The Impact of Air Pollution on Short-Term Mortality and Long-Term Clinical Outcomes of AMI Patients.

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Disclosure Information

I have nothing to disclose.

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Backgrounds (1)

1. Air pollution (AP) and metrological factors are well-known to be closely associated with cardiovascular diseases.

1. Miller *et al.* The New England journal of medicine. 2007
2. Mann et al. Environmental health perspectives. 2002

2. Our previous study has shown that exposure to cold or hot temperatures, or significant temperature change was associated with myocardial infarction (MI) risk.

Lee SJ, Rha SW et al. Plos One. 2014

Backgrounds (2)

PLOS | ONE

Short-Term Effect of Temperature on Daily Emergency Visits for Acute Myocardial Infarction with Threshold Temperatures

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Conclusions: We found a relationship between temperature and MI occurrence during both heat and cold exposure at the threshold temperature. Diurnal temperature or temperature change on successive days also increased MI risk.

Lee SJ, Rha SW et al. Plos One. 2014

Backgrounds (3)

3.   Acute myocardial infarction (AMI) is one of major ischemic heart diseases (IHD), and is closely associated with mortality and repeat-cardiovascular events.

4.   However, there is limited data whether there are significant association between the AP and cardiovascular events in AMI patients (pts), particularly in a series of Asian population.

Plausible Mechanisms
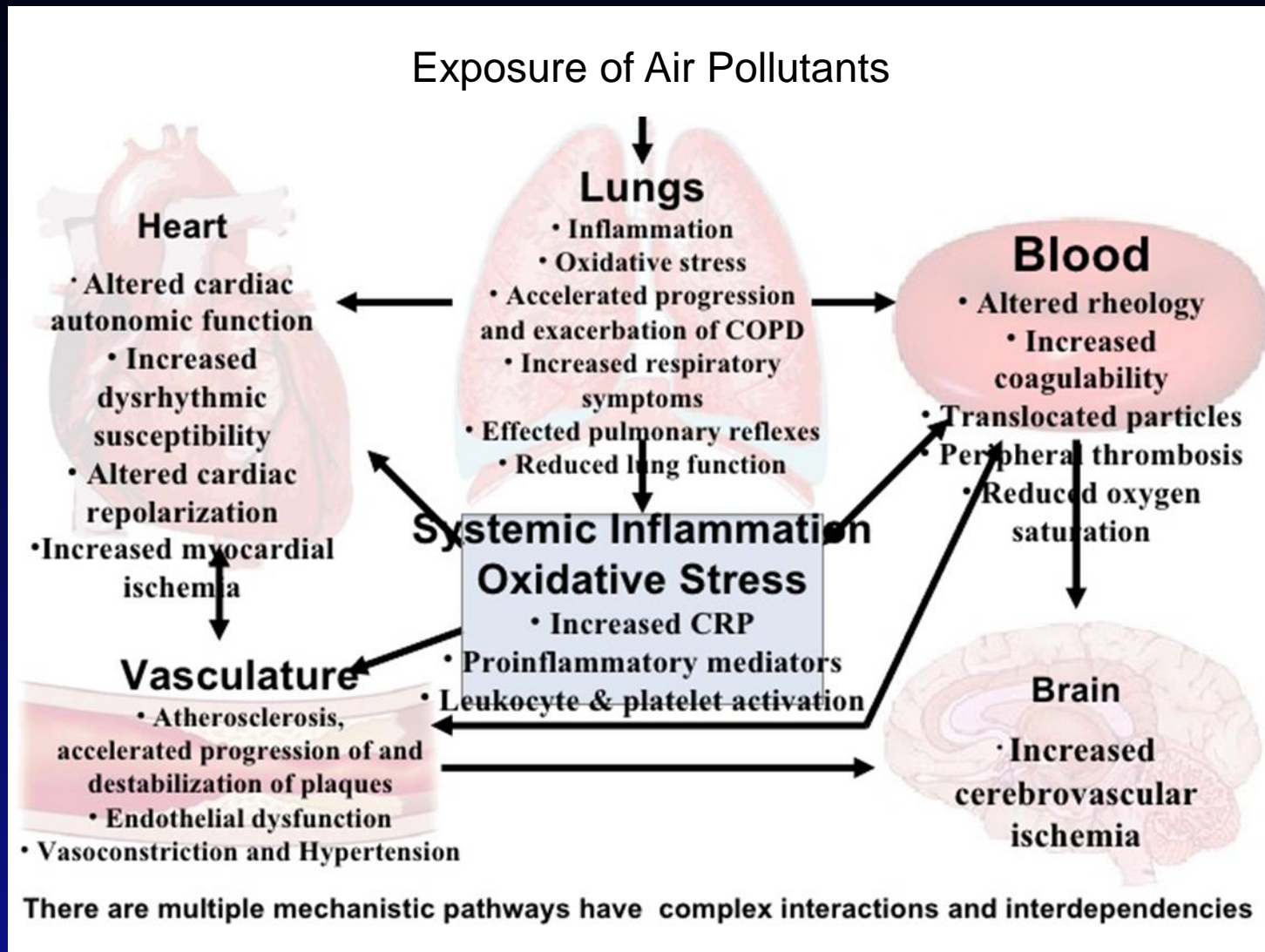
Purpose

To evaluate the impact of AP on short-term mortality and long-term clinical outcomes of AMI pts.

Methods

1. Source Data

1) The current data came from the

KAMIR (Korea AMI Registry)

2) Air pollutant concentrations for particulate matter ≤ 10 µm in aerodynamic diameter (PM_{10}), gaseous pollutant; ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and carbon monoxide (CO) were measured by the Korean National Institute of Environmental Research (NIER; http://www.nier.go.kr/) at 162 monitoring sites

Methods

3) Metrological factors (e.g., temperature, atmospheric pressure, humidity, cloud, rain, snow) were measured by [the Korea Metrological Administration](#) (KMA; http://www.kma.go.kr/) at 32 monitoring sites at 7 metropolises or 9 states of South Korea from October 2005 to December 2013.

Methods

2. Study Population

1) Patients with AMI, including both ST-segment elevation myocardial infarction (STEMI) and Non-STEMI (NSTEMI) were enrolled.

2) From October 2005 to December 2013, a total of **37,880 patients** were enrolled in a nationwide, prospective, multicenter registry.

Methods

3. Study Definitions
    1) Total deaths were considered cardiac in origin unless a non-cardiac cause could be documented.
    2) Total major adverse cardiac events (MACE) was defined as the composite of total death, non-fatal Re-MI, and revascularization.

4. Study Endpoints
    30-day mortality and 2-year clinical outcomes including mortality, recurrent MI (Re-MI), any revascularization and MACE.

Statistics

1. All statistical analyses were performed using SPSS 20.0.

2. For continuous variables, differences among the three groups were evaluated by ANOVA, and differences between the two groups were evaluated by unpaired t-test or Mann-Whitney rank test. Data were expressed as mean ± standard deviation.

3. Differences among the groups were expressed as counts and percentages, then analyzed with χ2 test. Data were expressed as percentages and were compared using chi-square statistics or Fisher's exact test.

4. A *P*-value of 0.05 was considered statistically significant.

Results

Baseline Clinical Characteristics (1)

Variables, N (%) or mean ± SD	Overall (n=37,880)	Spring (n=9,501)	Summer (n=8,486)	Fall (n=9,514)	Winter (n=10,401)	p Value
Sex (Male)	26787 (70.7)	6702 (70.5)	6063 (71.6)	6634 (69.7)	7388 (71.0)	0.036
Age, year	63.6 ± 12.8	64.0 ± 12.8	63.3 ± 12.7	63.7 ± 12.8	63.6 ± 12.8	0.002
Body mass index	23.9 ± 3.2	23.9 ± 3.2	23.9 ± 3.1	23.9 ± 3.2	23.9 ± 3.2	0.416
LV ejection fraction, %	51.8 ± 12.1	51.7 ± 12.3	52.1 ± 12.0	51.8 ± 12.2	51.8 ± 12.1	0.129
ST-segment elevation MI	21018 (55.4)	5220 (54.9)	4778 (56.4)	5286 (55.5)	5734 (55.1)	0.180
Risk Factors						
Ischemic heart disease	5696 (15.0)	1463 (15.3)	1289 (15.2)	1423 (14.9)	1521 (14.6)	0.448
Previous PCI	2224 (5.8)	583 (6.1)	513 (6.0)	550 (5.7)	578 (5.5)	0.289
Previous AMI	1331 (3.5)	343 (3.6)	311 (3.6)	316 (3.3)	361 (3.4)	0.573
Hypertension	18478 (48.7)	4673 (49.1)	4082 (48.2)	4637 (48.7)	5086 (48.8)	0.632
Diabetes mellitus	10187 (26.8)	2593 (27.2)	2226 (26.2)	2594 (27.2)	2774 (26.6)	0.359
Dyslipidemia	4113 (10.8)	1039 (10.9)	964 (11.3)	994 (10.4)	1116 (10.7)	0.225
Smokers	21077 (55.6)	5181 (54.5)	4866 (57.4)	5243 (55.1)	5787 (55.6)	0.001
Current smoker	15378 (40.5)	3774 (39.7)	3542 (41.8)	3878 (40.7)	4184 (40.2)	0.027
Ex-smoker	5699 (15.0)	1407 (14.8)	1324 (15.6)	1365 (14.3)	1603 (15.4)	0.058
Chronic obstructive pulmonary disease	712 (1.8)	175 (1.8)	161 (1.9)	184 (1.9)	192 (1.8)	0.958
Heart failure	763 (2.0)	205 (2.1)	155 (1.8)	180 (1.8)	223 (2.1)	0.258
Peripheral vascular disease	303 (0.7)	74 (0.7)	63 (0.7)	73 (0.7)	93 (0.8)	0.643
Cancer	645 (1.7)	164 (1.7)	133 (1.5)	187 (1.9)	161 (1.5)	0.097

Baseline Clinical Characteristics (2)

Variables, N (%) or mean ± SD	Overall (n=37,880)	Spring (n=9,501)	Summer (n=8,486)	Fall (n=9,514)	Winter (n=10,401)	p Value
Angiographic characteristics						
Left main disease	1292 (3.4)	368 (3.8)	243 (2.8)	321 (3.3)	360 (3.4)	0.003
Multi-vessel disease	18676 (49.3)	4759 (50.0)	4111 (48.5)	4761 (50.0)	5045 (48.5)	0.031
Single	14492 (38.2)	3522 (37.0)	3345 (39.5)	3681 (38.6)	3944 (37.9)	0.005
Double	9900 (26.1)	2503 (26.3)	2226 (26.2)	2452 (25.7)	2719 (26.1)	0.805
Triple	7971 (21.0)	2023 (21.2)	1731 (20.4)	2105 (22.1)	2112 (20.3)	0.007
Lesion Type (B2/C)	22259 (58.7)	5451 (57.3)	5019 (59.2)	5664 (59.5)	6125 (58.8)	0.012
Laboratory findings, mg/dL						
Maximum CK-MB	125 ± 244	125 ± 210	123 ± 183	128 ± 260	126 ± 296	0.596
Maximum Troponin T	5.1 ± 26.1	4.5 ± 16.9	5.8 ± 34.0	5.3 ± 30.1	4.8 ± 22.1	0.309
High-sensitive CRP	13.8 ± 65.4	12.8 ± 66.5	13.2 ± 65.4	14.4 ± 68.0	14.8 ± 62.1	0.202
Total cholesterol	182 ± 46	181 ± 46	181 ± 46	182 ± 45	182 ± 46	0.155
Triglyceride	130 ± 104	128 ± 100	135 ± 116	130 ± 103	128 ± 97	< 0.001
HDL-cholesterol	44 ± 20	44 ± 24	44 ± 21	44 ± 17	44 ± 19	0.191
LDL-cholesterol	115 ± 42	114 ± 42	115 ± 42	114 ± 40	116 ± 43	0.038
Glucose (on admission)	170 ± 82	171 ± 84	169 ± 81	171 ± 82	171 ± 83	0.135
A1C, %	6.6 ± 2.4	6.7 ± 3.1	6.6 ± 2.4	6.6 ± 1.7	6.6 ± 2.0	0.168
Creatinine (on admission)	1.2 ± 1.9	1.2 ± 1.9	1.1 ± 1.4	1.2 ± 2.0	1.2 ± 2.1	0.328
Total death at 30days	2150 (5.6)	535 (5.6)	426 (5.0)	571 (6.0)	618 (5.9)	0.020

Spearman Rank Correlation Coefficient Analysis of Metrological Factor and Daily Concentrations of Air Pollutions in South Korea in 2005 to 2013

Variables R \ p value	PM_{10}	O_3,	SO_2	NO_2	CO	T	Pressure	Humidity
PM_{10}, µg/m³	-	0.805	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
O_3, ppm	0.001	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
SO_2 , ppm	0.624	-0.340	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
NO_2 , ppm	0.565	-0.464	0.693	-	< 0.001	< 0.001	< 0.001	< 0.001
CO, ppm	0.618	-0.463	0.634	0.705	-	< 0.001	< 0.001	< 0.001
T (°C)	-0.208	0.398	-0.500	-0.342	-0.400	-	< 0.001	< 0.001
Pressure (hPa)	0.171	-0.436	0.445	0.353	0.372	-0.795	-	< 0.001
Humidity, (%)	-0.235	-0.120	-0.357	-0.181	-0.051	0.404	-0.462	-

Daily Concentrations of Air Pollutions and Metrological Factor Measured near the Admitted Hospital According to the Season in South Korea in 2005 to 2013

Variables mean ± SD [Range]	Overall (n=37,880)	Spring (n=9,501)	Summer (n=8,486)	Fall (n=9,514)	Winter (n=10,401)
PM_{10}, $\mu g/m^3$	52.51 ± 35.46 [4 - 874]	60.98 ± 47.13 [4 - 874]	35.08 ± 17.87 [6 - 145]	51.77 ± 28.66 [5 - 316]	59.54 ± 34.08 [4 - 507]
O_3, ppm	0.021 ± 0.011 [0.002 - 0.071]	0.032 ± 0.009 [0.005 - 0.071]	0.022 ± 0.009 [0.003 - 0.065]	0.014 ± 0.006 [0.002 - 0.043]	0.016 ± 0.008 [0.002 - 0.045]
SO_2, ppm	0.005 ± 0.002 [0.001 - 0.028]	0.004 ± 0.001 [0.001 - 0.020]	0.003 ± 0.001 [0.001 - 0.028]	0.005 ± 0.002 [0.001 - 0.018]	0.006 ± 0.002 [0.001 - 0.023]
NO_2, ppm	0.027 ± 0.012 [0.004 - 0.092]	0.026 ± 0.011 [0.006 - 0.077]	0.019 ± 0.008 [0.004 - 0.051]	0.030 ± 0.011 [0.006 - 0.092]	0.031 ± 0.012 [0.006 - 0.082]
CO, ppm	0.582 ± 0.246 [0.2 - 2.3]	0.505 ± 0.132 [0.2 - 1.3]	0.436 ± 0.132 [0.2 - 1.0]	0.645 ± 0.267 [0.2 - 1.8]	0.715 ± 0.286 [0.3 - 2.3]
T (°C), Mean	12.1 ± 10.1 [-14.6 - 31.7]	15.7 ± 5.5 [1.4 - 27.4]	24.8 ± 2.7 [12.9 - 31.7]	8.4 ± 8.2 [-14.5 - 25.6]	2.0 ± 4.9 [-14.6 - 19.5]
Pressure (hPa), Mean	1016 ± 8.0 [993 - 1038]	1012 ± 6.0 [993 - 1029]	1008 ± 4.3 [994 - 1022]	1021 ± 5.2 [1005 - 1038]	1023 ± 5.4 [998 - 1038]
Humidity, (%)	61.0 ± 15.6 [13.5 - 99]	57.4 ± 15.4 [18.4 - 97.1]	73.5 ± 10.1 [37.8 - 99]	59.7 ± 13.6 [18.3 - 96.4]	55.4 ± 15.7 [13.5 - 98.8]
Cloud, (1/10)	4.7 ± 3.1 [0.0 - 10.0]	4.8 ± 3.1 [0.0 - 10.0]	6.5 ± 2.8 [0.0 - 10.0]	3.8 ± 2.8 [0.0 - 10.0]	3.9 ± 3.0 [0.0 - 10.0]
Rain, mm	3.3 ± 13.5 [0.0 - 420]	2.7 ± 8.72 [0.0 - 98]	9.20 ± 25.2 [0.0 - 420]	1.0 ± 4.5 [0.0 - 102]	1.0 ± 4.0 [0.0 - 86]
Snow, cm	0.0 ± 0.7 [0.0 - 35.2]	0.0 ± 0.1 [0.0 - 5.1]	0.0 ± 0.0 [0.0 - 0.0]	0.1 ± 0.7 [0.0 - 35.2]	0.2 ± 1.2 [0.0 - 25.8]

Estimated Hazard Ratio for Shor-Term Mortality and Long-Term Cardiovascular Events Associated with Daily Concentrations of Air Pollutant

	30 days after AMI		2-year after AMI			
	Total death	P Value	Total death	p Value	MACE	p Value
Overall						
PM_{10}, $10\mu g/m^3$	0.998 (0.986 - 1.010)	0.823	1.000 (0.990 - 1.010)	0.959	1.003 (0.995 - 1.011)	0.383
O_3, 10 ppb	0.994 (0.990 - 0.998)	0.005	0.999 (0.995 - 1.002)	0.662	1.000 (0.997 - 1.003)	0.730
SO_2 , ppb	1.019 (1.003 - 1.036)	0.015	1.003 (0.989 - 1.018)	0.603	0.995 (0.984 - 1.006)	0.442
NO_2 , 10 ppb	1.097 (1.062 - 1.134)	< 0.001	1.047 (1.017 - 1.077)	0.002	1.023 (1.000 - 1.047)	0.043
CO, 0.1 ppm	1.021 (1.005 - 1.039)	0.010	1.009 (0.994 - 1.024)	0.208	1.012 (1.001 - 1.024)	0.032
Ischemic heart disease						
PM_{10}, $10\mu g/m^3$	1.013 (0.995 - 1.032)	0.146	1.010 (0.993 - 1.027)	0.211	1.010 (0.997 - 1.023)	0.129
O_3, 10 ppb	0.991 (0.981 - 1.000)	0.070	1.000 (0.992 - 1.008)	0.935	1.002 (0.996 - 1.008)	0.439
SO_2 , ppb	1.071 (1.037 - 1.107)	< 0.001	1.047 (1.017 - 1.078)	0.002	1.024 (1.000 - 1.050)	0.048
NO_2 , 10 ppb	1.216 (1.131 - 1.307)	< 0.001	1.109 (1.041 - 1.182)	0.001	1.072 (1.018 - 1.129)	0.008
CO, 0.1 ppm	1.072 (1.034 - 1.111)	< 0.001	1.043 (1.011 - 1.076)	0.008	1.033 (1.006 - 1.059)	0.013

Summary (1)

1. We observed that a 10 ppb increase in NO_2 concentration will increase the 30-day mortality rate of AMI patients by 9.7% (95% CI; 6.2% to 13.4%), 1 ppb increase in SO_2 concentration by 1.9% (95% CI, 0.3% to 3.6%), and 0.1 ppm increase in CO (0.1 ppm) concentration by 2.1% (95% CI, 0.5% to 3.9%).

2. Also, an increase in NO_2 concentrations increase the 2-year MACE rate of AMI patients by 2.3 % (95% CI; 0.0% to 4.7%), and an increase in CO concentrations by 1.2 % (95% CI, 0.1 % to 2.4%) for 2-year MACE in AMI pts.

Summary (2)

3. Particulate matter with a diameter of less than 10 µm (PM-10) and ozone (O_3) was not associated with any cardiovascular events in AMI pts.

4. AMI pts, especially those with a history of ischemic heart disease, *exposure to AP were closely associated with both worse short-term and long-term cardiovascular events.*

Conclusion

1. Short- and long-term exposure to AP was associated with higher incidences of short-term mortality and long-term cardiovascular events in AMI pts.

2. AMI pts, especially those with a history of ischemic heart disease, who are exposed to continuous AP need more careful management and closer clinical follow-up.

Thank you for your attention

Estimated Hazard Ratio for Shor-Term Mortality and Long-Term Cardiovascular Events Associated with Daily Concentrations of Air Pollutant

PM_{10}, $10\mu g/m^3$	30 days after AMI		2-year after AMI							
	Total death	P Value	Total death	p Value	Recurrent MI	p Value	Revascularization	p Value	MACE	p Value
Overall										
PM_{10}, $10\mu g/m^3$	0.998 (0.986 - 1.010)	0.823	1.000 (0.990 - 1.010)	0.959	1.009 (0.986 - 1.032)	0.409	1.000 (0.970 - 1.031)	0.971	1.003 (0.995 - 1.011)	0.383
O_3, 10 ppb	0.994 (0.990 - 0.998)	0.005	0.999 (0.995 - 1.002)	0.662	1.007 (0.999 - 1.016)	0.056	0.998 (0.988 - 1.008)	0.771	1.000 (0.997 - 1.003)	0.730
SO_2 , ppb	1.019 (1.003 - 1.036)	0.015	1.003 (0.989 - 1.018)	0.603	1.011 (0.976 - 1.047)	0.514	1.008 (0.967 - 1.051)	0.683	0.995 (0.984 - 1.006)	0.442
NO_2 , 10 ppb	1.097 (1.062 - 1.134)	< 0.001	1.047 (1.017 - 1.077)	0.002	0.996 (0.924 - 1.072)	0.916	1.092 (1.005 - 1.186)	0.037	1.023 (1.000 - 1.047)	0.043
CO, 0.1 ppm	1.021 (1.005 - 1.039)	0.010	1.009 (0.994 - 1.024)	0.208	0.988 (0.951 - 1.026)	0.537	1.011 (0.969 - 1.055)	0.598	1.012 (1.001 - 1.024)	0.032
Ischemic heart disease										
PM_{10}, $10\mu g/m^3$	1.013 (0.995 - 1.032)	0.146	1.010 (0.993 - 1.027)	0.211	1.014 (0.981 - 1.048)	0.398	1.025 (0.992 - 1.060)	0.129	1.010 (0.997 - 1.023)	0.129
O_3, 10 ppb	0.991 (0.981 - 1.000)	0.070	1.000 (0.992 - 1.008)	0.935	1.024 (1.008 - 1.041)	0.003	1.003 (0.980 - 1.027)	0.766	1.002 (0.996 - 1.008)	0.439
SO_2 , ppb	1.071 (1.037 - 1.107)	< 0.001	1.047 (1.017 - 1.078)	0.002	0.994 (0.924 - 1.070)	0.891	1.106 (1.025 - 1.193)	0.009	1.024 (1.000 - 1.050)	0.048
NO_2 , 10 ppb	1.216 (1.131 - 1.307)	< 0.001	1.109 (1.041 - 1.182)	0.001	0.879 (0.749 - 1.031)	0.114	1.285 (1.075 - 1.537)	0.006	1.072 (1.018 - 1.129)	0.008
CO, 0.1 ppm	1.072 (1.034 - 1.111)	< 0.001	1.043 (1.011 - 1.076)	0.008	0.958 (0.883 - 1.039)	0.302	1.055 (0.960 - 1.159)	0.260	1.033 (1.006 - 1.059)	0.013

Estimated Hazard Ratio for Shor-Term Mortality and Long-Term Cardiovascular Events Associated with Daily Concentrations of Air Pollutant

PM$_{10}$, 10μg/㎥	30 days after AMI		2-year after AMI								
	Total death	P Value	Total death	p Value	Recurrent MI	p Value	Revascularization	p Value	MACE	p Value
Overall	0.998 (0.986 - 1.010)	0.823	1.000 (0.990 - 1.010)	0.959	1.009 (0.986 - 1.032)	0.409	1.000 (0.970 - 1.031)	0.971	1.003 (0.995 - 1.011)	0.383
Age (≥ 65 year)	0.991 (0.977 - 1.006)	0.281	0.995 (0.983 - 1.007)	0.492	1.018 (0.992 - 1.044)	0.161	0.997 (0.964 - 1.032)	0.893	1.000 (0.991 - 1.010)	0.855
Sex										
Male	1.007 (0.992 - 1.022)	0.307	1.008 (0.995 - 1.020)	0.210	0.995 (0.961 - 1.029)	0.773	1.024 (0.993 - 1.056)	0.128	1.008 (0.998 - 1.017)	0.086
Female	0.984 (0.963 - 1.004)	0.132	0.987 (0.970 - 1.005)	0.164	1.023 (0.996 - 1.050)	0.085	0.952 (0.898 - 1.009)	0.099	0.994 (0.981 - 1.008)	0.446
History of Risk										
Hypertension	0.994 (0.978 - 1.011)	0.554	0.998 (0.984 - 1.012)	0.809	1.005 (0.973 - 1.038)	0.734	1.001 (0.962 - 1.041)	0.958	1.002 (0.991 - 1.012)	0.688
Diabetes	1.002 (0.983 - 1.020)	0.827	1.004 (0.989 - 1.019)	0.546	0.995 (0.953 - 1.040)	0.844	1.017 (0.982 - 1.054)	0.326	1.006 (0.994 - 1.018)	0.277
Dyslipidemia	0.975 (0.928 - 1.023)	0.312	1.001 (0.970 - 1.033)	0.936	1.019 (0.979 - 1.062)	0.346	0.897 (0.735 - 1.094)	0.284	1.004 (0.983 - 1.026)	0.690
Current smokers	0.998 (0.973 - 1.025)	0.934	1.004 (0.983 - 1.026)	0.658	1.021 (0.983 - 1.060)	0.277	1.024 (0.974 - 1.077)	0.345	1.009 (0.994 - 1.024)	0.206
Cancer history	1.017 (0.942 - 1.099)	0.653	0.995 (0.936 - 1.057)	0.873	1.055 (0.869 - 1.280)	0.586	1.170 (1.039 - 1.318)	0.010	1.001 (0.949 - 1.056)	0.957
COPD	0.988 (0.932 - 1.049)	0.712	0.978 (0.923 - 1.036)	0.460	1.026 (0.966 - 1.090)	0.399	1.022 (0.949 - 1.100)	0.564	0.979 (0.929 - 1.032)	0.448
Ischemic heart disease	1.013 (0.995 - 1.032)	0.146	1.010 (0.993 - 1.027)	0.211	1.014 (0.981 - 1.048)	0.398	1.025 (0.992 - 1.060)	0.129	1.010 (0.997 - 1.023)	0.129
Seasons										
Spring	0.990 (0.969 - 1.011)	0.360	0.985 (0.967 - 1.004)	0.143	0.996 (0.961 - 1.033)	0.862	1.003 (0.963 - 1.046)	0.850	0.988 (0.974 - 1.002)	0.105
Summer	0.989 (0.936 - 1.044)	0.695	0.986 (0.941 - 1.033)	0.573	1.045 (0.933 - 1.170)	0.441	1.025 (0.899 - 1.168)	0.707	1.016 (0.981 - 1.052)	0.367
Autumn	0.999 (0.971 - 1.029)	0.989	1.008 (0.984 - 1.033)	0.494	1.004 (0.941 - 1.071)	0.902	1.004 (0.932 - 1.082)	0.899	1.007 (0.987 - 1.027)	0.463
Winter	0.995 (0.971 - 1.019)	0.684	0.998 (0.978 - 1.018)	0.888	1.003 (0.951 - 1.057)	0.910	0.963 (0.899 - 1.031)	0.287	1.008 (0.992 - 1.023)	0.300
Temperature, mean										
~ -1.2℃ (10% lower)	1.037 (0.990 - 1.085)	0.117	1.025 (0.983 - 1.069)	0.242	0.985 (0.853 - 1.137)	0.839	1.064 (0.964 - 1.174)	0.212	1.017 (0.979 - 1.056)	0.367
-1.2-12.2 (10% to 50%)	0.991 (0.973 - 1.010)	0.390	0.993 (0.977 - 1.008)	0.396	0.998 (0.963 - 1.035)	0.944	0.967 (0.910 - 1.027)	0.279	0.996 (0.985 - 1.008)	0.590
12.2-25.5 (50% to 90%)	0.997 (0.976 - 1.018)	0.807	1.005 (0.987 - 1.022)	0.560	1.021 (0.984 - 1.061)	0.255	1.029 (0.985 - 1.076)	0.189	1.007 (0.994 - 1.021)	0.240
25.5 ~ (10% upper)	1.015 (0.931 - 1.106)	0.730	0.991 (0.920 - 1.068)	0.825	1.063 (0.881 - 1.282)	0.523	0.925 (0.743 - 1.151)	0.487	1.018 (0.962 - 1.078)	0.520

Estimated Hazard Ratio for Shor-Term Mortality and Long-Term Cardiovascular Events Associated with Daily Concentrations of Air Pollutant

O_3, 10 ppb	30 days after AMI		2-year after AMI								
	Total death	p Value	Total death	p Value	Recurrent MI	p Value	Revascularization	p Value	MACE	p Value
Overall	0.994 (0.990 - 0.998)	0.005	0.999 (0.995 - 1.002)	0.662	1.007 (0.999 - 1.016)	0.056	0.998 (0.988 - 1.008)	0.771	1.000 (0.997 - 1.003)	0.730
Age (≥ 65 year)	0.995 (0.990 - 0.999)	0.045	1.000 (0.996 - 1.004)	0.838	1.013 (1.002 - 1.024)	0.019	0.998 (0.987 - 1.009)	0.771	1.000 (0.997 - 1.004)	0.653
Sex										
Male	0.994 (0.989 - 0.999)	0.031	0.998 (0.994 - 1.003)	0.645	1.002 (0.992 - 1.013)	0.574	0.996 (0.982 - 1.010)	0.615	1.000 (0.997 - 1.003)	0.731
Female	0.995 (0.989 - 1.001)	0.120	1.000 (0.995 - 1.005)	0.917	1.018 (1.004 - 1.032)	0.011	1.003 (0.989 - 1.017)	0.666	1.000 (0.996 - 1.005)	0.725
History of Risk										
Hypertension	0.997 (0.991 - 1.002)	0.277	1.002 (0.997 - 1.006)	0.352	1.011 (1.000 - 1.022)	0.041	1.001 (0.988 - 1.014)	0.790	1.002 (0.999 - 1.006)	0.097
Diabetes	0.998 (0.991 - 1.005)	0.647	1.002 (0.996 - 1.007)	0.409	1.008 (0.994 - 1.022)	0.234	1.003 (0.987 - 1.019)	0.669	1.002 (0.997 - 1.006)	0.317
Dyslipidemia	0.998 (0.985 - 1.012)	0.849	1.004 (0.992 - 1.015)	0.470	1.011 (0.990 - 1.032)	0.296	1.010 (0.970 - 1.051)	0.617	1.003 (0.994 - 1.011)	0.467
Current smokers	0.992 (0.984 - 0.999)	0.045	0.998 (0.991 - 1.004)	0.578	1.004 (0.991 - 1.018)	0.506	1.006 (0.988 - 1.025)	0.490	1.001 (0.996 - 1.005)	0.596
Cancer history	1.019 (0.998 - 1.042)	0.073	1.015 (1.000 - 1.032)	0.049	1.008 (0.939 - 1.081)	0.819	1.027 (0.948 - 1.113)	0.507	1.012 (0.998 - 1.027)	0.085
COPD	0.997 (0.977 - 1.018)	0.831	1.002 (0.986 - 1.019)	0.766	0.973 (0.909 - 1.042)	0.446	1.002 (0.941 - 1.066)	0.947	1.003 (0.987 - 1.018)	0.687
Ischemic heart disease	0.991 (0.981 - 1.000)	0.070	1.000 (0.992 - 1.008)	0.935	1.024 (1.008 - 1.041)	0.003	1.003 (0.980 - 1.027)	0.766	1.002 (0.996 - 1.008)	0.439
Seasons										
Spring	0.994 (0.985 - 1.003)	0.232	1.002 (0.994 - 1.009)	0.597	0.998 (0.981 - 1.016)	0.891	0.985 (0.963 - 1.007)	0.190	0.998 (0.992 - 1.004)	0.696
Summer	1.002 (0.992 - 1.012)	0.665	1.005 (0.997 - 1.014)	0.182	1.004 (0.982 - 1.026)	0.716	1.013 (0.988 - 1.039)	0.290	1.003 (0.996 - 1.010)	0.289
Autumn	0.992 (0.980 - 1.004)	0.212	0.995 (0.985 - 1.006)	0.455	1.003 (0.976 - 1.030)	0.828	1.031 (1.000 - 1.064)	0.045	0.999 (0.991 - 1.008)	0.929
Winter	0.986 (0.976 - 0.996)	0.007	0.994 (0.985 - 1.002)	0.188	1.009 (0.986 - 1.032)	0.432	0.978 (0.954 - 1.003)	0.094	0.996 (0.989 - 1.003)	0.288
Temperature, mean										
~ -1.2°C (10% lower)	0.979 (0.961 - 0.998)	0.032	0.995 (0.979 - 1.012)	0.618	0.987 (0.940 - 1.037)	0.626	0.963 (0.920 - 1.007)	0.099	0.991 (0.977 - 1.005)	0.244
-1.2-12.2 (10% to 50%)	0.990 (0.983 - 0.998)	0.016	0.994 (0.988 - 1.000)	0.087	1.009 (0.994 - 1.024)	0.214	0.996 (0.978 - 1.015)	0.739	0.996 (0.991 - 1.001)	0.158
12.2-25.5 (50% to 90%)	0.996 (0.990 - 1.002)	0.214	1.002 (0.997 - 1.007)	0.310	1.006 (0.993 - 1.018)	0.325	1.006 (0.990 - 1.021)	0.430	1.001 (0.997 - 1.005)	0.423
25.5 ~ (10% upper)	1.003 (0.989 - 1.017)	0.662	1.001 (0.989 - 1.013)	0.763	0.998 (0.966 - 1.030)	0.908	0.996 (0.963 - 1.030)	0.826	1.001 (0.992 - 1.011)	0.710

Estimated Hazard Ratio for Shor-Term Mortality and Long-Term Cardiovascular Events Associated with Daily Concentrations of Air Pollutant

SO$_2$, ppb	30 days after AMI		2-year after AMI							
	Total death	p Value	Total death	p Value	Recurrent MI	p Value		p Value	MACE	p Value
Overall	1.019 (1.003 - 1.036)	0.015	1.003 (0.989 - 1.018)	0.603	1.011 (0.976 - 1.047)	0.514	1.008 (0.967 - 1.051)	0.683	0.995 (0.984 - 1.006)	0.442
Age (≥ 65 year)	1.010 (0.991 - 1.030)	0.265	0.991 (0.975 - 1.008)	0.318	1.005 (0.957 - 1.055)	0.834	1.008 (0.962 - 1.056)	0.717	0.989 (0.975 - 1.004)	0.163
Sex										
Male	1.032 (1.011 - 1.054)	0.002	1.013 (0.995 - 1.032)	0.155	1.032 (0.990 - 1.075)	0.129	1.051 (0.996 - 1.108)	0.065	1.000 (0.986 - 1.015)	0.913
Female	1.001 (0.976 - 1.026)	0.935	0.988 (0.967 - 1.011)	0.329	0.961 (0.898 - 1.028)	0.253	0.946 (0.885 - 1.011)	0.106	0.985 (0.966 - 1.004)	0.128
History of Risk										
Hypertension	1.018 (0.997 - 1.040)	0.085	1.000 (0.981 - 1.018)	0.999	1.006 (0.959 - 1.056)	0.787	1.007 (0.954 - 1.063)	0.781	0.989 (0.974 - 1.004)	0.179
Diabetes	1.026 (0.999 - 1.053)	0.054	1.009 (0.986 - 1.033)	0.411	1.011 (0.952 - 1.073)	0.711	1.006 (0.939 - 1.078)	0.846	1.003 (0.984 - 1.022)	0.714
Dyslipidemia	1.034 (0.980 - 1.091)	0.213	1.023 (0.976 - 1.072)	0.334	1.017 (0.929 - 1.113)	0.705	1.050 (0.897 - 1.229)	0.538	1.007 (0.972 - 1.043)	0.694
Current smokers	1.036 (1.006 - 1.068)	0.017	1.018 (0.992 - 1.046)	0.171	1.051 (0.998 - 1.107)	0.058	1.059 (0.987 - 1.135)	0.108	1.006 (0.987 - 1.026)	0.495
Cancer history	0.970 (0.872 - 1.078)	0.575	0.943 (0.872 - 1.021)	0.153	0.916 (0.619 - 1.356)	0.663	1.239 (0.961 - 1.596)	0.097	0.949 (0.884 - 1.019)	0.156
COPD	0.967 (0.879 - 1.063)	0.491	0.928 (0.853 - 1.009)	0.084	1.244 (1.022 - 1.512)	0.029	0.688 (0.433 - 1.093)	0.114	0.929 (0.860 - 1.005)	0.068
Ischemic heart disease	1.071 (1.037 - 1.107)	< 0.001	1.047 (1.017 - 1.078)	0.002	0.994 (0.924 - 1.070)	0.891	1.106 (1.025 - 1.193)	0.009	1.024 (1.000 - 1.050)	0.048
Seasons										
Spring	0.993 (0.950 - 1.037)	0.753	0.965 (0.929 - 1.002)	0.069	0.981 (0.901 - 1.068)	0.662	1.028 (0.929 - 1.138)	0.582	0.965 (0.937 - 0.994)	0.021
Summer	1.044 (0.978 - 1.114)	0.195	0.991 (0.930 - 1.056)	0.792	0.978 (0.828 - 1.155)	0.800	0.883 (0.715 - 1.092)	0.253	0.961 (0.913 - 1.011)	0.132
Autumn	0.999 (0.965 - 1.035)	0.990	0.992 (0.962 - 1.024)	0.644	1.045 (0.970 - 1.126)	0.236	0.983 (0.893 - 1.082)	0.738	0.992 (0.968 - 1.017)	0.573
Winter	1.021 (0.995 - 1.048)	0.104	1.001 (0.978 - 1.025)	0.890	1.019 (0.959 - 1.082)	0.535	1.005 (0.940 - 1.075)	0.871	0.999 (0.980 - 1.018)	0.936
Temperature, mean										
~ -1.2°C (10% lower)	1.111 (1.048 - 1.179)	< 0.001	1.055 (0.999 - 1.114)	0.052	1.032 (0.873 - 1.220)	0.709	1.195 (1.049 - 1.361)	0.007	1.041 (0.992 - 1.092)	0.097
-1.2-12.2 (10% to 50%)	1.010 (0.987 - 1.033)	0.379	0.999 (0.979 - 1.019)	0.964	1.004 (0.955 - 1.056)	0.855	0.992 (0.932 - 1.057)	0.819	0.995 (0.979 - 1.011)	0.592
12.2-25.5 (50% to 90%)	1.008 (0.972 - 1.044)	0.659	0.990 (0.959 - 1.022)	0.558	1.046 (0.977 - 1.120)	0.193	0.999 (0.911 - 1.096)	0.995	0.985 (0.961 - 1.010)	0.249
25.5 ~ (10% upper)	1.070 (0.978 - 1.170)	0.137	1.006 (0.917 - 1.103)	0.892	1.037 (0.825 - 1.304)	0.752	0.899 (0.670 - 1.206)	0.479	0.969 (0.897 - 1.046)	0.422

Estimated Hazard Ratio for Shor-Term Mortality and Long-Term Cardiovascular Events Associated with Daily Concentrations of Air Pollutant

	30 days after AMI		2-year after AMI							
NO_2, 10 ppb	Total death	p Value	Total death	p Value	Recurrent MI	p Value	Revascularization	p Value	MACE	p Value
Overall	1.097 (1.062 - 1.134)	< 0.001	1.047 (1.017 - 1.077)	0.002	0.996 (0.924 - 1.072)	0.916	1.092 (1.005 - 1.186)	0.037	1.023 (1.000 - 1.047)	0.043
Age (≥ 65 year)	1.080 (1.039 - 1.122)	< 0.001	1.027 (0.993 - 1.062)	0.110	0.979 (0.883 - 1.085)	0.687	1.118 (1.019 - 1.227)	0.017	1.022 (0.993 - 1.052)	0.138
Sex										
Male	1.117 (1.070 - 1.165)	< 0.001	1.056 (1.017 - 1.096)	0.004	1.010 (0.924 - 1.105)	0.813	1.107 (0.986 - 1.243)	0.085	1.027 (0.998 - 1.057)	0.064
Female	1.076 (1.022 - 1.132)	0.005	1.039 (0.993 - 1.087)	0.092	0.969 (0.848 - 1.106)	0.646	1.060 (0.938 - 1.198)	0.348	1.021 (0.983 - 1.062)	0.275
History of Risk										
Hypertension	1.087 (1.040 - 1.135)	< 0.001	1.028 (0.990 - 1.067)	0.150	0.977 (0.882 - 1.081)	0.655	1.125 (1.011 - 1.252)	0.031	1.011 (0.980 - 1.042)	0.479
Diabetes	1.088 (1.030 - 1.150)	0.003	1.043 (0.995 - 1.093)	0.080	0.995 (0.878 - 1.127)	0.937	1.081 (0.941 - 1.243)	0.268	1.032 (0.993 - 1.073)	0.101
Dyslipidemia	1.094 (0.977 - 1.224)	0.117	1.018 (0.921 - 1.125)	0.717	0.958 (0.789 - 1.164)	0.670	0.746 (0.491 - 1.134)	0.171	1.004 (0.934 - 1.080)	0.898
Current smokers	1.129 (1.060 - 1.202)	< 0.001	1.072 (1.015 - 1.133)	0.013	0.987 (0.874 - 1.114)	0.834	1.085 (0.926 - 1.271)	0.312	1.023 (0.983 - 1.065)	0.257
Cancer history	0.911 (0.730 - 1.136)	0.410	0.882 (0.751 - 1.036)	0.129	0.751 (0.354 - 1.592)	0.456	1.361 (0.671 - 2.759)	0.392	0.882 (0.762 - 1.020)	0.092
COPD	1.085 (0.913 - 1.290)	0.351	0.967 (0.830 - 1.128)	0.676	1.731 (1.134 - 2.643)	0.011	0.983 (0.560 - 1.723)	0.952	0.953 (0.825 - 1.101)	0.518
Ischemic heart disease	1.216 (1.131 - 1.307)	< 0.001	1.109 (1.041 - 1.182)	0.001	0.879 (0.749 - 1.031)	0.114	1.285 (1.075 - 1.537)	0.006	1.072 (1.018 - 1.129)	0.008
Seasons										
Spring	1.109 (1.035 - 1.188)	0.003	1.017 (0.957 - 1.082)	0.571	1.028 (0.894 - 1.181)	0.697	1.249 (1.063 - 1.466)	0.007	1.011 (0.964 - 1.061)	0.627
Summer	1.112 (0.998 - 1.240)	0.054	1.011 (0.917 - 1.114)	0.822	0.828 (0.635 - 1.080)	0.165	1.019 (0.767 - 1.353)	0.896	0.981 (0.909 - 1.058)	0.625
Autumn	1.043 (0.974 - 1.117)	0.224	1.018 (0.958 - 1.081)	0.552	1.006 (0.860 - 1.178)	0.932	0.902 (0.744 - 1.094)	0.296	1.004 (0.957 - 1.053)	0.861
Winter	1.098 (1.035 - 1.165)	0.002	1.053 (1.000 - 1.109)	0.047	0.982 (0.852 - 1.132)	0.806	1.114 (0.963 - 1.290)	0.145	1.031 (0.988 - 1.075)	0.154
Temperature, mean										
~ -1.2°C (10% lower)	1.130 (1.029 - 1.240)	0.010	1.036 (0.951 - 1.130)	0.409	1.108 (0.863 - 1.424)	0.419	1.322 (1.075 - 1.626)	0.008	1.044 (0.969 - 1.125)	0.247
-1.2-12.2 (10% to 50%)	1.080 (1.025 - 1.139)	0.004	1.054 (1.006 - 1.103)	0.024	0.909 (0.805 - 1.027)	0.129	0.993 (0.860 - 1.146)	0.930	1.011 (0.975 - 1.049)	0.526
12.2-25.5 (50% to 90%)	1.089 (1.028 - 1.153)	0.003	1.024 (0.973 - 1.077)	0.349	1.072 (0.953 - 1.206)	0.245	1.158 (1.006 - 1.332)	0.041	1.019 (0.979 - 1.060)	0.340
25.5 ~ (10% upper)	1.298 (1.112 - 1.516)	0.001	1.158 (1.006 - 1.334)	0.040	0.830 (0.531 - 1.295)	0.413	1.009 (0.666 - 1.530)	0.963	1.070 (0.955 - 1.200)	0.241

Estimated Hazard Ratio for Shor-Term Mortality and Long-Term Cardiovascular Events Associated with Daily Concentrations of Air Pollutant

CO, 0.1 ppm	30 days after AMI		2-year after AMI							
	Total death	p Value	Total death	p Value	Recurrent MI	p Value	Revascularization	p Value	MACE	p Value
Overall	1.021 (1.005 - 1.039)	0.010	1.009 (0.994 - 1.024)	0.208	0.988 (0.951 - 1.026)	0.537	1.011 (0.969 - 1.055)	0.598	1.012 (1.001 - 1.024)	0.032
Age (≥ 65 year)	1.008 (0.989 - 1.029)	0.381	0.995 (0.978 - 1.013)	0.633	0.980 (0.929 - 1.033)	0.461	1.002 (0.954 - 1.053)	0.916	1.001 (0.986 - 1.016)	0.841
Sex										
Male	1.031 (1.009 - 1.054)	0.004	1.015 (0.996 - 1.034)	0.118	1.000 (0.955 - 1.046)	0.987	1.057 (1.000 - 1.117)	0.049	1.016 (1.002 - 1.031)	0.021
Female	1.006 (0.980 - 1.032)	0.641	0.998 (0.976 - 1.022)	0.923	0.959 (0.894 - 1.029)	0.250	0.945 (0.881 - 1.013)	0.112	1.003 (0.984 - 1.022)	0.742
History of Risk										
Hypertension	1.017 (0.994 - 1.040)	0.133	1.003 (0.984 - 1.023)	0.700	0.977 (0.927 - 1.031)	0.410	1.019 (0.963 - 1.077)	0.507	1.005 (0.989 - 1.021)	0.494
Diabetes	1.015 (0.987 - 1.044)	0.276	1.007 (0.983 - 1.032)	0.539	1.018 (0.958 - 1.082)	0.549	1.018 (0.948 - 1.093)	0.613	1.016 (0.997 - 1.036)	0.086
Dyslipidemia	1.022 (0.962 - 1.085)	0.472	1.016 (0.965 - 1.071)	0.531	1.008 (0.912 - 1.114)	0.869	0.809 (0.621 - 1.054)	0.118	1.009 (0.971 - 1.048)	0.624
Current smokers	1.031 (0.999 - 1.064)	0.054	1.020 (0.992 - 1.049)	0.145	1.021 (0.964 - 1.082)	0.460	1.045 (0.968 - 1.128)	0.252	1.025 (1.005 - 1.045)	0.013
Cancer history	0.958 (0.853 - 1.077)	0.481	0.966 (0.890 - 1.049)	0.420	0.991 (0.706 - 1.390)	0.959	1.125 (0.801 - 1.582)	0.495	0.978 (0.909 - 1.051)	0.552
COPD	1.009 (0.920 - 1.107)	0.842	0.948 (0.871 - 1.032)	0.223	1.288 (1.052 - 1.576)	0.014	0.961 (0.691 - 1.336)	0.814	0.956 (0.885 - 1.034)	0.265
Ischemic heart disease	1.072 (1.034 - 1.111)	< 0.001	1.043 (1.011 - 1.076)	0.008	0.958 (0.883 - 1.039)	0.302	1.055 (0.960 - 1.159)	0.260	1.033 (1.006 - 1.059)	0.013
Seasons										
Spring	1.011 (0.949 - 1.077)	0.729	0.976 (0.924 - 1.031)	0.397	1.009 (0.893 - 1.141)	0.875	1.121 (0.965 - 1.301)	0.133	1.003 (0.962 - 1.046)	0.872
Summer	1.029 (0.959 - 1.105)	0.418	1.008 (0.948 - 1.073)	0.786	1.043 (0.895 - 1.216)	0.586	1.033 (0.863 - 1.236)	0.719	1.051 (1.002 - 1.101)	0.038
Autumn	1.005 (0.974 - 1.036)	0.750	1.004 (0.978 - 1.031)	0.735	0.990 (0.922 - 1.064)	0.795	0.956 (0.875 - 1.044)	0.322	1.010 (0.989 - 1.031)	0.348
Winter	1.018 (0.991 - 1.045)	0.192	0.998 (0.975 - 1.022)	0.926	0.979 (0.917 - 1.045)	0.540	1.008 (0.942 - 1.080)	0.797	1.006 (0.987 - 1.026)	0.479
Temperature, mean										
~ -1.2°C (10% lower)	1.043 (0.992 - 1.097)	0.099	0.998 (0.952 - 1.046)	0.944	0.957 (0.823 - 1.113)	0.570	1.117 (1.003 - 1.245)	0.044	1.016 (0.976 - 1.058)	0.428
-1.2-12.2 (10% to 50%)	1.017 (0.994 - 1.041)	0.131	1.012 (0.992 - 1.032)	0.225	0.982 (0.932 - 1.035)	0.519	0.975 (0.914 - 1.040)	0.449	1.012 (0.996 - 1.028)	0.124
12.2-25.5 (50% to 90%)	1.029 (0.987 - 1.074)	0.174	1.006 (0.970 - 1.044)	0.729	1.017 (0.932 - 1.109)	0.701	1.061 (0.955 - 1.179)	0.263	1.023 (0.994 - 1.052)	0.112
25.5 ~ (10% upper)	0.999 (0.893 - 1.117)	0.988	1.001 (0.911 - 1.101)	0.969	1.042 (0.818 - 1.328)	0.737	1.025 (0.793 - 1.325)	0.848	1.037 (0.965 - 1.115)	0.312