

## Supplementary Material

### The rationale of using PM<sub>2.5</sub>, O<sub>3</sub>, NO<sub>2</sub>, and SO<sub>2</sub> to construct the air quality health index (AQHI):

Similar to previous studies in Guangzhou Province (1) and New York City (2), the air pollutants in the AQHI included PM<sub>2.5</sub>, O<sub>3</sub>, NO<sub>2</sub>, and SO<sub>2</sub>. In Hong Kong, China, the developed AQHI were based on the health effects of PM<sub>10</sub>, O<sub>3</sub>, SO<sub>2</sub> (3), and NO<sub>2</sub>. While in Canada, the established AQHI were based on the health effects of PM<sub>2.5</sub>, O<sub>3</sub>, and NO<sub>2</sub> (4). The inclusion of O<sub>3</sub> and NO<sub>2</sub> is not controversial. Considering the collinearity of PM<sub>2.5</sub> and PM<sub>10</sub>, and the health hazard differences between them, PM<sub>2.5</sub> was chosen in our calculations. SO<sub>2</sub> was included by considering the pollution types in different regions of China. Several studies revealed that SO<sub>2</sub> was strongly associated with total mortality risk (5–6). SO<sub>2</sub> pollution mainly comes from the combustion of sulfur-containing fossil fuels (7). Notably, China is a country with massive coal production and consumption (8). According to the Bulletin of China's Ecological Environment 2018, the yearly average concentration of SO<sub>2</sub> in the Fen-Wei Plains was 24 µg/m<sup>3</sup> in 2018 (9). According to our data in 2013–2018 (Supplementary Table S1), more than 25% of daily average concentration of county was higher than 26 µg/m<sup>3</sup>. Therefore, the health risk of SO<sub>2</sub> pollution in China still needs to be considered.

SUPPLEMENTARY TABLE S1. Frequency distribution of air quality health index (AQHI) in 36 cities<sup>a</sup> of China, 2013–2018.

City	Level	Frequency	Distribution (%)
Xiamen	[1,3]	1,381	68.64
	(3,6]	609	30.27
	(6,10]	22	1.09
	(10,10+]	0	0
Shenzhen	(1,3]	1,345	66.68
	(3,6]	657	32.57
	(6,10]	15	0.74
	(10,10+]	0	0
Dalian	(1,3]	959	47.62
	(3,6]	968	48.06
	(6,10]	84	4.17
	(10,10+]	3	0.15
Qingdao	(1,3]	705	34.88
	(3,6]	1,183	58.54
	(6,10]	121	5.59
	(10,10+]	12	0.59
Ningbo	(1,3]	748	37.12
	(3,6]	1,172	58.16
	(6,10]	92	4.57
	(10,10+]	3	0.15
Beijing	(1,3]	628	31.99
	(3,6]	1,076	54.81
	(6,10]	227	11.56
	(10,10+]	32	1.63
Shanghai	(1,3]	539	26.74
	(3,6]	1,321	65.53
	(6,10]	148	7.34
	(10,10+]	8	0.40

Continued

City	Level	Frequency	Distribution (%)
Tianjin	(1,3]	398	19.77
	(3,6]	1,234	61.30
	(6,10]	317	15.75
	(10,10+]	64	3.18
Chongqing	(1,3]	704	34.90
	(3,6]	1,273	63.11
	(6,10]	40	1.98
	(10,10+]	0	0
Hefei	(1,3]	720	35.80
	(3,6]	1,206	59.97
	(6,10]	85	4.23
	(10,10+]	0	0
Fuzhou	(1,3]	1,502	74.58
	(3,6]	508	25.22
	(6,10]	4	0.20
	(10,10+]	0	0
Lanzhou	(1,3]	484	24.02
	(3,6]	1,377	68.34
	(6,10]	153	7.59
	(10,10+]	1	0.05
Guangzhou	(1,3]	798	39.62
	(3,6]	1,086	53.92
	(6,10]	125	6.21
	(10,10+]	5	0.25
Guilin	(1,3]	1,121	66.33
	(3,6]	542	32.07
	(6,10]	25	1.48
	(10,10+]	2	0.12
Guiyang	(1,3]	1375	68.24
	(3,6]	603	29.93
	(6,10]	37	1.84
	(10,10+]	0	0
Haikou	(1,3]	1,948	96.72
	(3,6]	66	3.28
	(6,10]	0	0
	(10,10+]	0	0
Shijiazhuang	(1,3]	250	12.39
	(3,6]	1,113	55.18
	(6,10]	463	22.95
	(10,10+]	191	9.47
Zhengzhou	(1,3]	1,345	66.68
	(3,6]	657	32.57
	(6,10]	15	0.74
	(10,10+]	0	0

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City	Level	Frequency	Distribution (%)
Harbin	(1,3]	789	39.12
	(3,6]	882	43.73
	(6,10]	264	13.09
	(10,10+]	82	4.07
Wuhan	(1,3]	493	24.52
	(3,6]	1,198	59.57
	(6,10]	293	14.57
	(10,10+]	27	1.34
Changsha	(1,3]	818	40.62
	(3,6]	1,050	52.14
	(6,10]	146	7.25
	(10,10+]	0	0
Changchun	(1,3]	660	32.77
	(3,6]	1,126	55.91
	(6,10]	212	10.53
	(10,10+]	16	0.79
Nanjing	(1,3]	438	21.73
	(3,6]	1,339	66.42
	(6,10]	228	11.31
	(10,10+]	11	0.55
Nanchang	(1,3]	973	48.31
	(3,6]	963	47.82
	(6,10]	75	3.72
	(10,10+]	3	0.15
Shenyang	(1,3]	402	20.00
	(3,6]	1,181	58.76
	(6,10]	324	16.12
	(10,10+]	103	5.12
Hohhot	(1,3]	538	26.74
	(3,6]	1,229	61.08
	(6,10]	237	11.78
	(10,10+]	8	0.40
Yinchuan	(1,3]	530	26.38
	(3,6]	1,108	55.15
	(6,10]	315	15.68
	(10,10+]	56	2.79
Xining	(1,3]	553	27.43
	(3,6]	1,404	69.64
	(6,10]	59	2.93
	(10,10+]	0	0
Jinan	(1,3]	133	6.58
	(3,6]	1,385	68.50
	(6,10]	421	20.82
	(10,10+]	83	4.10

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City	Level	Frequency	Distribution (%)
Taiyuan	(1,3]	320	15.90
	(3,6]	1,198	59.54
	(6,10]	399	19.83
	(10,10+]	95	4.72
Xi'an	(1,3]	365	18.13
	(3,6]	1,344	66.77
	(6,10]	264	13.11
	(10,10+]	40	1.99
Chengdu	(1,3]	387	19.22
	(3,6]	1,422	70.61
	(6,10]	198	9.83
	(10,10+]	7	0.35
Lhasa	(1,3]	1,792	88.98
	(3,6]	222	11.02
	(6,10]	0	0
	(10,10+]	0	0
Urumchi	(1,3]	530	26.36
	(3,6]	1,161	57.73
	(6,10]	292	14.52
	(10,10+]	28	1.39
Kunming	(1,3]	1,255	62.31
	(3,6]	755	37.49
	(6,10]	4	0.20
	(10,10+]	0	0
Hangzhou	(1,3]	709	35.19
	(3,6]	1,228	60.94
	(6,10]	76	3.77
	(10,10+]	2	0.10

Note: 36 cities refer to all municipalities directly under the central government, cities specifically designated in the state plan, and provincial-level capitals.

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