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Supplemental Information

Changes in Life Expectancy of Respiratory Diseases from Attaining Daily $PM_{2.5}$ Standard in China: A Nationwide Observational Study

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Supplemental Information

Table of Contents

Table S1. Life expectancy for Chinese population from 2013 to 2016.

Age	Life expectancy for Male, years				Life expectancy for Female, years			
	2013	2014	2015	2016	2013	2014	2015	2016
<1	74.4	74.6	74.8	75.0	77.3	77.5	77.7	77.9
<4	74.2	74.3	74.5	74.6	77.1	77.2	77.4	77.5
<9	70.3	70.5	70.6	70.7	73.2	73.4	73.5	73.6
<14	65.5	65.6	65.7	65.8	68.4	68.5	68.6	68.8
15-19	60.6	60.7	60.8	60.9	63.4	63.5	63.7	63.8
20-24	55.7	55.8	55.9	56.0	58.5	58.6	58.8	58.9
25-29	50.8	50.9	51.1	51.2	53.6	53.8	53.9	54.0
30-34	46.0	46.1	46.2	46.4	48.8	48.9	49.0	49.2
35-39	41.2	41.3	41.5	41.6	43.9	44.1	44.2	44.3
40-44	36.5	36.6	36.7	36.8	39.1	39.2	39.4	39.5
45-49	31.8	31.9	32.0	32.1	34.4	34.5	34.6	34.7
50-54	27.2	27.2	27.3	27.5	29.7	29.8	29.9	30.0
55-59	22.7	22.8	22.9	23.0	25.1	25.2	25.3	25.4
60-64	18.5	18.5	18.6	18.7	20.7	20.8	20.9	21.0
65-69	14.6	14.7	14.8	14.9	16.6	16.7	16.8	16.9
70-74	11.3	11.4	11.4	11.5	13.0	13.1	13.2	13.3
75-79	8.6	8.7	8.7	8.8	9.9	10.0	10.0	10.1
80-84	6.6	6.6	6.7	6.7	7.4	7.4	7.5	7.5
85+	4.9	4.9	5.0	5.0	5.4	5.5	5.5	5.6

Table S2. Spearman correlation coefficients of air pollutant, temperature, and relative humidity.

	$PM_{2.5}$	O_3	NO_2	SO_2	Temperature	Relative humidity
$PM_{2.5}$	1.00					
O_3	0.42	1.00				
NO_2	0.47	-0.01	1.00			
SO_2	0.28	0.47	0.36	1.00		
Temperature	-0.14	0.17	-0.30	-0.24	1.00	
Relative humidity	-0.04	-0.13	-0.12	-0.14	0.22	1.00

Table S3. The region-specific estimates of changes in years of life lost and excess risk of mortality caused by total respiratory diseases and COPD per 10 μg/m^3 increment of $PM_{2.5}$ at lag02.

Region	Changes in years of life lost (95% CI)		Excess risk of mortality, % (95% CI)	
	Respiratory diseases	COPD	Respiratory diseases	COPD
East (n=31)	**0.23 (0.11, 0.36)**	**0.18 (0.09, 0.27)**	**0.30 (0.14, 0.46)**	**0.28 (0.17, 0.39)**
South (n=8)	0.04 (-0.14, 0.22)	0.05 (-0.05, 0.16)	0.08 (-0.17, 0.33)	0.18 (-0.17, 0.53)
Southwest (n=8)	**0.42 (0.22, 0.62)**	1.07 (-1.14, 3.27)	**0.52 (0.33, 0.70)**	1.04 (-0.13, 2.23)
North (n=8)	-0.02 (-0.09, 0.05)	0.02 (-0.02, 0.05)	0.06 (-0.07, 0.18)	0.12 (-0.06, 0.30)
Northeast (n=14)	0.07 (-0.08, 0.23)	0.03 (-0.07, 0.12)	0.04 (-0.18, 0.26)	0.003 (-0.28, 0.28)
Northwest (n=12)	0.19 (-0.15, 0.53)	0.11 (-0.01, 0.22)	**0.71 (0.22, 1.21)**	**0.64 (0.25, 1.04)**
Central (n=15)	0.21 (-0.27, 0.70)	0.04 (-0.38, 0.47)	0.19 (-0.18, 0.56)	0.16 (-0.24, 0.57)
National (n=96)	**0.16 (0.08, 0.24)**	**0.10 (0.05, 0.15)**	**0.26 (0.15, 0.37)**	**0.28 (0.15, 0.41)**

Note: lag02, moving averaged concentration of lag 0 to lag 2 of daily $PM_{2.5}$; bold typeface indicates statistically significant ($P<0.05$).

Table S4. The region-specific estimates of changes in years of life lost and excess risk of mortality caused by total respiratory diseases per 10 μg/m^3 increment of $PM_{2.5}$ at lag02 (stratified by gender).

Region	Changes in years of life lost (95% CI)		Excess risk of mortality, % (95% CI)	
	Male	Female	Male	Female
East (n=31)	**0.08 (0.003, 0.15)**	**0.13 (0.07, 0.20)**	0.10 (-0.03, 0.24)	**0.47 (0.29, 0.65)**
South (n=8)	0.02 (-0.11, 0.16)	0.01 (-0.09, 0.11)	0.10 (-0.16, 0.37)	0.04 (-0.33, 0.41)
Southwest (n=8)	**0.28 (0.14, 0.42)**	**0.14 (0.04, 0.23)**	**0.50 (0.30, 0.71)**	0.77 (-0.09, 1.63)
North (n=8)	-0.03 (-0.08, 0.03)	0.002 (-0.04, 0.04)	-0.04 (-0.20, 0.12)	0.17 (-0.01, 0.35)
Northeast (n=14)	0.03 (-0.09, 0.14)	0.03 (-0.06, 0.13)	-0.01 (-0.34, 0.31)	0.16 (-0.09, 0.41)
Northwest (n=12)	0.04 (-0.10, 0.18)	0.17 (-0.15, 0.49)	**0.58 (0.09, 1.06)**	0.54 (-0.14, 1.22)
Central (n=15)	0.12 (-0.16, 0.41)	0.08 (-0.13, 0.29)	0.10 (-0.32, 0.52)	0.29 (-0.12, 0.69)
National (n=96)	**0.05 (0.01, 0.09)**	**0.07 (0.04, 0.11)**	**0.13 (0.02, 0.24)**	**0.35 (0.22, 0.48)**

Note: lag02, moving averaged concentration of lag 0 to lag 2 of daily $PM_{2.5}$; bold typeface indicates statistically significant ($P<0.05$).

Table S5. The region-specific estimates of changes in years of life lost and excess risk of mortality caused by COPD per 10 μg/m^3 increment of $PM_{2.5}$ at lag02 (stratified by gender).

Region	Changes in years of life lost (95% CI)		Excess risk of mortality, % (95% CI)	
	Male	Female	Male	Female
East (n=31)	**0.06 (0.01, 0.10)**	**0.09 (0.04, 0.14)**	**0.16 (0.01, 0.31)**	**0.50 (0.28, 0.71)**
South (n=8)	0.06 (-0.01, 0.13)	0.01 (-0.03, 0.06)	0.30 (-0.001, 0.60)	0.02 (-0.65, 0.71)
Southwest (n=8)	**0.25 (0.14, 0.36)**	**0.14 (0.05, 0.22)**	0.92 (-0.15, 2.01)	**1.35 (0.06, 2.65)**
North (n=8)	0.002 (-0.03, 0.03)	0.02 (-0.01, 0.04)	0.01 (-0.24, 0.25)	**0.28 (0.01, 0.55)**
Northeast (n=14)	0.01 (-0.06, 0.08)	0.01 (-0.04, 0.07)	-0.04 (-0.38, 0.31)	0.08 (-0.39, 0.54)
Northwest (n=12)	0.08 (-0.01, 0.17)	0.04 (-0.07, 0.16)	**0.61 (0.18, 1.04)**	**0.71 (0.03, 1.38)**
Central (n=15)	-0.01 (-0.26, 0.24)	0.05 (-0.11, 0.20)	-0.001 (-0.49, 0.49)	0.34 (-0.08, 0.77)
National (n=96)	**0.04 (0.01, 0.06)**	**0.03 (0.02, 0.05)**	**0.17 (0.03, 0.31)**	**0.37 (0.26, 0.48)**

Note: lag02, moving averaged concentration of lag 0 to lag 2 of daily $PM_{2.5}$; bold typeface indicates statistically significant ($P<0.05$).

Table S6. The region-specific estimates of changes in years of life lost associated with each 10 μg/m^3 increment in $PM_{2.5}$ at lag02 in two-pollutant models.

Pollutant and Model	Changes in years of life lost (95% CI)	
	Respiratory diseases	COPD
East (n=31)		
+ NO_2 (two-pollutant model)	**0.27 (0.10, 0.44)**	**0.17 (0.07, 0.28)**
+ SO_2 (two-pollutant model)	**0.29 (0.20, 0.37)**	**0.23 (0.14, 0.31)**
+ O_3 (two-pollutant model)	**0.23 (0.11, 0.35)**	**0.20 (0.11, 0.30)**
South (n=8)		
+ NO_2 (two-pollutant model)	0.001(-0.19, 0.19)	0.07 (-0.02, 0.16)
+ SO_2 (two-pollutant model)	0.32 (-0.2, 0.83)	**0.14 (0.03, 0.26)**
+ O_3 (two-pollutant model)	0.17 (-0.04, 0.38)	**0.16 (0.06, 0.26)**
Southwest (n=8)		
+ NO_2 (two-pollutant model)	**0.36 (0.15, 0.56)**	1.77 (-1.06, 4.61)
+ SO_2 (two-pollutant model)	**0.75 (0.52, 0.99)**	0.61 (-1.38, 2.60)
+ O_3 (two-pollutant model)	**0.40 (0.19, 0.61)**	1.49 (-0.92, 3.89)
North (n=8)		
+ NO_2 (two-pollutant model)	-0.05 (-0.14, 0.05)	-0.01 (-0.05, 0.03)
+ SO_2 (two-pollutant model)	0.01 (-0.07, 0.08)	0.03 (-0.01, 0.07)
+ O_3 (two-pollutant model)	-0.03 (-0.1, 0.04)	0.01 (-0.03, 0.05)
Northeast (n=14)		
+ NO_2 (two-pollutant model)	-0.01 (-0.2, 0.17)	-0.03 (-0.10, 0.05)
+ SO_2 (two-pollutant model)	0.07 (-0.07, 0.20)	0.01 (-0.08, 0.10)
+ O_3 (two-pollutant model)	0.02 (-0.11, 0.16)	0.01(-0.07, 0.08)
Northwest (n=12)		
+ NO_2 (two-pollutant model)	-0.05 (-0.25, 0.14)	0.06 (-0.07, 0.19)
+ SO_2 (two-pollutant model)	0.30 (-0.06, 0.65)	0.15 (0.03, 0.27)
+ O_3 (two-pollutant model)	0.07 (-0.13, 0.28)	0.07 (-0.06, 0.20)
Central (n=15)		

+ NO_2 (two-pollutant model)	0.15 (-0.49, 0.78)	-0.10 (-0.67, 0.46)
+ SO_2 (two-pollutant model)	0.20 (-0.35, 0.74)	-0.01 (-0.48, 0.47)
+ O_3 (two-pollutant model)	0.04 (-0.06, 0.15)	0.04 (-0.26, 0.33)
National (n=96)		
+ NO_2 (two-pollutant model)	**0.16 (0.05, 0.27)**	**0.08 (0.02, 0.14)**
+ SO_2 (two-pollutant model)	**0.23 (0.13, 0.33)**	**0.14 (0.07, 0.21)**
+ O_3 (two-pollutant model)	**0.12 (0.06, 0.19)**	**0.08 (0.04, 0.12)**

Note: lag02, moving averaged concentration of lag 0 to lag 2 of daily $PM_{2.5}$; bold typeface indicates statistically significant ($P<0.05$).

Table S7. Sensitivity analyses for the changes in years of life lost associated with each 10 μg/m^3 increment in $PM_{2.5}$ at lag02 in different models, with changing degrees of freedom.

Regions	df of temperature		
	5	**6**	**7**
East (n=31)	**0.23 (0.11, 0.36)**	**0.23 (0.11, 0.36)**	**0.23 (0.11, 0.36)**
South (n=8)	0.04 (-0.14, 0.22)	0.04 (-0.14, 0.22)	0.02 (-0.16, 0.2)
Southwest (n=8)	**0.42 (0.22, 0.62)**	**0.42 (0.22, 0.62)**	**0.42 (0.22, 0.62)**
North (n=8)	-0.02 (-0.09, 0.05)	-0.02 (-0.09, 0.05)	-0.02 (-0.09, 0.05)
Northeast (n=14)	0.07 (-0.08, 0.22)	0.07 (-0.08, 0.23)	0.07 (-0.08, 0.23)
Northwest (n=12)	0.19 (-0.15, 0.54)	0.19 (-0.15, 0.53)	0.19 (-0.15, 0.53)
Central (n=15)	0.22 (-0.27, 0.70)	0.21 (-0.27, 0.70)	0.22 (-0.27, 0.70)
National (n=96)	**0.16 (0.08, 0.24)**	**0.16 (0.08, 0.24)**	**0.16 (0.08, 0.24)**

Note: lag02, moving averaged concentration of lag 0 to lag 2 of daily $PM_{2.5}$; bold typeface indicates statistically significant (P<0.05).

Table S8. Sensitivity analyses for the changes in years of life lost associated with each 10 μg/m^3 increment in $PM_{2.5}$ at lag02, with adding calendar year in the models.

Region	Changes in years of life lost (95% CI)		Excess risk of mortality, % (95% CI)	
	Respiratory diseases	COPD	Respiratory diseases	COPD
East (n=31)	**0.11 (0.05, 0.17)**	**0.06 (0.02, 0.10)**	**0.18 (0.04, 0.32)**	**0.19 (0.08, 0.29)**
South (n=8)	0.004 (-0.17, 0.18)	0.06 (-0.02, 0.15)	0.09 (-0.19, 0.37)	0.20 (-0.14, 0.54)
Southwest (n=8)	**0.30 (0.13, 0.48)**	**0.27 (0.13, 0.42)**	**0.34 (0.18, 0.51)**	0.66 (-0.12, 1.45)
North (n=8)	-0.05 (-0.12, 0.03)	0.01 (-0.03, 0.05)	0.01 (-0.11, 0.13)	0.10 (-0.08, 0.28)
Northeast (n=14)	0.02 (-0.13, 0.18)	0.03 (-0.09, 0.14)	0.002 (-0.27, 0.28)	-0.01 (-0.31, 0.31)
Northwest (n=12)	0.19 (-0.25, 0.64)	0.05 (-0.07, 0.16)	**0.58 (0.13, 1.04)**	**0.64 (0.17, 1.11)**
Central (n=15)	-0.04 (-0.14, 0.05)	-0.06 (-0.32, 0.2)	0.03 (-0.23, 0.28)	-0.01 (-0.33, 0.31)
National (n=96)	0.05 (-0.003, 0.11)	**0.04 (0.01, 0.07)**	**0.12 (0.05, 0.20)**	**0.17 (0.08, 0.25)**

Note: lag02, moving averaged concentration of lag 0 to lag 2 of daily $PM_{2.5}$; bold typeface indicates statistically significant ($P<0.05$).

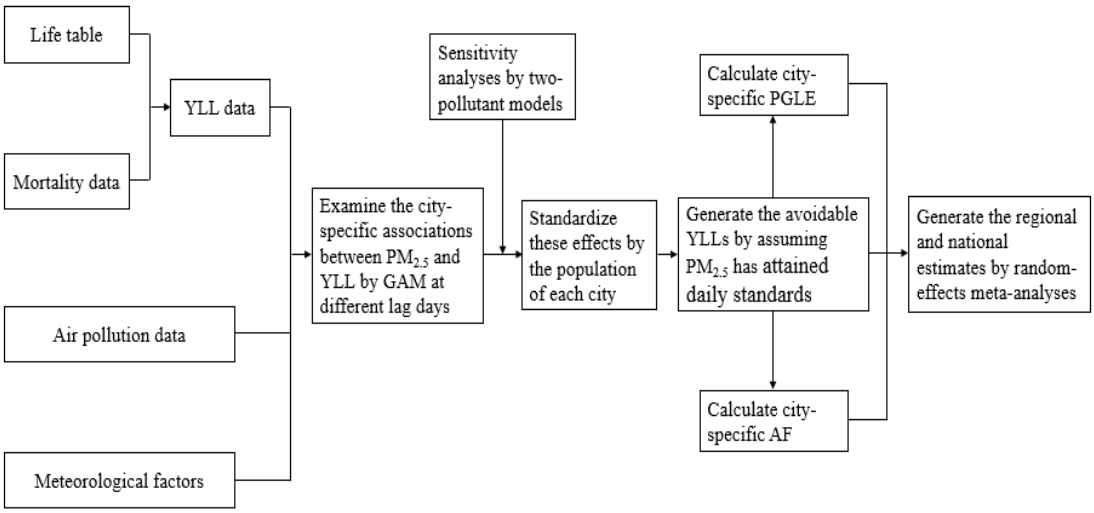

Figure S1. The flow chart of the analytical process.

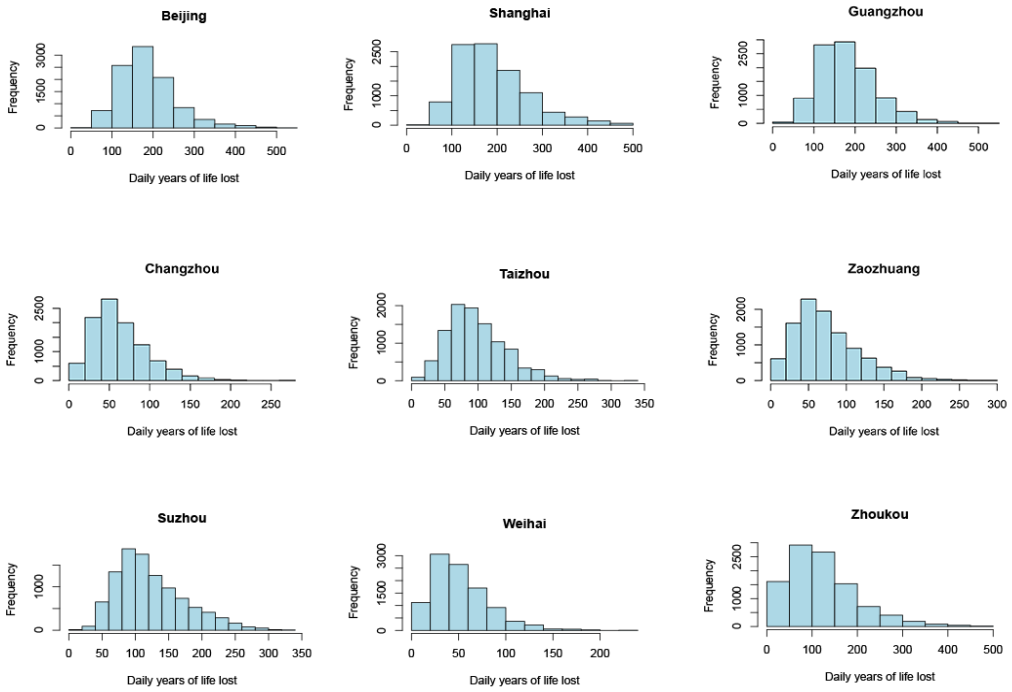

Figure S2. Histogram of daily years of life lost in several Chinese cities during 2013 to 2016.