Spatio-Temporal Variations of across Visited Place and Activities by Season, Weekdays and Weekends

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ABSTRACT:

Exposure to particulate matter with diameters ≤ 2.5 micrometers (PM2.5) has been reported to be associated with various health issues. Given the substantial spatial and temporal variability of PM2.5, an individual's exposure can vary depending on the array of locations visited in their daily routine, which varies by season and day. Understanding the spatio-temporal dynamics of places, activities, and exposure to PM2.5 can contribute to accurately assessing the health effect of PM2.5. The aim of this study is to examine the influence of visited places and activities on personal exposure to PM2.5 by two seasons and weekday/weekend using personal air pollution monitoring, travel surveys, and Global Positioning System (GPS) trajectory.

We performed a PM2.5 monitoring campaign for 54 participants in the Korean Genome and Epidemiology Study and the Korean Frailty and Aging Cohort Study in South Korea, from March 31 to June 20, 2023. During spring and summer, 50 and 54 senior participants were equipped with bags containing GPS devices and RTI MicroPEMs over five days. MicroPEMs collected real-time PM2.5 measurements which were corrected by gravimetric measurements and averaged for each hour afterwards. Participants also maintained hourly travel diaries, recording their activities, and visited places and move information which were cross-checked with the GPS data to enhance precision. Since activities, places, and moves of individuals are not exclusive, we combined these three and created 35 composite variables of the activity-place-move. The number of the activity-place-move variables was prune to 13, after we combined some activity-place-moves that were poorly correlated with PM2.5 (Pearson correlation coefficient < 0.01), were spent for few hours (< 10), or showed consistent PM2.5 concentrations with another activity-place-moves (PM2.5 difference < 1 $\mu g/m^3$). The final activity-place-move variables were move, outdoor, work at indoor, workout at indoor, cleaning at indoor, sleep at indoor, shower at indoor, preparing meals at home, preparing meals at non home indoor, eating at home, shopping at non-home indoor, eating at non-home indoor, and others at indoor. Then, we calculated the proportion of hours spent for each activity-place-move variable to the entire sampling hours until five days by four different season-day groups of spring/summer and weekday/weekend. We also computed the medians of 1-second PM2.5 concentrations over the entire sampling hours and log-transformed to approximate normality. Finally, we performed stratified analyses by using linear regression of individual log-transformed median PM2.5 concentrations on time proportions of 13 individual activity-place-moves, by spring-weekday, spring-weekend, summer-weekday, and summer-weekend.

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The mean of hourly PM2.5 concentrations was 15.15 (standard deviation [SD] = 15.08), 15.01 (16.59), 12.43 (11.73), and 13.28 (11.04) μg/m³ in spring-weekday, spring-weekend, summer-weekday, and summer-weekend, respectively. The stratified analyses showed the highest explanatory power in spring-weekend (R2=0.62) with much lower explainability in the other three season-days (R2=0.07-0.18). A 1% increase in time spent on ‘preparing meals at non-home-indoor’ was associated with a 1.92 and 1.17 μg/m³ decrease in PM2.5 personal exposure in spring-weekend and summer-weekend, respectively. However, this activity-place-move was not associated with PM2.5 in the other two seasons.
This study found some differences in the relationship between activity-place-move and personal exposure to PM2.5 depending on the season and day of the week. Future studies should compare our findings with previous evidence to provide partical guidance in activity and visited place to reduce personal air pollution exposure.

KEYWORDS: *$PM_{2.5}$, Spatio-temporal Variations, Time Activity, Season, weekdays and weekends*

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