A Study on Acute Effects of Ambient Air Particles on Pulmonary Function of Schoolchildren in Ulsan

Seung Do Yu*[1] · Dae-Seon Kim[1] · Jung Hoon Cha[1] · Seung Chul Ahn[1]
Jong Tae Lee[2]

[1]National Institute of Environmental Research, Incheon, 404-170 Korea
[2]College of Medicine, Ewha Womans Univeristy, Seoul, 120-750 Korea

Abstract

To evaluate the effect of air pollution on respiratory health in children, we conducted a longitudinal study in which children were asked to record their daily levels of peak expiratory flow rate using potable peak flow meter (mini-Wright) for 4 weeks. The relationship between daily PEFR and ambient air particle levels was analyzed using a mixed linear regression models including gender, age in year, weight, the presence of respiratory symptoms, and relative humidity as an extraneous variable. The daily mean concentrations of PM_{10} and $PM_{2.5}$ over the study period were 64.9$\mu g/m^3$ and 46.1$\mu g/m^3$, respectively. The range of daily measured PEFR in this study was 170-481 *l*/min. Daily mean PEFR was regressed with the 24-hour average PM_{10} (or $PM_{2.5}$) levels, weather information such as air temperature and relative humidity, and individual characteristics including sex, weight, and respiratory symptoms. The analysis showed that the increase of air particle concentrations was negatively associated with the variability in PEFR. We estimated that the IQR increment of PM_{10} or $PM_{2.5}$ were associated with 1.5 *l*/min (95% Confidence intervals -3.1, 0.1) and 0.8 *l*/min (95% CI -1.8, 0.1) decline in PEFR. Even though this study shows negative findings on the relationship between respiratory function and air particles, it is worth noting that the findings must be interpreted cautiously because exposure measurement based on monitoring of ambient air likely results in misclassification of true exposure levels and this is the first Korean study that $PM_{2.5}$ measurement is applied as an index of air particle quality.

Introduction

As information about the health risks associated with air pollution has become available, attention has focused increasingly on smaller air particles such as particulate matter with an aerodynamic diameter to or less than a 10 or 2.5 μm (PM_{10} or $PM_{2.5}$, respectively). A number of recent studies conducted in Asia, Europe and the United States have shown that acute exposure to current levels of air particles is associated with adverse health status, including mortality, hospital admissions due to asthma, severity of preexisting chronic illness,

low birth weight and pulmonary functions.

Our objective was to evaluate the relationship between ambient air particles and lung function measured by peak expiratory flow rate (PEFR) among school children.

This is a community-based diary study and uses a classic design for the respiratory effects of ambient air particles and uses longitudinal information for one month of follow-up starting from May 15, 2001 to June 12, 2001.

Materials and Method

Questionnaire :

This study was directed at the school children (3^{rd} and 6^{th} grades) surrounding the industrial complex of Ulsan. The participants were informed that they were part of an environmental study. Using the self-administered questionnaire written by a parent of each participating child, we obtained information on sociodemographic factors, preexisting respiratory illness and symptoms, and indoor air pollution sources.

PEFR(Peak Expiratory Flow Rate) :

Each child was provided with a mini-Wright peak flow meter and a preformatted health symptom diary for 4 weeks, and was trained on their proper use. Participant were instructed to perform the peak flow test three times in the standing position, three times daily (9 am, 12 pm, and 8 pm), and to record all the readings along with the symptoms (cold, cough, and asthmatic symptoms) experienced that day.

PM_{10} and $PM_{2.5}$:

Daily measurement of ambient air particles (PM_{10} and $PM_{2.5}$) were obtained in the corner of the playground of the participating elementary school during the month of this longitudinal study.

Statistical Analysis :

Because repeated observations are made on the same participant, the continuous response variable of lung function (PEFR) reported on successive days for 4 weeks is usually auto-correlated. The relationship between daily PEFR and ambient air particle levels was analyzed using a mixed linear regression models including gender, age in year, weight, the presence of respiratory symptoms, and relative humidity as an extraneous variable. The mixed model is a generalization of the standard linear model as follows [1]:

$$y = \chi \beta + Zu + \varepsilon$$

Where, u : unknown random-effects parameters,

β : fixed-effects parameters

[gender (male=0, female=1), age, height, respiratory symptom, PM_{10} or $PM_{2.5}$, relative humidity], u is an unknown vector of random effects with a design matrix Z.

y : daily average PEFR.

All statistical analyses were performed using the MIXED procedure in Windows/SAS Software version 6.12.

Results and Discussion

Characteristics of participants:

The total number of subjects participating in this longitudinal study was 271. About 57% of subjects were male students. There was no significant difference in height, age, and weight in male and female participants.

Daily PEFR :

The range of daily measured PEFR in this study was 170-481 *l*/min. Male students showed higher PEFR on average than female students did. In general, a PEFR measured in the morning was lower than a PEFR measured in the evening (or afternoon) on the same day.

Daily Concentrations of Ambient Air Particles (PM_{10} and $PM_{2.5}$) :

The daily mean concentrations of PM_{10} and $PM_{2.5}$ over the study period were 64.9$\mu g/m^3$ and 46.1$\mu g/m^3$, respectively. During the study period, the national air quality standard of 150 $\mu g/m^3$ was exceeded once. The analysis showed that an increase of 1$\mu g/m^3$ of PM_{10} corresponded to 0.42$\mu g/m^3$ increment of $PM_{2.5}$.

Association between Daily PEFR and Ambient Air Particles :

The relationship between PEFR and individual characteristics including age, sex, height, weight, experience of respiratory allergic symptoms has been studied. Gender, age, height, and experience of respiratory allergic symptoms were significantly represented the variation of PEFR.

Daily mean PEFR was regressed with the 24-hour average PM_{10} (or $PM_{2.5}$) levels, weather information such as air temperature and relative humidity, and individual characteristics including sex, weight, and respiratory symptoms. The analysis showed that the increase of air particle concentrations was negatively associated with the variability in PEFR. We estimated that the IQR increment of PM_{10} or $PM_{2.5}$ were associated with 1.5 *l*/min (95% Confidence

intervals -3.1, 0.1) and 0.8 l/min (95% CI -1.8, 0.1) decline in PEFR.

In the Six Cities study, which had the least statistical power, the association was very weak and and statistically insignificant. The results suggest that a $10\mu g/m^3$ increase in PM_{10} was associated with only small declines in lung function (typically about 1-3%). However, lung function measures have been shown to be important measures of health with remarkable predictive capacity for survival [2].

Furthermore, as reported in the 24-Cities study, the risk of relatively large deficts in lung function (less than 85% predicted) was much higer in the more polluted cities, suggesting detrimental effects of respirable particulates or particulate acidity on normal lung growth and development [3].

Conclusion

Our objective was to evaluate the relationship between ambient air particles and lung function measured by peak expiratory flow rate (PEFR) among school children. We conducted a community-based diary study and used a classic design for the respiratory effects of ambient air particles and uses longitudinal information for one month of follow-up starting from May 15, 2001 to June 12, 2001. The relationship between daily PEFR and ambient air particle levels was analyzed using a mixed linear regression models including gender, age in year, weight, the presence of respiratory symptoms, and relative humidity as an extraneous variable.

In conclusion, we did not find a significant association between outdoor levels of particulate matter and PEFR. Even though this study shows negative findings on the relationship between respiratory function and air particles, it is worth noting that the findings must be interpreted cautiously because exposure measurement based on monitoring of ambient air likely results in misclassification of true exposure levels and this is the first Korean study that $PM_{2.5}$ measurement is applied as an index of air particle quality.

References

1. Litteil, R.C., Milliken, G.A., Strope, W.W. and Wolfinger, R.D. : SAS System for Mixed Models: SAS Institute Inc, 1996.
2. Bates, D.V. : Altered Physiologic States and Associated Syndromes, *In* Respiratory Function in Disease. Philadelphia, Pennsylvania: W. B. Saunders Company, 1989.
3. Pope, C.A.III. and Dockery, D.W. : Epidemiology of Particle Effects, *In* Air Pollution and Health, London: Academic Press, 1999.