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	영문	Air pollution - A new risk factor in ischemic stroke mortality				
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<p>1. 목적</p> <p>Epidemiologic studies using time-series analysis have demonstrated an association between short-term exposure to air pollution and increased mortality, after adjusting for confounders. Meta-analysis of epidemiologic data has suggested that the relative risk of mortality is consistently increased by rising pollutant levels. Past studies have shown an association between air pollution and not only with respiratory mortality, but also with cardiovascular mortality. The involvement of cardiovascular disease is strongly supported by analyses showing associations between air pollution and hospital admissions for cardiovascular disease. Given these results, it is reasonable to hypothesize a similar situation might exist for stroke. However, little is known about the nature of the association between air pollution and stroke in spite of the health burden placed on the middle aged and the elderly. We hypothesize that air pollutants may have significant affects on mortality due to acute stroke events. In this analysis, we examined the association between air pollutants and ischemic and hemorrhagic stroke mortality. To investigate the nature of this relationship, we conducted a time-series study in Seoul, Korea, which has experienced a rapid rise in motor vehicle numbers. Seoul is an attractive location for such a study because stroke is a leading cause of death and the proportion of stroke death is higher than that in most western cities, giving us greater power to examine this outcome. We also investigated the lag times and exposure-response relationships between exposure to air pollutants and cause-specific stroke mortality.</p> <p>2. 방법</p> <p>A generalized additive model (GAM) was used to regress daily stroke death counts for each pollutant, controlling for time trends, day of the week, and meteorological influences such as same-day and previous day's temperature, relative humidity, and atmospheric pressure. Daily stroke mortality figures were fitted to the GAM, which included the locally weighted running-line smoother (loess) function of time, to capture seasonal and long-term trends. Autoregressive terms were inserted into the model to remove serial correlations of residuals. Smoothing parameters that minimized Akaike's Information Criteria were chosen to</p>						

capture short-term variations for day of the week and weather variables. Robust regression using M-estimation was utilized to reduce the influence of extreme observations on daily death counts. To minimize the influence of pollutant concentration outliers, we excluded air pollutant exposures exceeding 6 standard deviations above the mean. Because of the likelihood that air pollutants affect mortality after some time delay, lagged-day exposures of up to 4 days were examined. The lag effects on the relative risks of ischemic and hemorrhagic stroke mortality were plotted for each air pollutant. The associations between the levels of air pollutants singly and in combination and daily stroke mortality were evaluated. While our hypothesis testing for the pollutants used linear terms in the regression, we explored the shape of the dose-response relationship by fitting smooth functions of the pollutants.

3. 결과

The distributions of stroke mortality, meteorological measurements, and air pollution from the 1st January 1991 until the 31st December 1997 for the Seoul metropolitan area are shown in Table. An average of 2.8 and 4.6 people died of ischemic and hemorrhagic stroke in the city each day over the study period. The overall numbers of ischemic and hemorrhagic stroke deaths were 7,137 and 11,868. The number of deaths from ischemic stroke showed a slightly increasing trend but deaths due to hemorrhagic stroke showed a decreasing trend with seasonal fluctuation. Same day concentrations of primary pollutants [TSP, SO₂, NO₂, CO] were moderately to strongly correlated with each other, Pearson correlation coefficients ranged from 0.50 to 0.90. O₃ and temperature correlated negatively with the other pollutants. The Poisson regression model included time trends, day of the week and the weather variables. To determine the lag effects of air pollutants upon stroke mortality, the relative risks of different lag models, with a maximum lag of 4 days, were compared. The effects of air pollutants on ischemic stroke mortality were found to be statistically significant, whereas those on hemorrhagic stroke mortality were not statistically significant, except for TSP of the same day. The associations between TSP and SO₂ and ischemic stroke mortality were highest on the same day, whereas 1-day lagged concentrations of NO₂, CO, and 3-day lagged concentrations of O₃ showed the highest risk of ischemic stroke mortality. Table shows the estimated relative risks of ischemic stroke mortality attributable to each interquartile change in pollutant concentration after controlling for temporal trends, meteorological variables, and days of the week in single- and two-pollutant models. We observed estimated relative risks of 1.030 (95% CI: 0.997 to 1.064) and 1.041 (95% CI: 1.009 to 1.075) for ischemic stroke mortality for each interquartile range increase in TSP and SO₂ concentrations on the same day. We also found significantly increased relative risks of 1.04 (95% CI: 1.008 to 1.073) for NO₂ with a 1-day lag, 1.056 (95% CI: 1.022 to 1.091) for CO with a 1-day lag, and 1.057 (95% CI: 1.019 to 1.097) for O₃ with a 3-day lag for each interquartile range increase in single pollutant models. To consider the interrelationship between pollutants, we analyzed regression models for combinations of two pollutants. The associations of gaseous pollutants with ischemic stroke mortality were robust in two pollutant models, and the relative risk of ischemic stroke mortality with respect to TSP changed, but was without statistical significance, except in combination with O₃. The estimated log relative risk of ischemic stroke mortality for gaseous pollutants showed the exposure-response relationships in the GAM plot.

4. 고찰

We found that air pollution was statistically significantly associated with ischemic stroke mortality after taking into account time trends, day of the week, and meteorological variables. Relative risks for the pollutant increases were greater for ischemic stroke mortality than hemorrhagic stroke mortality, except for TSP on the same day.

Stroke is a very common cause of death and confers a great health risk on the middle aged and the elderly, especially in association with risk factors such as hypertension, diabetes mellitus, dyslipidemia, smoking, excessive alcohol consumption and atherosclerosis. However, if stroke is also associated with air pollution, the lowering the level of exposure could considerably reduce the associated health burden without relying on behavioral change.