Supplementary Materials to

Particulate Air Pollution and Mortality in China: A Time-Series Analysis in the Largest 38 Chinese Cities

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Supplementary Material 1: PM_{10} calculation

The API is constructed based on the concentrations of 3 atmospheric pollutants, namely sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and suspended particulates of 10 micrometers or less (PM_{10}) measured at the monitoring stations throughout each city. It is a proxy measure of the ambient air quality. The API indicates the maximum concentration of the three pollutants. Table SM1 shows the relationship between the API and the concentration of the three air pollutants.

Table SM1. The Relationship between the API and Air Pollutant Concentrations

API	SO_2	NO_2	PM_{10}	Air Quality Levels
0-50	0-0.05	0-0.08	0-0.05	Excellent
50-100	0.05-0.15	0.08-0.12	0.05-0.15	Good
100-200	0.15-0.8	0.12-0.28	0.15-0.35	Slightly Polluted
200-300	0.8-1.6	0.28-0.565	0.35-0.42	Moderately Polluted
300-400	1.6-2.1	0.565-0.75	0.42-0.5	Severely Polluted
400-500	2.1-2.62	0.75-0.94	0.5-0.6	Severely Polluted

Notes: Pollutant concentration is measured by mg/m^3. The last column is the official air quality description based on the API

The construction of the API takes four steps. First, measure the daily average concentration of each pollutant. Second, for each pollutant, find out its corresponding concentration interval in Table SM1. Third, calculate the pollution index (PI) of each pollutant linearly. Finally, take the maximum of all pollution indices and define it as the API.

For example, assume the concentrations of the three pollutants are: $C_{SO_2} = 0.07mg/m^3$, $C_{NO_2} = 0.10mg/m^3$, and $C_{PM_{10}} = 0.30mg/m^3$, then use Table SM1 we find that the concentrations of SO_2, and NO_2 are in the interval [50,100] while the PM_{10} concentration falls into the interval [100,200]. Within each interval we can calculate pollution index of each pollutant linearly:

$$PI_{SO_2} = \frac{100 - 50}{0.15 - 0.05} * (0.07 - 0.05) + 50 = 60$$

$$PI_{NO_2} = \frac{100 - 50}{0.12 - 0.08} * (0.10 - 0.08) + 50 = 75$$

$$PI_{PM_{10}} = \frac{200 - 100}{0.35 - 0.15} * (0.30 - 0.15) + 100 = 175$$

Then the $API = \max[PI_{SO_2}, PI_{NO_2}, PI_{PM_{10}}\} = 175$ and PM_{10} is called the primary pollutant. Reverse this process, we can recover the concentrations of the primary pollutant.

We use daily API to recover daily PM_{10} concentrations because the Chinese government did not provide daily individual pollution concentrations to the public. In our daily API data, PM_{10} is the primary pollutant for more than 90% of the days. So the reverse calculation can provide us accurate PM_{10} concentration data for 90% of the time. To deal with missing values in time series data, we use two different strategies to interpolate PM_{10} concentrations for the rest less than 10% sample: (1) treat those days as if PM_{10} is the primary pollutant, and (2) use linear interpolate for the missing values. We tried both methods and it turned out that both methods generated quantitatively similar empirical results. We also tried dropping the days with missing PM_{10} and re-estimated all the equations, and the results remained the same. The main results reported in the paper used PM_{10} concentrations from method (1). The results using alterative PM_{10} measure or API are quantitatively similar and are available upon request.

Supplementary Material 2: Disease Surveillance Point System

Daily mortality data come from the Disease Surveillance Point System (DSPS) of the Chinese Center for Disease Control and Prevention (CDC). The DSPS was established by the Chinese government to provide timely information on the causes and number of deaths in 1978. To represent national population and mortality trends, the DSPS adopted a multi-stage cluster population probability sampling method. The main objectives of the DSPS are to: (1) identify the number of deaths related to each disease category and provide basic mortality information about the deceased for public health officials; and (2) provide feedback to evaluate the impacts of the public health interventions. The DSPS initially covered 71 counties and city-districts in 29 provinces; this was expanded to 145 counties and city-districts in 31 provinces in 1990. The DSPS was overhauled following the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003; 161 city districts and counties were in the system from 2004 to the present. Currently 81.5 million people, or roughly 6 percent of the Chinese population live in those DSPS city districts and counties.

In the event of a death, the doctor or decedent's family is required to fill out a death certificate and submit it to the DSPS. The mortality data include basic demographic characteristics of the decedent and the cause of death. The causes of death are coded in the International Classification of Diseases 10 (ICD-10). Total mortality is classified by causes of death: cardiovascular (I00-99) and respiratory (J00-99) diseases, and all other diseases. For this study, we had daily numbers of deaths by age group, gender, and cause of death for all the DSPS districts in the largest 38 cities. The data period is from Jan 1st, 2010 to June 29th, 2013. Table SM2 presents more details about the cities covered by the DSPS.

Table SM2. Characteristics of DSPS Cities

City	DSPS Districts	City Area (KM^2)	City Pop. (1000)	District Pop.	Share of Female Population	Share of the Elderly (>60)	GDP Per Capita (10,000)	Share of Construction Workers
Anshan	Qianshan	9254	3512	211410	0.49	0.15	6.6	0.08
Beijing	Dongcheng,Tongzhou	16411	20166	1206066	0.49	0.12	7.1	0.08
Changchun	Nanguan	20604	7592	550888	0.5	0.12	7.0	0.04
Changde	Wuling	18670	5908	530319	0.5	0.12	5.4	0.06
Changsha	Tianxin	11816	6920	472816	0.5	0.13	10.4	0.07
Chengdu	Qingyang	12125	13247	823355	0.5	0.15	4.2	0.05
Chongqing	Dazu	82677	29162	704640	0.49	0.18	2.6	0.02
Guangzhou	Yuexiu	7323	12767	1163069	0.5	0.15	14.6	0.04
Guilin	Xiufeng	27809	5145	155925	0.5	0.13	4.6	0.01
Hangzhou	Xiacheng	16588	8748	506795	0.49	0.16	11.1	0.02
Harbin	Nangang	53068	9929	1313002	0.49	0.13	5.2	0.03
Hohhot	Huimin	17292	2719	394146	0.5	0.11	10.9	0.05
Liuzhou	Liubei	18617	3677	425676	0.49	0.14	8.8	0.03
Maanshan	Yushan	3259	1921	295972	0.48	0.15	7.9	0.18
Nanchang	Donghu	7402	5081	575977	0.5	0.14	7.2	0.02
Nanjing	Pukou	6587	7531	719366	0.48	0.13	9.1	0.04
Panzhihua	Renhe	7427	1188	261717	0.48	0.15	6.1	0.01
Qingdao	Shibei	11079	8056	512573	0.5	0.12	10.3	0.04
Qinhuangdao	Haigang	7709	2970	610139	0.5	0.13	6.0	0.04
Qiqihar	Meilisi	42469	5648	165790	0.49	0.13	3.3	0.01
Shanghai	Luwan	6340	23435	1553413	0.48	0.09	11.9	0.06
Shenyang	Shenbei	12980	7224	347655	0.49	0.15	8.0	0.04

Suzhou	Wuzhong	8488	9148	1165065	0.49	0.11	14.5	0.11
Taiyuan	Xinghualingqu	6972	4049	650546	0.5	0.14	5.8	0.04
Tangshan	Kaiping	13472	7549	270456	0.48	0.15	7.1	0.05
Tianjin	Hongqiao	11865	13557	550101	0.48	0.19	11.2	0.12
Tongchuan	WangYi	3882	838	200762	0.5	0.17	2.5	0.10
Urumqi	Tianshan	13788	2501	711443	0.5	0.12	6.3	0.02
Wuhan	Jiang'an	8494	9502	902296	0.5	0.15	9.5	0.05
Xining	Chengzhong	7662	2218	298421	0.5	0.13	4.8	0.05
Xuzhou	Yunlong	11259	8955	320533	0.5	0.14	6.1	0.04
Yantai	Zhifu	13746	6671	828652	0.5	0.13	10.2	0.04
Yichang	Wujiagang	21084	4047	213884	0.49	0.14	7.2	0.05
Yinchuan	Xingqing	8975	2026	679976	0.47	0.06	5.4	0.04
Yuxi	Hongta	15285	2318	494672	0.49	0.13	10.7	0.06
Zaozhuang	Xuecheng	4563	3875	391613	0.48	0.14	3.1	0.06
Zhengzhou	Zhongyuan	7446	8849	620825	0.49	0.11	4.1	0.05
Zunyi	Qianshan	30762	6117	627764	0.49	0.11	3.5	0.03

Notes: Data are collected from city statistical yearbooks and 2005 small census.

Table SM3. Coefficients of Figures 3, 4 and 5 in the Main Text

City	All Causes (1)	Cardiorespiratory (2)	Non-Cardiorespiratory (3)
Yuxi	1.80	0.93	2.72
	(0.60 to 3.00)	(-0.71 to 2.57)	(1.09 to 4.35)
Maanshan	1.72	2.38	1.17
	(0.72 to 2.72)	(0.85 to 3.91)	(-0.16 to 2.50)
Liuzhou	1.69	2.35	1.20
	(0.88 to 2.50)	(1.13 to 3.57)	(0.12 to 2.28)
Guangzhou	1.65	2.07	1.26
	(1.17 to 2.13)	(1.39 to 2.75)	(0.62 to 1.90)
Zaozhuang	1.09	1.52	0.64
	(0.36 to 1.82)	(0.59 to 2.45)	(-0.30 to 1.59)
Wuhan	0.77	1.09	0.40
	(0.40 to 1.15)	(0.58 to 1.60)	(-0.13 to 0.94)
Taiyuan	0.76	1.05	0.48
	(0.24 to 1.29)	(0.30 to 1.80)	(-0.21 to 1.18)
Changde	0.71	0.70	0.72
	(0.10 to 1.32)	(-0.18 to 1.58)	(-0.06 to 1.49)
Changchun	0.64	0.20	1.16
	(0.14 to 1.14)	(-0.49 to 0.90)	(0.43 to 1.89)
Nanjing	0.59	1.10	-0.06
	(0.16 to 1.02)	(0.53 to 1.67)	(-0.68 to 0.57)
Shenyang	0.58	0.68	0.43
	(0.03 to 1.13)	(-0.01 to 1.38)	(-0.44 to 1.31)
Tianjin	0.54	0.53	0.57
	(0.19 to 0.90)	(0.09 to 0.97)	(0.03 to 1.11)
Changsha	0.54	1.38	-0.39
	(-0.05 to 1.13)	(0.58 to 2.18)	(-1.25 to 0.48)
Hangzhou	0.50	0.50	0.50
	(-0.09 to 1.09)	(-0.38 to 1.39)	(-0.24 to 1.24)
Chongqing	0.48	0.62	0.32
	(0.19 to 0.78)	(0.23 to 1.02)	(-0.12 to 0.75)
Yichang	0.47	1.08	-0.20
	(-0.60 to 1.54)	(-0.35 to 2.51)	(-1.77 to 1.37)
Zunyi	0.45	0.35	0.58
	(-0.46 to 1.37)	(-0.83 to 1.53)	(-0.77 to 1.94)
Suzhou	0.44	1.02	-0.12
	(-0.00 to 0.89)	(0.37 to 1.67)	(-0.73 to 0.50)
Guilin	0.42	1.98	-1.03
	(-0.76 to 1.60)	(0.32 to 3.64)	(-2.64 to 0.58)
Qinhuangdao	0.37	0.19	0.53

	(-0.49 to 1.22)	(-0.97 to 1.36)	(-0.64 to 1.70)
Shanghai	0.31	0.28	0.35
	(0.00 to 0.61)	(-0.14 to 0.69)	(-0.10 to 0.79)
Chengdu	0.29	0.38	0.23
	(-0.20 to 0.79)	(-0.31 to 1.07)	(-0.32 to 0.77)
Beijing	0.29	0.54	-0.03
	(0.10 to 0.48)	(0.28 to 0.80)	(-0.31 to 0.25)
Yantai	0.25	0.90	-0.40
	(-0.30 to 0.81)	(0.12 to 1.69)	(-1.18 to 0.37)
Nanchang	0.22	0.51	-0.07
	(-0.50 to 0.94)	(-0.47 to 1.49)	(-1.05 to 0.91)
Zhengzhou	0.21	0.70	-0.27
	(-0.26 to 0.67)	(0.04 to 1.35)	(-0.92 to 0.39)
Qingdao	0.20	0.21	0.19
	(-0.11 to 0.50)	(-0.21 to 0.63)	(-0.25 to 0.63)
Tongchuan	0.20	1.52	-1.48
	(-1.07 to 1.46)	(-0.15 to 3.19)	(-3.31 to 0.35)
Hohhot	0.17	-0.01	0.36
	(-0.72 to 1.05)	(-1.14 to 1.13)	(-0.86 to 1.58)
Anshan	0.12	0.31	-0.11
	(-0.53 to 0.77)	(-0.57 to 1.19)	(-1.10 to 0.87)
Harbin	0.10	0.02	0.19
	(-0.28 to 0.48)	(-0.48 to 0.52)	(-0.36 to 0.73)
Urumqi	0.03	0.02	0.04
	(-0.43 to 0.49)	(-0.60 to 0.65)	(-0.58 to 0.66)
Xining	0.02	0.06	-0.02
	(-0.88 to 0.93)	(-1.20 to 1.32)	(-1.37 to 1.33)
Tangshan	-0.16	-0.34	0.21
	(-1.15 to 0.83)	(-1.56 to 0.87)	(-1.34 to 1.75)
Qiqihar	-0.24	-0.13	-0.41
	(-1.21 to 0.73)	(-1.37 to 1.11)	(-1.92 to 1.10)
Yinchuan	-0.43	-0.23	-0.64
	(-1.07 to 0.21)	(-1.11 to 0.66)	(-1.58 to 0.31)
Xuzhou	-0.64	-1.09	-0.06
	(-1.49 to 0.21)	(-2.28 to 0.10)	(-1.28 to 1.16)
Panzhihua	-0.98	-1.65	-0.25
	(-2.45 to 0.48)	(-3.61 to 0.31)	(-2.43 to 1.93)

Notes: Maximum likelihood estimates of the city-specific mean PM_{10} effects with different lags on total mortality in the largest 38 cities in China. The dependent variable is the percentage change in the number of daily all-cause deaths. P-values are in the parenthesis beneath the coefficients. Column (1) includes coefficients for Figure 2; Columns (2) includes coefficients for Figure 3; and Columns (4) includes coefficients for Figure 4.

Table SM4. Coefficients of Figures SM1-SM7

	Lag Structure						
	Lag=1	Lag=2	Lag=3	Lag=4	Lag=5	Lag=6	MA(0,1&2)
City	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Yuxi	1.32	1.26	1.13	0.48	-0.12	-0.25	2.1
	(0.14 to 2.50)	(0.11 to 2.41)	(-0.02 to 2.28)	(-0.67 to 1.63)	(-1.27 to 1.03)	(-1.41 to 0.90)	(0.68 to 3.52)
Maanshan	1.08	0.5	-0.11	0.52	-0.01	-0.21	1.75
	(0.08 to 2.08)	(-0.52 to 1.52)	(-1.14 to 0.91)	(-0.49 to 1.53)	(-1.03 to 1.01)	(-1.23 to 0.82)	(0.45 to 3.05)
Liuzhou	1.46	1.22	0.65	0.66	0.34	0.04	2.14
	(0.66 to 2.26)	(0.42 to 2.02)	(-0.15 to 1.45)	(-0.14 to 1.47)	(-0.47 to 1.15)	(-0.77 to 0.86)	(1.16 to 3.12)
Guangzhou	1.07	0.68	0.44	0.3	0.41	0.57	1.66
	(0.60 to 1.54)	(0.22 to 1.14)	(-0.03 to 0.90)	(-0.16 to 0.76)	(-0.05 to 0.87)	(0.11 to 1.03)	(1.08 to 2.24)
Zaozhuang	0.72	0.54	0.44	0.9	0.5	-0.36	1.33
	(-0.01 to 1.45)	(-0.21 to 1.29)	(-0.31 to 1.18)	(0.15 to 1.64)	(-0.25 to 1.24)	(-1.12 to 0.40)	(0.39 to 2.27)
Wuhan	0.5	-0.04	0.05	0.05	0.02	-0.13	0.59
	(0.14 to 0.86)	(-0.40 to 0.32)	(-0.31 to 0.41)	(-0.31 to 0.42)	(-0.35 to 0.38)	(-0.50 to 0.24)	(0.14 to 1.03)
Taiyuan	0.21	0.27	0.33	-0.28	-0.44	-0.28	0.66
	(-0.31 to 0.73)	(-0.26 to 0.79)	(-0.20 to 0.86)	(-0.82 to 0.26)	(-0.98 to 0.10)	(-0.83 to 0.26)	(-0.02 to 1.34)
Changde	0.23	0.06	0.02	0.08	-0.27	0	0.5
	(-0.38 to 0.84)	(-0.55 to 0.67)	(-0.59 to 0.63)	(-0.53 to 0.69)	(-0.88 to 0.34)	(-0.62 to 0.61)	(-0.24 to 1.23)
Changchun	0.06	0.24	0.25	0.04	-0.38	0.03	0.57
	(-0.46 to 0.57)	(-0.27 to 0.74)	(-0.26 to 0.75)	(-0.48 to 0.56)	(-0.90 to 0.15)	(-0.49 to 0.54)	(-0.11 to 1.26)
Nanjing	0.47	0.32	0.37	0.16	0.07	0.12	0.8
	(0.05 to 0.90)	(-0.11 to 0.74)	(-0.04 to 0.79)	(-0.26 to 0.57)	(-0.35 to 0.48)	(-0.30 to 0.53)	(0.26 to 1.34)
Shenyang	0.58	0.31	0.07	0.1	0.18	-0.08	0.74

	(0.05 to 1.12)	(-0.24 to 0.87)	(-0.49 to 0.63)	(-0.47 to 0.67)	(-0.38 to 0.75)	(-0.65 to 0.50)	(0.03 to 1.45)
Tianjin	0.37	-0.02	-0.17	-0.19	-0.06	0.09	0.64
	(0.01 to 0.72)	(-0.38 to 0.34)	(-0.53 to 0.20)	(-0.56 to 0.18)	(-0.42 to 0.31)	(-0.28 to 0.45)	(0.13 to 1.14)
Changsha	0.63	0.15	-0.04	-0.06	-0.17	-0.01	0.63
	(0.06 to 1.20)	(-0.42 to 0.73)	(-0.62 to 0.54)	(-0.64 to 0.52)	(-0.76 to 0.41)	(-0.60 to 0.58)	(-0.08 to 1.35)
Hangzhou	0.17	0.5	1	0.48	0.1	0.03	0.6
	(-0.41 to 0.76)	(-0.08 to 1.07)	(0.44 to 1.56)	(-0.09 to 1.05)	(-0.47 to 0.67)	(-0.55 to 0.61)	(-0.17 to 1.37)
Chongqing	0.33	0.18	0.1	0.18	0.19	0.13	0.45
	(0.03 to 0.62)	(-0.11 to 0.48)	(-0.19 to 0.39)	(-0.11 to 0.48)	(-0.11 to 0.49)	(-0.18 to 0.43)	(0.12 to 0.78)
Yichang	0.48	0.64	-0.12	-0.3	-0.1	0.53	0.79
	(-0.61 to 1.57)	(-0.46 to 1.74)	(-1.24 to 0.99)	(-1.43 to 0.83)	(-1.23 to 1.02)	(-0.59 to 1.65)	(-0.55 to 2.13)
Zunyi	0.61	0.64	0.4	0.16	0.07	-0.28	0.98
	(-0.30 to 1.52)	(-0.27 to 1.54)	(-0.50 to 1.31)	(-0.74 to 1.06)	(-0.83 to 0.98)	(-1.20 to 0.65)	(-0.15 to 2.11)
Suzhou	0.33	0.3	0.31	0.13	0.22	0.14	0.62
	(-0.10 to 0.76)	(-0.13 to 0.73)	(-0.12 to 0.73)	(-0.29 to 0.56)	(-0.20 to 0.65)	(-0.29 to 0.56)	(0.04 to 1.20)
Guilin	0.49	0.08	-0.84	-1.28	-0.68	0.09	0.5
	(-0.68 to 1.65)	(-1.09 to 1.24)	(-2.02 to 0.34)	(-2.47 to -0.09)	(-1.84 to 0.49)	(-1.06 to 1.24)	(-0.91 to 1.91)
Qinhuangdao	0	-0.49	0.05	-0.16	0.26	-0.37	-0.04
	(-0.85 to 0.86)	(-1.36 to 0.39)	(-0.84 to 0.93)	(-1.08 to 0.77)	(-0.66 to 1.17)	(-1.29 to 0.55)	(-1.21 to 1.13)
Shanghai	0.19	0.1	0.13	0.25	0.38	0.27	0.36
	(-0.10 to 0.49)	(-0.19 to 0.38)	(-0.16 to 0.42)	(-0.03 to 0.53)	(0.10 to 0.66)	(-0.01 to 0.56)	(-0.05 to 0.78)
Chengdu	-0.19	-0.5	-0.72	-0.1	-0.18	-0.47	-0.19
	(-0.69 to 0.31)	(-1.00 to 0.00)	(-1.22 to -0.21)	(-0.60 to 0.40)	(-0.69 to 0.32)	(-0.98 to 0.05)	(-0.81 to 0.42)
Beijing	0.14	-0.03	-0.12	-0.12	-0.02	-0.11	0.25
	(-0.05 to 0.33)	(-0.22 to 0.16)	(-0.30 to 0.07)	(-0.31 to 0.07)	(-0.21 to 0.17)	(-0.30 to 0.08)	(-0.02 to 0.51)
Yantai	0.19	0.17	-0.15	0.02	-0.1	0.12	0.37

	(-0.36 to 0.74)	(-0.38 to 0.72)	(-0.70 to 0.40)	(-0.53 to 0.57)	(-0.65 to 0.46)	(-0.43 to 0.67)	(-0.36 to 1.11)
Nanchang	0.14	0.2	-0.24	-0.22	-0.31	-0.31	0.29
	(-0.55 to 0.83)	(-0.47 to 0.88)	(-0.91 to 0.43)	(-0.90 to 0.46)	(-0.99 to 0.37)	(-1.01 to 0.38)	(-0.60 to 1.17)
Zhengzhou	0.11	-0.12	-0.18	0.04	0.16	-0.01	0.14
	(-0.35 to 0.58)	(-0.59 to 0.35)	(-0.65 to 0.29)	(-0.43 to 0.50)	(-0.31 to 0.62)	(-0.47 to 0.46)	(-0.46 to 0.74)
Qingdao	0.06	0.2	0.25	0.2	0.13	0.2	0.2
	(-0.24 to 0.36)	(-0.10 to 0.50)	(-0.05 to 0.55)	(-0.09 to 0.50)	(-0.17 to 0.43)	(-0.10 to 0.49)	(-0.19 to 0.58)
Tongchuan	0.2	0	-0.04	0.3	-0.05	0.23	0.11
	(-1.04 to 1.43)	(-1.25 to 1.24)	(-1.28 to 1.21)	(-0.96 to 1.56)	(-1.30 to 1.20)	(-1.02 to 1.49)	(-1.52 to 1.73)
Hohhot	0.11	-0.08	-0.49	0.02	0.16	0.73	-0.02
	(-0.76 to 0.99)	(-0.96 to 0.79)	(-1.37 to 0.39)	(-0.85 to 0.90)	(-0.71 to 1.02)	(-0.11 to 1.57)	(-1.19 to 1.15)
Anshan	0.2	0.25	0.27	0	0.3	0.16	0.34
	(-0.45 to 0.84)	(-0.40 to 0.89)	(-0.38 to 0.91)	(-0.65 to 0.64)	(-0.34 to 0.94)	(-0.48 to 0.80)	(-0.52 to 1.19)
Harbin	0.2	0.07	-0.06	0.25	0.04	-0.05	0.26
	(-0.17 to 0.57)	(-0.31 to 0.44)	(-0.44 to 0.32)	(-0.13 to 0.62)	(-0.33 to 0.42)	(-0.42 to 0.33)	(-0.26 to 0.79)
Urumqi	-0.05	-0.17	0.22	0.13	0.27	0.25	-0.19
	(-0.51 to 0.41)	(-0.64 to 0.29)	(-0.24 to 0.68)	(-0.33 to 0.59)	(-0.20 to 0.74)	(-0.23 to 0.72)	(-0.78 to 0.41)
Xining	-0.36	0.34	0.25	-0.74	-0.18	-0.01	-0.04
	(-1.26 to 0.54)	(-0.53 to 1.20)	(-0.62 to 1.12)	(-1.63 to 0.15)	(-1.02 to 0.67)	(-0.86 to 0.85)	(-1.25 to 1.18)
Tangshan	-0.79	-0.55	0.58	1.04	1.37	1.75	-0.84
	(-1.74 to 0.16)	(-1.50 to 0.40)	(-0.37 to 1.53)	(0.07 to 2.01)	(0.39 to 2.35)	(0.78 to 2.72)	(-2.17 to 0.50)
Qiqihar	-0.21	-0.43	-0.57	-0.26	-0.65	-0.59	-0.35
	(-1.20 to 0.77)	(-1.42 to 0.55)	(-1.57 to 0.42)	(-1.25 to 0.73)	(-1.64 to 0.35)	(-1.58 to 0.41)	(-1.56 to 0.85)
Yinchuan	-0.36	-0.19	0.08	0.21	0	0.37	-0.53
	(-0.99 to 0.28)	(-0.82 to 0.43)	(-0.53 to 0.69)	(-0.40 to 0.82)	(-0.61 to 0.61)	(-0.24 to 0.98)	(-1.38 to 0.33)
Xuzhou	-0.16	0.06	-0.19	0.09	0.19	-0.62	-0.6

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(-0.97 to 0.65)	(-0.74 to 0.87)	(-1.00 to 0.62)	(-0.71 to 0.89)	(-0.61 to 0.98)	(-1.44 to 0.21)	(-1.71 to 0.50)
Panzhihua	-0.37	-1.13	-0.22	0.14	0.58	0.3	-1.39
	(-1.84 to 1.10)	(-2.60 to 0.34)	(-1.67 to 1.24)	(-1.31 to 1.59)	(-0.87 to 2.02)	(-1.15 to 1.75)	(-3.35 to 0.57)

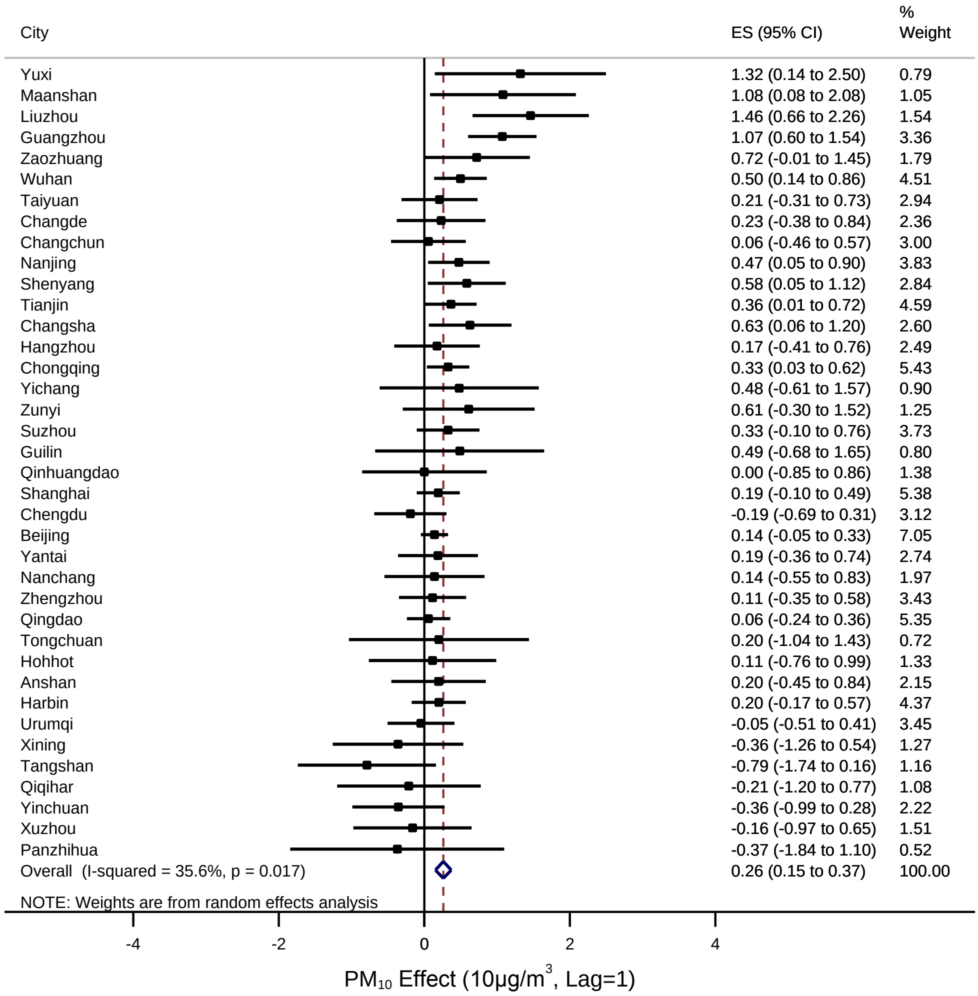
Notes: Maximum likelihood estimates of the city-specific mean PM_{10} effects with different lags on total mortality in the largest 38 cities in China. The dependent variable is the percentage change in the number of daily all-cause deaths. P-values are in the parenthesis beneath the coefficients. Columns (1)-(7) include coefficients for Figures SM1-SM7, respectively.

Table SM5. Relationships between Air Pollution Effect and City-specific Factors (excluding Urumqi)

	(1)	(2)	(3)
Mean PM_{10} (10 $\mu g/m^3$)	-0.15*	-0.27**	-0.31**
	(-0.31 - 0.01)	(-0.54 - -0.002)	(-0.56 - -0.07)
Mean PM_{10}×North		0.29**	0.27*
		(0.01 - 0.58)	(-0.00 - 0.55)
North (=1)		-3.01**	-2.78**
		(-5.54 - -0.49)	(-5.17 - -0.39)
GDP Per Capita			-0.05
(10,000 Yuan)			(-0.16 - 0.06)
Share of Workers in			6.81**
Construction Industry (%)			(1.26 - 12.37)
Share of Females			5.30
(%)			(-20.23 - 30.83)
Share of Old People			6.28*
(Age>60, %)			(-0.02 - 12.58)
Observations	37	37	37
R-squared	0.09	0.28	0.48

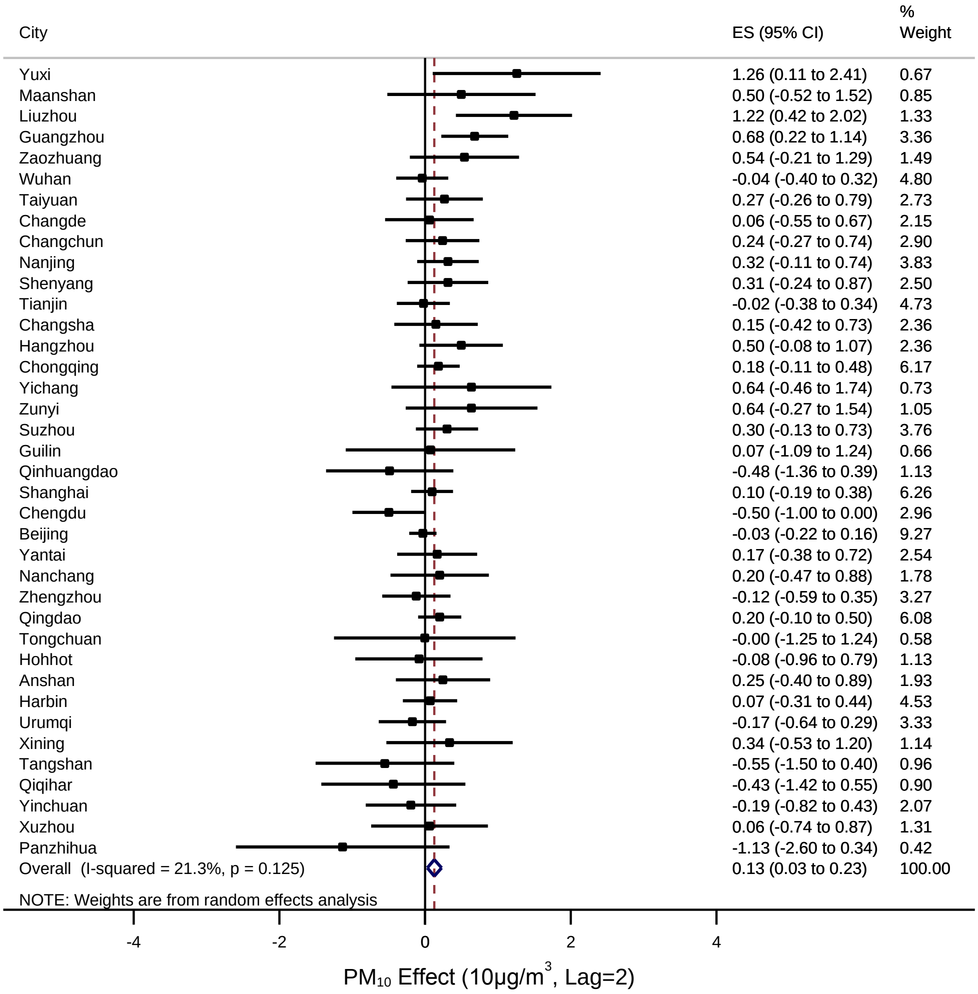
Notes: We regress the estimated air pollution effects (PM_{10} coefficients) in Figure 2 on mean PM_{10} concentrations (in 10 $\mu g/m^3$), a north indicator, GDP per capita (10,000 Yuan), share of workers in construction industry, share of female population, share of old population. GDP per capita is collected from city statistical yearbooks. Urumqi is excluded from the sample. Demographic variables are from 2005 micro census data. 95% confidence intervals are in parenthesis. *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively.

Figure SM1. Percentage Change in Daily Number of All-Cause Deaths per 10-$\mu g/m^3$ Increase in PM_{10} in 38 Chinese Cities (Lag 1 Day)



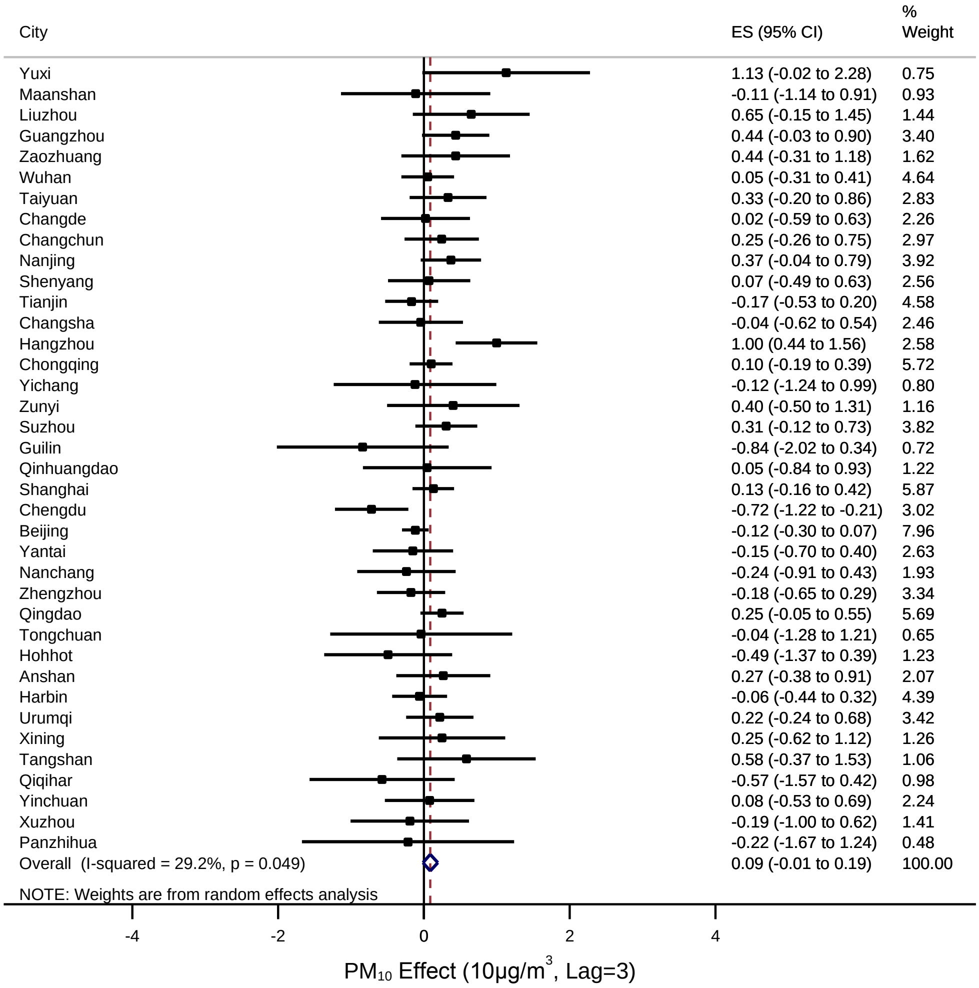
Notes: Maximum likelihood estimates and 95 percent confidence intervals of the city-specific mean PM_{10} effects on total mortality in the largest 38 cities in China. The dependent variable is the percentage change in the number of daily all-cause deaths. X-axis is percentage change. Each solid square represents an effect size. Horizontal lines indicate 95 percent CIs. ES=Effect Size.

Figure SM2. Percentage Change in Daily Number of All-Cause Deaths per 10-$\mu g/m^3$ Increase in PM_{10} in 38 Chinese Cities (Lag 2 Days)



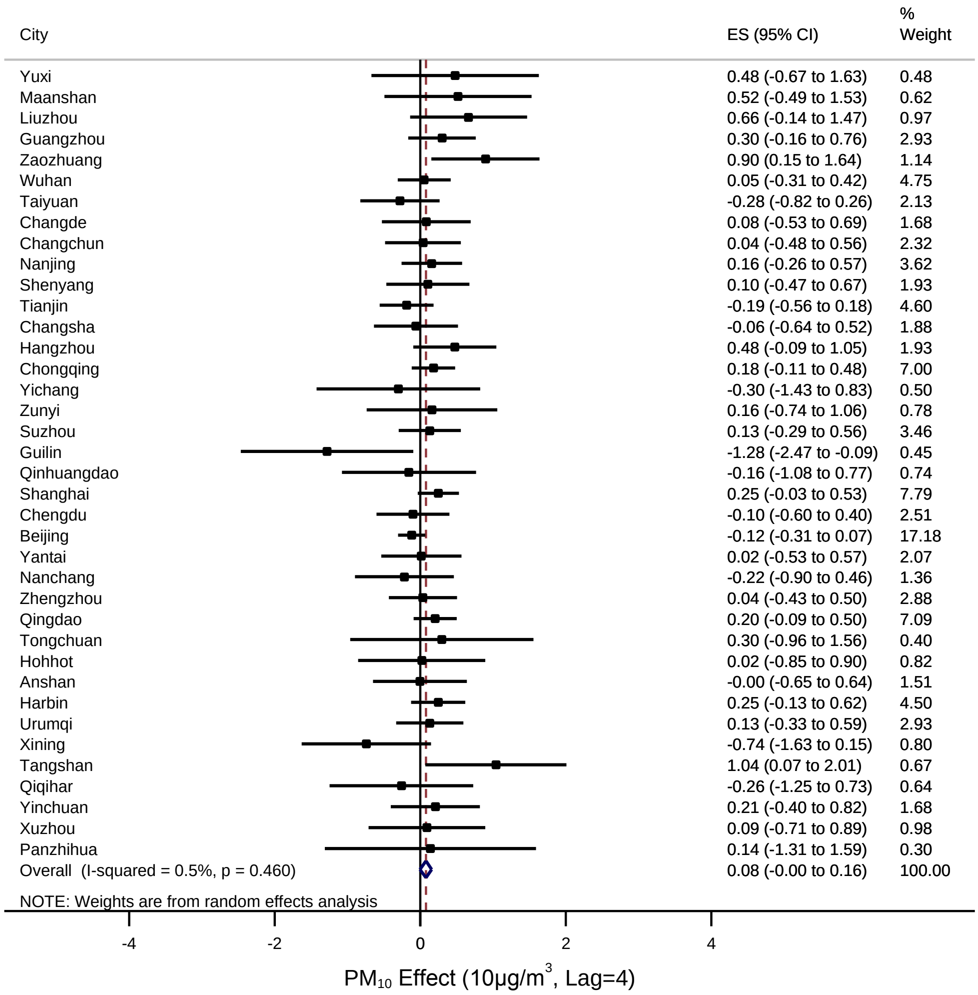
Notes: Maximum likelihood estimates and 95 percent confidence intervals of the city-specific mean PM_{10} effects on total mortality in the largest 38 cities in China. The dependent variable is the percentage change in the number of daily all-cause deaths. X-axis is percentage change. Each solid square represents an effect size. Horizontal lines indicate 95 percent CIs. ES=Effect Size.

Figure SM3. Percentage Change in Daily Number of All-Cause Deaths per 10-$\mu g/m^3$ Increase in PM$_{10}$ in 38 Chinese Cities (Lag 3 Days)



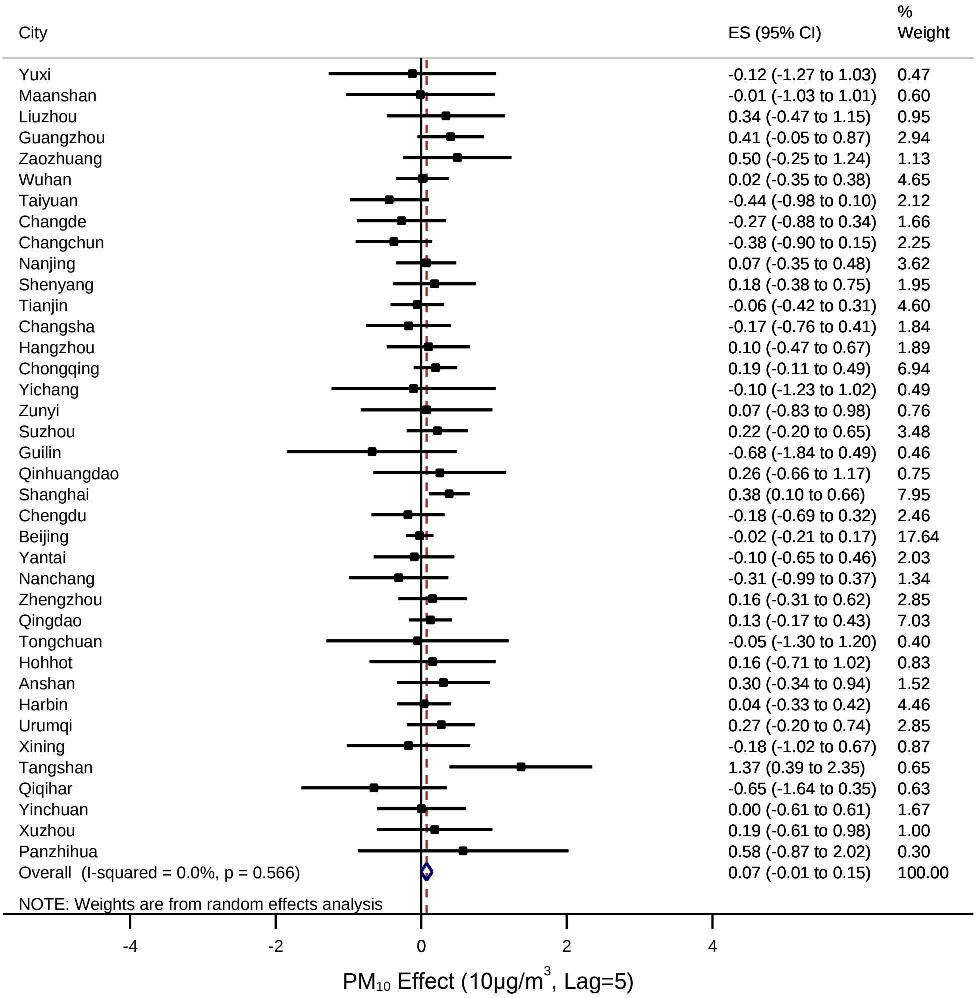
Notes: Maximum likelihood estimates and 95 percent confidence intervals of the city-specific mean PM$_{10}$ effects on total mortality in the largest 38 cities in China. The dependent variable is the percentage change in the number of daily all-cause deaths. X-axis is percentage change. Each solid square represents an effect size. Horizontal lines indicate 95 percent CIs. ES=Effect Size.

Figure SM4. Percentage Change in Daily Number of All-Cause Deaths per 10-$\mu g/m^3$ Increase in PM_{10} in 38 Chinese Cities (Lag 4 Days)



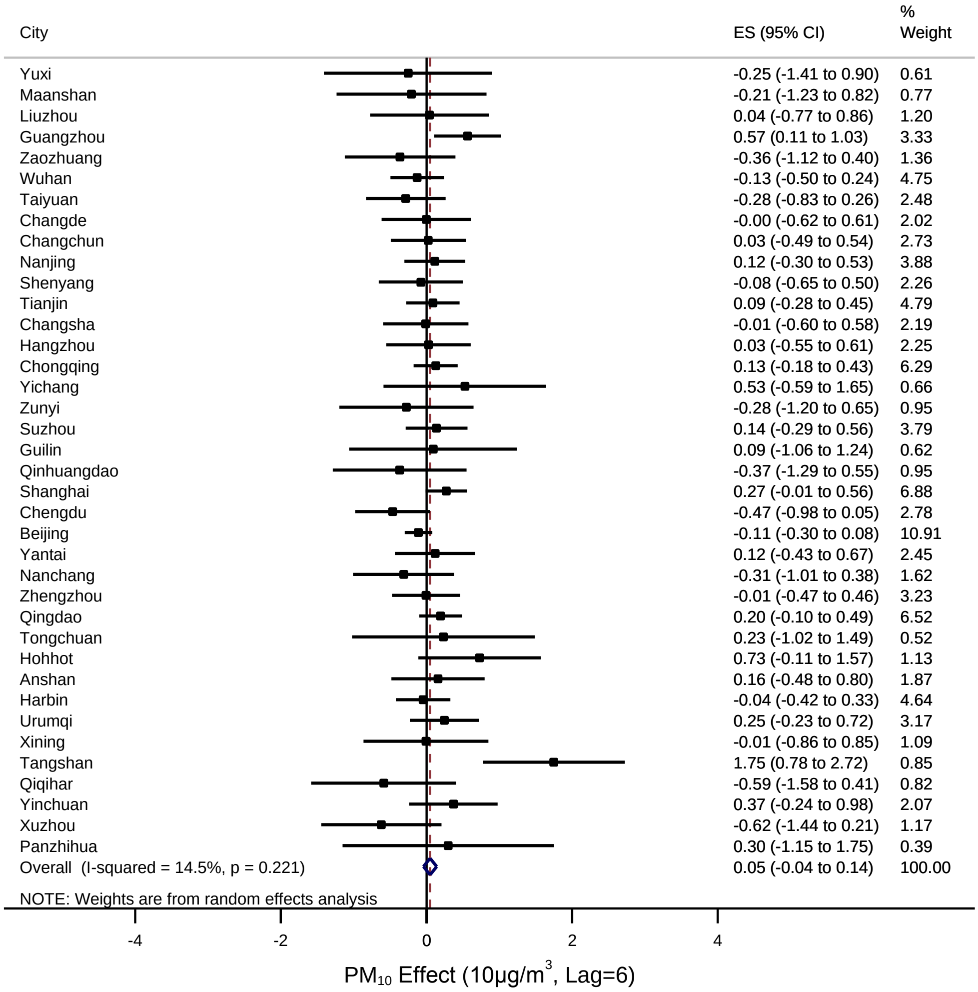
Notes: Maximum likelihood estimates and 95 percent confidence intervals of the city-specific mean PM_{10} effects on total mortality in the largest 38 cities in China. The dependent variable is the percentage change in the number of daily all-cause deaths. X-axis is percentage change. Each solid square represents an effect size. Horizontal lines indicate 95 percent CIs. ES=Effect Size.

Figure SM5. Percentage Change in Daily Number of All-Cause Deaths per 10-$\mu g/m^3$ Increase in PM_{10} in 38 Chinese Cities (Lag 5 Days)



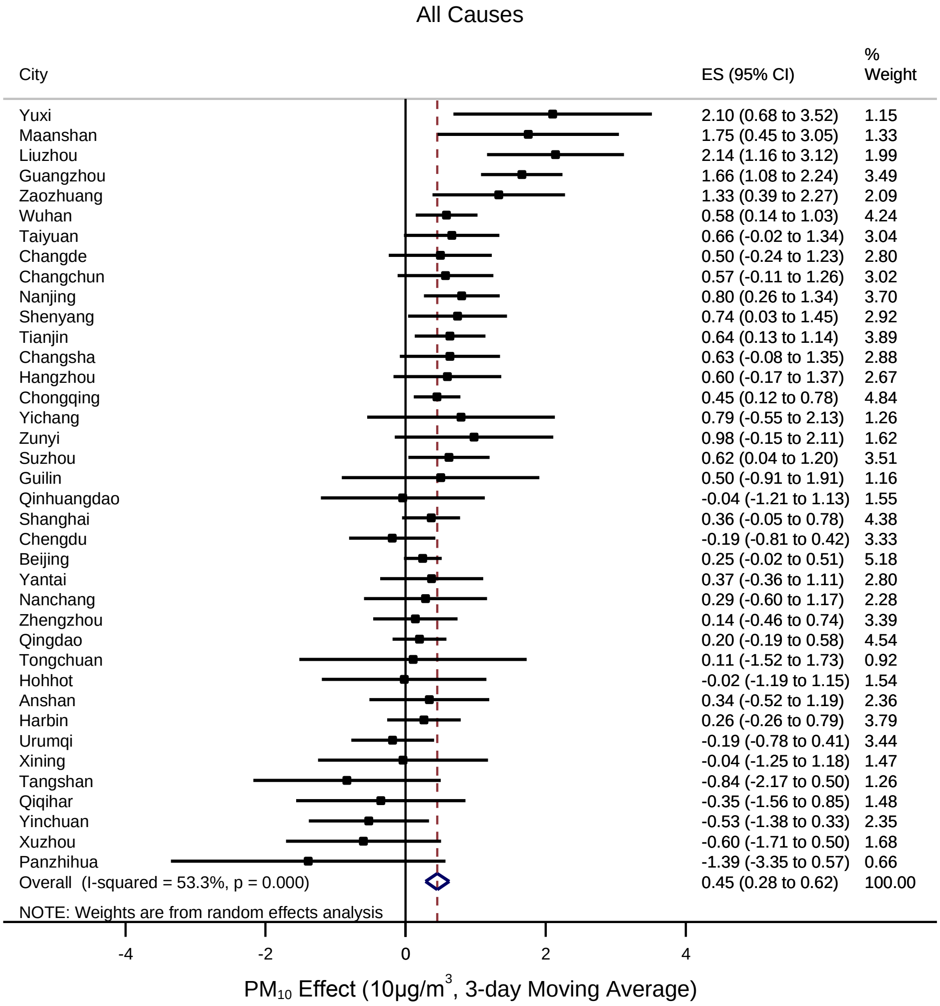
Notes: Maximum likelihood estimates and 95 percent confidence intervals of the city-specific mean PM_{10} effects on total mortality in the largest 38 cities in China. The dependent variable is the percentage change in the number of daily all-cause deaths. X-axis is percentage change. Each solid square represents an effect size. Horizontal lines indicate 95 percent CIs. ES=Effect Size.

Figure SM6. Percentage Change in Daily Number of All-Cause Deaths per 10-$\mu g/m^3$ Increase in PM_{10} in 38 Chinese Cities (Lag 6 Days)



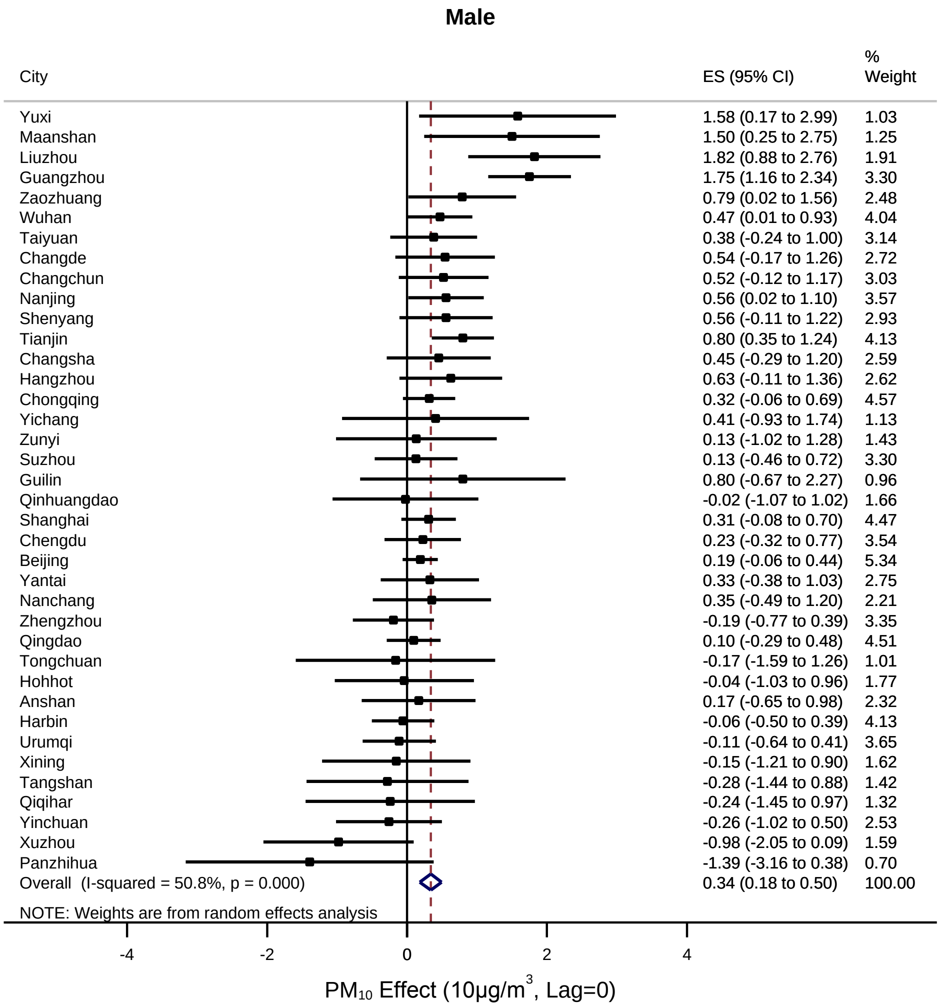
Notes: Maximum likelihood estimates and 95 percent confidence intervals of the city-specific mean PM_{10} effects on total mortality in the largest 38 cities in China. The dependent variable is the percentage change in the number of daily all-cause deaths. X-axis is percentage change. Each solid square represents an effect size. Horizontal lines indicate 95 percent CIs. ES=Effect Size.

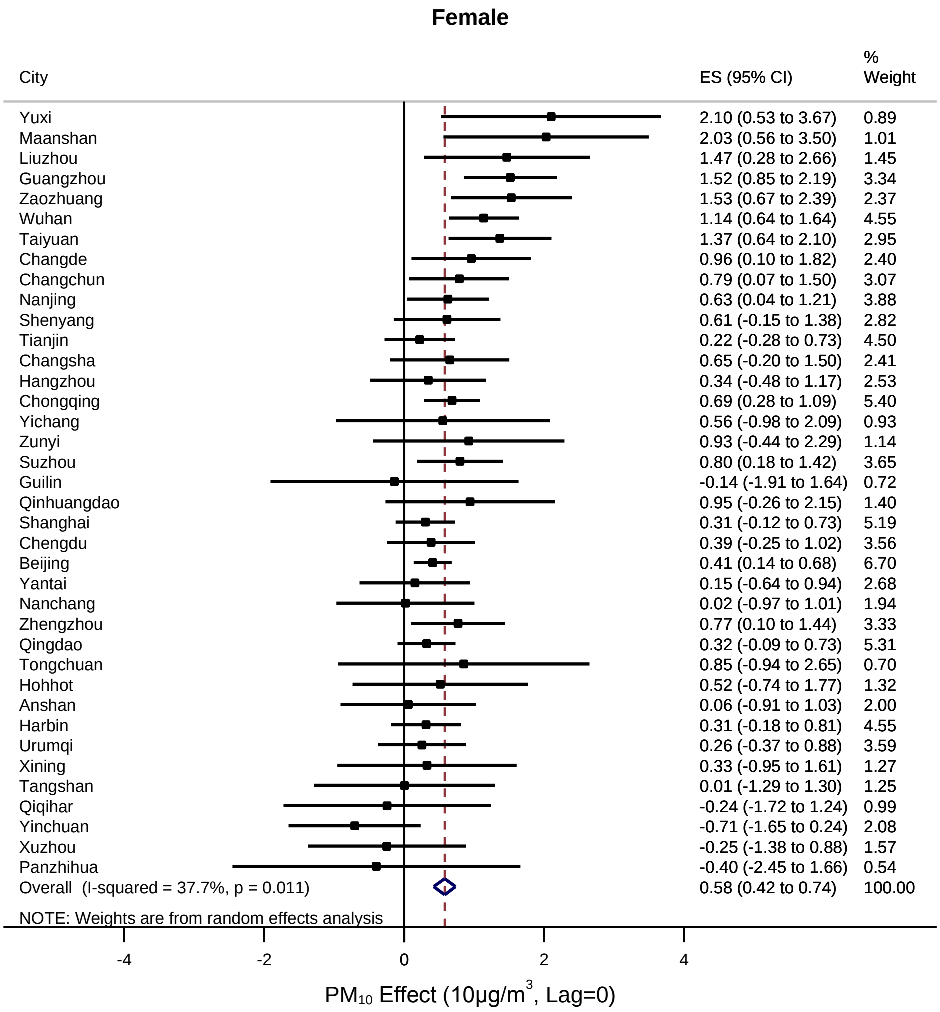
Figure SM7. Percentage Change in Daily Number of All-Cause Deaths per 10-$\mu g/m^3$ Increase in 3-day Moving Average PM_{10} (lags 0, 1, and 2) in 38 Chinese Cities

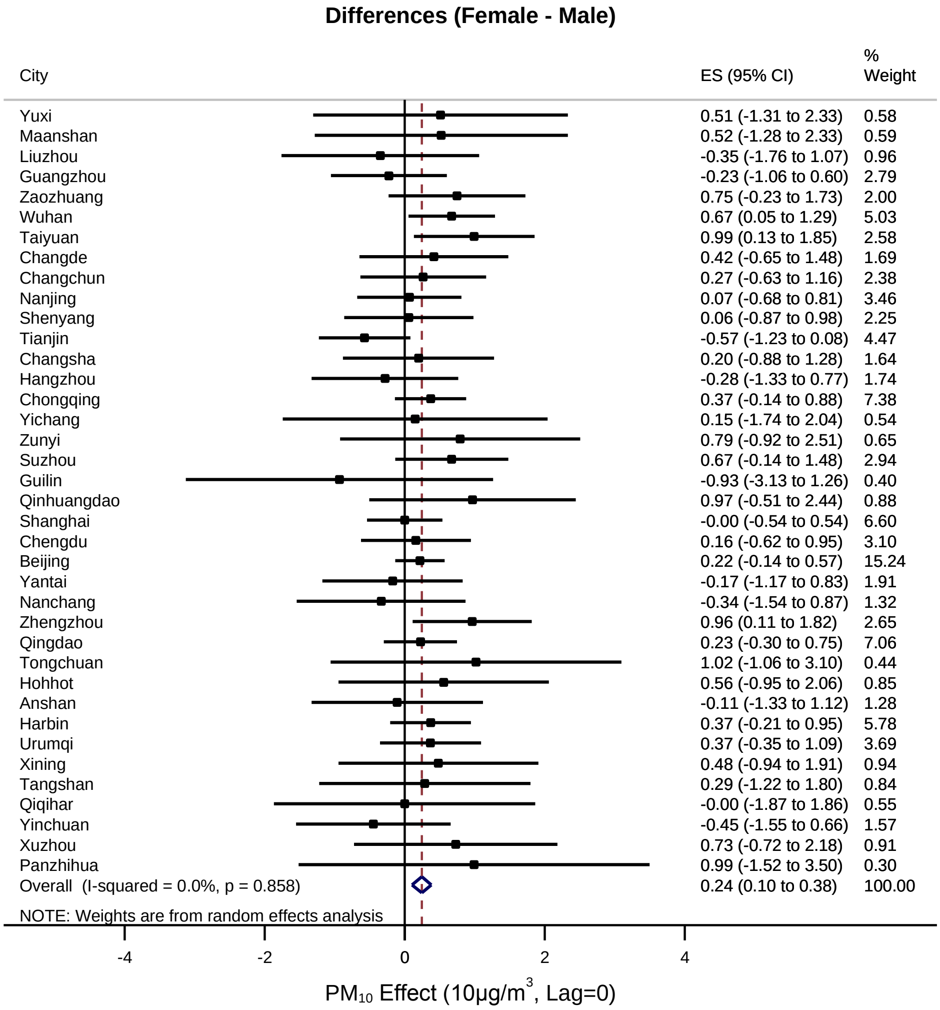


Notes: Maximum likelihood estimates and 95 percent confidence intervals of the city-specific mean lag PM_{10} effects on total mortality in the largest 38 cities in China. The dependent variable is the percentage change in the number of daily all-cause deaths. X-axis is percentage change. Each solid square represents an effect size. Horizontal lines indicate 95 percent CIs. ES=Effect Size.

Figure SM8 Percentage Change in Daily Number of Deaths per 10- $\mu g/m^3$ Increase in Concurrent Day PM_{10} in 38 Chinese Cities: Males vs. Females

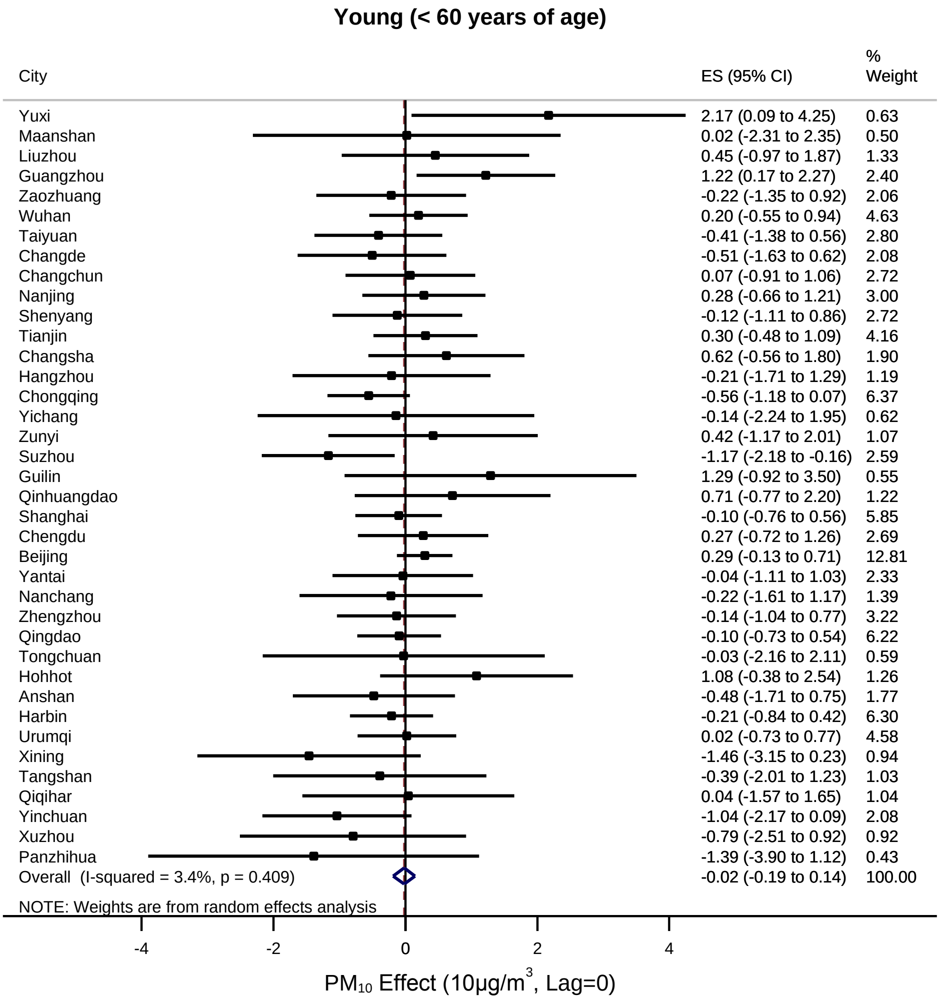


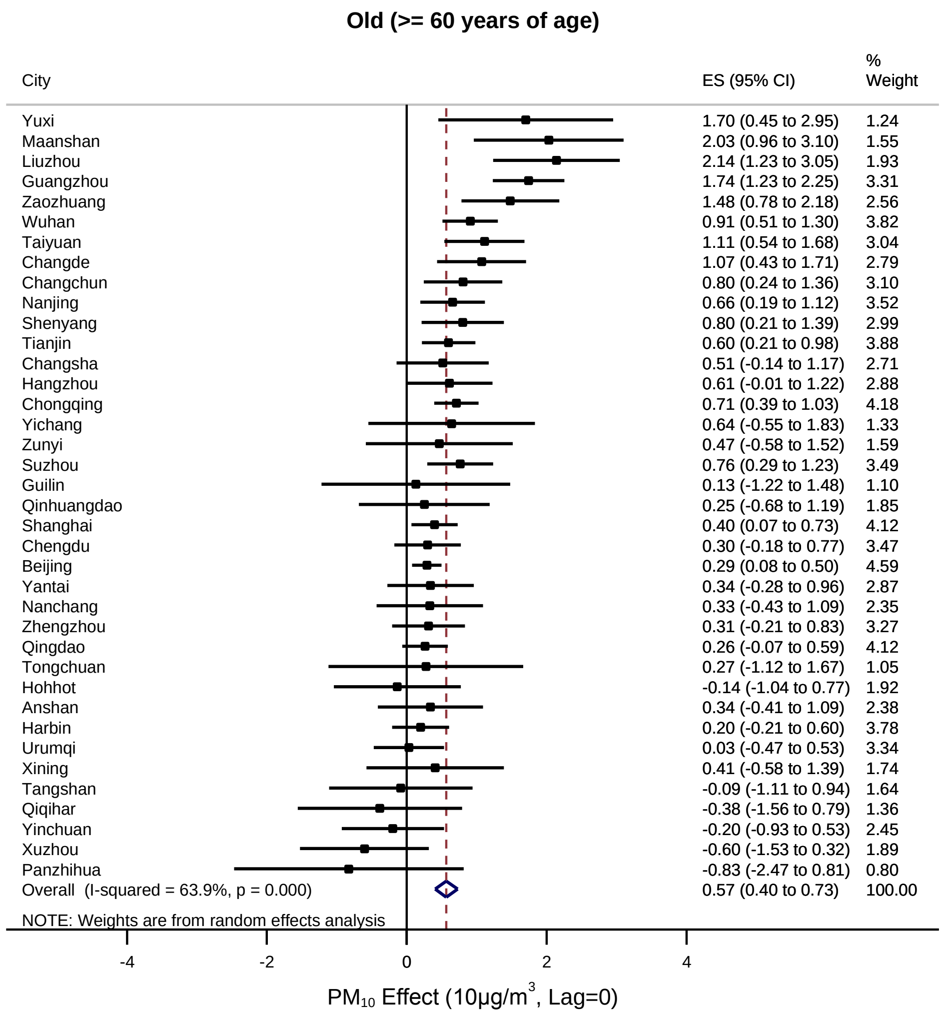

Female
City
ES (95% CI)
% Weight
Yuxi 2.10 (0.53 to 3.67) 0.89
Maanshan 2.03 (0.56 to 3.50) 1.01
Liuzhou 1.47 (0.28 to 2.66) 1.45
Guangzhou 1.52 (0.85 to 2.19) 3.34
Zaozhuang 1.53 (0.67 to 2.39) 2.37
Wuhan 1.14 (0.64 to 1.64) 4.55
Taiyuan 1.37 (0.64 to 2.10) 2.95
Changde 0.96 (0.10 to 1.82) 2.40
Changchun 0.79 (0.07 to 1.50) 3.07
Nanjing 0.63 (0.04 to 1.21) 3.88
Shenyang 0.61 (-0.15 to 1.38) 2.82
Tianjin 0.22 (-0.28 to 0.73) 4.50
Changsha 0.65 (-0.20 to 1.50) 2.41
Hangzhou 0.34 (-0.48 to 1.17) 2.53
Chongqing 0.69 (0.28 to 1.09) 5.40
Yichang 0.56 (-0.98 to 2.09) 0.93
Zunyi 0.93 (-0.44 to 2.29) 1.14
Suzhou 0.80 (0.18 to 1.42) 3.65
Guilin -0.14 (-1.91 to 1.64) 0.72
Qinhuangdao 0.95 (-0.26 to 2.15) 1.40
Shanghai 0.31 (-0.12 to 0.73) 5.19
Chengdu 0.39 (-0.25 to 1.02) 3.56
Beijing 0.41 (0.14 to 0.68) 6.70
Yantai 0.15 (-0.64 to 0.94) 2.68
Nanchang 0.02 (-0.97 to 1.01) 1.94
Zhengzhou 0.77 (0.10 to 1.44) 3.33
Qingdao 0.32 (-0.09 to 0.73) 5.31
Tongchuan 0.85 (-0.94 to 2.65) 0.70
Hohhot 0.52 (-0.74 to 1.77) 1.32
Anshan 0.06 (-0.91 to 1.03) 2.00
Harbin 0.31 (-0.18 to 0.81) 4.55
Urumqi 0.26 (-0.37 to 0.88) 3.59
Xining 0.33 (-0.95 to 1.61) 1.27
Tangshan 0.01 (-1.29 to 1.30) 1.25
Qiqihar -0.24 (-1.72 to 1.24) 0.99
Yinchuan -0.71 (-1.65 to 0.24) 2.08
Xuzhou -0.25 (-1.38 to 0.88) 1.57
Panzhihua -0.40 (-2.45 to 1.66) 0.54
Overall (I-squared = 37.7%, p = 0.011) 0.58 (0.42 to 0.74) 100.00
NOTE: Weights are from random effects analysis
-4
-2
0
2
4
PM10 Effect (10μg/m3, Lag=0)

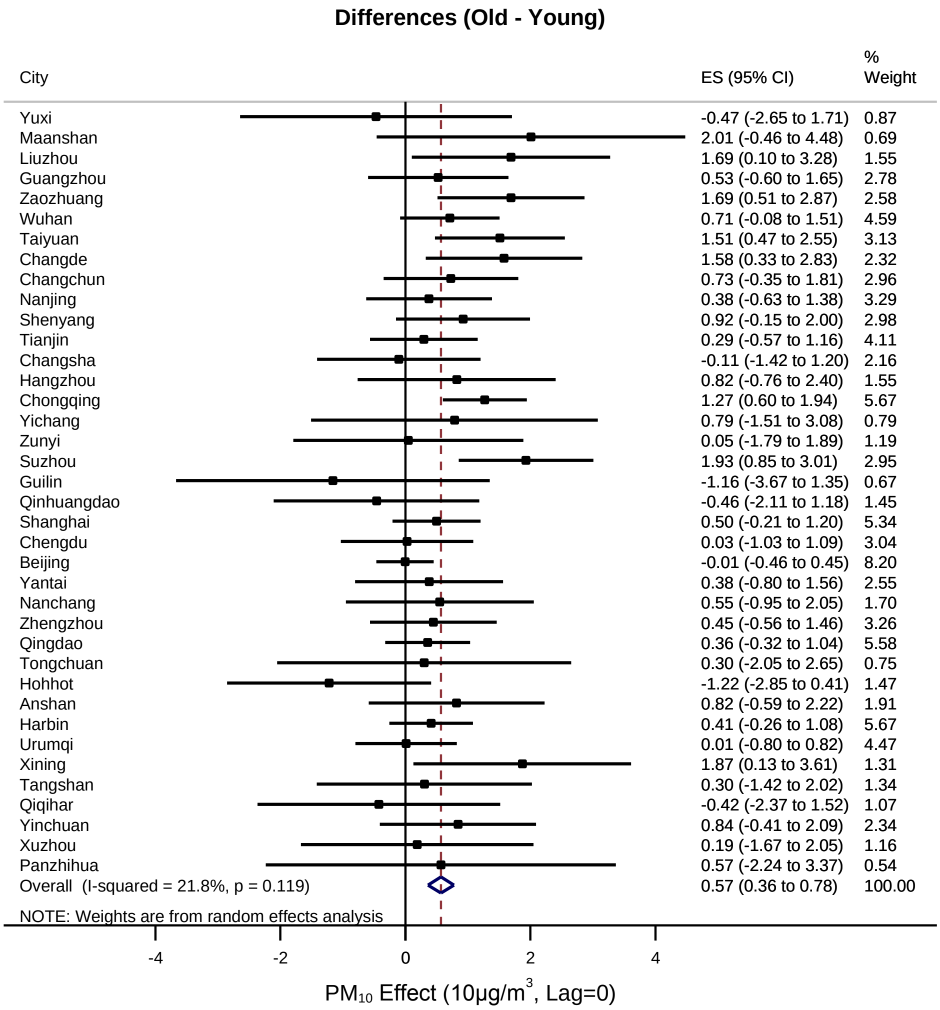


Notes: Maximum likelihood estimates and 95 percent confidence intervals of the city-specific mean lag PM_{10} effects on total mortality for male and female deaths and their differences in the largest 38 cities in China. Each solid square represents an effect size. Horizontal lines indicate 95% CIs. ES=Effect Size**.**

Figure SM9. Percentage Change in Daily Number of Deaths per 10- $\mu g/m^3$ Increase in Concurrent Day PM_{10} in 38 Chinese Cities: Old vs. Young

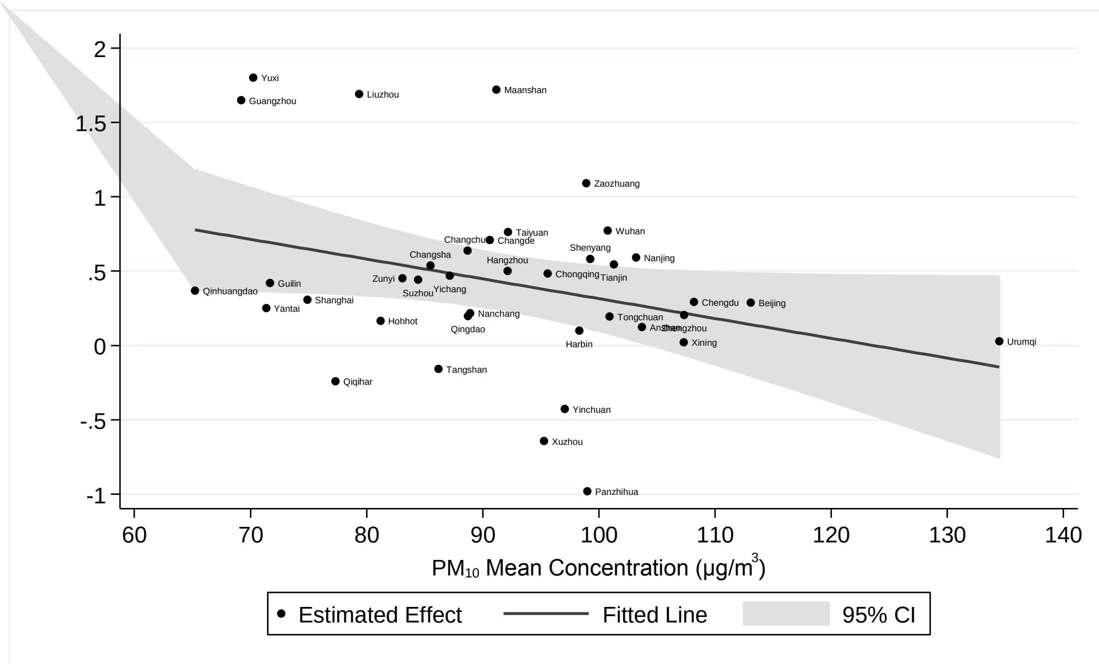



Old (>= 60 years of age)
City
ES (95% CI)
%
Weight
Yuxi 1.70 (0.45 to 2.95) 1.24
Maanshan 2.03 (0.96 to 3.10) 1.55
Liuzhou 2.14 (1.23 to 3.05) 1.93
Guangzhou 1.74 (1.23 to 2.25) 3.31
Zaozhuang 1.48 (0.78 to 2.18) 2.56
Wuhan 0.91 (0.51 to 1.30) 3.82
Taiyuan 1.11 (0.54 to 1.68) 3.04
Changde 1.07 (0.43 to 1.71) 2.79
Changchun 0.80 (0.24 to 1.36) 3.10
Nanjing 0.66 (0.19 to 1.12) 3.52
Shenyang 0.80 (0.21 to 1.39) 2.99
Tianjin 0.60 (0.21 to 0.98) 3.88
Changsha 0.51 (-0.14 to 1.17) 2.71
Hangzhou 0.61 (-0.01 to 1.22) 2.88
Chongqing 0.71 (0.39 to 1.03) 4.18
Yichang 0.64 (-0.55 to 1.83) 1.33
Zunyi 0.47 (-0.58 to 1.52) 1.59
Suzhou 0.76 (0.29 to 1.23) 3.49
Guilin 0.13 (-1.22 to 1.48) 1.10
Qinhuangdao 0.25 (-0.68 to 1.19) 1.85
Shanghai 0.40 (0.07 to 0.73) 4.12
Chengdu 0.30 (-0.18 to 0.77) 3.47
Beijing 0.29 (0.08 to 0.50) 4.59
Yantai 0.34 (-0.28 to 0.96) 2.87
Nanchang 0.33 (-0.43 to 1.09) 2.35
Zhengzhou 0.31 (-0.21 to 0.83) 3.27
Qingdao 0.26 (-0.07 to 0.59) 4.12
Tongchuan 0.27 (-1.12 to 1.67) 1.05
Hohhot -0.14 (-1.04 to 0.77) 1.92
Anshan 0.34 (-0.41 to 1.09) 2.38
Harbin 0.20 (-0.21 to 0.60) 3.78
Urumqi 0.03 (-0.47 to 0.53) 3.34
Xining 0.41 (-0.58 to 1.39) 1.74
Tangshan -0.09 (-1.11 to 0.94) 1.64
Qiqihar -0.38 (-1.56 to 0.79) 1.36
Yinchuan -0.20 (-0.93 to 0.53) 2.45
Xuzhou -0.60 (-1.53 to 0.32) 1.89
Panzhihua -0.83 (-2.47 to 0.81) 0.80
Overall (I-squared = 63.9%, p = 0.000) 0.57 (0.40 to 0.73) 100.00
NOTE: Weights are from random effects analysis
-4
-2
0
2
4
PM10 Effect (10μg/m3, Lag=0)



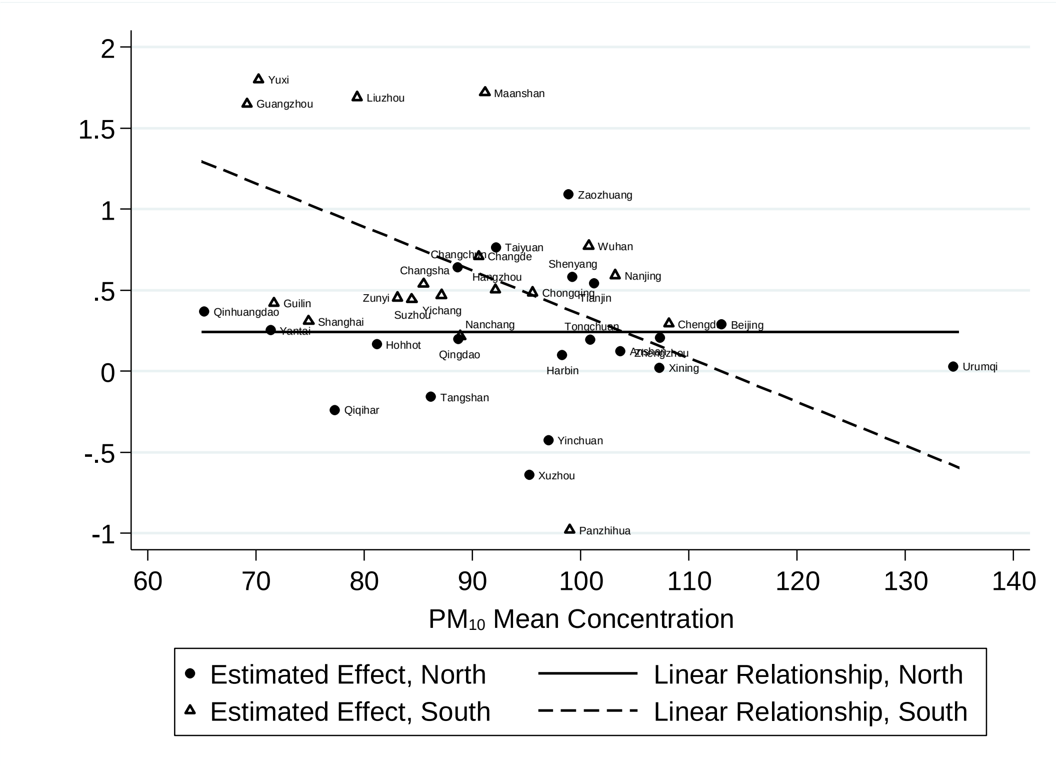
Notes: Maximum likelihood estimates and 95 percent confidence intervals of the city-specific mean lag PM_{10} effects on total mortality for young and old deaths and their differences in the largest 38 cities in China. Each solid square represents an effect size. Horizontal lines indicate 95% CIs. ES=Effect Size.

Figure SM10. City-Specific Air Pollution Estimates and Average PM_{10} Concentrations



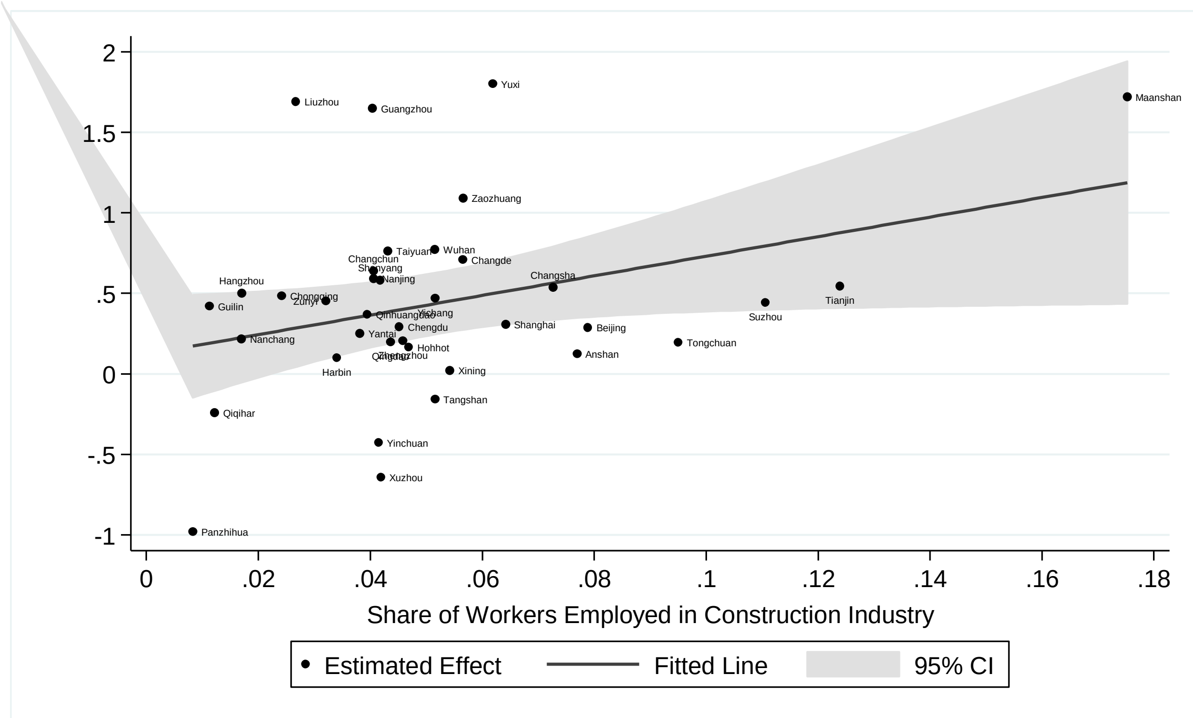
Notes: The figure plots estimated air pollution effect (percentage change in daily number of all-cause deaths per 10- $\mu g/m^3$ Increase in Concurrent Day PM_{10}, coefficients in Figure 2) against the mean PM_{10} concentrations. The solid line is a linear regression.

Figure SM11. City-Specific Air Pollution Estimates and Average PM_{10} Concentrations: North vs. South



Notes: The figure plots estimated air pollution effect (percentage change in daily number of all-cause deaths per 10- $\mu g/m^3$ Increase in Concurrent Day PM_{10}, coefficients in Figure 2). The solid dots are northern cities. The hollow triangles are southern cities. The solid line represents a linear relationship for northern cities. The dashed line is for southern cities. The regression lines are corresponding to coefficients in column (2) of Table 3.

Figure SM12. Socio-economic Factors and Marginal Pollution Effects



Notes: The figure plots estimated air pollution effect (percentage change in daily number of all-cause deaths per 10- $\mu g/m^3$ Increase in Concurrent Day PM_{10}, coefficients in Figure 2) against the share of workers employed in construction industry. The solid line is a linear regression.