

# Supplemental Material

## The association between air pollution and mortality in Thailand

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**Table S1:** Spearman correlation between air pollutants and weather conditions in 18 provinces in Thailand, during 199–2008.

Province	Pollutants	O <sub>3</sub>	SO <sub>2</sub>	Mean temperature	Relative humidity
Ayutthaya	PM <sub>10</sub>	0.67	0.17	-0.39	-0.69
	O <sub>3</sub>		0.15	-0.17	-0.7
	SO <sub>2</sub>			0.11	-0.08
	Mean temperature				0.24
Bangkok	PM <sub>10</sub>	0.49	0.37	-0.41	-0.45
	O <sub>3</sub>		0.05	-0.13	-0.63
	SO <sub>2</sub>			-0.03	-0.03
	Mean temperature				0.12
Chachoengsao	PM <sub>10</sub>	0.44	0.21	-0.57	-0.43
	O <sub>3</sub>		0.12	-0.46	-0.44
	SO <sub>2</sub>			-0.15	-0.09
	Mean temperature				0.06
Chiang mai	PM <sub>10</sub>	0.53	0.29	-0.14	-0.59
	O <sub>3</sub>		0.08	0.08	-0.75
	SO <sub>2</sub>			-0.02	-0.19
	Mean temperature				0.01
Chon buri	PM <sub>10</sub>	0.5	0.08	-0.26	-0.38
	O <sub>3</sub>		-0.07	-0.43	-0.64
	SO <sub>2</sub>			0.11	-0.02
	Mean temperature				0.2
Khon kaen	PM <sub>10</sub>	0.26	0.32	-0.2	-0.43
	O <sub>3</sub>		-0.02	0.12	-0.59
	SO <sub>2</sub>			-0.15	-0.27
	Mean temperature				0.04
Lampang	PM <sub>10</sub>	0.67	0.22	0.01	-0.66
	O <sub>3</sub>		0.14	0.16	-0.7
	SO <sub>2</sub>			-0.02	-0.13
	Mean temperature				-0.09
Nakhon sawan	PM <sub>10</sub>	0.62	0.32	-0.25	-0.61
	O <sub>3</sub>		0.28	-0.04	-0.68
	SO <sub>2</sub>			-0.08	-0.28
	Mean temperature				0.04
Nakhon ratchasima	PM <sub>10</sub>	0.26	-0.03	-0.29	-0.4
	O <sub>3</sub>		0.06	-0.05	-0.56
	SO <sub>2</sub>			-0.09	-0.02
	Mean temperature				0.15
Nonthaburi	PM <sub>10</sub>	0.54	0.35	-0.51	-0.51
	O <sub>3</sub>		0.23	-0.31	-0.62
	SO <sub>2</sub>			-0.2	-0.11
	Mean temperature				0.20

Pathum thani	PM <sub>10</sub>	0.34	0.17	-0.11	-0.42
	O <sub>3</sub>		0.2	-0.35	-0.52
	SO <sub>2</sub>			0.08	-0.2
	Mean temperature				0.16
Ratchaburi	PM <sub>10</sub>	0.69	0.42	-0.58	-0.23
	O <sub>3</sub>		0.38	-0.46	-0.42
	SO <sub>2</sub>			-0.31	-0.22
	Mean temperature				-0.16
Rayong	PM <sub>10</sub>	0.48	0.1	-0.41	-0.15
	O <sub>3</sub>		0.03	-0.52	-0.36
	SO <sub>2</sub>			-0.04	0.05
	Mean temperature				-0.18
Samutprakan	PM <sub>10</sub>	0.59	0.16	-0.26	-0.29
	O <sub>3</sub>		0.05	-0.38	-0.51
	SO <sub>2</sub>			0.11	0.15
	Mean temperature				0.18
Samut sakhon	PM <sub>10</sub>	0.52	0.6	-0.46	-0.38
	O <sub>3</sub>		0.27	-0.43	-0.37
	SO <sub>2</sub>			-0.33	-0.33
	Mean temperature				0.13
Saraburi	PM <sub>10</sub>	0.26	0.12	-0.31	-0.23
	O <sub>3</sub>		0.28	-0.38	-0.54
	SO <sub>2</sub>			-0.31	-0.22
	Mean temperature				-0.07
Songkhla	PM <sub>10</sub>	0.13	0.08	0.17	-0.16
	O <sub>3</sub>		0.05	-0.31	-0.17
	SO <sub>2</sub>			0.09	-0.03
	Mean temperature				-0.62
Surat thani	PM <sub>10</sub>	0.47	0.03	-0.26	-0.39
	O <sub>3</sub>		-0.03	-0.49	-0.50
	SO <sub>2</sub>			0.01	-0.13
	Mean temperature				0.15

**Table S2:** Pooled effect estimates (mean and 95% posterior intervals) for the increase in mortality associated with an increase of 10  $\mu\text{g}/\text{m}^3$  in  $\text{PM}_{10}$ , 10 ppb in  $\text{O}_3$ , 1 ppb in  $\text{SO}_2$  in Thailand during 1999–2008, using single pollutant models without controlling for temperature and relative humidity.

Pollutant	% increase (95% posterior intervals)		
	Non-accidental	Cardiovascular	Respiratory
$\text{PM}_{10}$	0.49 (0.3, 0.67)	0.29 (-0.02, 0.61)	0.40 (0.06, 0.75)
$\text{O}_3$	1.26 (0.64, 1.89)	1.88 (0.51, 3.25)	1.30 (-0.28, 2.87)
$\text{SO}_2$	0.38 (0.20, 0.57)	0.28 (-0.08, 0.63)	0.55 (0.06, 1.05)

**Table S3:** Descriptive summary for the study period, daily deaths, air pollutants and weather conditions in 18 provinces in summer (March–June) in Thailand, during 1999–2008

Province	Period	Mean (Standard deviation)							
		Non-accidental	Cardiovascular	Respiratory	PM <sub>10</sub>	O <sub>3</sub>	SO <sub>2</sub>	Mean temperature	Relative humidity
Ayutthaya	1999–2008	7 (2.9)	2 (1.3)	1 (1.1)	52.5 (23.7)	25 (8.4)	2.8 (1.6)	29.9 (1.4)	72.4 (8.1)
Bangkok	1999–2008	67 (10.6)	13 (4.1)	8 (3)	51.8 (14.3)	13.6 (5.9)	5.5 (1.7)	30.3 (1.4)	72.2 (6.4)
Chachoengsao	2004–2008	6 (2.5)	1 (1)	1 (1)	30.7 (11.9)	26.2 (6.7)	1.9 (1.2)	27.7 (2.1)	73.1 (10.3)
Chiang mai	1999–2008	21 (5.2)	3 (1.9)	3 (1.8)	61.5 (48)	22.4 (9.7)	1.6 (1.3)	28.1 (1.7)	67.8 (10.7)
Chon buri	1999–2008	13 (3.9)	2 (1.6)	2 (1.3)	39.4 (15.5)	15.7 (6.6)	3.8 (1.8)	29.3 (1.1)	76.3 (5.2)
Khon kaen	1999–2008	17 (4.4)	3 (1.7)	2 (1.3)	35.2 (20.6)	20.7 (8)	2.3 (1.5)	29 (2.1)	70.9 (9.4)
Lampang	1999–2008	11 (3.6)	2 (1.4)	1 (1.2)	59.9 (45.8)	21.1 (10.9)	1.2 (1.1)	29.5 (1.8)	75.4 (10)
Nakhon sawan	2000–2008	11 (3.6)	3 (1.8)	1 (1.2)	45.9 (19.9)	28.8 (10.8)	1.8 (1.5)	30.3 (1.8)	69.9 (8)
Nakhon ratchasima	1999–2008	21 (5.5)	4 (2.2)	3 (1.7)	51 (23.7)	23.8 (9)	2.1 (1.3)	28.8 (1.7)	70.8 (8.1)
Nonthaburi	1999–2008	9 (3.2)	2 (1.5)	1 (1.3)	39.7 (14.1)	18 (7.2)	4.6 (2)	29.5 (1.7)	72.9 (9.5)
Pathum thani	1999–2008	6 (2.9)	1 (1.2)	1 (0.9)	53.5 (27.8)	20.3 (8.6)	5.4 (3.1)	28.8 (2.3)	73.7 (11.2)
Ratchaburi	1999–2008	8 (3)	2 (1.3)	1 (1)	36.8 (16.9)	20.4 (8.7)	3.1 (2.4)	28.8 (1.9)	67.4 (11.8)
Rayong	1999–2008	5 (2.3)	1 (1)	1 (0.8)	38.9 (20.7)	16.5 (6.3)	4.2 (2.3)	27.7 (1.8)	70.8 (12.1)
Samutprakan	1999–2008	8 (3.1)	2 (1.5)	1 (1)	83.8 (35.1)	17.8 (8)	7.1 (4)	29.1 (1.1)	73.3 (5.8)
Samut sakhon	1999–2008	4 (2.1)	1 (0.9)	1 (0.8)	38.2 (15)	14.4 (7.6)	10.2 (6.2)	29.2 (1.2)	77.2 (5.1)
Saraburi	1999–2008	6 (2.8)	1 (1.2)	1 (1)	54.8 (21.5)	19 (8.1)	2.6 (1.3)	29.5 (1.7)	73.5 (7.6)
Songkhla	1999–2008	9 (3.1)	2 (1.5)	1 (1.1)	38.5 (13)	9.1 (5.9)	2.4 (2.2)	28.6 (1)	78.7 (4.2)
Surat thani	1999–2008	6 (2.6)	1 (1.1)	1 (0.9)	31.9 (13.4)	11.8 (5)	2.4 (1.6)	29.1 (2.2)	69.6 (9.4)

**Table S4:** Descriptive summary for the study period, daily deaths, air pollutants and weather conditions in 18 provinces in rainy season (July–October) in Thailand, during 1999–2008

Province	Period	Mean (Standard deviation)							
		Non-accidental	Cardiovascular	Respiratory	PM <sub>10</sub>	O <sub>3</sub>	SO <sub>2</sub>	Mean temperature	Relative humidity
Ayutthaya	1999–2008	7 (2.8)	2 (1.3)	1 (1.1)	42.3 (21.5)	16.7 (6.6)	2.8 (1.9)	28.5 (1)	79 (6.1)
Bangkok	1999–2008	68 (9.7)	14 (4)	9 (3)	51.3 (13.6)	10.7 (4.3)	5.6 (1.5)	29.4 (1)	73.5 (6)
Chachoengsao	2004–2008	6 (2.5)	1 (1.1)	1 (0.9)	31.1 (16.2)	21.2 (6.2)	2.5 (1.4)	27 (1.3)	79.8 (7.1)
Chiang mai	1999–2008	21 (5.4)	3 (1.9)	3 (1.8)	33.9 (14.4)	11.7 (3.9)	1.5 (1.4)	27.3 (1.1)	78.7 (4.8)
Chon buri	1999–2008	13 (3.8)	2 (1.7)	2 (1.2)	36.5 (11.7)	12.9 (6)	4.2 (2.4)	28.6 (1)	78.2 (5.7)
Khon kaen	1999–2008	17 (4.7)	3 (1.7)	2 (1.3)	30.9 (16)	12.1 (5.2)	2.2 (1.5)	27.8 (1.2)	78.8 (6.2)
Lampang	1999–2008	10 (3.5)	2 (1.4)	1 (1.2)	31.3 (12)	8.1 (3.1)	0.9 (0.7)	28.4 (1)	83.9 (5)
Nakhon sawan	2000–2008	11 (3.6)	3 (1.7)	1 (1.2)	36.9 (15.2)	16.6 (6.2)	1.2 (1)	28.6 (1)	77.9 (5.4)
Nakhon ratchasima	1999–2008	20 (5.9)	4 (2.1)	2 (1.7)	45 (25.4)	14.4 (5.3)	2.3 (1.7)	27.6 (1.2)	76.8 (6)
Nonthaburi	1999–2008	8 (2.9)	2 (1.4)	1 (1.2)	39.4 (12)	13.2 (4.9)	4.6 (1.7)	28.2 (1.1)	81.5 (5.2)
Pathum thani	1999–2008	7 (2.9)	1 (1.3)	1 (1)	38 (18.1)	14.2 (6.5)	4 (1.9)	27.9 (1.4)	81.7 (7.3)
Ratchaburi	1999–2008	8 (2.9)	2 (1.3)	1 (1)	36.2 (18.3)	14.3 (6.4)	3 (1.6)	27.5 (1.2)	79.8 (5.3)
Rayong	1999–2008	5 (2.4)	1 (1)	1 (0.8)	33.9 (15.1)	12.2 (4.7)	4.2 (1.9)	26.2 (1)	82.5 (4.4)
Samutprakan	1999–2008	8 (3.2)	2 (1.4)	1 (1)	77 (29.4)	13.4 (5.8)	6.2 (2.5)	28.6 (1)	72.7 (5.4)
Samut sakhon	1999–2008	4 (2.2)	1 (1)	1 (0.8)	43.6 (16.1)	10.3 (5.6)	13.8 (5.7)	28.8 (1.1)	78.2 (6.1)
Saraburi	1999–2008	6 (2.8)	1 (1.2)	1 (0.9)	52.2 (25.7)	12 (5.6)	2.4 (1.3)	28.4 (1)	80.5 (4.5)
Songkhla	1999–2008	9 (3.3)	2 (1.4)	1 (1)	42.8 (18.5)	7.2 (4.9)	2.4 (1.6)	28.2 (1)	79.5 (4.9)
Surat thani	1999–2008	6 (2.9)	1 (1)	1 (0.9)	24.7 (9.1)	8.8 (3)	2.1 (1.5)	28 (1.3)	77.9 (8)

**Table S5:** Descriptive summary for the study period, daily deaths, air pollutants and weather conditions in 18 provinces in winter (November–February) in Thailand, during 1999–2008

Province	Period	Mean (Standard deviation)							
		Non-accidental	Cardiovascular	Respiratory	PM <sub>10</sub>	O <sub>3</sub>	SO <sub>2</sub>	Mean temperature	Relative humidity
Ayutthaya	1999–2008	7 (3.1)	2 (1.5)	1 (1.1)	90 (31.8)	28.2 (7.9)	2.5 (1.4)	26.5 (2.2)	64.9 (8.2)
Bangkok	1999–2008	65 (12.1)	14 (4.2)	8 (3.2)	73.5 (23.9)	17 (5.5)	6 (2)	28 (1.8)	65.5 (7.7)
Chachoengsao	2004–2008	5 (2.2)	1 (1.1)	1 (0.8)	62.6 (30.3)	29.9 (9.7)	2.9 (1.9)	22.8 (2.9)	69.6 (8.2)
Chiang mai	1999–2008	20 (5.5)	3 (2)	3 (1.9)	64.8 (32)	18.5 (6.8)	1.8 (1.3)	23.6 (2.2)	68.4 (7.8)
Chon buri	1999–2008	12 (4.1)	3 (1.7)	2 (1.3)	56.1 (22)	25.5 (10.1)	3.6 (1.6)	27.3 (1.5)	69.8 (9.5)
Khon kaen	1999–2008	16 (5)	3 (1.8)	2 (1.3)	53.3 (29.8)	16.7 (6.4)	3.5 (2.8)	24.7 (2.8)	66.2 (6.4)
Lampang	1999–2008	10 (3.6)	2 (1.4)	1 (1.2)	68 (40.2)	16.9 (8.2)	1.2 (0.8)	26 (2.2)	73.5 (6.8)
Nakhon sawan	2000–2008	11 (3.7)	3 (1.8)	1 (1.2)	67.6 (25.5)	30.5 (8)	2.4 (1.6)	26.9 (2.2)	65.9 (7.2)
Nakhon ratchasima	1999–2008	20 (5.9)	4 (2.2)	3 (1.7)	80.9 (38.8)	22.1 (8.6)	2.4 (2)	25.1 (2.4)	66.7 (6.4)
Nonthaburi	1999–2008	8 (3.3)	2 (1.5)	1 (1.2)	66.6 (27.5)	22.7 (7.7)	5.5 (2.6)	25.8 (2.4)	66.2 (6.9)
Pathum thani	1999–2008	6 (2.9)	1 (1.2)	1 (0.9)	58.8 (27)	23.9 (8.4)	4.9 (2.8)	24.2 (2.8)	67.7 (7)
Ratchaburi	1999–2008	8 (3.2)	2 (1.4)	1 (1.1)	73.2 (29.4)	28.6 (8.9)	5 (2.8)	23.9 (2.5)	69.1 (7.9)
Rayong	1999–2008	5 (2.3)	1 (1)	1 (0.8)	54.1 (22.4)	24.8 (10)	4.2 (2)	23.5 (2.3)	71.9 (8)
Samutprakan	1999–2008	8 (3.3)	2 (1.4)	1 (1.1)	124.8 (46.7)	24.7 (8.5)	6.1 (3.3)	27.2 (1.7)	67.7 (9.6)
Samut sakhon	1999–2008	4 (2.2)	1 (0.9)	1 (0.8)	64 (28.5)	22 (8.4)	17.8 (9.7)	26.6 (1.7)	73.8 (7.4)
Saraburi	1999–2008	6 (2.9)	1 (1.3)	1 (1)	80.9 (40.3)	24.3 (9.1)	3.8 (2.2)	25.8 (2.4)	72.4 (4.7)
Songkhla	1999–2008	9 (3.2)	2 (1.5)	1 (1.1)	34.6 (13.9)	13.5 (9.1)	2.1 (2.3)	27 (0.9)	80.9 (5.6)
Surat thani	1999–2008	6 (2.9)	1 (1.1)	1 (1)	37.7 (14.5)	17.7 (9.2)	2.2 (1.6)	24.7 (2.8)	62.6 (5.9)