RELATIONSHIP BETWEEN PARTICULATE MATTER EXPOSURE AND PUBLIC INTEREST IN SEOUL, KOREA

[1]Chae-Bong Kim, [2]Seong-Min Han, [3]Seon-O Yoon

ABSTRACT

Background/Objectives: This research aims to increase public interest about particulate matter (PM) exposure using Google Trends (GT) to determine the correlation between the actual concentration value of PM and public perception. Methods/Statistical analysis: We collected open public data on average concentrations of PM10 and PM2.5, weather/climate, real-time web search volume on PM, PM-related consumer goods, and health-related information for 70 days from January 1 to March 11, 2019 for Seoul. Statistical analysis on correlation was carried out on this data. Findings: PM10 was correlated with real-time web search, air cleaner, and filter-mask (or dust mask), while PM2.5 was correlated with temperature, humidity, real-time web search, air cleaner, and filter-mask. We found that when the concentrations of PM10 and PM2.5 were high, the search volumes for PM10 and PM2.5 increased, and the rate of purchase of air cleaners and filter-masks increased. This indicated a correlation between increased concentrations of PM10 and PM2.5 and respiratory diseases. In particular, when PM2.5 concentration was higher than PM10, it was found to be more sensitive to PM-related information. Improvements/Applications: To minimize the adverse effects of PM on public health, we need to have objective information related to PM and public attention and participation.

Keywords:

Particulate matter, Google trends, Public health risk communication, Seoul.

Article Received: 18 October 2020, Revised: 3 November 2020, Accepted: 24 December 2020

[1] Department of Preventive Medicine, Korea University, Seoul, South Korea. Email: bbp62@nate.com

[2,3] Department of Counsel & Social Welfare, Kyungwoon University, Gumi, South Korea. Email: hsm1025@ikw.ac.kr, soyoon@ikw.ac. kr

1.Introduction

Air pollution has become a growing concern worldwide. The World Health Organization and the Global Burden of Disease group announced that Asia and the Pacific region have recorded the highest number of deaths due to air pollution (Ferkol & Schraufnagel, 2014). However, many Asian countries have been suffering from lack of information, cooperation, and linkages with other countries regarding health impacts due to air pollution. In particular, transboundary air pollution has been found to be a complex issue. Based on the studies on human health, particulate matter (PM), such as PM10 and PM2.5, have been reported to increase mortality (Hvidtfeldt et al., 2019) and prevalence of cardiovascular disease (Pascal et al., 2014). In particular, children and the elderlies have been found to have low respiratory functions due to increase in PM (Lee, Son, & Cho, 2007; Park et al., 2005). Significantly high and diverse amount of information and researches are available on PM, however, there is inconsistency or lack of clarity among the information available, and it has been seen that many people consider the false information to be true. To minimize the health damage caused by PM, it is important to understand public perception and adopt necessary and helpful public relation strategies. Currently, many people use internet to find information and as the population accessing internet is growing worldwide, people are creating big data and providing research results on internet (Eysenbach, 2009). Additionally, internet is used to share information with others on specific subjects. Thus, digital behavior data can be used to analyze search behaviors of the users to determine topics of interest with regards to health (Raghupathi & Raghupathi, 2014). Internet also helps in understanding the background of a population (Vosen & Schmidt, 2011). In this study, we aimed to understand public perception on exposure to PM using Google Trends (GT) data to determine the relationship between PM concentrations and public perception.

2. Materials and Methods

We analyzed the correlation between weather/climate data and PM-related web searches to determine the relationship between PM concentrations and real-time searches in Seoul. The scope of the study was three.

First, analyze the correlation between PM concentrations and weather/climate; 1) strong wind speed resulted in lower PM concentration, 2) rise in temperature increased the PM concentration, and 3) high humidity increased the PM concentration.

Second, analyze the correlation between PM10/PM2.5 concentrations and PM related information: 1) high PM10/PM2.5 concentration increased the real-time web search, 2) high PM10/PM2.5 concentrations increased the real-time web search related to health, and 3) high PM10/PM2.5 concentrations increased the purchase of air cleaners and filter-masks.

Third, analyze public sensitivity between PM10 and PM2.5.

2.1. Study Model

We collected open public data on average concentrations of PM10 and PM2.5, weather/climate, real-time web search volume on PM, PM-related consumer goods, and health-related information for 70 days from January 1 to March 11, 2019 in Seoul. A new data set was established by merging the data from air pollution monitoring network, GT according to the time and date. [Figure 1]

2.2. Material

2.2.1. Search keywords obtained from Google Trends

GT can identify patterns on specific topics (Choi & Varian, 2012). We collected web-based information for 70 days from January 1 to March 11, 2019 from GT (https://trends.google.com/trends/). From GT, search data on PM10 and PM2.5, air cleaner, and filter-masks were collected

2.2.2. Particulate matter concentrations obtained from the air pollution monitoring network

We collected data for 70 days from January 1 to March 11, 2019 from the air monitoring network of Seoul Metropolitan Government (http://data.seoul.go.kr:8080/) and Air-Korea of the Korea Environment Corporation (http://www.airkorea.or.kr/web). The air pollution monitoring data were collected for temperature, wind speed, humidity, gusts, and PM10 and PM2.5 concentrations, which are the air pollution indicators.

2.3. Analysis

We analyzed cross-correlations and conducted logistic regression analysis to identify the factors affecting PM10 and PM2.5.

3. Results and Discussion

Temperature correlations were obtained for PM10 ($r = 0.547$, $p < 0.001$) and PM2.5 ($r = 0.579$, $p < 0.001$). Wind speed and PM were not observed to be correlated; however, humidity and PM10 ($r = 0.259$, $p = 0.030$) and PM2.5 ($r = 0.358$, $p = 0.002$) displayed weak correlation [Figure 1].

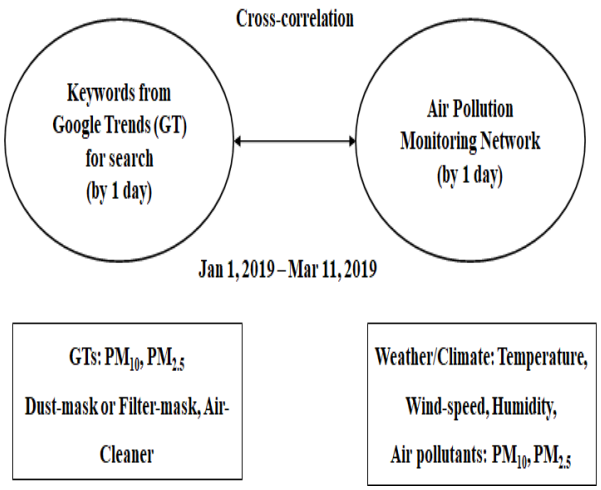
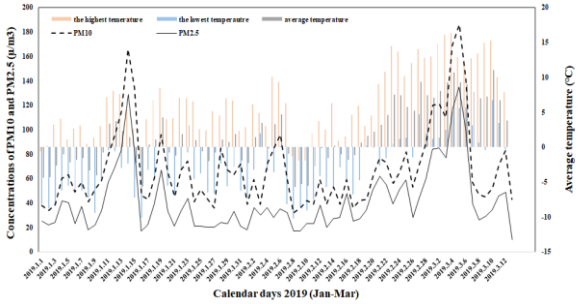


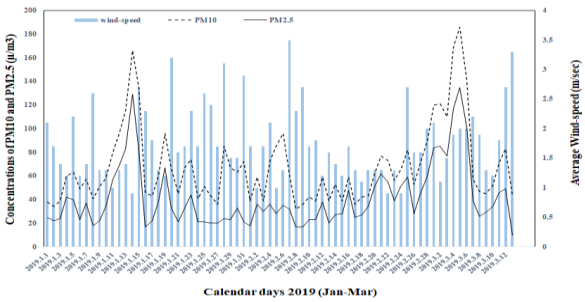
Figure 1: Correlation between particulate matter exposure and public awareness

PM10 and PM2.5 search data collected from GT and PM10 ($r = 0.763$, $p < 0.001$) and PM2.5 ($r = 0.776$, $p < 0.001$) concentrations obtained from the air pollution monitoring network exhibited high correlation. Furthermore, the purchase of both air cleaners and filter-masks exhibited high correlation with the PM10 ($r = 0.599$ and 0.778, $p < 0.001$) and PM2.5 ($r = 0.778$ and 0.786, $p < 0.001$) concentrations, respectively, obtained from the air pollution monitoring network [Figure 2].

(A)



(B)



(C)

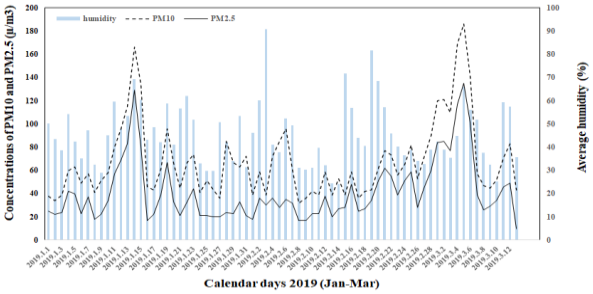


Figure 2: Correlation between PM10/PM2.5 concentration and weather/climate; (A) PM10/PM2.5 concentration and temperature; (B) PM10/PM2.5 concentration and wind-speed; (C) PM10/PM2.5 concentration and humidity

Searches with respiratory disease as the keyword and PM10 and PM2.5 concentrations showed weak correlations.

Furthermore, when PM10 concentration obtained from the air pollution monitoring network increased, searches using PM10 keyword obtained from GT and purchase of air cleaners and filter-masks were observed to increase. Moreover, when PM2.5 concentration obtained

from the air pollution monitoring network increased, a difference was observed between the humidity and temperature, and searches using PM2.5 keyword obtained from GT and purchase of air cleaners and filter-masks were observed to increase [Table 1].

Table 1: Relationship between PM10 and PM2.5 concentrations and PM-related information (n = 70)

	PM10			PM2.5		
	β	t	*p*	*β*	t	*p*
Temperature	N.A	N.A	N.A	3.434	4.555	0.001
Humidity	N.A	N.A	N.A	0.169	3.084	0.003
PM_{10} in GT	1.338	7.288	0.001	N.A	N.A	N.A
$PM_{2.5}$ in GT	N.A	N.A	N.A	0.127	2.131	0.037
Air-cleaner in GT	0.831	5.532	0.001	0.977	6.386	0.001
Filter-mask in GT	1.361	9.766	0.001	1.023	7.084	0.001

In summary, PM10 exhibited a correlation with searches using PM10 keyword and purchase of air cleaners and filter-masks. PM2.5 was observed to be correlated with temperature, humidity, PM2.5 keyword searches, and purchase of air cleaners and filter-masks. Air pollution monitoring network data were observed to be more sensitive to the public when PM2.5 concentration observed to be higher than PM10. Regarding PM10/PM2.5 concentrations and health information, a correlation was observed in the searches using respiratory diseases as the keyword than with asthma and allergic rhinitis as the keywords. However, the difference was not observed to be statistically significant. The high concentration of PM2.5 in Gwangju was reported from October 16 to 24, 2015. In this study, SO_4^{2-}, NO_3^-, and NH_4^+ were found to be the components of PM2.5. Furthermore, low wind speed and high relative humidity, atmospheric congestion due to the development of high pressure around Korea, long-distance transportation, and inflow of fog from China were found to cause high concentration of PM2.5 (Yu et al., 2018). In the preceding and this study, PM2.5 was found to be correlated with temperature and humidity (Csavina et al., 2014; Yu et al., 2018). Based on the four seasons of observation in Seoul, the characteristics of PM2.5 were reported for one year from October 2012 to 2013. In this study, PM2.5 was reported to have seasonal

characteristics that were high in winter and low in summer. It was also observed that the high concentration of PM10 in Seoul was mostly due to transportation from outside during winters (Kim et al., 2018). We used the winter data as a seasonal factor but did not consider the transportation data. Additional analysis is needed in future which should consider the traffic volume data as well. Furthermore, another study reported the effects of PM2.5 on the seasons and regions in East Asia and found a high PM2.5 level during the fall and winter months in South Korea (Jeong, Park, & Yeh, 2018). We demonstrated the seasonal factors using the data from winter to spring months, when the cases of disease have been reported to be high due to PM (Beard et al., 2012). Air pollution monitoring network data showed low correlation between respiratory and allergic diseases. However, people purchased air cleaners and filter-masks to protect themselves when PM increased (König & Mösges, 2014). Transboundary air pollution has been a complex issue which requires governmental, intergovernmental, and regional cooperation and efforts to efficiently address the issue. We consider that this study will be important in promoting and improving these efforts in

addressing air pollution and its health impacts in the region. We expect to increase the overall understanding of PM exposure and its health impacts and promote effective actions from the public by developing a cooperative information exchange channel.

4. Conclusion

PM in Korea and East Asia has emerged as a diplomatic issue, affecting the entire society. Efforts should be made to find a social solution by comprehensively understanding the PM problem through public opinion. Providing public information on high-concentration PM in the future can be a step towards reaching public consensus on PM. Therefore, we consider that this study will provide a relevant source for reducing high concentrations of PM.

5. Acknowledgment

This research was funded by Kyungwoon University

REFERENCES

[1] Beard, J. D., Beck, C., Graham, R., Packham, S. C., Traphagan, M., Giles, R. T., & Morgan, J. G. (2012). Winter temperature inversions and emergency department visits for asthma in Salt Lake County, Utah, 2003–2008. *Environmental health perspectives, 120*(10), 1385-1390.

[2] Choi, H., & Varian, H. (2012). Predicting the present with Google Trends. *Economic record, 88*, 2-9.

[3] Csavina, J., Field, J., Félix, O., Corral-Avitia, A., Sáez, A., & Betterton, E. (2014). Effect of wind speed and relative humidity on atmospheric dust concentrations in semi-arid climates. *Science of the Total Environment, 487*, 82-90.

[4] Eysenbach, G. (2009). Infodemiology and infoveillance: framework for an emerging set of public health informatics methods to analyze search, communication and publication behavior on the Internet. *Journal of medical Internet research, 11*(1), e11.

[5] Ferkol, T., & Schraufnagel, D. (2014). The global burden of respiratory disease. *Annals of the American Thoracic Society, 11*(3), 404-406.

[6] Hvidtfeldt, U. A., Sørensen, M., Geels, C., Ketzel, M., Khan, J., Tjønneland, A., . . . Raaschou-Nielsen, O. (2019). Long-term residential exposure to PM2. 5, PM10, black carbon, NO2, and ozone and mortality in a Danish cohort. *Environment international, 123*, 265-272.

[7] Jeong, J. I., Park, R. J., & Yeh, S.-W. (2018). Dissimilar effects of two El Niño types on PM2. 5 concentrations in East Asia. *Environmental pollution, 242*, 1395-1403.

[8] Kim, Y., Seo, J., Kim, J. Y., Lee, J. Y., Kim, H., & Kim, B. M. (2018). Characterization of PM 2.5 and identification of transported secondary and biomass burning contribution in Seoul, Korea. *Environmental Science and Pollution Research, 25*(5), 4330-4343.

[9] König, V., & Mösges, R. (2014). A model for the determination of pollen count using google search queries for patients suffering from allergic rhinitis. *Journal of Allergy*.

[10] Lee, J.-T., Son, J.-Y., & Cho, Y.-S. (2007). The adverse effects of fine particle air pollution on respiratory function in the elderly. *Science of the Total Environment, 385*(1-3), 28-36.

[11] Park, J. W., Lim, Y. H., Kyung, S. Y., An, C. H., Lee, S. P., Jeong, S. H., & JU, Y. S. (2005). Effects of ambient particulate matter on peak expiratory flow rates and respiratory symptoms of asthmatics during Asian dust periods in Korea. *Respirology, 10*(4), 470-476.

[12] Pascal, M., Falq, G., Wagner, V., Chatignoux, E., Corso, M., Blanchard, M., . . . Larrieu, S. (2014). Short-term impacts of particulate matter (PM10, PM10–2.5, PM2. 5) on mortality in nine French

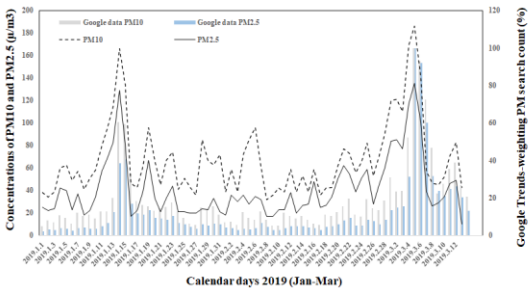
cities. *Atmospheric Environment*, *95*, 175-184.

[13] Raghupathi, W., & Raghupathi, V. (2014). Big data analytics in healthcare: promise and potential. *Health information science and systems*, *2*(1), 3.

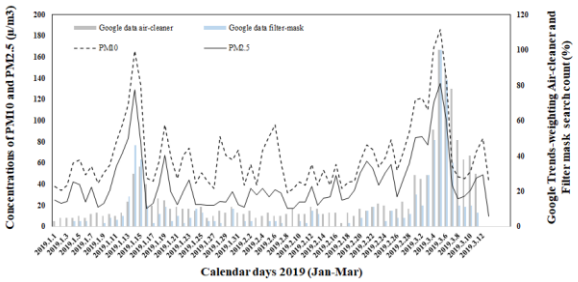
[14] Vosen, S., & Schmidt, T. (2011). Forecasting private consumption: survey-based indicators vs. Google trends. *Journal of forecasting*, *30*(6), 565-578.

[15] Yu, G.-H., Park, S.-S., Jung, S. A., Jo, M. R., Lim, Y. J., Shin, H. J., . . . Ghim, Y. S. (2018). Investigation on characteristics of high PM 2.5 pollution occurred during October 2015 in Gwangju. *Journal of Korean Society for Atmospheric Environment*, *34*(4), 567-587.

(A)



(B)



(C)

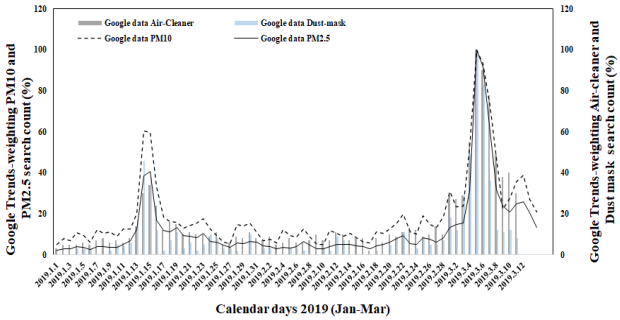


Figure 3: Correlation between PM10/PM2.5 concentration and PM related web search; (A) PM10/PM2.5 concentration and PM10/PM2.5 search results on GT; (B) PM10/PM2.5 concentration and air-cleaner and filter-mask search results on GT; (C) Correlation between search results for PM10/PM2.5 and air-cleaner and filter-mask on GT