

Short-term Effect of Air Pollution on Respiratory Disease
in Seoul : A Case-Crossover Design

2000 8

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1.	17
2.	24
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1.	36
2.	41
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	55

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가

1995 11 1 1996 10 31

3 7, 14, 21 6 1, 2, 3 1

6가

30ppb 가 24
1.91(95% CI = 1.78-2.05)
24 O₃ SO₂, O₃ NO₂, O₃
CO, O₃ TSP, O₃ PM₁₀ 1

가 가 1.87(95% CI=1.73- 2.03)

가

: , , , ,

•

1.

가

1930 12 Meuse vally, 1948 10 Donora, 1952 12 London,
1955 8 Los Angeles 가

.

(, , ,)

) ,

가

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가

(Logan, 1953; , 1989; , 1997).

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(,

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, , , ,

, , , ,

가

, , , ,

,

(, 1997).

가

가 (Lippmann, 1989).

가

가

가

가

가

가

가

가

가

가

2.

(1)

(smog)

가

가

(NO_x)

(NO_x)

(HC)

HC NO_x

(, 1991).

20- 30ppb

13,000ppb

1,500- 2,000ppb

2

, 2,500ppb

(Dix, 1981).

가

가

. Bates (1983)

1

. Ponka(1991)

,
65

50µg/ m³ 가 1.244

(Schwartz , 1993). White (1994) 1990 6 8

1- 16

가 가 0.11ppm

가 37%

가 . 1994 65

(Schwartz, 1994). Romieu (1995)

가

, 가

. Stieb (1996) 1984 1992

가

16 1981 1991

720,519 30ppb 가

1.024- 1.043 (Burmett , 1997).

12

(O₃, NO₂, SO₂, PM₁₀) 가

10µg/ m³ 가 (Wong , 1999).

(1999) 1994 1997
 200 General
 Additive Poisson Model 100ppb 가
 1.30- 1.62 (2000)
 가 1970
 1979 LA
 (Kimney , 1991). 1987 1992
 가
 percentile 가 10 percentile 90
 3.5% (95%
 1.7% - 5.3%) 가 , 3.5% (95% 1.04% - 6.1%),
 5.4% (95% 0.4% - 10.7%) 가
 (Anderson , 1996).
 (1999)
 가 가
 가 , (, 1998). (1999)
 Equation 가 General Estimating

(2) 가

, 가

(SO_x)

1

.

,

가

2.5 μ m

2.5 μ m

. 1987

EPA

(, TSP)

10 μ m

(PM₁₀)

. PM₁₀

가

가

1995

PM₁₀

Pennsylvania

Philadelphia

TSP 100 μ g/ m³ 가

7% (95% CI = 1.04- 1.10) 가

가 100 μ g/ m³ 가

5% 가

가

. TSP

가

(Schwartz, 1992).

TSP 100 μ g/ m³ 가

6% (95% CI = 1.05- 1.07)

(Schwartz, 1994)

65

가

PM₁₀ 가

(Saldiva , 1995).

가 ,

가

가

가 (Touloumi, 1994). 6

가 가 가

1.26(95% CI = 1.08- 1.47)

가 (Dockery, 1993).

가 가

. Ohio

가 . TSP(24

) 가 $100\mu\text{g}/\text{m}^3$ 가

가 3% 가 (Samet, 1981).

5 (1985- 1989)

가 , 가 (Sunyer, 1993).

Ponka (1994) 1987 3

, , SO_2 NO_2

(1998) PM_{10}

, (1997)

가 . (1994)

, 가 ,

(3)

(NO)
 (NO₂) (NO_x)
 가 NO₂ (hydrocarbon)
 가 2
 가
 가 ,
 가 , 가

(4)

가
 가 가 가
 , 가 ,
 가
 carboxy hemoglobin(COHb)
 가

3. (Case - crossover design)

1)

1991

Maclure

“the Onset study”

- (case-crossover design)

(Maclure, 1991).

가

가 ,

가

(Mittleman , 1995)

2)

가

(control period)

(1)

(Unidirectional Pair-matched and multiple interval approach)

2
() ()
1:1
1 2 , 4
, ..., 1
1:N

(2) (Bidirectional Case-crossover design)

Navidi(1998)

가

가

RR

()

가

가

가

가

가

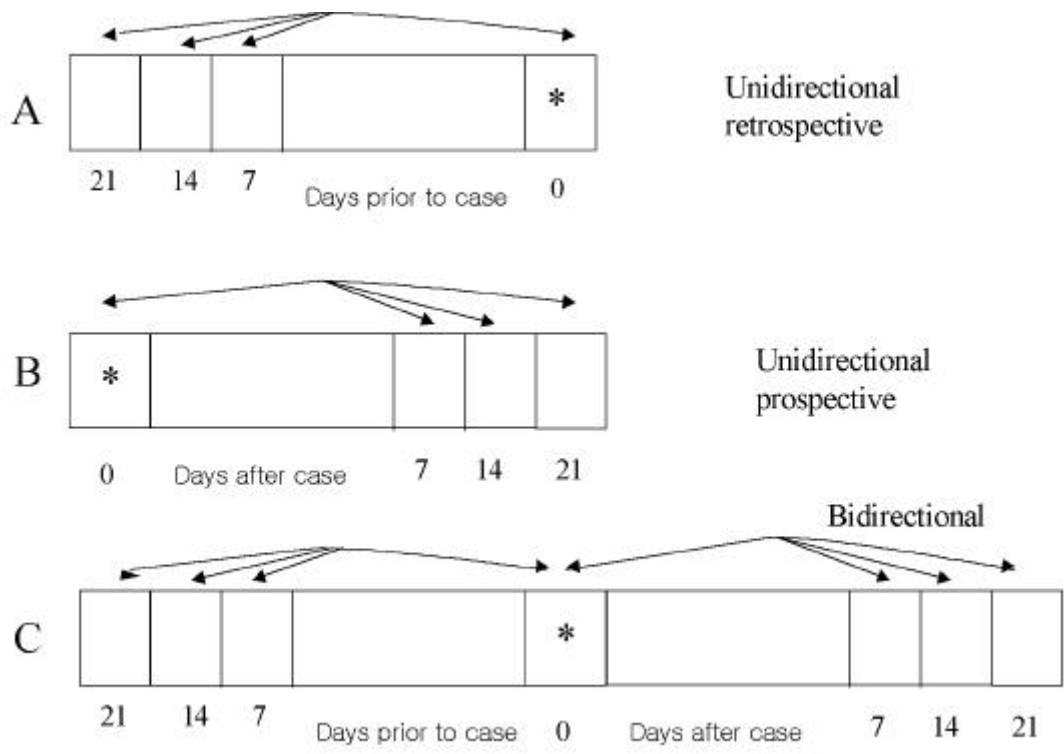


Fig 1. Control selection method

4.

1.

가

2.

,

.

,

(medical utilization data

of unscheduled visit by respiratory diseases)

가

.

. 24 24 ,
9 5
8 8 .

(2)

1
15m . 3
가

(3)

, ,
, , / , , , , , , ,
.

(medical utilization data of
unscheduled visit by respiratory diseases) . 1996

가 , ,
.
,

가 가 가

ICD- 10 code

J20;

J21;

J40;

J41;

J42;

J43;

J44;

J45;

J46;

J96;

J99;

가

1996

1995

1996

1995

11 1

1996 10 31

. 1996

30,898

1995 11

1 1996 10 31

27,952

. , 2

, 18,959

2.

가 (Lee, 1999)

Navidi(1998)가

(bidirectional control period

selection)

7, 14, 21

6

7, 14, 21

1

24

, 24

, 8

가

6가

1

(one

pollutant model) 6가

2

(two pollutants model)

, 24

, 24

, 8

1, 2, 3

가

, 가 ,

30ppb 가 ,

$30\mu\text{g}/\text{m}^3$ 가

1.

1995 11 1 1996 10 31

81 (Table 1).

1 10 - 12 3 - 5

가

가 .(Figure. 2.)

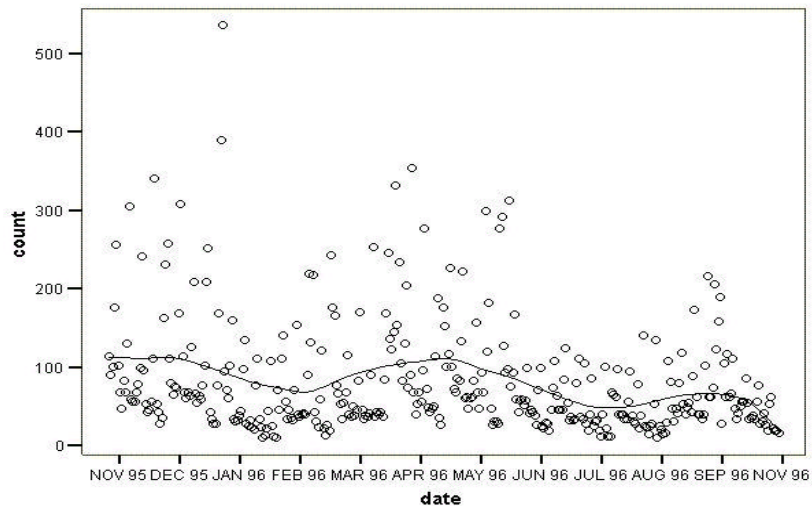


Figure 2. Daily counts of respiratory emergency visits

, 가 , , , ,

15.6ppb, 13.9ppb, 32.9ppb, 12.6ppb, $86.4\mu\text{g}/\text{m}^3$, $76.4\mu\text{g}/\text{m}^3$,

12.7 , 64.5% . 가 , ,

가

(Table 1).

Table 1. Distribution of emergency respiratory disease visits, 24hr means of air pollutants, temperature and relative humidity

Variable	Mean	Standard deviation	Min ¹⁾	Percentile			Max ²⁾
				25th	50th	75th	
Emergency visits	81.4	71.6	9	36	58	100	536
O ₃ (ppb)	15.6	7.2	3.7	9.5	14.8	20.8	41.1
SO ₂ (ppb)	13.9	7.3	3.7	8.1	12.0	18.0	36.9
NO ₂ (ppb)	32.9	9.4	12.1	25.9	31.8	39.5	57.0
CO (ppb)	12.6	4.6	6.3	9.6	11.2	13.9	33.8
TSP (μg/m ³)	86.4	38.5	20.3	58.3	82.6	109.4	265.2
PM ₁₀ (μg/m ³)	73.4	31.7	22.3	50.4	70.0	90.0	236.9
Temperature ()	12.7	6.7	-13.6	5.3	14.6	22.7	31.3
Relative humidity (%)	64.5	20.8	30.3	54.8	65.9	74.3	93.2

1) Min. : minimum

2) Max. : maximum

Table 2, 3, 4

(O₃, SO₂, CO, NO₂, TSP, PM₁₀)

가

가 24 -0.01 가 ,
 가 -0.50 가 ,
 , 가 가

Table 3. Pearson Correlation Coefficients for 24hr maximum of air pollutants

Variable	O ₃	SO ₂	NO ₂	CO	TSP	PM ₁₀	Temperature	Humidity
O ₃	1	-0.200*	-0.024	-0.267*	-0.027	-0.118	0.593*	-0.156 [#]
SO ₂		1	0.537*	0.492*	0.418*	0.373*	-0.381*	-0.159 [#]
NO ₂			1	0.504*	0.579*	0.415*	-0.089	-0.051
CO				1	0.439*	0.314*	-0.192	0.031
TSP					1	0.544*	-0.064	0.070
PM ₁₀						1	-0.191 [#]	0.053
Temperature							1	0.583*
Humidity								1
* P - value	0.0001							
# P - value	0.005							

Table 4. Pearson Correlation Coefficients for 8hr means of air pollutants

Variable	O ₃	SO ₂	NO ₂	CO	TSP	PM ₁₀	Temperature	Humidity
O ₃	1	-0.397*	-0.214*	-0.495*	-0.096	-0.120	0.586*	-0.116
SO ₂		1	0.752*	0.849*	0.731*	0.765*	-0.488*	-0.179 [#]
NO ₂			1	0.759*	0.774*	0.781*	-0.071	-0.118
CO				1	0.763*	0.765*	-0.393*	0.022
TSP					1	0.975*	-0.113	0.082
PM ₁₀						1	-0.157 [#]	0.050
Temperature							1	0.583*
Humidity								1
* P - value	0.0001							
# P - value	0.005							

11 - 2

가 3

5 - 7

가 .(Figure. 3)

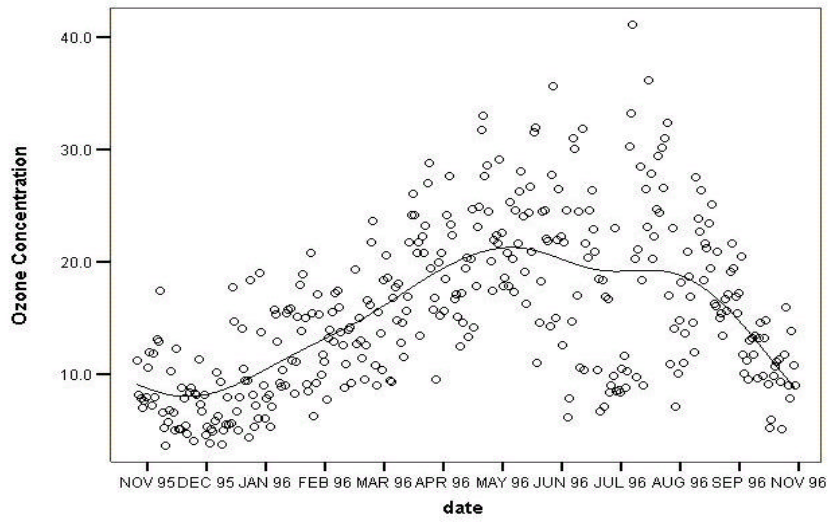


Figure 3. Daily mean O₃ concentration

11 - 1

가

가 7 - 8

가

(Figure. 4)

(Figure. 5).

(Figure. 6),

(Figure. 7)

(Figure.8)

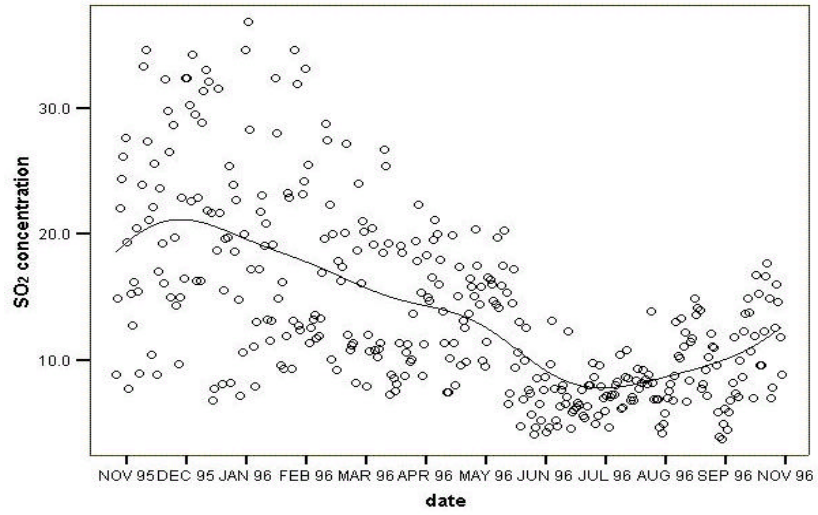


Figure 4. Daily mean SO₂ concentration

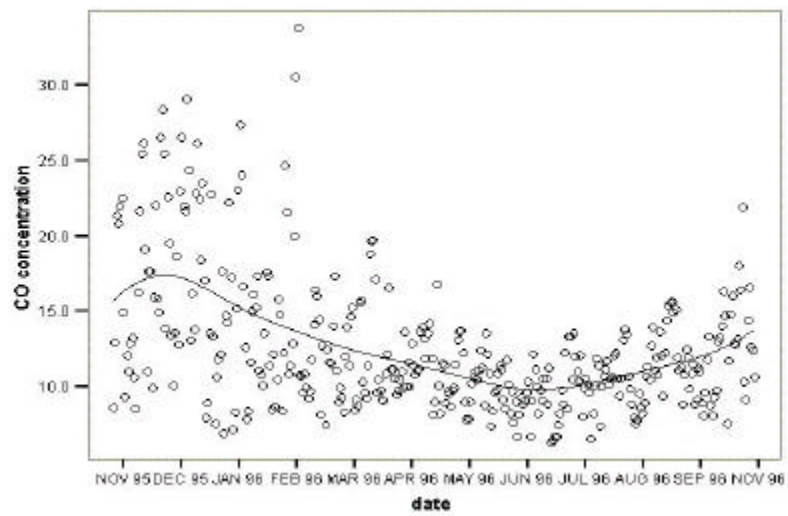


Figure 5. Daily mean CO concentration

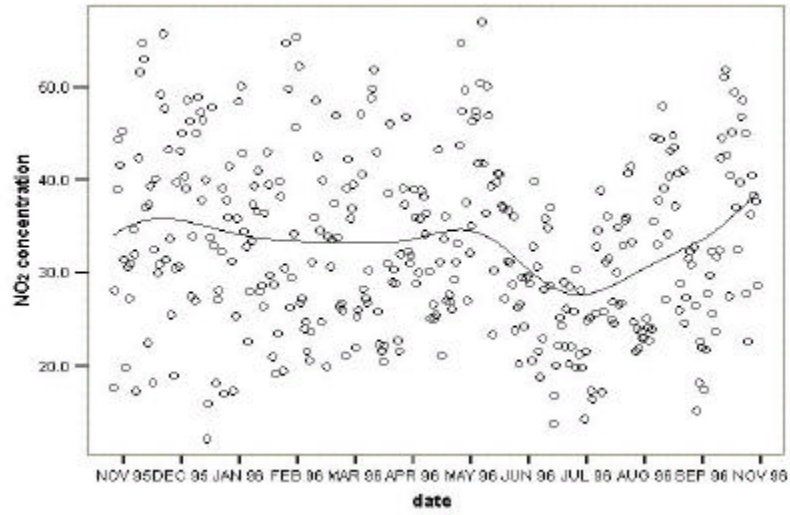


Figure 6. Daily mean NO₂ concentration

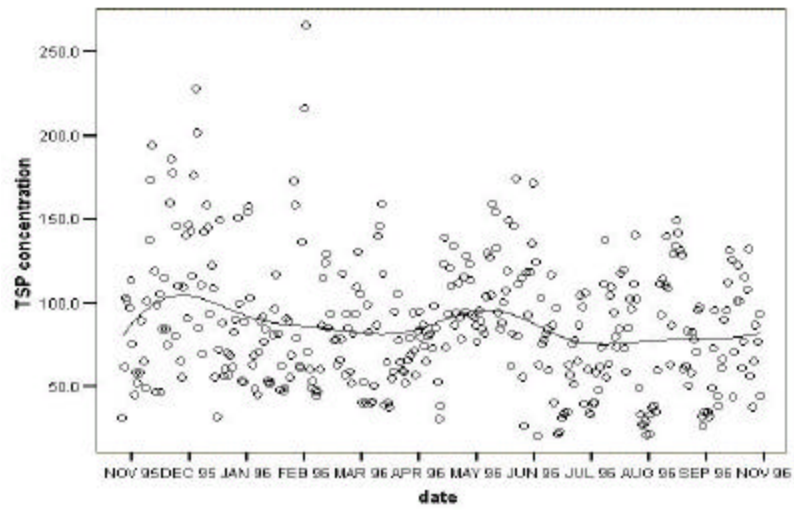


Figure 7. Daily mean TSP concentration

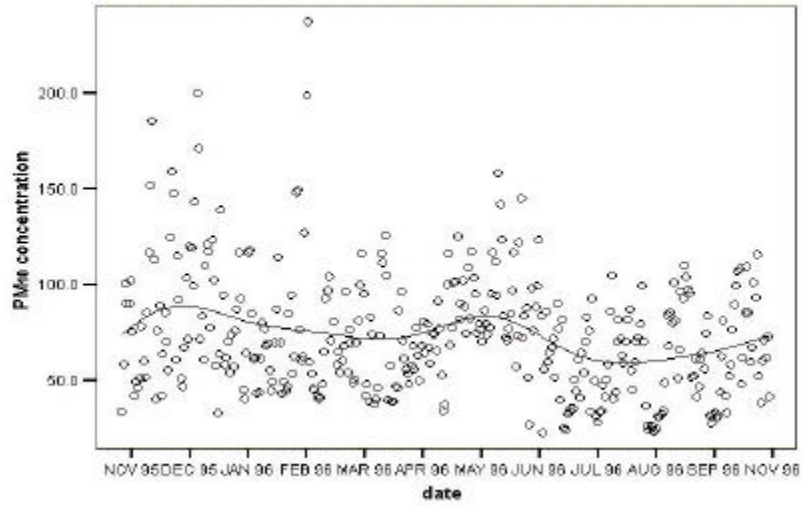


Figure 8. Daily mean PM₁₀ concentration

2.

6가

,
 24, 8,
 24, 1,
 가 .

one pollutant model

two pollutants model

, 24

1

one pollutant model

1.910 1.008

(SO₂, NO₂, CO, TSP, PM₁₀)

		. Two pollutants model						24
		O ₃	SO ₂ , O ₃	NO ₂ , O ₃	CO, O ₃	TSP	O ₃	PM ₁₀
	가							가
								1.879(95% CI=1.739- 2.031)
24		O ₃	SO ₂ , O ₃	NO ₂ , O ₃	CO, O ₃	TSP		O ₃
PM ₁₀	1					1.007	1.027	
								가
3					SO ₂	CO		CO가
					(1.003	1.118).	NO ₂	CO
3					CO			1.060(95% CI=1.033-
1.087)					Table 3.	CO	SO ₂	NO ₂
가	0.49, 0.50							
								가
8		O ₃	SO ₂ , O ₃	NO ₂ , O ₃	CO, O ₃	TSP		O ₃
PM ₁₀	1					O ₃		
								가

Table 5. Relative risk at one pollutant model of O₃, SO₂, NO₂, CO, TSP, PM₁₀ with various lag times

Pollutant		RR ³⁾ (95% CI ⁴⁾)		
		lag 1 day	lag 2 day	lag 3 day
O ₃ ¹⁾	24hr mean	1.910 (1.778-2.053)	1.327 (1.237-1.423)	1.634 (1.522-1.754)
	24hr max ⁵⁾	1.008 (0.987-1.029)	0.922 (0.903-0.941)	0.922 (0.903-0.941)
	8hr mean	1.387 (1.328-1.449)	0.985 (0.944-1.029)	1.082 (1.036-1.130)
SO ₂ ¹⁾	24hr mean	0.777 (0.728-0.830)	0.617 (0.578-0.659)	0.590 (0.554-0.629)
	24hr max ⁵⁾	0.935 (0.924-0.946)	0.931 (0.920-0.942)	0.909 (0.899-0.918)
	8hr mean	0.822 (0.775-0.872)	0.781 (0.737-0.828)	0.719 (0.679-0.760)
NO ₂ ¹⁾	24hr mean	0.764 (0.733-0.796)	0.706 (0.678-0.736)	0.687 (0.661-0.715)
	24hr max ⁵⁾	0.927 (0.913-0.940)	0.905 (0.891-0.918)	0.908 (0.895-0.922)
	8hr mean	0.779 (0.752-0.808)	0.783 (0.756-0.811)	0.767 (0.741-0.793)
CO ¹⁾	24hr mean	0.605 (0.550-0.667)	0.504 (0.459-0.554)	0.536 (0.490-0.586)
	24hr max ⁵⁾	0.957 (0.934-0.980)	0.934 (0.912-0.957)	0.975 (0.952-0.997)
	8hr mean	0.619 (0.555-0.690)	0.667 (0.601-0.740)	0.589 (0.534-0.649)
TSP ²⁾	24hr mean	0.944 (0.934-0.954)	0.937 (0.927-0.946)	0.952 (0.943-0.962)
	24hr max ⁵⁾	0.994 (0.991-0.996)	0.985 (0.982-0.987)	0.989 (0.986-0.991)
	8hr mean	0.957 (0.948-0.966)	0.953 (0.944-0.961)	0.959 (0.951-0.967)
PM ₁₀ ²⁾	24hr mean	0.944 (0.932-0.956)	0.943 (0.931-0.955)	0.962 (0.951-0.973)
	24hr max ⁵⁾	0.995 (0.992-0.998)	0.993 (0.991-0.996)	0.992 (0.989-0.995)
	8hr mean	0.963 (0.953-0.974)	0.964 (0.954-0.974)	0.971 (0.961-0.980)

1) O₃, SO₂, NO₂, CO : RR for the increase of 30 ppb

2) TSP, PM₁₀ : RR for the increase of 30 µg/m³

3) RR : Relative Risk

4) CI : Confidence Interval

5) max : Maximum

Table 6. Relative risk at two pollutants model of O₃, SO₂, NO₂, CO, TSP, PM₁₀ with various lag times using 24hr mean values

Pollutant (24hr mean)	RR ³⁾ (95% CI ⁴⁾)		
	lag 1 day	lag 2 day	lag 3 day
O ₃	1.879 (1.739- 2.031)	1.127 (1.045- 1.214)	1.365 (1.265- 1.474)
SO ₂	0.961 (0.895- 1.031)	0.640 (0.598- 0.686)	0.653 (0.611- 0.699)
O ₃	1.737 (1.610- 1.875)	1.117 (1.038- 1.203)	1.327 (1.230- 1.433)
NO ₂	0.846 (0.810- 0.884)	0.720 (0.690- 0.752)	0.729 (0.698- 0.760)
O ₃	1.806 (1.669- 1.954)	1.105 (1.024- 1.193)	1.413 (1.307- 1.527)
CO	0.830 (0.748- 0.922)	0.530 (0.479- 0.587)	0.639 (0.579- 0.704)
O ₃	1.844 (1.715- 1.983)	1.260 (1.173- 1.352)	1.550 (1.442- 1.667)
TSP	0.953 (0.943- 0.963)	0.941 (0.931- 0.950)	0.963 (0.954- 0.973)
O ₃	1.857 (1.727- 1.997)	1.277 (1.190- 1.371)	1.588 (1.477- 1.707)
PM ₁₀	0.955 (0.943- 0.968)	0.948 (0.936- 0.960)	0.976 (0.965- 0.988)
SO ₂	1.504 (1.327- 1.704)	0.990 (0.869- 1.127)	0.955 (0.839- 1.086)
NO ₂	0.613 (0.566- 0.663)	0.710 (0.654- 0.771)	0.705 (0.650- 0.766)
SO ₂	1.141 (1.009- 1.289)	0.750 (0.662- 0.849)	0.570 (0.506- 0.642)
CO	0.515 (0.430- 0.616)	0.720 (0.601- 0.862)	1.061 (0.896- 1.256)
SO ₂	1.010 (0.921- 1.108)	0.681 (0.620- 0.748)	0.537 (0.491- 0.588)
TSP	0.943 (0.929- 0.957)	0.979 (0.965- 0.993)	1.020 (1.006- 1.034)
SO ₂	0.921 (0.839- 1.010)	0.574 (0.522- 0.631)	0.450 (0.411- 0.493)
PM ₁₀	0.954 (0.937- 0.972)	1.019 (1.001- 1.038)	1.072 (1.054- 1.090)
NO ₂	0.765 (0.714- 0.820)	0.736 (0.687- 0.788)	0.644 (0.601- 0.690)
CO	0.994 (0.847- 1.165)	0.890 (0.761- 1.042)	1.195 (1.026- 1.392)
NO ₂	0.800 (0.751- 0.852)	0.699 (0.656- 0.744)	0.594 (0.559- 0.631)
TSP	0.985 (0.969- 1.000)	1.003 (0.988- 1.019)	1.048 (1.033- 1.063)
NO ₂	0.747 (0.702- 0.794)	0.624 (0.587- 0.664)	0.536 (0.506- 0.569)
PM ₁₀	1.009 (0.990- 1.029)	1.051 (1.032- 1.071)	1.103 (1.084- 1.122)
CO	0.804 (0.690- 0.938)	0.568 (0.487- 0.662)	0.471 (0.404- 0.548)
TSP	0.961 (0.945- 0.977)	0.984 (0.967- 1.000)	1.018 (1.001- 1.034)
CO	0.664 (0.570- 0.772)	0.409 (0.351- 0.476)	0.325 (0.279- 0.378)
PM ₁₀	0.984 (0.965- 1.004)	1.036 (1.015- 1.057)	1.086 (1.064- 1.108)

1) O₃, SO₂, NO₂, CO : RR for the increase of 30 ppb

2) TSP, PM₁₀ : RR for the increase of 30 µg/ m³

3) RR : Relative Risk

4) CI : Confidence Interval

Table 7. Relative risk at two pollutants model of O₃, SO₂, NO₂, CO, TSP, PM₁₀ with various lag times using 24hr maximum values

Pollutant (24hr max ⁵⁾)	RR ³⁾ (95% CI ⁴⁾)		
	lag 1 day	lag 2 day	lag 3 day
O ₃	1.010 (0.989- 1.031)	0.921 (0.902- 0.941)	0.916 (0.897- 0.935)
SO ₂	0.935 (0.924- 0.946)	0.931 (0.920- 0.942)	0.907 (0.898- 0.917)
O ₃	1.027 (1.006- 1.049)	0.941 (0.921- 0.961)	0.934 (0.914- 0.954)
NO ₂	0.924 (0.910- 0.938)	0.911 (0.897- 0.925)	0.912 (0.899- 0.926)
O ₃	1.007 (0.986- 1.028)	0.918 (0.898- 0.937)	0.920 (0.901- 0.940)
CO	0.957 (0.934- 0.981)	0.928 (0.906- 0.951)	0.970 (0.948- 0.993)
O ₃	1.013 (0.992- 1.034)	0.931 (0.911- 0.951)	0.925 (0.905- 0.945)
TSP	0.994 (0.991- 0.996)	0.986 (0.983- 0.988)	0.989 (0.986- 0.991)
O ₃	1.010 (0.989- 1.031)	0.924 (0.905- 0.944)	0.921 (0.902- 0.941)
PM ₁₀	0.995 (0.992- 0.997)	0.994 (0.991- 0.997)	0.992 (0.989- 0.995)
SO ₂	0.952 (0.939- 0.965)	0.959 (0.946- 0.973)	0.921 (0.909- 0.933)
NO ₂	0.958 (0.942- 0.975)	0.930 (0.914- 0.947)	0.966 (0.949- 0.983)
SO ₂	0.931 (0.920- 0.943)	0.930 (0.918- 0.943)	0.885 (0.874- 0.896)
CO	1.018 (0.991- 1.046)	1.003 (0.976- 1.031)	1.118 (1.088- 1.148)
SO ₂	0.936 (0.924- 0.947)	0.949 (0.937- 0.961)	0.913 (0.902- 0.924)
TSP	0.999 (0.997- 1.002)	0.989 (0.987- 0.992)	0.997 (0.995- 1.000)
SO ₂	0.936 (0.925- 0.948)	0.934 (0.922- 0.945)	0.907 (0.897- 0.918)
PM ₁₀	0.998 (0.995- 1.001)	0.998 (0.995- 1.000)	1.001 (0.998- 1.004)
NO ₂	0.921 (0.906- 0.937)	0.901 (0.886- 0.917)	0.892 (0.877- 0.907)
CO	1.020 (0.993- 1.048)	1.011 (0.985- 1.039)	1.060 (1.033- 1.087)
NO ₂	0.920 (0.903- 0.936)	0.928 (0.911- 0.946)	0.918 (0.902- 0.935)
TSP	1.002 (0.999- 1.006)	0.992 (0.989- 0.995)	0.997 (0.994- 1.000)
NO ₂	0.928 (0.914- 0.942)	0.906 (0.892- 0.921)	0.910 (0.895- 0.925)
PM ₁₀	0.999 (0.996- 1.002)	0.999 (0.996- 1.002)	0.999 (0.996- 1.002)
CO	0.978 (0.952- 1.005)	1.000 (0.973- 1.027)	1.032 (1.006- 1.059)
TSP	0.995 (0.992- 0.998)	0.985 (0.982- 0.988)	0.987 (0.984- 0.990)
CO	0.965 (0.941- 0.989)	0.944 (0.921- 0.968)	0.994 (0.970- 1.019)
PM ₁₀	0.996 (0.993- 0.998)	0.995 (0.992- 0.998)	0.992 (0.989- 0.995)

1) O₃, SO₂, NO₂, CO : RR for the increase of 30 ppb

2) TSP, PM₁₀ : RR for the increase of 30 µg/ m³

3) RR : Relative Risk

4) CI : Confidence Interval

5) max : maximum

Table 8. Relative risk at two pollutants model of O₃, SO₂, NO₂, CO, TSP, PM₁₀ with various lag times using 8hr mean values

Pollutant (8hr mean)	RR ³⁾ (95% CI ⁴⁾)		
	lag 1 day	lag 2 day	lag 3 day
O ₃	1.369 (1.310- 1.430)	0.964 (0.923- 1.006)	1.042 (0.998- 1.089)
SO ₂	0.867 (0.817- 0.920)	0.777 (0.733- 0.824)	0.724 (0.684- 0.767)
O ₃	1.339 (1.281- 1.400)	0.940 (0.900- 0.982)	1.004 (0.960- 1.050)
NO ₂	0.806 (0.777- 0.836)	0.777 (0.750- 0.805)	0.767 (0.741- 0.794)
O ₃	1.346 (1.286- 1.408)	0.939 (0.898- 0.981)	1.010 (0.965- 1.057)
CO	0.749 (0.670- 0.838)	0.641 (0.575- 0.714)	0.593 (0.535- 0.656)
O ₃	1.404 (1.344- 1.467)	0.990 (0.948- 1.033)	1.071 (1.025- 1.118)
TSP	0.953 (0.945- 0.962)	0.953 (0.944- 0.961)	0.960 (0.951- 0.968)
O ₃	1.396 (1.336- 1.458)	0.988 (0.946- 1.031)	1.073 (1.028- 1.121)
PM ₁₀	0.960 (0.950- 0.971)	0.964 (0.954- 0.974)	0.972 (0.962- 0.981)
SO ₂	1.531 (1.381- 1.697)	1.363 (1.226- 1.516)	1.158 (1.043- 1.285)
NO ₂	0.628 (0.589- 0.669)	0.669 (0.627- 0.714)	0.712 (0.668- 0.758)
SO ₂	1.048 (0.948- 1.159)	0.830 (0.749- 0.920)	0.784 (0.709- 0.867)
CO	0.577 (0.479- 0.694)	0.877 (0.731- 1.053)	0.835 (0.701- 0.993)
SO ₂	1.027 (0.939- 1.122)	0.968 (0.886- 1.058)	0.751 (0.690- 0.817)
TSP	0.954 (0.941- 0.968)	0.956 (0.943- 0.970)	0.991 (0.978- 1.004)
SO ₂	0.897 (0.819- 0.982)	0.799 (0.730- 0.875)	0.612 (0.561- 0.668)
PM ₁₀	0.979 (0.962- 0.996)	0.995 (0.978- 1.011)	1.038 (1.022- 1.054)
NO ₂	0.713 (0.670- 0.757)	0.679 (0.640- 0.721)	0.708 (0.668- 0.751)
CO	1.395 (1.164- 1.670)	1.674 (1.406- 1.992)	1.319 (1.116- 1.557)
NO ₂	0.755 (0.715- 0.797)	0.787 (0.746- 0.830)	0.727 (0.692- 0.764)
TSP	1.011 (0.997- 1.025)	0.998 (0.985- 1.012)	1.018 (1.006- 1.031)
NO ₂	0.683 (0.646- 0.722)	0.698 (0.662- 0.736)	0.645 (0.613- 0.678)
PM ₁₀	1.054 (1.036- 1.072)	1.047 (1.030- 1.064)	1.070 (1.054- 1.086)
CO	0.809 (0.680- 0.963)	1.086 (0.917- 1.287)	0.652 (0.554- 0.768)
TSP	0.971 (0.956- 0.986)	0.947 (0.933- 0.961)	0.989 (0.975- 1.003)
CO	0.604 (0.509- 0.718)	0.725 (0.612- 0.858)	0.425 (0.361- 0.501)
PM ₁₀	1.003 (0.986- 1.021)	0.989 (0.972- 1.007)	1.043 (1.025- 1.061)

1) O₃, SO₂, NO₂, CO : RR for the increase of 30 ppb

2) TSP, PM₁₀ : RR for the increase of 30 µg/ m³

3) RR : Relative Risk

4) CI : Confidence Interval

Table 9. Relative risk at one pollutants model of retrospective selection with various lag times using 24hr mean values

Pollutant		RR ³⁾ (95% CI ⁴⁾)		
		lag 1 day	lag 2 day	lag 3 day
O ₃ ¹⁾	7days before	2.263 (2.036-2.516)	1.121 (1.016- 1.237)	1.805 (1.630- 1.998)
	14days before	2.962 (2.683- 3.271)	1.692 (1.542- 1.856)	1.842 (1.674- 2.025)
	21days before	2.416 (2.187- 2.668)	1.517 (1.384- 1.663)	1.785 (1.626- 1.959)
SO ₂ ¹⁾	7days before	0.719 (0.659- 0.785)	0.608 (0.560- 0.661)	0.574 (0.530- 0.622)
	14days before	0.532 (0.488- 0.579)	0.485 (0.444- 0.529)	0.550 (0.507- 0.597)
	21days before	0.374 (0.342- 0.409)	0.326 (0.300- 0.355)	0.513 (0.474- 0.555)
NO ₂ ¹⁾	7days before	0.727 (0.688- 0.768)	0.721 (0.684- 0.760)	0.681 (0.647- 0.717)
	14days before	0.692 (0.656- 0.730)	0.663 (0.628- 0.699)	0.728 (0.691- 0.766)
	21days before	0.665 (0.631- 0.701)	0.637 (0.605- 0.671)	0.750 (0.713- 0.788)
CO ¹⁾	7days before	0.552 (0.486- 0.626)	0.583 (0.517- 0.658)	0.492 (0.439- 0.552)
	14days before	0.354 (0.312- 0.401)	0.369 (0.326- 0.417)	0.561 (0.501- 0.629)
	21days before	0.310 (0.274- 0.350)	0.273 (0.242- 0.306)	0.525 (0.470- 0.587)
TSP ²⁾	7days before	0.951 (0.939- 0.964)	0.956 (0.944- 0.969)	0.975 (0.962- 0.987)
	14days before	0.951 (0.938- 0.964)	0.923 (0.910- 0.935)	0.963 (0.951- 0.976)
	21days before	0.927 (0.915- 0.939)	0.915 (0.904- 0.927)	0.977 (0.966- 0.988)
PM ₁₀ ²⁾	7days before	0.943 (0.929- 0.958)	0.955 (0.940- 0.970)	0.971 (0.956- 0.986)
	14days before	0.958 (0.942- 0.975)	0.925 (0.910- 0.940)	0.977 (0.962- 0.993)
	21days before	0.917 (0.903- 0.932)	0.912 (0.898- 0.927)	0.999 (0.978- 1.007)

1) O₃, SO₂, NO₂, CO : RR for the increase of 30 ppb

2) TSP, PM₁₀ : RR for the increase of 30 µg/ m³

3) RR : Relative Risk

4) CI : Confidence Interval

Table 10. Relative risk at one pollutants model of prospective selection with various lag times using 24hr mean values

Pollutant		RR ³⁾ (95% CI ⁴⁾)		
		lag 1 day	lag 2 day	lag 3 day
O ₃ ¹⁾	7days after	1.343 (1.208- 1.493)	1.238 (1.119- 1.369)	1.805 (1.630- 1.998)
	14days after	2.063 (1.870- 2.277)	1.536 (1.395- 1.690)	1.842 (1.674- 2.025)
	21days after	1.567 (1.424- 1.724)	1.105 (1.008- 1.210)	1.785 (1.626- 1.959)
SO ₂ ¹⁾	7days after	1.144 (1.045- 1.251)	0.718 (0.660- 0.782)	0.574 (0.530- 0.622)
	14days after	1.013 (0.929- 1.104)	0.690 (0.634- 0.751)	0.550 (0.507- 0.597)
	21days after	1.354 (1.238- 1.482)	1.196 (1.093- 1.309)	0.513 (0.474- 0.555)
NO ₂ ¹⁾	7days after	0.966 (0.912- 1.024)	0.721 (0.684- 0.760)	0.681 (0.647- 0.717)
	14days after	0.746 (0.708- 0.787)	0.663 (0.628- 0.699)	0.728 (0.691- 0.766)
	21days after	0.850 (0.806- 0.897)	0.637 (0.605- 0.671)	0.750 (0.713- 0.788)
CO ¹⁾	7days after	1.050 (0.921- 1.196)	0.583 (0.517- 0.658)	0.492 (0.439- 0.552)
	14days after	0.744 (0.653- 0.848)	0.369 (0.326- 0.417)	0.561 (0.501- 0.629)
	21days after	1.134 (0.995- 1.293)	0.273 (0.242- 0.306)	0.525 (0.470- 0.587)
TSP ²⁾	7days after	0.937 (0.924- 0.950)	0.956 (0.944- 0.969)	0.975 (0.962- 0.987)
	14days after	0.933 (0.920- 0.946)	0.923 (0.910- 0.935)	0.963 (0.951- 0.976)
	21days after	0.963 (0.950- 0.977)	0.915 (0.904- 0.927)	0.977 (0.966- 0.988)
PM ₁₀ ²⁾	7days after	0.941 (0.926- 0.956)	0.955 (0.940- 0.970)	0.971 (0.956- 0.986)
	14days after	0.929 (0.914- 0.946)	0.925 (0.910- 0.940)	0.977 (0.962- 0.993)
	21days after	0.982 (0.965- 1.000)	0.912 (0.898- 0.927)	0.9992(0.978- 1.007)

1) O₃, SO₂, NO₂, CO : RR for the increase of 30 ppb

2) TSP, PM₁₀ : RR for the increase of 30 $\mu\text{g}/\text{m}^3$

3) RR : Relative Risk

4) CI : Confidence Interval

Table 11. Relative risk at one pollutants model of retrospective selection with various lag times using 24hr maximum values

Pollutant		RR ³⁾ (95% CI ⁴⁾)		
		lag 1 day	lag 2 day	lag 3 day
O ₃ ¹⁾	7days before	1.044 (1.014- 1.076)	0.895 (0.871-0.921)	0.990 (0.962- 1.019)
	14days before	1.113 (1.080- 1.147)	0.961 (0.932-0.991)	1.021 (0.989- 1.054)
	21days before	1.059 (1.033- 1.087)	0.989 (0.965- 1.015)	0.966 (0.941- 0.991)
SO ₂ ¹⁾	7days before	0.925 (0.912-0.939)	0.955 (0.941-0.970)	0.903 (0.890-0.916)
	14days before	0.868 (0.856-0.881)	0.896 (0.882- 0.910)	0.894 (0.881- 0.906)
	21days before	0.829 (0.816-0.842)	0.861 (0.849-0.874)	0.865 (0.854- 0.877)
NO ₂ ¹⁾	7days before	0.884 (0.867-0.901)	0.901 (0.883-0.919)	0.902 (0.884- 0.920)
	14days before	0.842 (0.826-0.859)	0.845 (0.827- 0.862)	0.898 (0.881- 0.916)
	21days before	0.876 (0.860-0.892)	0.848 (0.832-0.864)	0.898 (0.881- 0.915)
CO ¹⁾	7days before	0.804 (0.778-0.830)	0.848 (0.822-0.875)	0.861 (0.836- 0.888)
	14days before	0.852 (0.825-0.880)	0.864 (0.837- 0.892)	0.958 (0.929- 0.988)
	21days before	0.858 (0.831-0.885)	0.836 (0.812- 0.861)	0.938 (0.912- 0.965)
TSP ²⁾	7days before	0.990 (0.987-0.993)	0.986 (0.983- 0.989)	0.996 (0.993- 0.999)
	14days before	1.001 (0.997- 1.005)	0.981 (0.978- 0.984)	0.994 (0.991- 0.997)
	21days before	0.989 (0.985-0.992)	0.983 (0.980- 0.986)	0.997 (0.994- 1.000)
PM ₁₀ ²⁾	7days before	0.983 (0.980-0.986)	0.985 (0.982- 0.988)	0.995 (0.992- 0.999)
	14days before	0.999 (0.996- 1.003)	0.997 (0.993- 1.000)	0.998 (0.994- 1.002)
	21days before	0.993 (0.990-0.997)	0.991 (0.988- 0.995)	0.987 (0.984- 0.990)

1) O₃, SO₂, NO₂, CO : RR for the increase of 30 ppb

2) TSP, PM₁₀ : RR for the increase of 30 $\mu\text{g}/\text{m}^3$

3) RR : Relative Risk

4) CI : Confidence Interval

Table 12. Relative risk at one pollutants model of prospective selection with various lag times using 24hr maximum values

Pollutant		RR ³⁾ (95% CI ⁴⁾)		
		lag 1 day	lag 2 day	lag 3 day
O ₃ ¹⁾	7days after	0.898 (0.872- 0.926)	0.845 (0.821-0.869)	0.796 (0.773- 0.819)
	14days after	0.950 (0.922- 0.979)	0.919 (0.891-0.947)	0.861 (0.934- 0.888)
	21days after	0.993 (0.968- 1.018)	0.916 (0.892- 0.939)	0.906 (0.882- 0.929)
SO ₂ ¹⁾	7days after	0.992 (0.978- 1.007)	0.960 (0.946-0.975)	0.922 (0.910- 0.935)
	14days after	1.009 (0.994- 1.025)	0.950 (0.935- 0.965)	0.923 (0.910- 0.936)
	21days after	1.000 (0.985- 1.015)	0.973 (0.959- 0.988)	0.964 (0.951- 0.977)
NO ₂ ¹⁾	7days after	0.985 (0.965- 1.005)	0.907 (0.889- 0.925)	0.876 (0.860- 0.893)
	14days after	0.985 (0.966- 1.004)	0.942 (0.924- 0.961)	0.908 (0.891- 0.926)
	21days after	0.998 (0.979- 1.017)	0.991 (0.972- 1.010)	1.001 (0.982- 1.022)
CO ¹⁾	7days after	1.031 (0.996- 1.067)	0.925 (0.896- 0.954)	0.970 (0.941- 1.001)
	14days after	1.063 (1.027- 1.100)	1.011 (0.978- 1.045)	1.001 (0.981- 1.042)
	21days after	1.241 (1.199- 1.285)	1.194 (1.155- 1.233)	1.128 (1.094- 1.163)
TSP ²⁾	7days after	0.999 (0.995- 1.003)	0.985 (0.981- 0.988)	0.985 (0.982- 0.989)
	14days after	0.998 (0.995- 1.002)	0.982 (0.978- 0.985)	0.978 (0.975- 0.981)
	21days after	0.987 (0.984- 0.990)	0.992 (0.989- 0.995)	0.983 (0.980- 0.986)
PM ₁₀ ²⁾	7days after	0.996 (0.993- 0.999)	0.997 (0.994- 1.000)	0.995 (0.991- 0.998)
	14days after	1.000 (0.996- 1.003)	0.993 (0.990- 0.997)	0.984 (0.980- 0.988)
	21days after	1.004 (1.001- 1.008)	1.000 (0.997- 1.004)	0.992 (0.988- 0.995)

1) O₃, SO₂, NO₂, CO : RR for the increase of 30 ppb

2) TSP, PM₁₀ : RR for the increase of 30 $\mu\text{g}/\text{m}^3$

3) RR : Relative Risk

4) CI : Confidence Interval

Table 13. Relative risk at one pollutants model of retrospective selection with various lag times using 8hr mean values

Pollutant		RR ³⁾ (95% CI ⁴⁾)		
		lag 1 day	lag 2 day	lag 3 day
O ₃ ¹⁾	7days before	1.433 (1.344- 1.527)	0.844 (0.794- 0.897)	1.102 (1.036- 1.172)
	14days before	1.734 (1.632- 1.844)	1.076 (1.015- 1.141)	1.166 (1.096- 1.240)
	21days before	1.516 (1.431- 1.605)	1.046 (0.991- 1.103)	1.168 (1.106- 1.233)
SO ₂ ¹⁾	7days before	0.809 (0.746- 0.876)	0.745 (0.692- 0.802)	0.674 (0.627- 0.725)
	14days before	0.627 (0.582- 0.676)	0.644 (0.596- 0.696)	0.690 (0.642- 0.742)
	21days before	0.529 (0.489- 0.571)	0.480 (0.446- 0.517)	0.695 (0.648- 0.745)
NO ₂ ¹⁾	7days before	0.783 (0.747- 0.822)	0.802 (0.766- 0.839)	0.742 (0.710- 0.775)
	14days before	0.699 (0.668- 0.731)	0.723 (0.690- 0.757)	0.793 (0.758- 0.828)
	21days before	0.733 (0.700- 0.768)	0.712 (0.681- 0.744)	0.791 (0.759- 0.825)
CO ¹⁾	7days before	0.633 (0.545- 0.734)	0.706 (0.615- 0.811)	0.467 (0.410- 0.532)
	14days before	0.367 (0.320- 0.421)	0.475 (0.416- 0.542)	0.601 (0.533- 0.679)
	21days before	0.517 (0.449- 0.595)	0.448 (0.393- 0.510)	0.755 (0.670- 0.852)
TSP ²⁾	7days before	0.965 (0.953- 0.977)	0.964 (0.952- 0.976)	0.971 (0.960- 0.983)
	14days before	0.958 (0.947- 0.970)	0.926 (0.915- 0.937)	0.969 (0.958- 0.980)
	21days before	0.951 (0.940- 0.962)	0.935 (0.925- 0.946)	0.983 (0.973- 0.994)
PM ₁₀ ²⁾	7days before	0.960 (0.946- 0.974)	0.966 (0.953- 0.980)	0.965 (0.952- 0.977)
	14days before	0.962 (0.948- 0.976)	0.929 (0.916- 0.942)	0.985 (0.972- 0.998)
	21days before	0.951 (0.938- 0.964)	0.935 (0.923- 0.948)	0.993 (0.981- 1.005)

1) O₃, SO₂, NO₂, CO : RR for the increase of 30 ppb

2) TSP, PM₁₀ : RR for the increase of 30 $\mu\text{g}/\text{m}^3$

3) RR : Relative Risk

4) CI : Confidence Interval

Table 14. Relative risk at one pollutants model of prospective selection with various lag times using 8hr mean values

Pollutant		RR ³⁾ (95% CI ⁴⁾)		
		lag 1 day	lag 2 day	lag 3 day
O ₃ ¹⁾	7days after	1.297 (1.215- 1.385)	0.938 (0.881-0.998)	0.925 (0.870- 0.984)
	14days after	1.427 (1.341- 1.518)	1.064 (1.003- 1.128)	1.200 (1.129- 1.276)
	21days after	1.248 (1.181- 1.318)	0.963 (0.913- 1.016)	1.052 (0.996- 1.111)
SO ₂ ¹⁾	7days after	1.018 (0.938- 1.106)	0.809 (0.749-0.874)	0.709 (0.659- 0.763)
	14days after	0.957 (0.884- 1.035)	0.879 (0.814-0.949)	0.689 (0.640- 0.741)
	21days after	1.233 (1.137- 1.337)	1.478 (1.362- 1.605)	0.869 (0.805- 0.938)
NO ₂ ¹⁾	7days after	0.919 (0.874- 0.967)	0.789 (0.752-0.829)	0.760 (0.727- 0.794)
	14days after	0.747 (0.712- 0.784)	0.768 (0.733-0.805)	0.713 (0.682- 0.745)
	21days after	0.822 (0.783- 0.862)	0.892 (0.851- 0.935)	0.779 (0.744- 0.815)
CO ¹⁾	7days after	0.891 (0.761- 1.043)	0.692 (0.600- 0.799)	0.604 (0.532- 0.685)
	14days after	0.587 (0.505- 0.681)	0.690 (0.598- 0.795)	0.464 (0.408- 0.528)
	21days after	0.858 (0.741- 0.994)	1.234 (1.072- 1.421)	0.662 (0.584- 0.750)
TSP ²⁾	7days after	0.953 (0.941- 0.965)	0.934 (0.923- 0.946)	0.946 (0.935- 0.957)
	14days after	0.943 (0.931- 0.955)	0.959 (0.947- 0.971)	0.924 (0.913- 0.935)
	21days after	0.968 (0.956- 0.980)	0.997 (0.985- 1.010)	0.946 (0.936- 0.957)
PM ₁₀ ²⁾	7days after	0.962 (0.948- 0.976)	0.954 (0.940- 0.967)	0.960 (0.948- 0.973)
	14days after	0.953 (0.939- 0.968)	0.979 (0.964- 0.994)	0.937 (0.923- 0.950)
	21days after	0.994 (0.979- 1.009)	1.023 (1.009- 1.039)	0.965 (0.952- 0.977)

1) O₃, SO₂, NO₂, CO : RR for the increase of 30 ppb

2) TSP, PM₁₀ : RR for the increase of 30 µg/ m³

3) RR : Relative Risk

4) CI : Confidence Interval

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1.

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가 (Navidi, 1998).

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(selection bias),

(information bias),

(confounding bias) 3가

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(selection bias)

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bias) 가 (information
(misclassification) 가
가 (nondifferential
misclassification)가 가
가
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가 (differential
misclassification)가
(recall bias) .
가 가 가 .
가
가 .

(confounding bias)

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가

. Navidi(1998)

PM₁₀

Neas(1999)

가 0.014

0.012

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. Lee

(1999)

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1 , 2 , 3)

(Table.5)

(Table.9,11,13)

(Table 10,12,14)

가 1

, 2 , 3 (Fig 1. A)

1 , 2 , 3

1 , 2 , 3 (Fig 1. B)

1 , 2 , 3

(Fig 1. C)

24 1

7 2.263(95%CI=2.036- 2.516), 14 2.962(95%CI=2.683- 3.271), 21

2.416(95%CI=2.187- 2.668) , 7 1.343

(95%CI=1.2.08- 1.493), 14 2.063(95%CI=1.870- 2.277), 21 1.567

(95%CI=1.424- 1.724)

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 3 가 .
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2.

가 가
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 (, 1998; , 2000)
 10.1%
 85.0% 가 .
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 (National Ambient
 Air Quality Standard) ,

가 (, 1991).

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가 (Kleeberger, 1995). 가 (Van Rooij, 1994).

가 (, 1995; , 1996; 1997).

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(Mumtaz , 1995).

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(Liu, 1997)

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1995 11 1

1996 10 31

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SO₂

24

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1.910(95%CI=1.778- 2.553)

가 30ppb

가

1.91

가

가

24

O₃

SO₂, O₃

NO₂, O₃

CO, O₃

TSP, O₃

PM₁₀

1

가

가

1.87(95%CI=1.73- 2.03)

가

가

1997; 13(5) : 333-343

1999; 32(2) : 191-199

1994 3 11 - 17

1995; 11(3) : 263-272

1997; 23(1) : 137-145

1991; 7(1) : 67-71

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1994; 16(1) : 6-19

2000; 33(1) : 76-82

1998; 31(3) : 460-470

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- 1994). 1998; 31(1) : 82-90

, Dockery DW,
(1991 - 1995). 1999; 32(2) : 177- 182

1998; 10(3) : 333- 342

2000; 12(2) : 249- 257

, 1997; 193- 203

1991; 7(3) : 169- 179

1989; 32(12) : 1272- 1278

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1998

, 1999

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1995; 17(1) : 64- 75

1996; 12(4) : 389- 393

, 1994; 217- 229

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= Abstract =

**Short - term Effect of Air Pollution on Respiratory Disease
in Seoul : A Case-Crossover Design**

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Graduate School of
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Yonsei University

(Directed by Professor Jong-Tae Lee)

It is well known that short-term increase in air pollution such as those that occurred in developed countries during this century, are associated with an increased number of death, hospital admission and hospital emergency room visits especially among those with preexisting illnesses like cardiovascular disease and chronic respiratory disease. This study was designed and conducted to evaluate the hypothesis that increased emergency room visits for medical utilization data of unscheduled visit by respiratory diseases, and if so, to quantify the strength of association between those.

Daily counts of emergency room visits for respiratory disease, air quality, and weather data were collected. We compiled daily records of hospital emergency room visits in Seoul from November 1. 1995 to October 31. 1996. Daily respiratory disease emergency room visits were regressed on temperature, humidity, day of week indications seasonal variation indications and air pollution. Each pollutant was first examined individually and then two pollutants model were fitted.

Lately the case-crossover design that was newly developed by Malculare has been being introduced in the fields of air pollution epidemiology. This study,

using case-crossover design search a relationship between air pollutants and emergency room visits for respiratory disease.

We analyzed the data by conditional logistic regression used when matched case-control study is analysed. Control periods were chosen by bidirectional paired matching technic 7, 14, 21days before and after case periods.

Only ozone was associated with increased risk of emergency room visits for respiratory disease. The relative risk of respiratory emergency room for 30ppb increase in ozone (24hr mean, lagged 1day) was 1.91(95% confidence interval; 1.78-2.05) and we observed that.

In conclusion, there was statistically significant association between ambient levels of ozone and daily counts of emergency room visits for respiratory disease. So, we have to exert our efforts to minimize the air pollution effectively to protect public health from air pollution.

Key words : air pollution, ozone, conditional logistic regression, case-crossover design, emergency room visit