

(1991 ~1994 )

1 . 2 . 1 . 1  
1  
2

Abstract

Air particulate matters and daily mortality in Ulsan, Korea

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A large number of studies have indicated associations between particulate air pollution and daily mortality. Daily measurements of total suspended particulates (TSP) by high volume air sampler were matched to daily death counts supplied by the National Statistics Office, Korea. All deaths, except deaths from accidents, occurred at Ulsan from 1 January 1991 to 31 December 1994 were considered in the poisson regression analysis. The multiple regression models were used to investigate a main effects of air particulate pollution controlling for SO<sub>2</sub> levels, air temperature, relative humidity, seasonal variation, and calendar year. The results indicated that the effects of TSP, SO<sub>2</sub>, temperature, and relative humidity were not significantly associated with all cause mortality. It could, however, be emphasized that the size of the parameter estimate of TSP was very similar to that of previous studies. An increase in particulates of 100 $\mu\text{g}/\text{m}^3$  was associated with a 3% increase in mortality. This relationship was observed at TSP levels well below the current National Ambient Air Quality Standard of 150 $\mu\text{g}/\text{m}^3$  in Korea as well.

Key words: air pollution, air particulate pollution, mortality



가

, ,

가

가

가

가

가

가

(Pope , 1991; Hoek Brunekreef, 1993)

(Pope , 1991)

가

가

(sulfate aerosols)

가

(Schwartz, 1996).

가

(Fairley, 1990; Pope , 1992; Pope Kalkstein, 1996; Saldiva , 1995;

Schwartz Dockery, 1992; Schwartz, 1994; Schwartz , 1996).

Schwartz (1994) Ostro (1993)

가  $100\mu\text{g}/\text{m}^3$  가

3~5%

가

가

1991

1994

4

가

## II.

1.

1)

2)

1991 1 1 1994 12 31

가 800 (ICD 9<sup>th</sup> 800),

3)

가

( , , , ) 가

(TSP)

( )

가

가

24

가

20

2.

가

0

24

1991

가

가

가

가

가

5%

5~90%

90%

가

90%

1991 1994 가  
 가 4.6 4.8 가  
 Liang Zeger(1986) Generalized Estimation Equation( GEEs)  
 Statistical Analysis System  
 SAS/ STAT Software, Version 6.12 PROC GENMOD

$$\log [E ( Y )] = \beta X$$

X E(Y)  
 가 24

exchangeable correlation 가 covariance  
 structure , (Y<sub>ij</sub>) correlation r<sub>ik</sub>=  
 (where i k), exchangeable correlation

$$Corr( Y_{ij}, Y_{ik} ) = \begin{cases} 1, & j = k \\ \alpha, & j \neq k \end{cases}$$

i (i=1991, 1992, 1993, 1994) , j  
 (j=1, 2, 3,..., 365) Y<sub>ij</sub>  
 가 -

$$cov( Y_{ij}, Y_{ik} ) = \Phi A_i^{1/2} R(\alpha) A_i^{1/2}$$

A<sub>i</sub> Y<sub>ij</sub> 가 dispersion parameter

### III.

1 가 4 가 150µg/  
 m<sup>3</sup> 0.05ppm 가 16%가 가  
 가 6% 가 ,

가 . 가

( >27.6 ) ( <0.8 )

가 0.8 27.6

90% 가

1991 가

가

SO<sub>2</sub> 가 100 $\mu$ g/ m<sup>3</sup> 가

5% 3%가 가

가

U J 가

가 가

가 가

( 720,000~740,000 )

가

3

(60 ) (15 , 60 )

15 가 가

가

**IV.**

가 가



(Styer, 1995) 가

가

PM<sub>10/2.5</sub>

surveillance system 가

가 Seaton (1995) 가

(Burnett, 1995; Schwartz, Morris, 1995; Peters, 1997). 가 가 (Seaton, 1995).

## V.

1952 가

가 가

100µg/ m<sup>3</sup> 가 3~5%

( 100µg/ m<sup>3</sup> 가 3% )  
 ( =0.05 ) 가

SO<sub>2</sub>

가 Schwartz(1994)가

가

가 가

가

가가



(PM<sub>10/2.5</sub>)

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. 1996

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Table 1. Summary information on the distribution of daily mortality, weather, and selected air pollutants in Ulsan, 1991-1994

| Parameter                                     | Number of days | Mean (Standard deviation) |
|---|----------------|---------------------------|
| Deaths/ day                                   | 1460           | 4.6 (2.2)                 |
| TSP <sup>1</sup> ( $\mu\text{g}/\text{m}^3$ ) | 1223           | 75.3 (32.1)               |
| SO <sub>2</sub> (ppb)                         | 1366           | 32.7 (13.7)               |
| 24-hr mean temperature ( )                    | 1460           | 14.0 (8.5)                |
| 24-hr mean humidity (%)                       | 1460           | 65.7 (16.5)               |

<sup>1</sup>TSP: Total Suspended Particulate

Table 2. Poisson regression analysis of daily mortality and total suspended particulate using GEE<sup>1</sup> approach, Ulsan, 1991-1994

| Variable  | Estimated Coefficient (SE <sup>1</sup> ) | RR <sup>1</sup> (95% CI <sup>1</sup> ) |
|---|--|--|
| Intercept                                       | 1.13 (0.08)                              | -                                      |
| TSP <sup>1</sup> (100 $\mu$ g/ m <sup>3</sup> ) | 0.03 (0.02)                              | 1.03 (0.99-1.07)                       |
| Hot day <sup>2</sup>                            | 0.06 (0.04)                              | 1.07 (0.98-1.16)                       |
| Cold day <sup>2</sup>                           | 0.18 (0.12)                              | 1.20 (0.94-1.53)                       |
| Humiday <sup>3</sup>                            | 0.09 (0.05)                              | 1.09 (0.98-1.21)                       |
| Winter <sup>4</sup>                             | 0.20 (0.03)                              | 1.22 (1.14-1.30)                       |
| Spring <sup>4</sup>                             | 0.20 (0.05)                              | 1.23 (1.11-1.34)                       |
| Fall <sup>4</sup>                               | 0.12 (0.01)                              | 1.13 (1.11-1.15)                       |
| 92year  | 0.04 (0.00)                              | 1.04 (1.04-1.04)                       |
| 93year  | 0.14 (0.00)                              | 1.15 (1.15-1.16)                       |
| 94year  | 0.16 (0.02)                              | 1.18 (1.14-1.21)                       |

<sup>1</sup>GEE: Generalized Estimating Equation; SE: Standard Error; RR: Relative Risk; CI: Confidence Interval; and TSP: Total Suspended Particulate

<sup>2</sup>Hot day>27.6 ; Cold day<0.8

<sup>3</sup>Humiday>90%

<sup>4</sup>Winter: Dec, Jan, Feb; Spring: Mar, Apr, May; Fall: Sep, Oct, Nov

Table 3. Adjusted relative risks (per  $100\mu\text{g}/\text{m}^3$  change in TSP<sup>1</sup>) from Poisson regression using GEE<sup>1</sup> approach in different age groups

| Group by age     | RR <sup>1</sup> (95% CI <sup>1</sup> ) | Average daily deaths |
|------------------|--|----------------------|
| All ages         | 1.03 (0.99-1.07)                       | 4.6                  |
| Age 60           | 0.98 (0.96-1.01)                       | 2.7                  |
| Age<15 or Age 60 | 1.00 (0.98-1.02)                       | 2.9                  |
| 15 Age<60        | 1.06 (0.94-1.20)                       | 1.7                  |
| Age<15           | 1.22 (0.86-1.73)                       | 0.2                  |

<sup>1</sup>TSP: Total Suspended Particulate; GEE: Generalized Estimating Equation; RR: Relative Risks; and CI: Confidence Interval

Table 4. Comparisons of daily average death counts in several cities

| City                     | Time period | Population | Average daily deaths |
|--------------------------|-------------|------------|----------------------|
| Athens                   | 1987~1991   | 2,000,000  | 35                   |
| London                   | 1987~1991   | 7,200,000  | 176                  |
| Paris                    | 1987~1990   | 6,140,000  | 130                  |
| Mexico City <sup>1</sup> | 1990~1992   | 2,082,000  | 25                   |
| Köln                     | 1977~1989   | 740,000    | 18                   |
| Utah County              | 1985~1989   | 260,000    | 2.7                  |
| Philadelphia             | 1973~1980   | 1,688,710  | 48.2                 |
| Ulsan                    | 1991~1994   | 740,000    | 4.6                  |

<sup>1</sup>Southeast area of Mexico City

Table 5. Comparisons of mortality characteristics between Ulsan and the whole country, 1994

| Area          | Number of population aged 60 (%) | Number of deaths defined as ICD <sup>1</sup> <800 (%) |
|---------------|----------------------------------|---|
| Whole country | 3,861,859/ 44,453,179<br>(8.7)   | 198,661/ 230,677<br>(86.1)                            |
| Ulsan         | 30,662/ 767,093<br>(4.0)         | 6,785/ 8,724<br>(77.8)                                |

<sup>1</sup>ICD: International Classification of Deaths, 9th