; Mello

& Hornik, 2015), but only few studies have examined protective behaviors on air pollution specifically (e.g. avoid outdoor activities, wear facemasks). To infer which factors predict self-protective behaviors on air pollution, health-belief model (HBM) might offer a clue. According to HBM, primary predictive factors of individuals' behavior are the perception of the risk and the need to avoid negative consequences (Masiero et al., 2016; Rosenstock, 1974). When dealing with environmental risks such as air pollution, individuals may have various beliefs about how these problems have been originated, about the kind of impacts they or the population would have and about how to better manage the risk for them or the others.

In general, behavioral changes are likely to depend primarily upon personal concern regarding risk. As the health belief model (Rosenstock, 1974; Rosenstock, Strecher & Becker, 1988) emphasizes, cognition of personal susceptibility to a health risk is considered as a key determinant of behavior. Meanwhile, perceived risk to others may more predict air pollution reductive actions if they perceive the general population as more vulnerable to air pollution risks. This kind of association is supported in many third-person effect studies and impersonal impact studies. For example, people supported regulative policies when they presumed general others as susceptible to the possible risks (Slater, Hayes & Chung, 2015; Wei, Lo & Lu, 2007).

### 2.4.1. Actions to Reduce Air Pollution (pro-environment behavior)

Reducing pollution may require changes in the behavior of individuals, in particular the decisions that people make about transportation options or air pollution campaigns. Previous studies have found that few people reduced car use either as a result of the general environmental concern or a result of solely noticing air pollution alerts or campaigns. For instance, Skov et al (1991) found that people were not willing to avoid car driving upon getting daily air quality information, even though they knew cars were major emission source and were concerned about the health effects of exposing to air pollution. Besides working on the motives of the drivers, creating proper social context was considered as a plausible mechanism to facilitate behavior change as well. For instance, Henry and Gordon (2003) uncovered a significant effect of air pollution campaign when air quality campaign was delivered in social context.

Several researchers base their assumptions on theories of altruism, asserting that altruism is needed or at least supports pro-environmental behavior (De Groot, Steg, 2008; Steg & Vlek, 2009). Of note is the work of Allen and Ferrand (1999) who tested the 'actively caring' hypothesis of Geller. Geller hypothesized that in order to conduct pro-environmental actions, individuals ought to focus beyond themselves and be concerned about the community at large. Geller suggested that this state of 'actively

caring' can occur if the need for self-esteem, belonging, self-efficacy, and optimism has been satisfied (Allen & Ferrand, 1999).

### 2.4.2. Actions to Minimize Exposure to Polluted Air (self-protective behavior)

Most research into avoidance of air pollution exposure is based on individuals' responses to survey questions about their behavior with respect to air quality information. For example, Bresnahan, Dickie and Gerking (1997) conducted survey with 230 Los Angeles residents during 1985 to 1986, revealing that people made behavior changes to avoid smoggy conditions. Skov et al., (1991) conducted a survey in Copenhagen, Denmark, asking around 1000 respondents about their responses to air quality information. They found that people with pre-existing health conditions are more likely to report avoiding outdoor activity in response to an air pollution alert.

Previous studies observed that individuals engaged in low levels of protective actions to minimize exposure to air pollution (Semenza et al., 2008). For instance, a few studies conducted in the US during the 1970s, as summarized in Evans and Jacobs (1981), showed that recreational outdoor activities were not significantly curtailed on highly polluted days. The

assumed reason was that citizens were not adequately informed about the adverse health effects of exposure to polluted air. However, there were some exceptions. A study conducted in 2007 in New Jersey, US showed that 71% of the respondents reported that they stayed indoors with the windows closed during the weather forecast informed high air pollutant levels (Johnson, 2012). Perceived air quality and self-reported sensitivity to air pollution were two strong predictors of these protective behaviors. Health status, especially symptoms attributable to air pollution, also influences actions to minimize personal exposure to air pollution (Bresnahan, Dickie & Gerking, 1997).

In sum, we can expect that people might cope with air pollution risk if they consider air pollution as risky problem. People who are more concerned with risk to oneself may take actions to reduce possible harmful effects of air pollutants. On the other hand, those who perceive others are more vulnerable to air pollution risk, compared to oneself, may take actions to solve air pollution itself by the mechanism of altruism and self-enhancement. Based on these assumptions, hypotheses and research questions are suggested:

*Hypothesis* 5 *(H5)*: Society-level risk perception will increase pro-environmental behavior intention

*Research Question 3* (*RQ3*): Does social risk increase self-protective behavior intention?

*Hypothesis* 6 *(H6)*: Personal-level risk perception will increase self-protective behavior intention to minimize fine PM exposure

*Research Question 4* (*RQ4*): Does personal risk increase intention to reduce air pollution?

## 3. Research Model

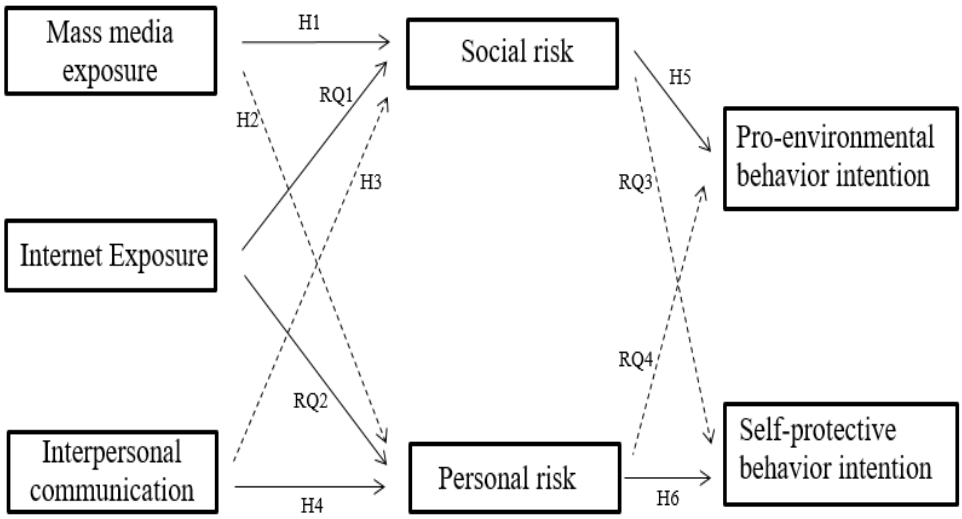


**Figure 1.** Research model.

# 4. Study 1. Content Analysis

Frame refers to densely interconnected clusters of concepts in discourse that jointly construct coherent meaning (Baden, 2010; Motta & Baden, 2013). Motta and Baden (2013) asserted that coherent meaning emerges from the association of concepts, forming frames that vary in prominence. In order to code discourse frames and to know the characteristic of frames, various approaches have been conducted to detect frames (Matthew & Kohring, 2008).

There are three categories of unsupervised techniques: cluster analysis, dimensional reduction and topic modeling (Petchler & Gonzalez-Bailon, 2015). Clustering refers to a set of techniques for detecting subgroups in a data set. When we cluster the elements, the data is partitioned into distinct groups so that the elements within each group is quite similar to each other, while different elements in distinct clusters (James et al., 2014). In order to apply clustering to frame research, each cluster represents the frame which is an association of concepts (Kohring & Matthes, 2002; Matthes & Kohring, 2008). As a way of clustering, several unsupervised learning approaches such as *k*-means clustering or hierarchical clustering are available (James et al., 2014). The foremost merit of applying unsupervised learning is that it derives clusters in the absence of manual-

dictionaries. As manually compiled dictionaries are likely to be biased by limited capacity of the researchers (Burscher, Vliegenthart & Vreese, 2015), unsupervised learning which do not require prior dictionary may derive frames and internal structure of discourse automatically.

Frame coding can be done in various ways; completely qualitative approaches to automated methods (David et al., 2011). Qualitative approaches are usually based on human-coding which can be advantageous of revealing latent meanings but time-consuming (David et al., 2011). At the other extreme are completely computer-assisted approaches based on word frequencies and co-occurrence. The semantic network analysis is one of computer-assisted approaches to detect frames through associations among concepts (Qin, 2015). In general, the term 'semantic network' refers to the structure of concepts in natural language (Murphy, 2001). The content and structure of a semantic network represent frames in public discourse (Pan & Kosicki, 1993). According to symbolic convergence theory (Bormann, 1985; Li et al., 2016), individuals of the same group tend to share homogenous meaning and consciousness through symbolic interaction. Thus, we can expect that understanding of the semantic network would largely represent how the population as a whole perceives the risk of fine particulate matter pollution.

Detecting frames by semantic network analysis would be advantageous for two reasons (Qin, 2015). First of all, as a bottom-up approach, it lets frames emerge by themselves. That means semantic network has a chance to be considered as reliable, compared to human coding which is often criticized for arbitrariness (David et al., 2011; Matthes & Kohring, 2008; Scheufele & Scheufele, 2010). Second, semantic analysis enables analyzing associations among multiple frames. This is worthy of notice because manual coding cannot examine associations among frames due to limited processing capacity, However, researchers can reveal the degree of association between concepts through analyzing semantic network (Qin, 2015). To consider aforementioned traits, we can expect the semantic network to be appropriate for analyzing public discourses if arbitrariness problem is complemented.

To describe the trait of the fine particulate matter information available on the Internet, this study conducted a computational content analysis. To be specific, semantic network combined with two unsupervised learning techniques (hierarchical clustering, multidimensional scaling) were processed as a means of detecting frames. If we define frames as patterns of closely interconnected concepts (Yang & Gonzalez-Bailon, 2015), semantic network analysis can reveal inter-frame relationships such as how focal concepts are associated with other concepts (Baden, 2010). The semantic

network analysis had been applied to public opinion and frame studies by highlighting the importance of relational nature of conceptual structures. For example, recent research on Ebola discourse compared semantic structures of mass media coverage and twitter messages (Mondragon, Montes, & Valencia, 2017).

Documents on online websites were scraped via Textom and then frequently occurring keywords were extracted. Afterwards, unsupervised machine learning, especially hierarchical clustering, was conducted based on Euclidean distance between keywords to see which concepts are grouped together. Then the results were described in two-dimension structure through multidimensional scaling (MDS) in order to visualize distribution of the societal or individual keywords.

## 4.1. Data Collection and Analysis Strategy

In the process of scraping, Boolean search logic, determining a set of keywords related to air pollution will be used. Boolean search logic for this study is as follows: “fine particulate matter OR ultrafine particulate matter”.

Online documents on Naver (www.naver.com) and Daum (www.daum.net), which mention fine particulate, were scraped from August

7 to September 6, 2017. This period is over a month before the panel survey. Scraped documents were converted into matrices containing information about the linkages of main words within the same texts (Carley, 1997). Each sentence was treated as a separate unit. More specifically, a list of stopwords – such as prepositions, conjunctions, and other non-substantive words in themselves were eliminated. Then nouns were left through pre-processing steps and cleaning (Diesner & Carley, 2011). The relationships among the remaining words were accumulatively counted whenever co-occurrence happens and build words-by-words matrices. Co-occurrence ties of words indicate cognitive relationships or significant meanings beyond mere lexical relationships (Coronges, Stacy, & Valente, 2007).

Discovering themes by direct inspection of the word list and co-occurrence matrix would be difficult and subject to interpretive distortion; thus hierarchical clustering (HCA) was applied to the word co-occurrence matrix. Clustering is an unsupervised machine learning technique aimed at finding groups of similar entities or patterns in a sample of data (James et al., 2013). Hierarchical clustering proceeds by considering each item as its own cluster and then successively merging smaller clusters into larger ones on the basis of similarity. The similarity would be based on the Euclidean distance which indicates the straight-line distance between two points.

Interpretation of clusters were conducted by human coder. Attributions of causal responsibility can be divided into personal and societal causes. Personal causes include individual behaviors or life-styles that might be responsible for air pollution (Kim et al., 2015). Social causes, on the other hand, will be the social, industrial and international conditions that contribute to air pollution. Attributions of personal influence include possible health effect while social influence includes economic or industrial impact caused by air pollution (Kim et al., 2015). Attributions of solution were categorized into personal and societal solutions. Personal solution includes possible individual actions such as wearing face masks, using an air purifier or eating healthier food (Kim et al.,2015). Social solutions include concepts regarding international cooperation, reducing fossil-fuel power plant, government policies and improving fine PM forecast systems (Kim et al.,2015).

Clustering reports grouped concepts but does not reveal how clusters are associated with each other (David et al., 2011). Thus multidimensional scaling (MDS) were applied to the same co-occurrence matrices in order to produce a spatial arrangement based on Euclidean distance to find out which clusters of words are closely related in terms of overall co-occurrence patterns.

For this study, I collected and analyzed web data using automated web-scraping software, Textom, developed by The IMC. This software randomly scraped about 0.02% of total web data (5,808 posts out of 377,702 posts) and the way Textom calculates the word frequencies and correlations is based on krkwic (Park & Leydesdorff, 2004). In the process of web-scraping, Boolean search logic was applied, determining a set of keywords related to fine dust and government measures. Boolean search logic for this study is as follows: 'fine dust OR ultrafine dust'.

Documents were changed into matrices including the linkage rate of words within each sentence (Carley, 1997). In order to do so, stopwords such as prepositions, conjunctions, and other non-substantive words were first eliminated. As a result of filtering process, nouns, verbs and adverbs within each sentence were left. Then the linkages among the residual words were counted whenever two words occur together in the same sentence, and built word-by-word matrices.

### 4.1.1. Hierarchical clustering analysis

The 25 most frequent words were subjects of analyses. Nevertheless, detecting frames by direct human-inspection would be time consuming, and

likely to result in biased interpretations; thus we conducted hierarchical cluster analysis (HCA) to the word co-occurrence matrix. Primarily, the aim of cluster analysis is finding groups of entities with similar features in data (Sampaio, Saraiva & Guimarães, 2011). The Netminer 4.1 (Cyram, 2013) was utilized for HCA. In beginning of HCA process, each item was considered as cluster itself, and small clusters are sequentially integrated into larger ones on the basis of Euclidean distance. The Euclidean distance refers to similarity is which can be calculated as the straight-line distance between two points. We applied complete linkage method, which compute similarity by calculating the longest distance from an element of one cluster to the other element of different cluster. Even though this linkage measure can be distracted by outliers (Yim & Radeem, 2015), however, complete linkage measurement was applied in order to minimize overlap of clusters.

### 4.1.2. Multi-dimensional scaling

Multi-dimensional scaling (MDS) is a means of visualizing the level of similarity of each case. The classical MDS result illustrates spatial arrangement of cases based on similarity which is elicited from Euclidean distance. As cluster analysis reports how some words compose of clusters but does not reveal how different clusters are associated with each other

(David et al., 2011). Thus the same co-occurrence matrices were analyzed by multidimensional scaling (MDS) in order to produce a spatial arrangement based on Euclidean distance to find out which clusters of words are closely associated. SPSS 23.0 was used for multidimensional scaling and plotting. Ideally, words in the same cluster ought to be grouped together in the MDS result as well. However, this is not always the case because there can be a distortion when higher dimensions are reduced into low dimensions (Doerfel & Marsh, 2003).

## 4.2. Results

'Fine PM', 'purifier', 'facial mask', 'nationwide', 'China', 'countermeasure', 'automobile', 'health', 'school' and 'concern' were ten most frequently occurred words. To see words like 'purifier', 'facial mask', 'rhinitis', 'window', 'skin', 'cleansing' or 'eye', it revealed that many fine dust related discourses were commonly done in the context of personal experience or measures.

**Table 1.** Keyword frequency

| Order | Keyword | Frequency | Order | Keyword | Frequency |
|---|---|---|---|---|---|
| 1 | fine PM | 8306 | 14 | rhinitis | 325 |
| 2 | purifier | 637 | 15 | air conditioner | 313 |
| 3 | facial mask | 632 | 16 | window | 301 |
| 4 | nationwide | 583 | 17 | cleaning | 292 |
| 5 | China | 573 | 18 | water purifier | 275 |
| 6 | countermeasure | 547 | 19 | eye | 265 |
| 7 | automobile | 526 | 20 | Ministry of environment | 255 |
| 8 | health | 506 | 21 | parliament | 254 |
| 9 | school | 427 | 22 | system | 252 |
| 10 | concern | 426 | 23 | goods | 248 |
| 11 | skin | 424 | 24 | kid | 204 |
| 12 | gauge | 421 | 25 | ventilation | 203 |
| 13 | cleansing | 387 | | | |

**Table 2.** Hierarchical clustering result

| | |
|---|---|
| Cluster 1 | Fine PM |
| Cluster 2 | purifier, skin, system |
| Cluster 3 | countermeasure, rhinitis, window, goods |
| Cluster 4 | facial mask, water purifier, Ministry of Environment, cleaning, automobile, gauge, parliament, eye, concern |
| Cluster 5 | nationwide, cleansing, ventilation, China, school |
| Cluster 6 | kid, air conditioner |
| Cluster 7 | health |

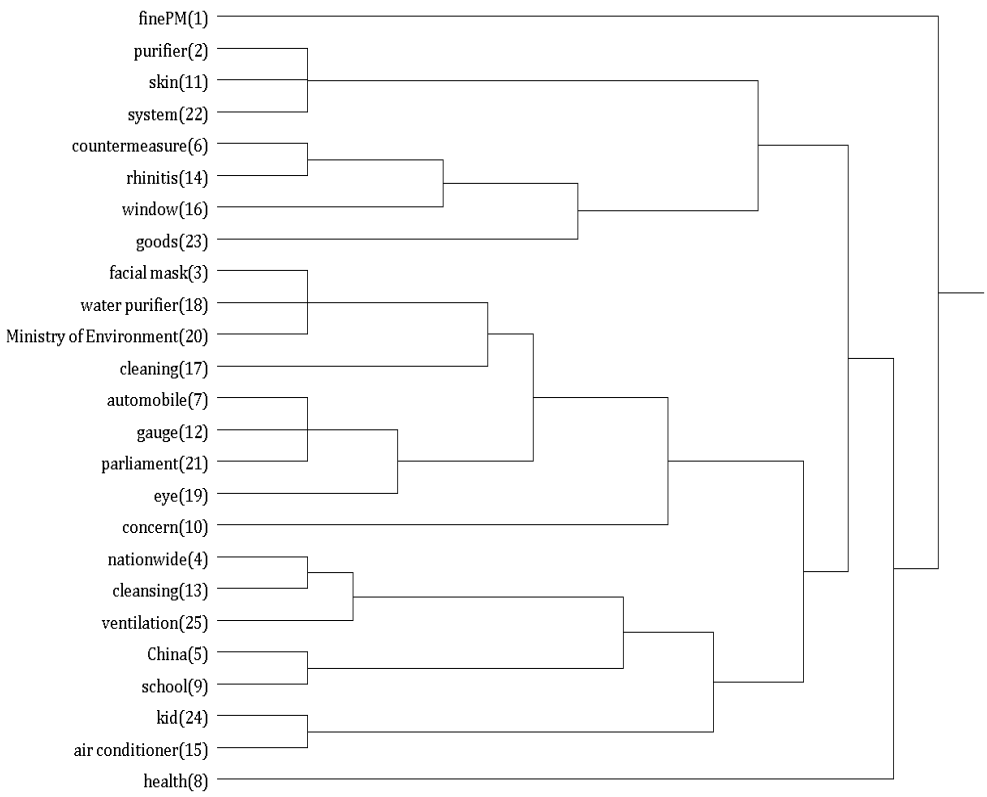


**Figure 2**. Hierarchical clustering process of 25 unique keywords**.** Numbers in the parenthesis refer to the word frequency order

In Cluster 1, there is ‘fine PM’, which is the most frequently occurred word. In Figure 3, it sits by itself in the MDS frame map, meaning that it has a weak connection with the other concepts.

In Cluster 2, there are ‘purifier’, ‘skin’, ‘system’. ‘Skin’ and ‘purifier’ suggest that people were curious about the impact of fine PM and purifier on their skin. In Cluster 3, there are ‘countermeasure’, ‘rhinitis’, ‘window’, and ‘goods’. This cluster also refers to personal impact such as rhinitis and countermeasures such as buying some eco-friendly goods or closing windows. For example:

> *“Allergic rhinitis, which is caused from fine particulate matter… what kind of goods are helpful? In this hot weather… Closing the windows is an effective way to manage the season” – Naver Blog*

In Cluster 4, there are ‘facial mask’, ‘water purifier’, ‘Ministry of Environment’, ‘cleaning’, ‘automobile’, ‘gauge’, ‘parliament’, ‘eye’, and ‘concern’. This cluster is combined with social and personal contributions. ‘Facial mask’, ‘water purifier’ can be referred as personal behaviors but ‘Ministry of Environment’ and ‘parliament’ refer to social concern. In Figure 3, this cluster is the largest one and in the center of the map, which refers to the fact that this issue is the one of the most popular frame.

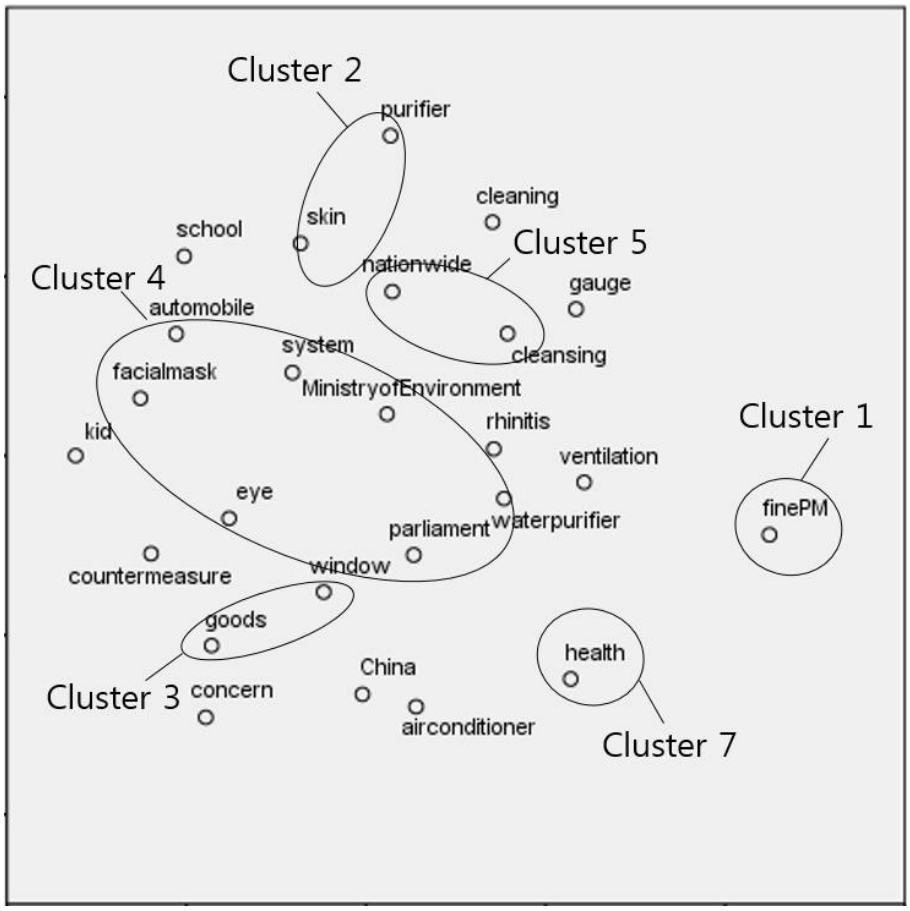


**Figure 3**. Frame distribution. Words in Cluster 6 do not fit the results of hierarchical cluster analysis

In Cluster 5, there are ‘nationwide’, ‘cleansing’, ‘ventilation’, ‘China’, and ‘school’. which reveals social risk and personal countermeasures. Considering that China is considered as the main cause of fine PM pollution in South Korea, this frame can be considered as social frame. However, counteractions are rather personal such as ‘ventilation’ and ‘cleansing’. In Figure 3, it is adjacent to Cluster 2, which is consisted of

‘purifier’ and ‘skin’, in the MDS frame map. It means that it has close connection with concepts in Cluster2.

In Cluster 6, the word ‘kid’ was associated with ‘air conditioner’. This also refers to personal frame which reveals concerns of impacts on child. For example:

> *“I am really worried about the fine particulate matter these days. I have to be more careful about my kids, pregnant women and the elderly people. With air conditioner filter, be safe” – Naver Blog*

In Cluster 7, ‘harmful effect’, ‘risk’ and ‘human body’ were closely associated. The words in this cluster are associated with the harmful effect of the fine dust particles on human body. However, this cluster is not well represented in an MDS map (Figure 2). In Cluster 7, ‘China’, ‘Korea’, ‘ultrafine dust’, ‘Asian dust’, ‘respiratory organ’, and ‘health’ were in the same group. The keywords in this cluster show that people perceive China and Asian dust are in close relation to the fine dust issue. In addition, people associate ‘ultrafine dust’ and ‘Asian dust’ with ‘health’ and ‘respiratory organ’.

Figure 3 shows a frame map generated by an MDS analysis of the text from the online documents containing the public perception of the fine

dust issue and related governmental actions. The distribution of the words displayed in this MDS map is largely correlated with clusters in HCA. In order to compare the distribution of words in the MDS map (Figure 3) with the HCA word clusters (Table 2), boundaries were drawn around word groupings based on the HCA clusters. Some words in the MDS map do not perfectly fit to the grouping of HCA. Words in Cluster 5, such as ‘nationwide’, ‘cleansing’, ‘ventilation’, ‘China ’and ‘school’, do not closely located in MDS result. Words grouped in the same hierarchical clusters are not necessarily proximate in an MDS concept map because they may present two different perspectives on the same data. Also, the Euclidean distances between words visualized in a two-dimensional MDS map may not correspond to the structures of clusters represented in three or more dimensions. However, the overall distribution of words does align with the interpretation of the HCA results.

# 5. Study 2

## 5.1. Data Acquisition

This study aimed to test the relationship between media exposure, risk perception and behavior intentions by conducting a nationally representative survey between September 7 and September 19, 2017. Study participants consisted of 981 adults who were part of the nationwide panel of Micromillembrain Inc. Variables to be measured include basic demographic information and questions regarding mass media exposure, internet exposure, interpersonal communication, perceived risk to self/general others, pro-environmental behavior intention and self-protective behavior intention.

## 5.2. Questionnaire and Measures

### 5.2.1. Mass media exposure.

Media exposure consists of four variables: nationwide newspaper, local newspaper, nationwide television news and local television news. Mass media exposure was measured by asking the sample to indicate on a four-point scale (1= never, 2= almost never, 3= often, 4=very often) about how often they had "seen, read, or heard of fine particulate pollution ($M$ = 2.59,

*SD* = 0.69, α= .764).” For example, the audience were asked “How often have you seen, read, or head of fine particulate pollution on nationwide television news in the past 30 days?”, “How often have you seen, read, or head of fine particulate pollution on nationwide print media in the past 30 days?”, “How often have you seen, read, or head of fine particulate pollution on local television news in the past 30 days?”, “How often have you seen, read, or head of fine particulate pollution on local print media in the past 30 days?” Four items were averaged to form an index for mass media exposure.

**Table 3.** Descriptive characteristics of the survey sample

| | N | Percent |
|---|---|---|
| Age | | |
| 20-29 | 149 | 15.2 |
| 30-39 | 233 | 23.7 |
| 40-49 | 296 | 30.2 |
| 50-59 | 303 | 30.9 |
| Gender | | |
| Male | 562 | 57.3 |
| Female | 419 | 42.7 |
| Educational Attainment | | |
| <=High school graduate | 147 | 15.0 |
| >High school graduate | 734 | 85.0 |
| Household Income (monthly) | | |
| < | | |
| >= | | |
| Employment status | | |
| Employed | 740 | 75.4 |
| Unemployed | 222 | 22.6 |
| Political Ideology | | |

| | | |
|---|---|---|
| Liberal | 208 | 21.2 |
| Neutral | 576 | 58.7 |
| Conservative | 207 | 20.1 |
| Relationship Status | | |
| In a relationship | 633 | 64.5 |
| Single | 348 | 35.5 |

### 5.2.2. Interpersonal communication.

Consistent with previous tests of impersonal impact hypothesis (Cho, Lee & Lee, 2013; Morton & Duck, 2001), we measured the amount of information that the participants received from interpersonal communication by using a retrospective measure. Respondents indicate on two 4-point scales (1= never, 2= almost never, 3= often, 4=very often) how much they had talked about fine particulate matter pollution with a range of different others during the last month *(M* =2.53, *SD* = 0.70, r= .37). For example, the audience were asked "During the past 30 days, how often you received information about fine particulate pollution from your family, friends, or co-workers?", "During the past 30 days, how often you received information about fine particulate pollution from doctor or medical experts?" Two items were averaged to form an index for interpersonal communication.

### 5.2.3. **Internet exposure**.

Participants were asked to think about how much air pollution-related information they heard from internet. We measured the amount of information that the participants received from interpersonal communication by using a retrospective measure. Respondents indicate on three 4-point scales (1= never, 2= almost never, 3= often, 4=very often) how much they had seen, read or heard about fine particulate matter pollution on the Internet during the last month. For example, the audience were asked "How often have you come across information about fine particulate pollution in the past 30 days through online news (e.g. www.chosun.com, www.naver.com)?", "How often have you come across information about fine particulate pollution in the past 30 days through social media (e.g. Facebook, Youtube, Twitter, microblogs)?", "How often have you come across information about fine particulate pollution in the past 30 days through health or medical website?" *(M* =2.59, *SD* = 0.66, $\alpha$= .621). Three items were averaged to form an index for internet exposure.[1]

---

[1] The correlation between variables are as follows: mass media exposure and the internet exposure was .58 ($p < .01$), mass media exposure and interpersonal communication was .60 ($p < .01$), the internet exposure and interpersonal communication was .59 ($p < .01$). Correlation between health concern and media exposure are as follows: mass media exposure and health concern was .07 ($p < .05$), interpersonal communication and health concern was .11 ($p < .01$), the internet exposure and health concern was .04.

### 5.2.4. **Risk perception (personal risk/ social risk)**.

Risk perception is composed of perceived severity and perceived susceptibility (El-Toukhy, 2015). Adapted from previous studies (Han et al., 2014; Paek, Oh & Hove, 2016), two kinds of perceived risks were assessed with following five items on 7-point scales (1= not at all, 7= very much). In order to measure personal risk, respondents answered to "The problem of fine particulate pollution is important to me"; "I am worried that I would caught respiratory disease because of fine particulate pollution"; "I am worried that I would catch cardiovascular disease because of fine particulate pollution"; "It is likely that I would caught respiratory disease because of fine particulate pollution"; "It is likely that I would caught cardiovascular disease because of fine particulate pollution ($M$ = 4.75, $SD$ = 0.41, $\alpha$= .953)".

Social risk was assessed with following five items: The problem of fine particulate pollution is important to me/general others"; "I am worried that general others would caught respiratory disease because of fine particulate pollution"; "I am worried that general others would caught cardiovascular disease because of fine particulate pollution"; "It is likely that general others would caught respiratory disease because of fine particulate pollution"; "It is likely that general others would caught cardiovascular disease because of fine particulate pollution"($M$ = 5.12, $SD$ =

0.37, $\alpha$= .954).

The data suggested two factors of risk perception of air pollution. Table 4 shows the factor loadings. The two factors have been labeled personal risk and social risk. The first factor, consisting primarily of the social risk, accounted for 42.41% of the data's total variance. In addition, the second factor consisted exclusively 84.44% of the total variance. The correlation between behavior variables were .78 ($p < .01$).

**Table 4.** Factor loadings of personal risk and social risk

| | Factor 1 | Factor 2 |
|---|---|---|
| Personal risk 1 | .458 | .721 |
| Personal risk 2 | .366 | .862 |
| Personal risk 3 | .376 | .869 |
| Personal risk 4 | .397 | .841 |
| Personal risk 5 | .398 | .834 |
| Social risk 1 | .781 | .318 |
| Social risk 2 | .840 | .409 |
| Social risk 3 | .830 | .420 |
| Social risk 4 | .851 | .411 |
| Social risk 5 | .845 | .411 |
| Explained variance (%) | 42.41 | 84.44 |
| Eigenvalues | 4.24 | 4.20 |

### 5.2.5. Self-protective behavior intention.

The participants were asked to indicate their willingness to engage in five types of self-protective behaviors. Self-protective behaviors refer to actions to minimize exposure to air pollution. Regarding air pollution, individuals may: a) reduce outdoor activities; b) avoid heavy traffic; c) wear face masks; d) use air purifier; e) keep windows closed (Bickerstaff & Walker, 1999; Ministry of Environment, 2016, WHO, 2016b). The degree to which people intend to engage in self-protective actions were assessed by asking the five statements with 7-point scales (1 = not at all, 7 = very much). “I will reduce outdoor activities to protect myself from fine particulate matter,” “I will avoid heavy traffic in order to protect myself from fine particulate matter,” “I will wear face masks in order to protect myself from fine particulate matter,” “I will use air purifier in order to protect myself from fine particulate matter,” “I will wear face masks in order to protect myself from fine particulate matter,” “I will close windows in order to protect myself from fine particulate matter.” ($M$ = 5.11, $SD$ = 1.20, $\alpha$= .898).

### 5.2.6. **Pro-environmental behavior intention**.

Pro-environmental behaviors refer to actions to reduce contribution to air pollution. Individuals can reduce their contribution by a) manage waste; b) reduce cooking indoors; c) decrease automobile use; d) turn off light and electronics not in use; e) take part in air pollution activism (Ministry of Environment, 2016; Oltra & Sala, 2014; WHO, 2016b). The degree to which people intend to engage in pro-environmental actions were assessed by asking four statements with 7-point scales (1 = not at all, 7 = very much). "I will manage waste in order to help reduce air pollution," "I will reduce cooking indoors in order to help reduce air pollution," "I will reduce automobile driving in order to help reduce air pollution," "I will turn off light and electronics not in use in order to help air pollution." "I will take part in air pollution activism to help reduce air pollution" ($M$ = 4.95, $SD$ = 1.17, $\alpha$= .905).

The data suggested two factors of behaviors. Table 5 shows the factor loadings. The two factors have been labeled self-protective behavior and pro-environmental behavior. The first factor, consisting primarily of the self-protective behaviors, accounted for 57.3% of the data's total variance. In addition, the second factor consisted exclusively 14.84% of the total variance. The correlation between behavior variables were .59 ($p < .001$).

**Table 5.** Factor loadings of self-protective behaviors and pro-environment behaviors

| | Factor 1 | Factor 2 |
|---|---|---|
| Self- protective behavior 1 | .197 | .871 |
| Self- protective behavior 2 | .296 | .847 |
| Self- protective behavior 3 | .245 | .813 |
| Self- protective behavior 4 | .295 | .702 |
| Self- protective behavior 5 | .282 | .768 |
| Pro-environmental behavior 1 | .798 | .314 |
| Pro-environmental behavior 2 | .827 | .288 |
| Pro-environmental behavior 3 | .781 | .260 |
| Pro-environmental behavior 4 | .841 | .281 |
| Pro-environmental behavior 5 | .801 | .189 |
| Explained variance (%) | 36.34 | 35.83 |
| Eigenvalues | 3.63 | 3.58 |

### 5.2.7. **Other Antecedent Variables**.

A series of potential confounding variables were measured and controlled. They are likely to be responsible for concurrent and confounded relationships among media exposure, risk perceptions and behavior intentions. Some possible confounders were included in the analysis as

control variables. These variables include gender, age, occupational status, marital status, levels of education, income and knowledge. These questions also correspond to those that are utilized in SSB-G survey and then tailored to Korean sample. Demographic variables were as follow: age (*M* = 41.91, *SD* = 10.45), gender (42.7% females), formal education in years (*M* = 15.44, *SD* = 2.07), income (median monthly household income between 4,000,000 ~ 5,000,000 KRW), employment status (75.4 % employed) and current relationship status (64.5% currently in relationship). Current relationship status was coded as either 0 (widowed; separated; divorced; never married) or 1 (in a relationship; married).

Scientific knowledge about air pollution was measured with nine dichotomous items (1= True, 2= False; Myers, Boyes & Stanisstreet, 2004). For each item, the correct answer was recoded into "1", whereas the incorrect answer was recoded into "0." Responses that fell into the "don't know" or "refused to answer" were recoded into "0." Nine questions for measuring air pollution knowledge are as follows: "Fine particulate matter in South Korea comes from foreign countries" (answer: False), "Yellow dust and fine particulate matter are synonym"(answer: False), "When cooking in the kitchen, a lot of fine particulate matter is emitted"(answer: True), "A lot of fine particulate matter comes out when turning the vacuum cleaner" (answer: False), "You should not go outside on high dusty days" (answer:

True), “You should not ventilate on dusty days” (answer: True), “Using air purifiers can help you to reduce fine particulate matter indoors” (answer: True), “Fine particulate matter affects the brain” (answer: True), “Drinking a lot of water on high dusty days will help your health” (answer: True). Scores for nine items were summed, with high scores indicating higher level of air pollution knowledge ($M$ = 5.52, $SD$ = 1.82).

## 6. Results

The cross-sectional test of the hypotheses (H1, H3) and a research question (RQ1) are presented in Table 6. Regarding social risk, the variance explained by sociodemographics, and scientific knowledge explained approximately 10% of the variance (Incremental $R^2$=9.8%). The significant beta showed that interpersonal communication was positively related to society-level risk perception, after controlling for sociodemographics, and scientific knolwedge ($\beta$ = .121, $p$ <.01). VIF scores of all of the variables were from 1.02~1.91, which shows that there is no problem with multicollinearity. The results did not support hypothesis H1, which expected coming across air pollution information on mass media may increase society-level risk perception. In addition H3, which expected coming across air pollution information on face to face communication may not increase society-level risk perception was not supported as well. Research Question 1 asked about whether coming across air pollution information on the Internet may increase society-level risk perception. Result shown in Table 6 indicates that exposure to the Internet does not lead to higher level of society-level risk perception ($\beta$= .080, $p$ > .05).

**Table 6.** Hierarchical multiple regression predicting social risk: Cross-sectional analysis

| | Social Risk | |
|---|---|---|
| | Zero-order Correlation Coefficient | Final standardized regression coefficient |
| **Block 1: control variables** | | |
| Age | .017 | -.040 |
| Gender (male=1, female=0) | .121*** | .085** |
| Year of education | -.016 | -.008 |
| Employment Status | -.070** | -.039 |
| Relationship Status | .072** | .047 |
| Income | .056* | .015 |
| Political Ideology | -.041 | -.031 |
| Knowledge | .288*** | .277*** |
| Incremental $R^2$ (%) | 9.8 | |
| **Block 2** | | |
| Mass Media Exposure | .185*** | .037 |
| Internet Exposure | .213*** | .080 |
| Interpersonal Communication | .223*** | .121** |
| Incremental $R^2$ (%) | 4.0 | |
| Total $R^2$ (%) | 13.8 | |
| *N* | 981 | |

*p < .05; **p < .01; ***p <.001.

For perception of personal risk, the cross-sectional test of the hypotheses (H2, H4) and a research question (RQ2) are presented in Table 7.

Control variables explained approximately 10% of the variance (Incremental $R^2$ = 9.5%). The significant beta showed that increase of internet exposure ($\beta$= .118, $p$ < .05) and interpersonal communication ($\beta$= .122, $p$ < .05) were positively related to personal risk perception, after controlling for sociodemographics, and scientific knowledge. The result supported hypothesis H2, which expected coming across air pollution information on mass media may not increase personal level risk perception ($\beta$= .006, $p$ > .05). H4, which expected coming across air pollution information through interpersonal communication may increase personal level risk perception, was also supported. A z test indicated that the two coefficients differed at the .01 level (z = 2.85, $p$ = .004). Research Question 2 asked about whether coming across air pollution information on the Internet may increase personal-level risk perception. Result shown in Table 7 indicates that exposure to the Internet increases personal-level risk perception.

**Table 7.** Hierarchical multiple regression predicting personal risk: Cross-sectional analysis

| | Personal Risk | |
|---|---|---|
| | Zero-order Correlation Coefficient | Final standardized regression coefficient |
| **Block 1: control variables** | | |

| | | | |
|---|---|---|---|
| Age | .012 | | -.053 |
| Gender (male=1, female=0) | .128*** | | .096** |
| Year of education | -.008 | | -.304 |
| Employment Status | -.064** | | -.029 |
| Relationship Status | .076** | | .050 |
| Income | .076** | | .035 |
| Political Ideology | -.002 | | .311 |
| Knowledge | .280*** | | .268*** |
| Incremental $R^2$ (%) | | 9.5 | |
| **Block 2** | | | |
| Mass Media Exposure | .180*** | | .006 |
| Internet Exposure | .236*** | | .118** |
| Interpersonal Communication | .233*** | | .122** |
| Incremental $R^2$ (%) | | 4.5 | |
| Total $R^2$ (%) | | 14.0 | |
| *N* | | 981 | |

*p < .05; **p < .01; ***p <.001.

The cross-sectional test of the hypotheses (H5, RQ4) are presented in Table 8, which presents hierarchical multiple regression predicting pro-environmental behavior intention. The first model presents the correlations of each independent variable with the pro-environmental behavior intention measure, and the second presents the final model that includes all variables.

The confounders (i.e., sociodemographic, scientific knowledge and media exposure) accounted for a relatively small portion of the variance in

pro-environmental behavior intention (incremental $R^2$ = 15.2%). After controlling other variables, the significant final beta of all risk perception variables showed that social risk ($\beta$= .367, $p$ < .001) and personal risk ($\beta$= .233, $p$ < .001) were positively related to self-protective behavior intention. VIF scores of all of the variables were from 1.03~2.59, which shows that there is no problem with multicollinearity. The results supported hypotheses H5, which predicted that society-level risk perception would increase pro-environment behavior intention. Research Question 4 asked about whether the perception of personal risk increases intention of self-protective behavior. Result shown in Table 8 indicates that personal risk perception increases pro-environmental behavior intention.

**Table 8.** Hierarchical multiple regression predicting pro-environmental behavior intention: Cross-sectional analysis

| | Pro-environmental Behavior Intention | |
|---|---|---|
| | Zero-order Correlation Coefficient | Final standardized regression coefficient |
| **Block 1: control variables** | | |
| Age | 153*** | .141*** |
| Gender (male=1, female=0) | .125*** | .113** |
| Year of education | -.009 | -.005 |
| Employment Status | -.065** | -.028 |
| Relationship Status | .106*** | .047 |

| | | | |
|---|---|---|---|
| Income | .112*** | | .066* |
| Political Ideology | -.027 | | -.036 |
| Knowledge | .290*** | | .250*** |
| Incremental $R^2$ (%) | | 11.7 | |
| **Block 2** | | | |
| Mass Media Exposure | .199*** | | .069 |
| Internet Exposure | .200*** | | .119** |
| Interpersonal Communication | .167*** | | .033 |
| Incremental $R^2$ (%) | | 3.5 | |
| **Block 3** | | | |
| Social Risk | .594*** | | .367*** |
| Personal Risk | .566*** | | .233*** |
| Incremental $R^2$ (%) | | 27.2 | |
| Total $R^2$ (%) | | 42.3 | |
| *N* | | 981 | |

*p < .05; **p < .01; ***p <.001.

The cross-sectional test of the hypotheses (H6, RQ3) are presented in Table 9, which presents hierarchical multiple regression predicting self-protective behavior intention. The first model presents the correlations of each independent variable with the self-protective behavior intention measure, and the second presents the final model that includes all variables.

The confounders (i.e., sociodemographic, scientific knowledge and

media exposure) accounted for a relatively small portion of the variance in self-protective behavior intention (incremental $R^2$ = 15.9%). After controlling other variables, the significant final beta of all of the risk perception variables showed that social risk ($\beta$= .133, $p$ < .01) and personal risk ($\beta$= .490, $p$ < .001) was each positively related to self-protective behavior intention. A z test indicated that the two coefficients differed at the .001 level (z = 9.82, $p$ < .001). The results supported hypotheses H6. Research Question 4 asked about whether the perception of the personal risk and social risk increase intention of self-protective behavior. Result shown in Table 9 indicates that perception of personal risk increases intention to reduce exposure to air pollution.

**Table 9.** Hierarchical multiple regression self-protective behavior intention: Cross-sectional analysis

| | Self-protective behavior Intention | |
|---|---|---|
| | Zero-order Correlation Coefficient | Final standardized regression coefficient |
| **Block 1: control variables** | | |
| Age | -.004 | -.085** |
| Gender (male=1, female=0) | .137*** | .094** |
| Year of education | .005 | -.012 |
| Employment Status | -.074** | -.046 |
| Relationship Status | .091** | .063 |

| | | | |
|---|---|---|---|
| Income | .134*** | | .093** |
| Political Ideology | -.048 | | -.034 |
| Knowledge | .317*** | | .277*** |
| Incremental $R^2$ (%) | | 13.1 | |
| **Block 2** | | | |
| Mass Media Exposure | .168*** | | .035 |
| Internet Exposure | .216*** | | .115** |
| Interpersonal Communication | .185*** | | .048 |
| Incremental $R^2$ (%) | | 2.8 | |
| **Block 3** | | | |
| Social Risk | .650*** | | .133** |
| Personal Risk | .570*** | | .490*** |
| Incremental $R^2$ (%) | | 30.5 | |
| Total $R^2$ (%) | | 46.4 | |
| *N* | | 981 | |

*p < .05; **p < .01; ***p <.001.

**Table 10.** Hypothesis test results

| | |
|---|---|
| H 1 | Not supported |
| H 2 | Supported |
| H 3 | Not supported |
| H 4 | Supported |
| H 5 | Supported |
| H 6 | Supported |

## 7. Discussion

The aim of this study was to examine the role of communication process in the perception of air pollution risk to self and to others. In order to do so, we conducted content analysis in order to understand traits of information environment on the Internet and then conducted cross-sectional survey.

The content analysis using semantic network analysis followed by hierarchical clustering and multidimensional scaling revealed the frames and their closeness in the context of the fine particulate pollution issue. By exploring frequently co-occurring words and plotting the multidimensional scaling results, focal frames and concepts of fine dust discourses were revealed. In addition, by deploying words according to proximities, we could infer which concepts were closely related and shifts of public viewpoints after government announcements. We could notice many discussions were personal frames which contained personal countermeasures or causes. Especially, personal counteractions such as ventilation, cleaning, or facial mask was pointed out as the reaction to the air pollution problem as well as physical symptoms such as rhinitis, eye, skin, and concern. Therefore, we could conclude that air pollution information on the Internet is mostly composed of personal framed

messages rather than focusing on social causes or effects.

This study enabled us to construct public perception frames of the fine particulate matter. The integration of semantic network and unsupervised learning techniques allowed me to minimize the potential impacts of subjectivity on frame coding (Li et al., 2016). Semantic network describes the key concepts that are used in natural conversations, including daily interactions through the internet. Social groups tend to share common values, concerns, and interpretation of events (Bormann, 1985). If so, an understanding of public discourse frames may provide insights of how fine dust pollution problem and relevant governmental actions were perceived as. In addition, as the hierarchical clustering combined with multidimensional scaling offers a complementary approach to detect frames without prior dictionaries, potential arbitrary clustering could be avoided, which is considered as drawback of dictionary-based frame coding (Burscher et al., 2014). Even though some researchers (Lewis, Zamith & Hermida, 2013; Su et al., 2017) suggested combining human and computer-based approaches to minimize validity problem of computational approach, combining semantic network with several unsupervised learning methods can be an alternative way to solve the validity problem. Since hierarchical clustering provides the way to form clusters by themselves, and multidimensional scaling shows proximities between the concepts in graphic, we could expect less

arbitrariness problem by integrating several computational approaches.

The cross-sectional survey results showed that internet exposure is positively related to perception of personal risk ($\beta$= .118, $p$ < .01) after controlling for sociodemographic, and knowledge. Interpersonal communication is positively related to all kinds of risk perception variables: society-level risk and personal risk. Internet exposure was positively related to social risk ($\beta$= .121, $p$ < .01), and persoanl risk ($\beta$= .122, $p$ <. 01) after controlling for sociodemographic, and knowledge. The results supported two hypotheses regarding risk perception (H3, H4) were supported.

The cross-sectional test of the hypotheses (H5, H6) and research questions (RQ3, RQ4) were examined through hierarchical multiple regression predicting two kinds of behavior intentions: pro-environmental behavior and self-protective behavior. After controlling other variables, the significant final beta of perception of social risk variable was each positively related to pro-environmental behavior intention and self-protective behavior intention ($\beta$ = .367, $p$ < .001; $\beta$ = .133, $p$ < .01). The significant final beta of perception of personal risk variable was also each positively related to pro-environmental behavior intention and self-protective behavior intention ($\beta$ = .233; $\beta$ = .490, respectively at $p$ < .001). The results supported all the hypotheses H5 and H6. Results indicated some

support for predictions derived from the impersonal impact hypothesis, however, the impact of mass media was found not to have significant impact on audiences' perceptions of air pollution risk to self or to the others. Instead, interpersonal communication was found to have an impact on both personal and society-level risk. In addition, the Internet had an impact on personal risk only. This may have caused by traits of messages on the Internet, which is seen in content analysis that many fine particulate matter-related discussions are personal-framed.

This study could be utilized as a suggestion to campaign planners in environment agencies to focus on the Internet or personal networks in order to lead people to join pro-environmental behaviors. If the goal of health agency is to make people to be keep their own health from fine particulate matter, then it would be better to focus campaign through interpersonal networks. In addition, mass media messages didn't lead directly to change in perception of air pollution risk and behaviors. In further studies, we need to consider about whether this is caused by poor quality of campaign messages or unique recognition mechanisms of air pollution. If more relevant and credible content were embedded within mass media programs, audiences could perceive risks and raise intention of pro-environmental or self-protective behaviors.

## 8. Limitation and Conclusion

The limitations of this study are as follows. First, as computer algorithmic analysis was applied, possible opportunities to reveal more latent frames may have missed. This limitation has been brought up in many preceding studies (Guo et al., 2016; Lewis, Zamith & Hermida, 2013) and some proposed alternative to combine human coding and computational coding. In order to interpret more complex context, human coding could be a possible complement. Second, media content other than portal websites should be included in the future content analysis. As contents in mass media, social media and face-to-face conversation also include important clues about the information environment, future studies should include these media in order to assess the media effect. Third, although the dimensionality reduction is useful for visualizing similarities of the concepts, it can suggest only the extent of relatedness. In other words, it may help us understand the strength of associations among concepts, but it does not directly identify causal relations (Bergstorm & Holmes, 2000). Last, although HCA and MDS were used for identification and visualization of clusters, researchers had to determine the number of clusters, and interpret the meaning of the clusters. Those decisions made by the researcher may influence the

interpretation of the results (Matthes & Kohring, 2008).

Despite these limitations, the result of study 1 is certainly notable to reveal frames of fine particulate matter pollution. The results offered useful ways of exploring how the public frames. The risk perception gap between the public and the government has been a barrier for efficient communication between the public and the government. It will help governmental agencies to figure out how the public frames the problem and address the issue.

Limitations of study 2 are as follows: First, to examine the relationship between the risk perceptions and behaviors, more than one variables are likely to be highly correlated. Therefore, it would be better to run SEM in order to solve the possible problem of multicollinearity. However, in this study, I only analyzed relationships between media exposure and behaviors through Hierarchical Multiple Regression, thus limiting the reasoning power of our study. At this stage, this study is only preliminary, and further studies should examine relationships between media exposure and behaviors through SEM or stricter analytic strategies, and more other media channels. Second, we used cross sectional survey to analyze our results, and this hinders our judgment of causality in the study. I would like to propose that future studies examine the relationship in

question through a longitudinal panel survey for causal relationship. Also, the result is likely to be changed if the survey was taken in spring, which means that there can be seasonal effect on this result. Therefore, further studies should consider about when to begin survey. In addition, this study examines the most proximal predictor of reactive behaviors to air pollution through pro-environmental and self-protective behavior intention. Idealistically, future studies should continue to explore communication factors that shape people's behaviors through examining behavioral data over a longer term for comprehensive results.

## Reference

Allen, J. B., & Ferrand, J. L. (1999). Environmental locus of control, sympathy, and proenvironmental behavior: A test of Geller's actively caring hypothesis. *Environment and behavior*, *31*(3), 338-353.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological bulletin*, *103*(3), 411.

Aral, S., & Walker, D. (2012). Identifying influential and susceptible members of social networks. *Science, 337*(6092), 337-341.

Baden, C. (2010, June). *Contextualizing frames in political discourse: Using semantic network analysis to investigate political parties' framing strategies in the Dutch EU referendum campaign*. Paper presented at the International Communication Association Annual Conference 2010, Singapore.

Ball-Rokeach, S. J. (1985). The origins of individual media-system dependency a sociological framework. *Communication research*, *12*(4), 485-510.

Ball-Rokeach, S. J., Kim, Y. C., & Matei, S. (2001). Storytelling neighborhood: Paths to belonging in diverse urban

environments. *Communication Research*, *28*(4), 392-428.

Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological bulletin*, *88*(3), 588.

Bickerstaff, K., & Walker, G. (1999). Clearing the smog? Public responses to air□quality information. *Local Environment*, *4*(3), 279-294.

Bresnahan, B. W., Dickie, M., & Gerking, S. (1997). Averting behavior and urban air pollution. *Land Economics*, 340-357.

Carcioppolo, N., Li, C., Chudnovskaya, E. V., Kharsa, R., Stephan, T., & Nickel, K. (2017). The Comparative Efficacy of a Hybrid Guilt-Fear Appeal and a Traditional Fear Appeal to Influence HPV Vaccination Intentions. *Communication Research*, *44*(3), 437-458.

Carley, K. M. (1997). Network text analysis: The network position of concepts. *Text analysis for the social sciences: Methods for drawing statistical inferences from texts and transcripts*, 79-100.

Chapin, J. R. (2000). Third-person perception and optimistic bias among urban minority at-risk youth. *Communication research*, *27*(1), 51-81.

Chew, C., & Eysenbach, G. (2010). Pandemics in the age of Twitter: content analysis of Tweets during the 2009 H1N1 outbreak. *PloS one*, *5*(11),

e14118.

Cho, H., Lee, J. S., & Lee, S. (2013). Optimistic bias about H1N1 flu: Testing the links between risk communication, optimistic bias, and self-protection behavior. *Health communication*, *28*(2), 146-158.

Chung, J. E. (2016). A Smoking Cessation Campaign on Twitter: Understanding the Use of Twitter and Identifying Major Players in a Health Campaign. *Journal of health communication*, *21*(5), 517-526.

Cohen, J., Mutz, D., Price, V., & Gunther, A. (1988). Perceived impact of defamation an experiment on third-person effects. *Public Opinion Quarterly*, *52*(2), 161-173.

Coronges, K. A., Stacy, A. W., & Valente, T. W. (2007). Structural Comparison of Cognitive Associative Networks in Two Populations1. *Journal of Applied Social Psychology*, *37*(9), 2097-2129.

Cumming, G. (2009). Inference by eye: reading the overlap of independent confidence intervals. *Statistics in medicine*, *28*(2), 205-220.

Davison, W. P. (1983). The third-person effect in communication. *Public opinion quarterly*, *47*(1), 1-15.

Davison, W. P. (1983). The third-person effect in communication. *Public opinion quarterly*, *47*(1), 1-15.

De Groot, J. I., & Steg, L. (2008). Value orientations to explain beliefs related to environmental significant behavior how to measure egoistic, altruistic, and biospheric value orientations. *Environment and Behavior*, *40*(3), 330-354.

Diesner, J., & Carley, K. M. Words and Networks: Information and Relation Extraction from Texts

Dillard, A. J., McCaul, K. D., & Klein, W. M. (2006). Unrealistic optimism in smokers: Implications for smoking myth endorsement and self-protective motivation. *Journal of health communication, 11*(S1), 93-102.

El-Toukhy, S. (2015). Parsing susceptibility and severity dimensions of health risk perceptions. *Journal of health communication*, *20*(5), 499-511.

Evans, G. W., & Jacobs, S. V. (1981). Air pollution and human behavior. *Journal of Social Issues*, *37*(1), 95-125.

Geller, E. S. (1995). Actively caring for the environment: An integration of behaviorism and humanism. *Environment and Behavior*, *27*(2), 184-195.

Gerbner, G. (1969). Toward “cultural indicators”: The analysis of mass mediated public message systems. *Educational Technology Research and Development*, *17*(2), 137-148.

Griffin, R. J., & Dunwoody, S. (2000). The relation of communication to risk judgment and preventive behavior related to lead in tap water. *Health communication*, *12*(1), 81-107.

Guan, M., Coles, V. B., Samp, J. A., Sales, J. M., DiClemente, R. J., & Monahan, J. L. (2016). Incorporating Communication into the Theory of Planned Behavior to Predict Condom Use Among African American Women. *Journal of Health Communication*, *21*(9), 1046-1054.

Gunther, A. (1991). What we think others think: Cause and consequence in the third-person effect. *Communication Research*, *18*(3), 355-372.

Han, G., Zhang, J., Chu, K., & Shen, G. (2014). Self–other differences in H1N1 flu risk perception in a global context: a comparative study between the United States and China. *Health communication*, *29*(2), 109-123.

Henry, G. T., & Gordon, C. S. (2003). Driving less for better air: Impacts of a public information campaign. *Journal of Policy Analysis and*

*Management*, *22*(1), 45-63.

Ho, S. S., Liao, Y., & Rosenthal, S. (2015). Applying the theory of planned behavior and media dependency theory: Predictors of public pro-environmental behavioral intentions in Singapore. *Environmental Communication*, *9*(1), 77-99.

Ho, S. S., Scheufele, D. A., & Corley, E. A. (2013). Factors influencing public risk–benefit considerations of nanotechnology: Assessing the effects of mass media, interpersonal communication, and elaborative processing. *Public Understanding of Science*, *22*(5), 606-623.

Howel, D., Moffatt, S., Bush, J., Dunn, C. E., & Prince, H. (2003). Public views on the links between air pollution and health in Northeast England. *Environmental Research*, *91*(3), 163-171.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, *6*(1), 1-55.

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An introduction to statistical learning* (Vol. 6). New York: springer.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of

decision under risk. *Econometrica: Journal of the econometric society*, 263-291.

Kay, S., Zhao, B., & Sui, D. (2015). Can social media clear the air? A case study of the air pollution problem in Chinese cities. *The Professional Geographer*, *67*(3), 351-363.

Kim, S. H., & Anne Willis, L. (2007). Talking about obesity: News framing of who is responsible for causing and fixing the problem. *Journal of health communication*, *12*(4), 359-376.

Kim, S. H., Carvalho, J. P., & Davis, A. C. (2010). Talking about poverty: News framing of who is responsible for causing and fixing the problem. *Journalism & Mass Communication Quarterly*, *87*(3-4), 563-581.

Kiousis, S. (2004). Explicating media salience: A factor analysis of New York Times issue coverage during the 2000 US presidential election. *Journal of Communication*, *54*(1), 71-87.

Knuth, D., Kehl, D., Hulse, L., & Schmidt, S. (2014). Risk Perception, Experience, and Objective Risk: A Cross-National Study with European Emergency Survivors. *Risk analysis*, *34*(7), 1286-1298.

Lee, C. J., & Niederdeppe, J. (2011). Genre-specific cultivation effects:

Lagged associations between overall TV viewing, local TV news viewing, and fatalistic beliefs about cancer prevention. *Communication Research*, *38*(6), 731-753.

Lee, N. M., & VanDyke, M. S. (2015). Set it and forget it: the one-way use of social media by government agencies communicating science. *Science Communication*, *37*(4), 533-541.

Mayer, B. (2012). 'Relax and take a deep breath': Print media coverage of asthma and air pollution in the United States. *Social Science & Medicine*, *75*(5), 892-900.

Mello, S., & Hornik, R. C. (2015). Media coverage of pediatric environmental health risks and its effects on mothers' protective behaviors. *Risk analysis*.

Mondragon, N. I., Gil de Montes, L., & Valencia, J. (2017). Ebola in the Public Sphere: A Comparison Between Mass Media and Social Networks. *Science Communication*,*39*(1), 101-124.

Morton, T. A., & Duck, J. M. (2001). Communication and health beliefs: Mass and interpersonal influences on perceptions of risk to self and others. *Communication Research*, *28*(5), 602-626.

Myers, G., Boyes, E., & Stanisstreet, M. (2004). School students' ideas

about air pollution: Knowledge and attitudes. *Research in Science & Technological Education*, *22*(2), 133-152.

Nabi, R. L., & Sullivan, J. L. (2001). Does television viewing relate to engagement in protective action against crime? A cultivation analysis from a theory of reasoned action perspective. *Communication research*, *28*(6), 802-825.

Nan, X. (2007). Social distance, framing, and judgment: A construal level perspective. *Human Communication Research*, *33*(4), 489-514.

North, D. W. (2016). Introduction to Special Issue on Air Pollution Health Risks. *Risk Analysis*, *36*(9), 1688-1692.

Oh, S. (2014*). Am I in danger? : Predictors and behavioral outcomes of public perception of risk associated with food hazards* (Doctoral dissertation). Retrieved from http://scholarcommins.sc.edu/etd/2876.

Oltra, C., & Sala, R. (2014). *A Review of the Social Research on Public Perception and Engagement Practices in Urban Air Pollution* (No. CIEMAT--1317). Centro de Investigaciones Energeticas Medioambientales y Tecnologicas (CIEMAT). Retrieved from http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/45/046/45046 419.pdf

Paek, H. J., Oh, S. H., & Hove, T. (2016). How fear-arousing news messages affect risk perceptions and intention to talk about risk. *Health communication*,*31*(9), 1051-1062.

Rebich-Hespanha, S., Rice, R. E., Montello, D. R., Retzloff, S., Tien, S., & Hespanha, J. P. (2015). Image themes and frames in US print news stories about climate change. *Environmental Communication*, *9*(4), 491-519.

Romer, D., Jamieson, K. H., & Aday, S. (2003). Television news and the cultivation of fear of crime. *Journal of communication*, *53*(1), 88-104.

Rosenstock, I. M. (1974). The health belief model and preventive health behavior. *Health education monographs*, *2*(4), 354-386.

Rosenstock, I. M., Strecher, V. J., & Becker, M. H. (1988). Social learning theory and the health belief model. *Health Education & Behavior*, *15*(2), 175-183.

Schill, M., & Shaw, D. (2016). Recycling today, sustainability tomorrow: Effects of psychological distance on behavioural practice. *European Management Journal*, *34*(4), 349-362.

Semenza, J. C., Wilson, D. J., Parra, J., Bontempo, B. D., Hart, M., Sailor, D. J., & George, L. A. (2008). Public perception and behavior change in

relationship to hot weather and air pollution. *Environmental research*, *107*(3), 401-411.

Skov, T., Cordtz, T., Jensen, L. K., Saugman, P., Schmidt, K., & Theilade, P. (1991). Modifications of health behaviour in response to air pollution notifications in Copenhagen. *Social Science & Medicine*, *33*(5), 621-626.

Slater, M. D., Hayes, A. F., & Chung, A. H. (2015). Injury news coverage, relative concern, and support for alcohol-control policies: An impersonal impact explanation. *Journal of health communication*, *20*(1), 51-59.

So, J. (2012). Uses, gratifications, and beyond: Toward a model of motivated media exposure and its effects on risk perception. *Communication Theory*, *22*(2), 116-137.

So, J., Cho, H., & Lee, J. (2011). Genre-specific media and perceptions of personal and social risk of smoking among South Korean college students. *Journal of health communication*, *16*(5), 533-549.

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of environmental psychology*, *29*(3), 309-317.

Tilt, B., & Xiao, Q. (2010). Media coverage of environmental pollution in the People's Republic of China: responsibility, cover-up and state control. *Media, Culture & Society*, *32*(2), 225-245.

Trope, Y., & Liberman, N. (2003). Temporal construal. *Psychological review*,*110*(3), 403.

Trope, Y., Liberman, N., & Wakslak, C. (2007). Construal levels and psychological distance: Effects on representation, prediction, evaluation, and behavior. *Journal of consumer psychology*, *17*(2), 83-95.

Trumbo, C., Meyer, M. A., Marlatt, H., Peek, L., & Morrissey, B. (2014). An assessment of change in risk perception and optimistic bias for hurricanes among Gulf Coast residents. *Risk analysis*, *34*(6), 1013-1024.

Tyler, T. R. (1980). Impact of directly and indirectly experienced events: The origin of crime-related judgments and behaviors. *Journal of Personality and Social Psychology*, *39*(1), 13.

Tyler, T. R., & Cook, F. L. (1984). The mass media and judgments of risk: Distinguishing impact on personal and societal level judgments. *Journal of Personality and Social Psychology*, *47*(4), 693.

Weinstein, N. D. (1987). Unrealistic optimism about susceptibility to health problems: Conclusions from a community-wide sample. *Journal of behavioral medicine*, *10*(5), 481-500.

Wei, R., Lo, V. H., & Lu, H. Y. (2007). Reconsidering the relationship between the third-person perception and optimistic bias. *Communication Research*, *34*(6), 665-684.

WHO (2013). Review of evidence on health aspects of air pollution : REVIHAAP Project. Retrieved from World Health Organization Website: http://www.euro.who.int/__data/assets/pdf_file/0020/182432/e96762-final.pdf

WHO (2016a). Ambient air pollution. Retrieved from World Health Organization Website: http://apps.who.int/iris/bitstream/10665/250141/1/9789241511353-eng.pdf

WHO (2016b). Air pollution is an invisible killer. Retrieved from World Health Organization Website: http://www.who.int/sustainable-development/news-events/breath-life/en/

WHO (2016c). Zika virus fact sheet. Retrieved from World Health

Organization Website:
http://www.who.int/mediacentre/factsheets/zika/en/

Yang, S., & Gonzalez-Bailon, S. Semantic Networks and Applications in Public Opinion Research. In *The Oxford Handbook of Political Networks*.

Zhao, X., & Nan, X. (2016). The influence of absolute and comparative risk perceptions on cervical cancer screening and the mediating role of cancer worry. *Journal of health communication*, *21*(1), 100-108.

김영욱, 이현승, 장유진, 이혜진. (2015). 언론은 미세먼지 위험을 어떻게 구성하는가?. 한국언론학보, 59(2), 121-154.

이은주. (2011). 컴퓨터 매개 커뮤니케이션으로서의 트위터. 언론정보연구, 48(1), 29-58.

환경부 (2016). <바로 알면 보인다. 미세먼지, 도대체 뭘까?>, 세종: 환경부 기후대기정책과.

# APPENDIX – SURVEY QUESTIONS

1. 귀하의 성별은 무엇입니까?

1) 남성 2) 여성

2. 귀하의 연령은 어떻게 되십니까?

만 ____ 세

3. 귀하의 직업은 무엇입니까?

1) 자영업 2) 사무직/기술직 3) 경영/관리직
4) 전문직
5) 기능/생산직 6) 판매/서비스직 7) 농/임/축/어업
8) 주부
9) 학생 10) 무직 11) 기타( )

4. 혼인 상태는 어떠합니까?

1) 미혼 2) 기혼 3) 동거
4) 사별
5) 이혼 6) 별거

5. 귀하께서는 정규교육은 어디까지 받았습니까?

- 교육부장관이 인정하는 학력을 정규교육으로 봅니다
- 검정고시에 합격한 경우는 정규교육을 받은 것으로 인정합니다.
- 초등학교 취학 이전의 아동은 "받지 않았음(미취학 포함)"에 표시합니다

1) 받지 않았음 2) 초등학교 3) 중학교 4) 고등학교

5) 대학교 (2,3년제) 6) 대학교 (4년제 이상) 7) 대학원 석사 과정 8) 대학원 박사 과정

6. 귀 댁의 지난 1년 동안 세금 납부(공제) 전의 월평균 가구 소득은 얼마입니까? 연간 소득을 월평균으로 환산하여 해당되는 곳에 표시하여 주십시오. (가구소득은 전 가구원의 근로소득, 사업소득, 재산소득 및 이전소득 등의 합계를 말합니다.)

1) 100만원 미만 2) 100~200만원 미만 3) 200~300만원 미만 4) 300~400만원 미만

5) 400~500만원 미만 6) 500~600만원 미만 7) 600~700만원 미만 8) 700만원 이상

7. 귀하의 건강상태는 어떻습니까?

1) 매우 건강하다 2) 건강하다 3) 보통이다 4) 건강하지 않다 5) 매우 건강하지 않다

8. 미세먼지로 인한 신체적 증상 경험

다음 문장을 읽고 이에 얼마나 동의하는지 응답해주세요

(1= 전혀 그렇지 않다, 4= 보통이다, 7= 매우 그렇다)

8-1. 나는 미세먼지가 심한 날에 평소보다 눈에 이물감을 더 많이 느낀다.

1_____2_____3_____4_____5_____6_____7

8-2. 나는 미세먼지가 심한 날에 평소보다 더 많이 기침을 한다

1_____2_____3_____4_____5_____6_____7

8-3. 나는 미세먼지가 심한 날에 평소보다 코가 더 많이 막힌다

1_____2_____3_____4_____5_____6_____7

**A**. 미세먼지

**AA**. 다음 문장을 읽고 이에 얼마나 동의하는지 응답해주세요.

| | 전혀 그렇지 않다 | | | | | | 매우 그렇다 |
|---|---|---|---|---|---|---|---|
| 나는 미세먼지가 높을 때에는 나를 보호하기위해 야외활동을 줄일 의향이 있다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 나는 미세먼지가 높을 때에는 미세먼지로부터 나를 보호하기 위해 혼잡한 도로를 피할 의향이 있다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 나는 미세먼지가 높을 때에는 미세먼지로부터 나를 보호하기 위해 외출시 마스크를 착용할 의향이 있다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 나는 미세먼지가 높을 때에는 미세먼지로부터 나를 보호하기 위해 공기 청정기를 사용할 의향이 있다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 나는 미세먼지가 높을 때에는 미세먼지로부터 나를 보호하기 위해 창문을 닫아 미세먼지 유입을 차단할 의향이 있다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

**AB**. 다음 문장을 읽고 이에 얼마나 동의하는지 응답해주세요.

| | 전혀 그렇지 않다 | | | | | | 매우 그렇다 |
|---|---|---|---|---|---|---|---|
| 나는 미세먼지 문제 해결을 위해 쓰레기 배출을 줄일 의향이 있다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 나는 미세먼지 문제 해결을 위해 주방에서 오븐 사용을 자제할 의향이 있다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 나는 미세먼지 문제 해결에 동참하기 위해 자가용 차량 이용을 줄일 의향이 있다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 나는 미세먼지 문제 해결을 위해 전기를 절약할 의향이 있다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 나는 미세먼지 문제 해결을 위한 환경 운동에 참여할 의향이 있다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

**AC**. 다음 문장을 읽고 이에 얼마나 동의하는지 응답해주세요.

| | 전혀 그렇지 않다 | | | | | | 매우 그렇다 |
|---|---|---|---|---|---|---|---|
| 미세먼지 문제는 나에게 아주 중요한 문제이다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 나는 미세먼지로 인해 호흡기 질환에 걸리는 것이 우려된다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 나는 미세먼지로 인해 심혈관 질환에 걸리는 것이 우려된다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 미세먼지로 인해 내가 호흡기 질환에 걸릴 가능성이 높아질 것이다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 미세먼지로 인해 내가 심혈관 질환에 걸릴 가능성이 높아질 것이다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

**AD**. 다음 문장을 읽고 이에 얼마나 동의하는지 응답해주세요.

| | 전혀 그렇지 않다 | | | | | | 매우 그렇다 |
|---|---|---|---|---|---|---|---|
| 미세먼지 문제는 내 주변 이웃들에게 아주 중요한 문제이다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 미세먼지로 인해 내 주변 이웃들이 호흡기 질환에 걸리는 것이 우려된다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 미세먼지로 인해 내 주변 이웃들이 심혈관 질환에 걸리는 것이 우려된다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 미세먼지로 인해 내 주변 이웃들이 호흡기 질환에 걸릴 가능성이 높아질 것이다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 미세먼지로 인해 내 주변 이웃들이 심혈관 질환에 걸릴 가능성이 높아질 것이다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

**AE**. 다음 문장을 읽고 이에 얼마나 동의하는지 응답해주세요.

| | 전혀 그렇지 않다 | | | | | | 매우 그렇다 |
|---|---|---|---|---|---|---|---|
| 미세먼지는 한국 사회의 아주 중요한 문제이다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 미세먼지로 인해 한국 사회 구성원들이 호흡기 질환에 걸리는 것이 우려된다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 미세먼지로 인해 한국 사회 구성원들이 심혈관 질환에 걸리는 것이 우려된다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 미세먼지로 인해 한국 사회 구성원들이 호흡기 질환에 걸릴 가능성이 높아질 것이다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 미세먼지로 인해 한국 사회 구성원들이 심혈관 질환에 걸릴 가능성이 높아질 것이다. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

**AF.** 다음의 서술문에 대해 어떻게 생각하는지 응답해주십시오

| 그렇다 | 아니다 | 모르겠다 |
|---|---|---|
| 1 | 2 | 3 |

1. 우리나라의 미세먼지는 대부분 외국에서 유입된다.

2. 미세먼지와 황사는 동의어이다.

3. 주방에서 요리할 때에 미세먼지가 많이 나온다.

4. 진공청소기를 돌릴 때에 미세먼지가 많이 나온다.

5. 미세먼지가 높은 날에는 밖에 나가면 안된다.

6. 미세먼지가 높은 날에는 외부환기를 하면 안된다.

7. 공기청정기를 사용하면 실내의 미세먼지를 줄이는데 도움이 된다.

8. 미세먼지는 뇌에까지 영향을 미친다.

9. 미세먼지가 높은 날에 물을 많이 마시면 건강에 도움이 된다.

**AG**. 지난 한달 동안 아래의 정보원을 통해 미세먼지에 관한 보도나 정보를 얼마나 자주 접했습니까?

| 자주 접했다 | 조금 접했다 | 거의 접하지 못했다 | 전혀 접하지 못했다 |
|---|---|---|---|
| 1 | 2 | 3 | 4 |

1. 온라인 뉴스 (예: www.chosun.com, www.naver.com)
2. 소셜미디어 (예: Facebook, YouTube, Twitter, 혹은 블로그)
3. 건강 또는 의료 전문 웹사이트 (예: 보건복지부 웹사이트)
4. 텔레비전(전국 방송)
5. 텔레비전(지역 방송)
6. 전국 일간지 또는 잡지
7. 지역 일간지 또는 잡지
8. 가족, 친구, 또는 직장 동료
9. 의사 또는 다른 의료 전문가
10. 기타.

*용어 정의

전국방송: 텔레비전 화면을 통한 TV방송의 시청. 지상파 TV, 케이블 TV, 위성TV, IPTV, DMB시청 행위 포함

지역방송: 텔레비전 화면을 통한 지역 지상파 방송

전국 일간지: 전국 단위로 매일 발행되는 종이 형태의 신문

지역 일간지: 지역에서 매일 발행되는 종이 형태의 신문

# 국문 초록

# Is air pollution a serious threat to me or society?

Information sources as explanatory variables for different risk perceptions and behaviors

박 준 모

서울대학교 언론정보학과

본 연구는 최근 우리 사회의 주요 건강 문제이자 사회 문제로 급부상한 미세먼지 문제에 주목, 미디어를 통한 정보 획득 경로에 따른 위험 인식 및 행동 의도 변화를 알아보고자 했다. 이를 위해 주요 미세먼지 정보 획득 경로인 포털 사이트 내 미세먼지 관련 게시물을 분석하고, 전

국단위 설문조사를 통해 그 영향력을 검증하고자 했다.

연구1에서는 미세먼지와 관련된 위험 묘사 프레임을 분석하기 위해 주요 포털 사이트의 버즈 데이터를 대상으로 텍스트 마이닝을 실시했다. 분석 결과, 포털 사이트내에서는 개인적 원인 및 대책 방안 위주로 미세먼지를 언급하고 있었다. 미세먼지 발생원인 관련 중국이, 대응 프레임 중 정부 차원의 대응이 언급되기는 하나, 환기, 마스크 등 개인적 대응이 가장 강조됨으로써 사람들이 개인적 대응의 문제로 인식하고 있는 것을 확인하였다.

연구2에서는 미세먼지 관련 미디어 경로가 위험인식 및 행동의도에 미치는 영향을 검증하였다. 구체적으로 대중 매체, 인터넷, 대면 커뮤니케이션간이 각각 사회적 위험 및 개인적 위험에 영향을 미치는지 보고자 했고, 더 나아가 위험제거 행동 및 위험 회피 행동 의도 중 어느 행동에 영향을 미치는지 탐색했다. 연구 결과, 대면 커뮤니케이션 및 인터넷은 개인적 위험 인식에 유의한 영향을 미치는 것으로 나타났다. 그러나 대중매체는 사회적 위험, 개인적 위험 모두에 영향을 미치지 못하는 것으

로 나타났다. 더 나아가 사회적 위험 인식 정도가 높을수록 위험 제거 행동 의도가 높아지고, 개인적 위험 인식 정도가 높을수록 위험 회피 행동 의도가 높아지는 것으로 나타났다.

**주요어: 미세먼지, 미디어 전략, 비대인적 영향 가설, 위험인식, 프레임 텍스트 마이닝, 건강커뮤니케이션, 미디어 심리**

**학번: 2016-20220**