

PARTICULATE AIR POLLUTION AND INFANT MORTALITY

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Air Resources Board
California Environmental Protection Agency



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Thank you Ms. Witherspoon. Good morning Chairman Lloyd and members of the Board. In today's Health Update we will discuss the results of two studies evaluating the possible association between particulate air pollution and infant mortality in Seoul, South Korea and the United States.

Although several studies have reported elevated incidence of mortality in the elderly in relation to particulate pollution, much less information exists on the adverse effects of particulate pollution in infants. Understanding the relationship between particulate pollution and infant mortality is very important, since infants may be especially vulnerable to air pollution.

METHODS

- **Seoul, South Korea**
- **Daily mortality records 1995-1999**
- **Few confounders adjusted for**
- **PM10, NO₂, SO₂, CO, O₃**
- **Risk of mortality calculated**



Ha EH. et al. Infant susceptibility of mortality to air pollution in Seoul, South Korea. *Pediatrics*. 2003;111:284-290.

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The first study is, "Infant susceptibility of mortality to air pollution in Seoul, South Korea". The purpose of this five year study was to compare the effects of air pollution on mortality among three groups: infants, defined as babies aged 1 month to 1 year, individuals aged 2 to 64 years old, and the elderly aged 65 and over. Investigators defined infants in this study as age 1 month to 1 year in order to limit the effects of pregnancy outcomes on mortality. However, conditions during pregnancy can influence mortality outcomes after one month of age. In addition, this study did not differentiate between low and normal birth weight. Premature birth and other risk factors were also not accounted for.

Seoul is the largest metropolitan city and the major air pollution sources are automobile exhaust and domestic heating. Pollutant measurements were taken from 27 monitoring sites, which represent all of the administrative zones in the city. Meteorological data were collected from a station in the central part of Seoul, and included temperature and relative humidity.

The investigators calculated the relative risk of respiratory mortality for changes in the level of air pollution on the same day as the mortality event. As is the case in many studies of this type, the investigators also looked at air pollution levels up to seven days before the mortality event and determined that using the air pollution data on the day of the mortality event gave them the most consistent and robust results.

RESULTS: Air Pollution

	PM10 ($\mu\text{g}/\text{m}^3$)	NO ₂ (ppb)	SO ₂ (ppb)	CO (ppm)	O ₃ (ppb)
Mean	69.2	32.5	11.1	1.2	12.9
Median	64.2	31.4	8.9	1.1	19.4
Min	10.5	10.2	2.4	0.4	2.9
Max	245.4	65.1	46.0	3.4	69.1



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The air pollution data for the time period of the study are presented here. Although data were collected on an hourly basis, 24 hour averages were constructed for PM10, nitrogen dioxide, sulfur dioxide, and carbon monoxide. For ozone, daily 8 hour averages were constructed. The data shown are the mean, median, minimum and maximum 24 hour levels of pollutants, except for ozone, which relates to an 8 hour level.

The mean PM10 level in Seoul is higher than the mean in the Los Angeles Air Basin of California, although the range in the Los Angeles Air Basin is larger.

RESULTS: PM10 & respiratory mortality

- Infants at greatest risk

Age	1 month-1 year	2-64 years	≥65 years
% Increase in Risk*	102%	6.6%	6.3%



* Per 43 $\mu\text{g}/\text{m}^3$ increase in PM10

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The investigators found that exposure to PM10 was associated with increased respiratory mortality in infants 1 month to 1 year old. Infant mortality increased by 102% for each 43 micrograms per cubic meter increase in PM10. Although mortality in other age groups was significantly associated with PM10, the effect size was smaller, 6.6% in persons aged 2 to 64 and 6.3% in those over 65.

The advantage of this study was that the authors were able to compare the association between respiratory mortality and PM10 across the population. The finding that infants were most at risk of respiratory mortality from increased exposure to PM10 relative to the other age groups lends credence to the idea that infants may be especially vulnerable to the adverse effects of air pollution.

Relevant U.S. Study

- Infants born 1989-1991 in the U.S.
- PM10 data from EPA's Aerometric Database
 - PM10 range: 11.9-68.8 $\mu\text{g}/\text{m}^3$
- 20% increase in infant mortality per 10 $\mu\text{g}/\text{m}^3$ increase in PM10



Woodruff T.J. et al. The Relationship between Selected Causes of Postneonatal Infant Mortality and Particulate Air Pollution in the United States. Environmental Health Perspectives 1997; 105:608-612.

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Now, I would like to change our focus to a study concerning air pollution and infant mortality conducted in the United States. Woodruff and colleagues conducted a study to evaluate the relationship between infant mortality and particulate pollution in several metropolitan areas across the United States.

Infants born between 1989 and 1991 were eligible for the study. As in the paper from Seoul, an infant was defined as babies between 1 month and 1 year old. For this study, an infant's exposure was considered to be the mean of the PM10 levels for the first 2 months of life. The range of PM10 exposures in this study was from 11.9 to 68.8 micrograms per cubic meter.

Because it is known that many factors may influence an infant's risk of mortality, the authors took into account the effects of maternal education, marital status, maternal race, maternal smoking during pregnancy, average temperature, and year and month of birth when they built their models for statistical analysis. Even with adjustment for all of these factors, infant mortality increased with increasing PM10 levels. Infant respiratory mortality among normal birth weight infants increased 20% per 10 micrograms per cubic meter increase in PM10.

Conclusions

- **PM exposure associated with infant mortality from respiratory causes**
- **Studies add to our knowledge of the significant PM health effects**
- **ETS and other important factors were not considered**
- **Studies looked only at outdoor concentration**



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The main conclusion of both studies is that PM10 is significantly related to infant mortality due to respiratory causes even in the United States. These studies add to our knowledge of the significant health effects of PM10 in infants.

There are several limitations to both of these papers that should be noted. The authors in the Seoul paper did not take into account important factors such as maternal smoking or education. Neither study considered exposure to environmental tobacco smoke, or ETS.

Another limitation that should be addressed is the fact that both studies looked at only outdoor concentrations of pollutants. Infants, especially infants less than a year old, spend most of their time indoors. It is unclear, therefore, how representative the outdoor concentrations of pollutants were of the infant's true exposure .

Future investigators need to take these important limitations into account when designing and conducting studies to understand the relationship between infant mortality and air pollution.