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ORIGINAL ARTICLE

Transboundary Air Pollution in South Korea: An Analysis of Media Frames and Public Attitudes and Behavior

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Abstract   The lack of a coherent policy to address seasonal air pollution in Northeast Asia is partly due to the complexity of the issue—that it is both domestic and transboundary in nature—and partly due to media frames that emerge in response to seasonal fluctuations. To provide a better understanding of these factors as well as their potential impact on public opinion and behavior, this paper claims that the varying narratives conveyed in the Korean media have an impact on and provide a basis for assessing Koreans' opinions about the problem of air pollution, both transboundary and domestically. Invoking the extant literature that connects media effects with public opinion about air pollution, the analysis proceeds in two stages. First, based on an analysis of Yonhap News Agency reporting, it is shown that the emerging media-based frames are dominated by China and health-related content. Second, and in light of these frames, a survey is conducted of a representative sample of Seoul Metropolitan Area residents to determine how attention to the air pollution issue drives attitudes and, in turn, how such attitudes may be associated with specific pollution-reduction actions. Consistent with the media-based frames, it is shown that one's attentiveness to the air pollution issue increases the importance one places on reducing Korea's air pollution. Knowledge about air pollution also decreases one's satisfaction with both Korea's and China's air pollution-reduction efforts. Knowledge about air pollution does not impact on Koreans' decision to minimize exposure to air pollution outdoors (by wearing masks) or indoors (by using

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air purifiers), but it does increase the likelihood that one will simply stay indoors, indicating that health concerns are paramount for the average citizen.

1 Introduction

The amount of air pollution that South Koreans (henceforth "Koreans") encounter on a seasonal basis is extreme. At times, the country is ranked among the most polluted places in the world;[1] yet, there is still debate regarding the source of this pollution. Some attribute it entirely to the pollution that blows in from China, others attribute it to Korea's use of coal for energy, while others recognize some combination of both sources. Public perceptions about who is primarily responsible for the problem are undoubtedly influenced by media coverage and shape the policies that Koreans would be willing to support to curb air pollution.

Koreans' understanding and reaction to the air pollution issue are the focus on this paper, and we approach this incrementally. Given the lack of research addressing how media coverage contributes to public understanding about the air pollution issue, we must consider the implications of variations in how media frame the debate and, thus, we engage in a content analysis of the Korean media to identify the specific frames employed about Korean air pollution. Our analysis shows that the Korean media seasonally connect China to Korea's air pollution problem. However, the most consistent frame attached to air pollution is its health-related aspects.

Under the assumption that these media-based frames—the China connection and the health aspects of air pollution—affect Korean public opinion, we conduct a survey of Koreans during the peak of the spring 2017 air pollution cycle, which coincides with the conclusion of the media content analysis. The survey has been designed to understand how attentiveness to these media-based frames impacts attitudes Koreans have toward the following: importance of reducing air pollution, satisfaction with Korea's air pollution-reduction efforts, satisfaction with China's air pollution-reduction efforts, and the need to coordinate between the two countries to solve the air pollution problem. We then examine how these attitudes impact pollution-averting behavior, concluding that those Koreans with stronger attitudes will be more likely to stay indoors in order to avoid air pollution. This is, however, not a long-term solution.

2 Korea's Air Pollution: Exacerbated and Untreated

The specific air pollution upon which we focus is particulate matter, i.e., all solid and liquid airborne matter. When combined with nitrous oxide, the short-term effects of particulate matter increase mortality, hospital admissions, and asthma

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[1] See details provided by the Data-Driven Yale and AirVisual databases: http://datadriven.yale.edu/air-quality-2/air-pollutions-hazy-future-in-south-korea-2/; https://airvisual.com/south-korea.

symptoms, and particulate matter by itself has long-term effects that include chronic obstructive pulmonary disease, lung cancer, diabetes-related effects, and increased risk of myocardial infarction (OECD 2008). Globally, attendant healthcare costs are projected to increase from $21 billion in 2015 to $176 billion in 2060, and air pollution costs are expected to result in the reallocation of 1% of global GDP by 2060 (OECD 2016). In sum, particulate matter concentrations are positively correlated with increased human mortality and morbidity (Cook et al. 2005; Pope and Dockery 2006), particularly cardiovascular disease and dementia (Chen et al. 2017; Miller et al. 2017; Kim et al. 2012). In East Asia, these problems are in no way subsiding as premature mortality from particulate matter is predicted to range from nearly a half-million to over 1 million cases in 2020 (Nawahda et al. 2012). By some estimations, these negative health effects of air pollution amount to 80% of all air pollution costs (Pearce et al. 2006).

A share of Korea's air pollution originates in China. Fall and spring trade winds blow desert dust from northern China and Mongolia, to which Chinese pollution and particulate matter attach. The pollution-laden dust then heads for destinations elsewhere in China, Korea, Japan, and even California (Choi et al. 2016; Lee et al. 2013). The Chinese Academy of Sciences has explicitly called for the regulation and reduction in China-based sulfur dioxide and nitrogen oxides (Qu et al. 2016), and major changes began in 2014, when $1.6 billion was allocated for air pollution prevention and control, coal mining facilities were shut down to improve coal quality, and clean energy was promoted (Xinhua News 2015). In early 2016, Chinese Environmental Minister Chen Jining ramped up enforcement by penalizing polluting firms, ultimately shutting down or suspending operations of one-quarter of the 191,000 firms that were found to be violating regulations in 2015 (Xinhua News 2016).

The remainder of Korea's pollution is locally produced given its energy supply portfolio. Coal provided 39.1% of Korea's electricity in 2014 and, according to the Seventh Basic Electricity Supply Plan, this will be reduced to 32.3% by 2029. Overall coal use in Korea is projected to increase at 0.5% per year through 2040 because of its use in steel production, representing 27% of electricity generation (US Energy Information Administration 2013). Yet, this proportion does not fully account for ex-President Park Geun-hye's plans to expand Korea's coal-fired power plant energy production capacity: 20 additional coal plants scheduled to be completed by 2029 according (11 remain according to the Plan's schedule), and these planned plants will have larger coal consuming capacities than those that they will be replacing (MOTIE 2015). Most affected is the region surrounding Dangjin, South Chungcheong Province, home to nearly half of all of Korea's coal-fired power plants (Son et al. 2015). In response, environmental NGOs such as the Korean Federation for Environmental Movements make every effort to publicize the accompanying particulate matter generated in Dangjin (Jackson 2017; Kim 2017).

If the planned number of coal-fired power plants goes forward, the health-related costs will be significant. In addition to the effects of particulate matter already mentioned, coal-fired power leads to increased frequency of stroke, heart disease, chronic obstructive pulmonary disease, lung disease, lung cancer, and other types of heart and lung diseases (Chikkatur et al. 2011; Pope and Dockery 2006; Son et al. 2015). There would be 1900 premature deaths per year from 2021, which is 800

more than the current level, and the original plan (as of 2014) would have caused a total of 32,000 premature deaths from air pollution (Son et al. 2015).

At the center of Korea's air pollution problem is the lack of clarity about the actors who are responsible and, thus, how the source of the emissions can be targeted. There have been numerous efforts to analyze Korea's air quality and track transboundary air pollution from China. One recent example worth mentioning is the International Korean air quality study (KORUS-AQ) that involves more than 580 researchers from 72 institutions, three planes, two ships, and 300 ground-based monitoring sites (Zastrow 2016). Based on the results of flyovers above the Korean peninsula in spring 2016, led by NASA scientists and researchers, it was determined that only 15% of Korea's particulate matter can be attributed to Korean anthropogenic sources while a large part of the remainder originates in China (Lee et al. 2017). Pollution is certainly blowing east from China, and a substantial portion of it is the result of Chinese manufacturing, energy production, and transportation, which the media has particularly emphasized (Shapiro 2016). The media has also increasingly discussed Korea's contributions to its own air pollution by highlighting Korea's coal use and coal expansion plans, but the public is primarily receiving media-based communications that highlight Korea's lack of agency to deal with the problem.

The primary message is one of the prevention in order to minimize the health effects of air pollution, i.e., donning masks for 6–8 weeks out of the year or even staying indoors (Kim et al. 2015; Shapiro 2016). Air pollution-related policies are thus focused on avoidance and adaptation. As well, the seasonal nature of severe air pollution in Northeast Asia may diminish the urgency of solving the problem. Indeed, politicians typically avoid the air pollution issue when campaigning for office, the exception of which was the 2017 presidential election held during the spring. The presence of high levels of air pollution during the campaign period virtually required all viable presidential candidates to discuss the need for Korea to coordinate with China and/or change its energy portfolio. President Moon Jae-in, for example, vowed to "establish a long-term plan to cut back on coal-fired power generation in order to reduce the fine dust emissions level by 50%. In addition, I will bring up the fine dust problem as one of the most pressing issues in Korea-China summit meetings" (Bae 2017).

Policy solutions are also unsatisfactory because cross-national efforts have been extremely tame. In 2001, the environmental ministers of China, South Korea and Japan first agreed to prioritize the yellow dust problem, establishing a formal, state-level channel to deal with the problem. Yet, regular discussions since then have done little more than keep the problem on the regional policy agenda. We acknowledge that the most recent meeting of the environmental ministers from these three countries was particularly focused on air pollution, accompanied by a call for the Northeast Asia Clean Air Partnership in October 2018 (Lee 2018b). Between China and Korea specifically, environmental ministers will have additional opportunities to target air pollution with the opening of the Korea-China Environmental Cooperation Center, which will monitor two technology-related initiatives relevant for air pollution: the Korea-China Air Quality Joint Research Team and the Korea-China Environmental Technology Demonstration Center (Ministry of the Environment of

Korea 2018). This appears promising, but we must be realistic given its similarity to the numerous efforts made on paper among the Northeast Asian countries to address regional air pollution.

3 Air Pollution: The Korean Media

3.1 Media-Based Frames

Motivation for policy change may be lacking because of how Korea's air pollution is covered in the media. Frames communicated in media stories serve as narrative devices and provide storylines that help define social and political problems, make attributions about causal responsibility for the problem, and identify solutions for addressing such problems (Entman 1993; O'Neill et al. 2015). Media frames prominent in Korean news stories about air pollution, such as messages that attribute responsibility to China for the problem, likely shape the public's beliefs about what policies and actions are needed to address the issue.

In a study of nearly 1200 newspaper articles from Korea's top five newspapers, a common narrative employed in the news focused on the role of China as the source of Korea's pollution, which increased the public's perception that China was to blame for the problem (Kim et al. 2015). Shapiro (2016) also confirmed that news coverage related to air pollution in Korea highlights China as primarily responsible. Alternative frames in the media focus on domestic contributions to Korea's air pollution, best illustrated by the reporting that followed the publication of a 2015 Greenpeace study on Korea's air pollution. The study concluded that China was not the major culprit of Korean pollution (Son et al. 2015), contrasting with previous estimates that the origins of particulate matter in Korea have been China and North Korea (see, for example, Lee and Kim (2007).[2] These alternative frames are consistent with media coverage of science-based information that over-simplifies the nature of a complex process such as air pollution (Allan 2011).

It must be noted that the traditional media is no longer the only source of information regarding air pollution. For the Chinese case, there is considerable attention on the role of online messages with regard to air quality trends and public perceptions [see, for example Shiliang Wang et al. (2015) as well as Jiang et al. (2015)], particularly social media dominated by health-related matters (Gurajala and Matthews 2018). That said, the traditional media is prioritized here given evidence that information flows from the traditional media to social media, consistent with findings about Twitter dynamics in Korea (Ko et al. 2014).

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[2] Updates from Greenpeace have also connected Korean coal plant construction to transboundary air pollution flowing out of Korea to Southeast Asia, attributed to Korea's and other countries' continued and projected increases in coal use from the present to 2030 (Koplitz et al. 2017). See the following Greenpeace press release for details: http://www.greenpeace.org/international/en/press/releases/2017/Cancelling-new-coal-plants-in-Southeast-Asia-Korea-Japan-would-save-50000-lives-a-year/.

3.2 Yonhap News Media Content

We collect all news articles from May 2016 through April 2017 to assess how transboundary particulate matter and air pollution is framed in the media. The source of this news content is Korea's newswire, Yonhap News (YN) Agency (www.yonnhapnews.co.kr), which provides services analogous to other news agencies such as United Press International. This focus on YN is consistent with existing research on attribution frames in transboundary air pollution-related media content. For example, Shapiro (2016) confirmed that "China" is less prevalent as a media-based narrative in the spring months when combined with "yellow dust," while it is strongly present during the winter months when combined with "particulate matter." As well, yellow dust focuses more on health-related information and preventative measures, highlighting pollution-averting topics such as dust masks, air purifiers, humidifiers, advisories, and respirators. Thus, Shapiro (2016) concluded that the Korean Medical Association plays a key role in driving the media's air pollution narrative, in line with extant efforts to prevent pulmonary diseases by restricting outdoor activities and communicating the risks of exposure to the public (Kang and Kim 2014; Kyung et al. 2015).

We assume that "particulate matter" and "air pollution" are two variants of the same narrative and examine the frequency in which each set of terms co-occurs with the following: "China," "coal," "diesel," "economy," and "health." These frames were selected based on the content analysis in Kim et al. (2015), i.e., because news content on Korean air pollution tends to invoke issues related to China, coal-based energy, diesel-fueled transportation, the economy, and health-related matters. Informal checks confirmed that, among particulate matter and air pollution narratives separately, each keyword combination was relatively distinct from every other combination. Overlaps were negligible, implying that YN reported, for example, "particulate matter + diesel" distinctly from "particulate matter + coal." Both combinations were, in turn, distinct from reporting about "particulate matter + economy," and so on. The same pattern holds true for keyword combinations referencing the air pollution frames.

3.3 Framing Analysis

With regard to the media-based frames, our selection of keyword combinations for particulate matter and air pollution is strongly representative of all YN articles covering these subjects, indicated by the yellow lines in Figs. 1 and 2. This is true to a slightly lesser degree for articles on particulate matter as, during the summer and fall months, these keyword combinations represent approximately 75% of all articles discussing particulate matter. Also shown in Figs. 1 and 2 are lulls in reporting during the summer and fall seasons, while there are increases in reporting during the spring and winter months. Most importantly, when reporting increases, China-related and health-related content represent the largest share of news content, confirming Kim et al. (2015) and Shapiro's (2016) findings.
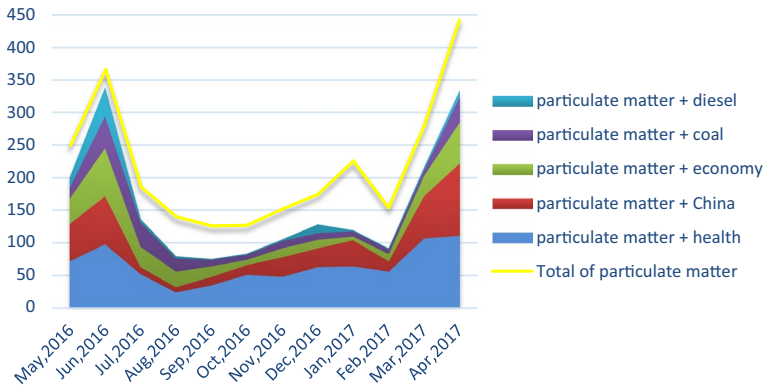
Fig. 1 Number of Yonhap News articles covering particulate matter across select keyword combinations
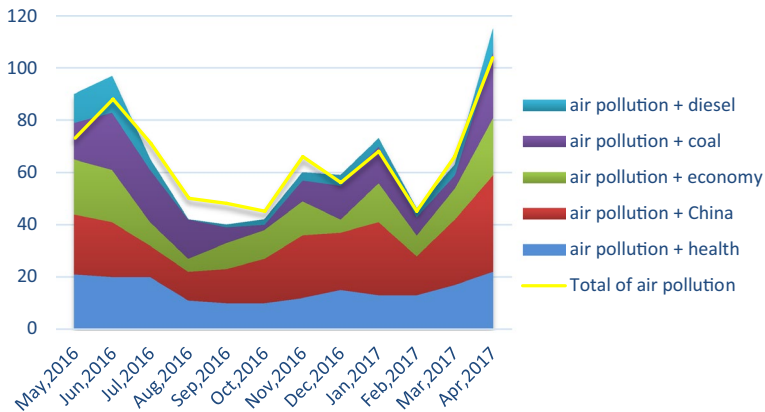

Fig. 2 Number of Yonhap News articles covering of air pollution across select keyword combinations

The frequency of YN reports about particulate matter is, on average, more than three times more prevalent than news reports about air pollution. There is also variance across the keyword combinations with particulate matter and air pollution. For example, for the 12-month period under analysis here, health is reported with particulate matter at least four times more than it is reported with air pollution. During the summer months, the economy is reported with particulate matter at least three times more than it is with air pollution. Particularly representative of a dynamic keyword mix is the increase in particulate matter across all keyword combinations leading up to and including the spring months. Yet, it is also precisely at that time that the combination of "air pollution" with "China," as well as the combination of "particulate matter" with "China," is present in YN articles increasingly more.

4 Air Pollution: The Korean Public

4.1 Media Attention and Pollution-Related Knowledge

In line with the existing literature, we argue that there is a crucial need to understand how people follow news focusing on the environment (Hansen 2011), that individuals are in fact following environmental news, and that the public experiences concern particularly about the health-related consequences of air pollution (Kim et al. 2015). In addition, there are psychological effects (anxiety) accompanying the aforementioned physical effects of air pollution, shown in Power et al.'s (2015) study of more than 70 thousand women in the US states. It has also been shown that psychosomatic status matters in terms of one's evaluations of air pollution (Xiang et al. 2017). Correlations between suicide rates and ozone concentrations and between suicide rates and particulate matter concentrations have been identified among the Korean population (Kim et al. 2015).

Media frames provide storylines that people use to make sense of a given topic or policy issue (Chong and Druckman 2013; Entman 1993). We assume that attention to the air pollution issue can be represented by one's knowledge about air pollution itself. Research on mass opinion formation demonstrates that knowledge is the strongest and most consistent predictor of news attention (Price and Zaller 1993). Further, higher levels of knowledge are associated with attaching greater personal importance to an issue and can generate greater self-relevant knowledge (Bolsen and Leeper 2013; Holbrook et al. 2005).

We expect that Koreans will be influenced by the China-related and health-related media frames identified in content analysis of YN articles. One recent study found that exposure to media content connecting China to the air pollution in Korea increased dissatisfaction with China's efforts to deal with the problem (citation withheld). In line with research on how people respond to air pollution-related threats, namely that anxiety, anger, and satisfaction impact an individual's willingness to pay to address the issue (Xu and Shan 2018), we also expect that the presence of the health-related frame in YN news articles increases both the importance of reducing Korea's air pollution and the need for Korea to coordinate with China to alleviate the problem.

4.2 Attitudes and Behavior

We expect that attitudinal and behavioral changes for the Korean air pollution issue reflect the media-based frames present in the YN articles. Specifically, health-related and transboundary-related content in the media is expected to promote strong attitudes and corresponding pollution-avoiding actions. Admittedly, the behavioral choices made by people in response to attitudes about air pollution have only recently become clear, but we invoke the corpus of research that connects strong attitudes to behavioral responses, such as Ajzen (1991) and Ajzen and Fishbein (1980). This research has shown, for example, that individuals use respirator-style

face masks based on perceptions of the severity, the susceptibility of the risk, and how fully one understands the risks to oneself (Bish and Michie 2010; Zou et al. 2015); however, this is not always the case, shown in a recent experiment based on the Chinese public's exposure to a highly publicized documentary about air pollution in China (Qin et al. 2018).

The research has also identified implications for the economy, transportation, and policy support from the public. Analyses of revealed preferences confirm that retail purchases decrease in the presence of air pollution (Kang et al. 2017), that high levels of air pollution promote the purchase of masks and air filters (Liu et al. 2018), and that policies incentivize commuters to ride on public transit during high-pollution periods (Poon 2018). Health costs play a particularly important role; Koreans, for example, are more willing to pay to alleviate occurrences of high particulate matter concentrations than occurrences of more frequent but less severe concentrations of particulate matter (Lee 2018a).

At an exploratory level, our focus is thus on those behaviors that would, for the individual, mitigate exposure to pollution outdoors, those that would mitigate exposure to pollution indoors, and those that result in avoiding the outdoors altogether. There is evidence that perceptions of air quality and frequent access to air quality reports lead to unwarranted behavioral shifts such as staying indoors during periods of perceived high air pollution (Johnson 2012; Oltra and Sala 2018; Xu et al. 2017). For the Korean case, however, there has been no research to date regarding the relationship between an individual's air pollution attitude and his/her pollution-averting behavior.

5 Survey Construction and Analysis

5.1 Details of Survey Instrument

Our survey of Korean public opinion is based on data generated from a survey of a representative sample of the Seoul Metropolitan Area. Launched in mid-April, 2017 to temporally correspond with the end of our sample of YN articles, the survey was administered by the Korean web survey agency, Macromilll-Embrain, Inc. ("Embrain").[3] At the time of the survey's launch, Embrain's panel was comprised of 1.166 million people from which we took a quota sample based on Seoul Metropolitan Area residency as well as gender and age distributions consistent with Seoul-based representative samples, determined by population data from the Ministry of Government Administration and Home Affairs statistical database for April 2017. Respondents were recruited via computer-telephony integration/random digit dialing, voluntary registration on Embrain's panel site, word of mouth, or banner

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[3] Institutional Review Board approval granted by the [withheld] IRB on February 15, 2017; Protocol #: IRB2017-014. This survey was part of a larger survey of the Korean public with regard to air pollution.

advertisements on portal sites.[4] Importantly, individuals in our sample are actively following the news in some form or fashion.[5]

With these survey data, we use air pollution knowledge as a proxy for attention to the air pollution issue and measure such knowledge by asking respondents to select those compounds from the following list that contributes to air pollution: carbon dioxide, carbon monoxide, nitrogen oxides, $PM_{2.5}$, and sulfur oxides. All five compounds contribute to air pollution, and we ranked respondents' air pollution knowledge from least to most knowledgeable based on their selection of one (least knowledgeable) to five (most knowledgeable) air pollution contributors. This measurement avoids the problems surrounding subjective measures of air pollution knowledge mentioned earlier.

Second, we measure attitudes toward air pollution in Korea, focusing on its transboundary nature. These attitudinal measures are based on the following four survey questions: "To what extent is it important to take action to reduce Korea's air pollution?" (1 = "extremely unimportant"; 7 = extremely important), "To what extent is it necessary for Korea to coordinate with China to reduce Korea's air pollution?" (1 = "extremely unnecessary"; 7 = "extremely necessary"), "To what extent are you satisfied with Korea's efforts to reduce its air pollution?" (1 = "extremely unsatisfied"; 7 = "extremely satisfied"), and "To what extent are your satisfied with China's efforts to reduce its air pollution?" (1 = "extremely unsatisfied"; 7 = "extremely satisfied").[6]

Third, we measure specific pollution-averting behaviors by asking respondents to select from a list those actions regularly taken "to reduce the effects of air pollution," including the following: "wearing a hospital-style face mask," "wearing a respirator-style face mask," "covering face with scarf or other clothing," "using an air filtration machine at home," "using an air filtration machine at work," and "staying inside as much as possible."[7] We can classify these behaviors into three groups: covering one's face outdoors, filtering indoor air, and avoiding the outdoors. Each of the protective behaviors represents individual-level actions taken to avoid the effects of air pollution.

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[4] Specifically, an individual must first request to be a panel member for Embrain, which is followed by an email sent from Embrain's Panel Management Team to request additional information to confirm the validity of the potential panel member's email. To finally confirm that the requesting individual is who s/he says s/he is, an Embrain Panel Management Team member contacts the individual via telephone. This process ensures that heads of households are in fact registering for the service. Management of the panel is conducted by randomly sent invitations for participation in Internet surveys with monetary incentives for participation. The estimated monetary incentive for respondents participating in the present study was approximately $5. Selection bias from targeting only Internet users is alleviated given the nearly 89.9% Internet penetration rate in Korea (CIA World Factbook: https://www.cia.gov/library/publications/the-world-factbook/geos/ks.html).

[5] This is consistent with the sample analyzed below: 9% primarily obtain their news from newspapers, 65% from Internet-based news, 4% from social media, 19% from television and radio, while only the remaining 3% use another source or do not follow the news at all.

[6] Given the potential for priming effects to result from a particular ordering of the second, third, and fourth questions, they were randomly ordered across survey respondents.

[7] The exact language used for the survey can be found in the "Appendix".

Table 1 Descriptive statistics for pollution-related knowledge, attitudes, and behavior

	N	Mean	SD	Minimum	Maximum
Knowledge					
Pollutants identified	125	3.096	1.394	1	5
Attitudes					
Importance of reducing Korea's pollution	125	6.256	0.915	3	7
Need to coordinate with China	125	6.368	0.778	4	7
Satisfaction with Korea	125	2.808	1.281	1	6
Satisfaction with China	125	1.872	1.085	1	5
Behavior					
Wear mask	125	0.488	0.502	0	1
Wear respirator	125	0.128	0.335	0	1
Wear scarf	125	0.120	0.326	0	1
Use filter at home	125	0.280	0.451	0	1
Use filter at work	125	0.088	0.451	0	1
Stay inside	125	0.568	0.497	0	1
Controls					
Presence of respiratory problems	125	0.388	0.488	0	1
Hours spent outside	125	2.732	1.139	1	4

5.2 An Analysis of Knowledge, Attitudes, and Action

Presented in Table 1 are the descriptive statistics for this study's knowledge, attitudinal, and behavioral variables. In terms of air pollution knowledge, we observe that the average number of pollutants identified was 3.096. In terms of attitudes toward air pollution, we also observe that the Korean public places a high priority on reducing Korea's air pollution as well as on Korea coordinating with China. This is a general dissatisfaction with both Korea's efforts to address its air pollution and as China's efforts to address its own air pollution. Whether or not China is truly responsible for Korea's pollution, a paired t test confirms that the differences between the mean values of Korea-satisfaction and China-satisfaction are significantly different ($t = 8.747$).[8] We also note in Table 1 that the behavior most employed by Koreans to avoid air pollution is to stay indoors (56.8%), followed by wearing a hospital-style mask (48.8%), using an air filter at home (28.0%), wearing a respirator (12.8%), wearing a scarf (12.0%), and using an air filter at work (8.8%).

Presented in Table 2 are the results of least squares estimations where each of the attitudinal measures is regressed on air pollution-related knowledge as well as

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[8] It is highly doubtful that the difference between the Korea-satisfaction and the China-satisfaction means is due to other factors such as a general perception that China's air pollution problems are worse than Korea's. Attribution of responsibility is the focus when China is discussed in the context of Korea's air pollution.

Table 2 Regressing air pollution-related attitudes on pollution-related knowledge, least squares

	(1) Importance of reducing Korea's air pollution	(2) Necessity of Korea coordinating with China	(3) Satisfaction with Korea's efforts to reduce its air pollution	(4) Satisfaction with China's efforts to reduce its air pollution
Pollutants identified	0.132* (0.059)	0.070 (0.052)	−0.224** (0.084)	−0.255** (0.069)
Presence of respir. problems	0.211 (0.161)	0.126 (0.142)	−0.250 (0.229)	−0.210 (0.186)
Hours spent outside	−0.163* (0.076)	−0.092 (0.067)	0.078 (0.109)	0.128 (0.088)
Constant	6.120** (0.328)	6.344** (0.289)	3.392** (0.467)	2.403** (0.379)
N	125	125	125	125
R^2	0.107	0.045	0.078	0.151
F	4.81**	1.91	3.39*	7.18**

Standard errors in parentheses; *$p < 0.05$; **$p < 0.01$

Table 3 Regressing behaviors on attitudes, logit

	Wear mask	Wear respirator	Wear scarf	Use filter at home	Use filter at work	Stay inside
Importance of reducing Korea's pollution	n.s.	n.s.	n.s.	n.s.	n.s.	0.440*
Need to coordinate with China	n.s.	n.s.	n.s.	n.s.	n.s.	0.494*
Satisfaction with Korea	n.s.	− 0.570*	n.s.	n.s.	n.s.	n.s.
Satisfaction with China	n.s.	n.s.	n.s.	n.s.	n.s.	− 0.431*

*$p < 0.05$; "n.s." indicates nonsignificant results; to address multicollinearity, each cell represents a separate regression for each behavior on each attitude; presence of respiratory problems among household members and hours spent outside are included as controls

the following two control variables: whether at least one person in the household suffers from respiratory problems; the number of hours spent outdoors each day (coded 1–4, where "4" represents four or more hours). As shown in the first row of Table 2, air pollution-related knowledge significantly decreases satisfaction with both Korea's and China's efforts to reduce their respective air pollution. In addition, increases in pollution-related knowledge decrease satisfaction with China more than satisfaction with Korea, which is all the more remarkable given the considerably lower y-intercept for the former (2.403). Pollution-related knowledge has no effect on attitudes about Korea's need for coordination with China to address the air pollution problem. In summary, attention to the air pollution issue—and, in turn, attention to media content with China and health frames—produces the expected effects with regard to each of the attitudinal measures except for the need for coordinating with China.

In Table 3, we present the extent to which each of these attitudes influences air pollution-averting behaviors. As a mean of addressing multicollinearity across attitudes, each cell in Table 3 presents the results of a separate regression for each pollution-averting behavior on each attitude.[9] Our sole expectation regarding the relationship between attitudes and behavior—that importance of reducing Korea's air pollution is the only attitude that affects behavior—was not met. This attitude is statistically significant in only the case of staying inside, and its coefficient is comparable to the coordinate-with-China and satisfaction-with-China attitudes. To clarify, one's air pollution-related attitudes have virtually no impact on whether people cover their faces outdoors or filter their indoor air. With the exception of how greater satisfaction with Korea decreases the use of respirators to avoid air pollution, the

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[9] The pairwise correlation coefficients among attitudes were all statistically significant at the $p < 0.01$ level.

pattern arising from air pollution-related attitudes is one where people's behavior is alterable only with regard to staying indoors.

Given that media content in peak air pollution reporting periods typically focuses on, separately, China and health-related matters, and given that the most common method employed by Koreans to avoid air pollution is to stay indoors, we are convinced that one's decision to stay indoors is driven by two factors: concerns for one's health and attitudes toward China. With one exception, none of these attitudes significantly predicts any of the other possible pollution-averting behaviors.

6 Conclusion

This paper offers a badly needed update to our understanding of how and why Koreans approach air pollution given a seasonal media blitz on the subject. It was necessary to understand precisely how different news frames are constructed given differences in the discourse, narratives, and imagery used by the media to promote a specific interpretation of events regarding Korea's periodic air pollution disaster. Targeting April 2017, we examined the suspected effects on public opinion when it was most volatile rather than when there was a lull in the media's news cycle. We discovered that what is prioritized in the news media is reflected by the importance assigned by general public: particulate matter/air pollution and health issues, particulate matter/air pollution and China. We have also shown that, while attention to air pollution and, we assume, media content on the subject is the strong predictor of the importance who assigns to the problem as well as satisfaction regarding Korea's and China's respective efforts, attitudes overall are not strong predictors of Koreans' behavioral responses to air pollution. The exception is the decision to stay inside to avoid air pollution.

A bridge has been provided here between environmental communication research focusing on media content and framing effects studies, but this study serves as a call for more comprehensive research on Korean public opinion. Air pollution concentrations are exacerbated and, whether or not overall concentrations are decreasing, the government is being forced to enact new policies to address the health-related implications of air pollution, both transboundary and domestically produced. One way to track how this might progress in Korea is to look to China, where people face even more extreme air pollution but also practice different forms of behavior. Relative to Koreans' practice of avoidance, the Chinese public is less willing to close schools on days with high levels of pollution (Zhao et al. 2018), implying that the government's protective measures are not always welcome and that staying indoors is not a universal preference. In short, we should not assume that, under constant conditions, Koreans' attitudes and behaviors will necessarily remain unchanged.

One concern we have regarding our approach is the potential for attitudinal shifts to be endogenous. That is, air pollution-related media content may be tailored to attract the largest market share, structuring the news in ways that resonate with the Korean public. Future research can study whether news is being tailored for an audience by engaging in a comparative analysis of air pollution-related content across different media sources. For example, more conservative news outlets may

disproportionately highlight China as a source of Korea's air pollution while more liberal sources might highlight the need for coordination between Korea and China. Yonhap News is arguably a neutral and more objective news source, though, which was the primary reason we selected it for our content analysis; granted, not all Koreans are strictly reading Yonhap News.

The Korean government can continue to push for behavioral change among the public by incentivizing transportation alternatives, namely getting people out of personal vehicles when commuting, particularly older diesel cars and vans. The solution for Korea's air pollution is, we believe, much more complicated. Despite our earlier concerns regarding coordination across the region to address the transboundary air pollution problem in Northeast Asia, we remain convinced that the most appropriate policy option should approach the issue regionally. This approach would be consistent with Koreans' attitudes about coordination with China. It is noteworthy that the average score for coordinating with China, on a 7-point scale, was 6.368. It is also noteworthy that, among all attitudinal measures, attitudes about coordinating with China yielded the greatest behavioral change measured by the decision to stay indoors. The outlook is necessarily grim, but the Korean public is primed to push for greater engagement with China on this issue.

Appendix

Survey instrument

To what extent is it important to take action to reduce Korea's air pollution?
한국이 대기오염 감축을 위해 대책을 세우는 일이 얼마나 중요하다고 생각하십니까?
Extremely unimportant전혀 중요하지 않다.
Very unimportant중요하지 않다.
Somewhat unimportant다소 중요하지 않다.
Neutral 보통이다
Somewhat important다소 중요하다.
Very important중요하다.
Extremely important 매우 중요하다.

[The three following questions are randomly ordered.]

To what extent is it necessary for Korea to coordinate with China to reduce Korea's air pollution?
대기오염 감축을 위해 한국이 중국과 함께 대책을 세우는 것이 얼마나 필요하다고 생각하십니까?
Extremely unnecessary전혀 필요하지 않다.

Very unnecessary필요하지 않다.

Somewhat unnecessary조금 필요하지 않다.

Neutral 보통이다

Somewhat necessary조금 필요하다.

Very necessary필요하다.

Extremely necessary매우 필요하다.

To what extent are you satisfied with Korea's efforts to reduce its air pollution?
대기오염 감축을 위한 한국의 노력에 어느정도 만족하십니까?

Extremely unsatisfied매우 불만족

Very unsatisfied불만족

Somewhat unsatisfied다소 불만족

Neutral 중간

Somewhat satisfied다소 만족

Very satisfied만족

Extremely satisfied 매우 만족

To what extent are you satisfied with China's efforts to reduce its air pollution?
대기오염 감축을 위한 중국의 노력에 어느정도 만족하십니까?

Extremely unsatisfied매우 불만족

Very unsatisfied불만족

Somewhat unsatisfied다소 불만족

Neutral 중간

Somewhat satisfied다소 만족

Very satisfied만족

Extremely satisfied 매우 만족

If applicable, which of the following methods do you regularly use to reduce the effects of air pollution? Check all that apply.
만약 해당된다면, 대기오염의 영향을 줄이기 위해 다음 중 어떤 방법을 규칙적으로 사용하십니까? 해당되는 모든 선택지에 체크해 주십시오.

Wearing a hospital-style face mask 일반 마스크

Wearing a respirator-style face mask 방독마스크

Covering face with scarf or other clothing 스카프나 옷으로 얼굴을 가린다.

Using an air filtration machine at home 가정에서 공기청정기 사용

Using an air filtration machine at work 직장에서 공기청정기 사용

Staying inside as much as possible 가급적 실내에 있는다.

Which of the following contribute to air pollution? (check all that apply)
다음 중 대기오염에 영향을 미치는 오염물질은 어느 것입니까? (해당되는 사항에 모두 체크해주십시오.)

Carbon dioxide (CO2) 이산화탄소(CO_2)

Carbon monoxide (CO) 일산화탄소(CO)

Nitrogen oxides (NOx) 질소산화물(NO_X)

$PM_{2.5}$ 초미세먼지

Sulfur oxides (SOx) 황산화물(SO_X)

How many people in your household suffer from respiratory problems?

귀하의 가정에서 몇 분이 호흡기 관련된 문제를 가지고 있습니까?

None 없음

1 person 1명

2 people 2명

3 or more people 3명 이상

How hours per day do you spend outdoors?

귀하는 하루 평균 몇 시간을 야외에서 보내십니까?

1–24. [1시간-24시간]

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