

### **Supplemental Materials:**

Fig. S1. Changes in the length and area of paved roads of Zhengzhou from 1993 to 2016 [data from <http://www.zzstjj.gov.cn>].

Fig. S2. Seasonal and annual concentrations of elements in PM<sub>2.5</sub> among the sampling sites in Zhengzhou in 2016.

Fig. S3. Seasonal and annual concentrations of elements in PM<sub>10</sub> among the sampling sites in Zhengzhou in 2016.

Fig. S4. Cluster analysis of elements in PM<sub>2.5</sub> among the sampling sites in Zhengzhou in 2016.

Fig. S5. Cluster analysis of elements in PM<sub>10</sub> among the sampling sites in Zhengzhou in 2016.

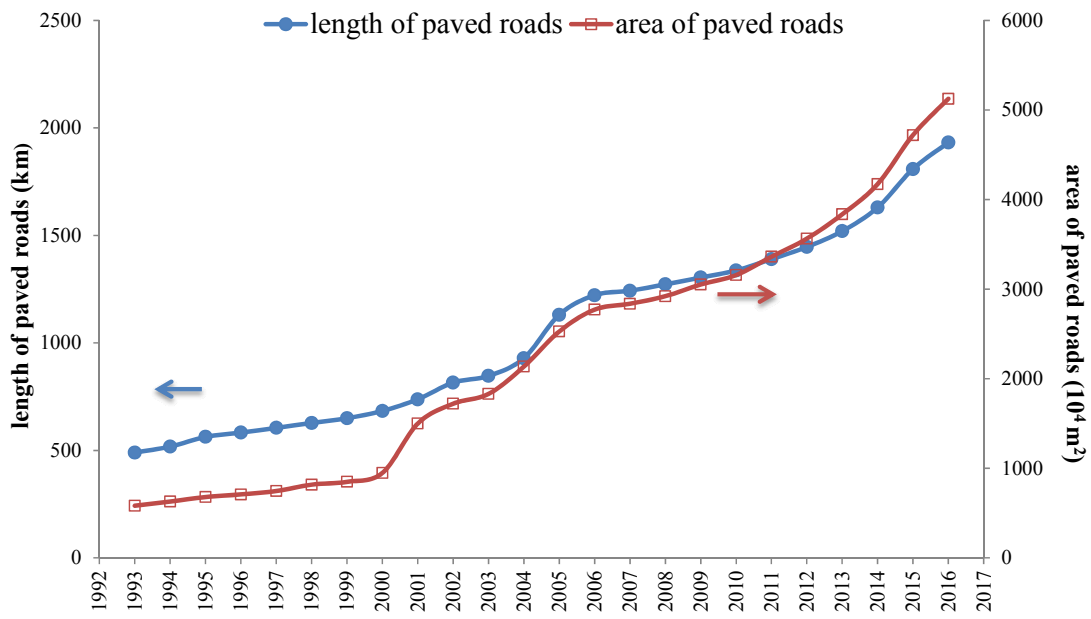
Table S1 Detailed data on the evaluation of health risk posed by toxic elements through the inhalation pathway.

Table S2 Detailed data on the evaluation of health risk posed by toxic elements through the dermal absorption pathway.

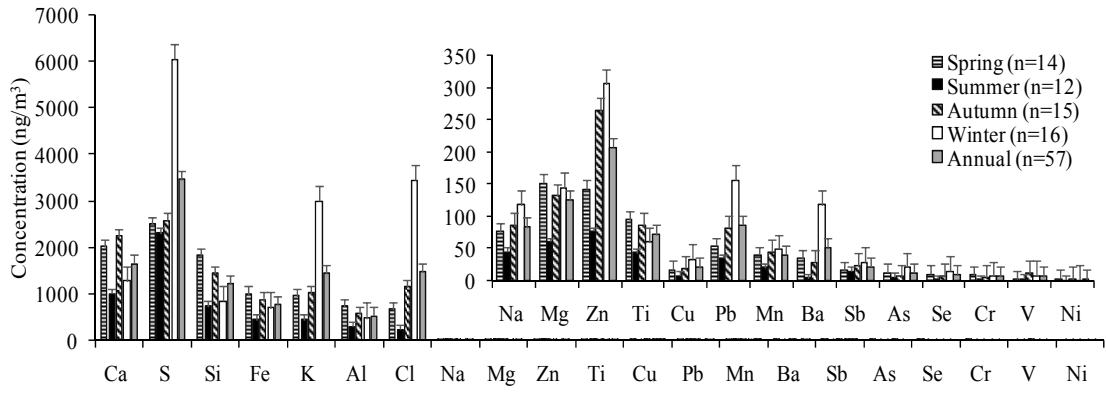
Table S3 Detailed data on the evaluation of health risk posed by toxic elements through the daily intake pathway.

Table S4 Carcinogenic and noncarcinogenic risks for each element in PM<sub>2.5</sub> and PM<sub>10</sub> through the inhalation pathway among the sampling sites in Zhengzhou.

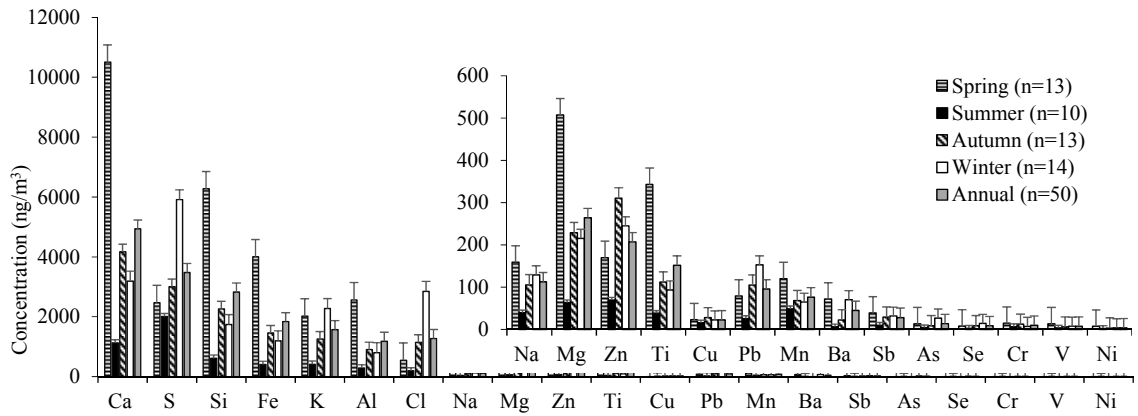
Table S5 Carcinogenic and noncarcinogenic risks for each element in PM<sub>2.5</sub> and PM<sub>10</sub> through the dermal absorption pathway among the sampling sites in Zhengzhou.



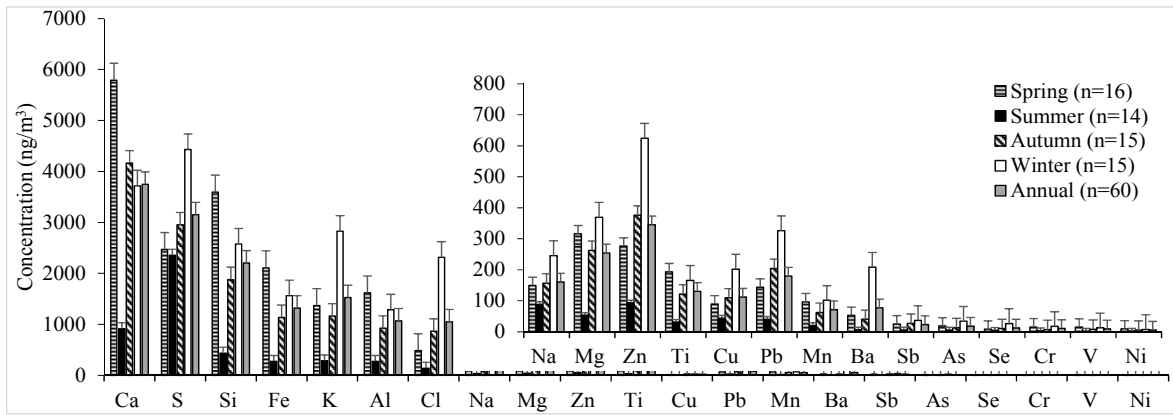
**Fig. S1.** Changes in the length and area of paved roads of Zhengzhou from 1993 to 2016 [data from <http://www.zzstjj.gov.cn>].



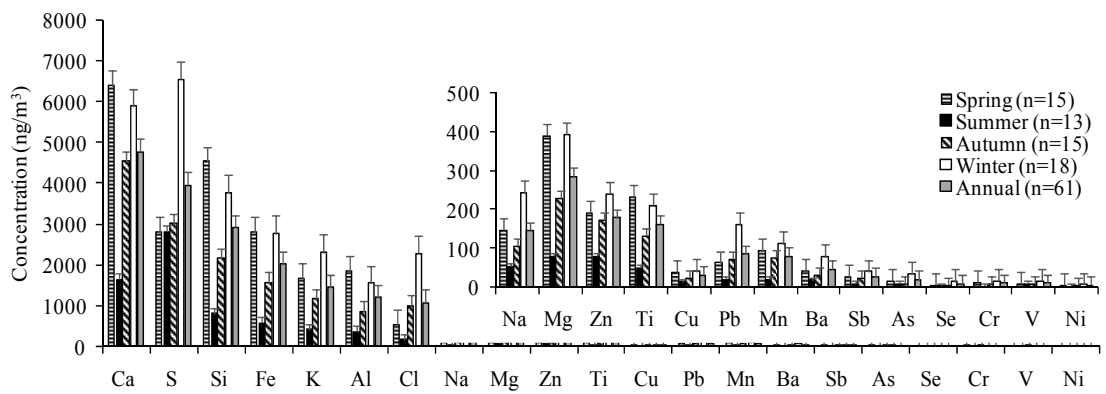
(a) ZM



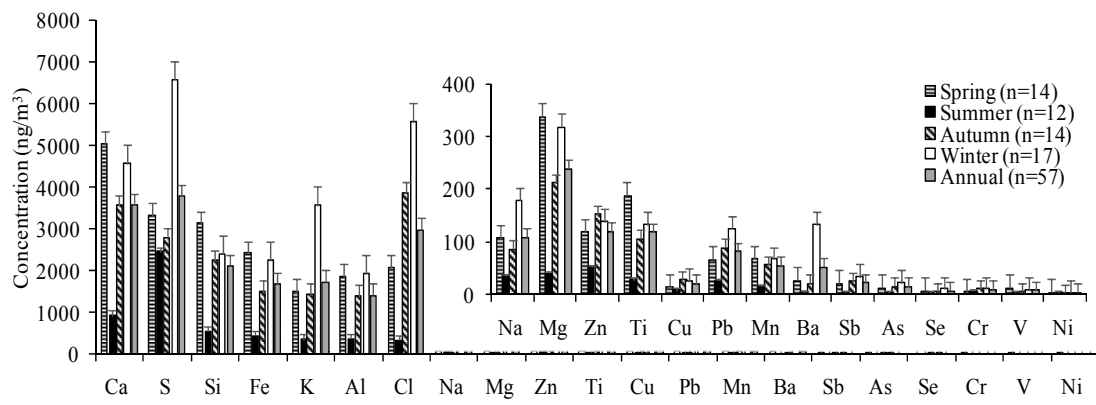
(b) HKG



(c) GY

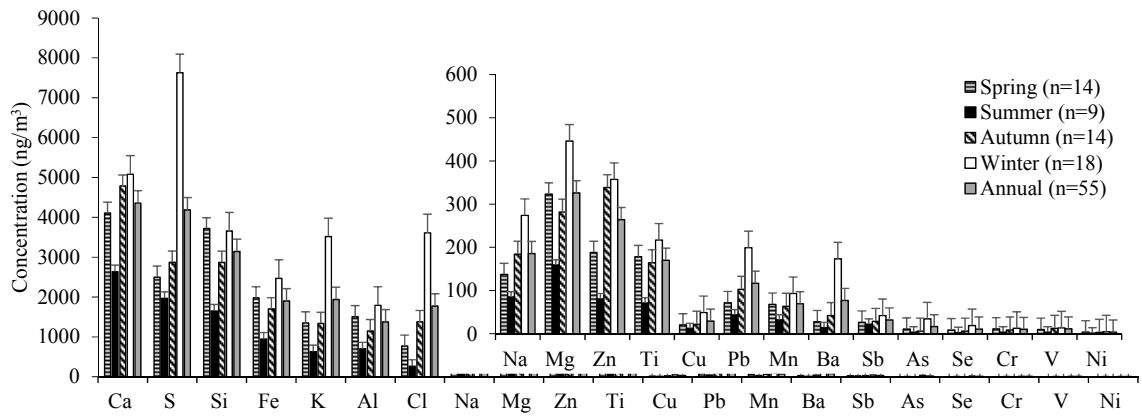


(d) SSQ

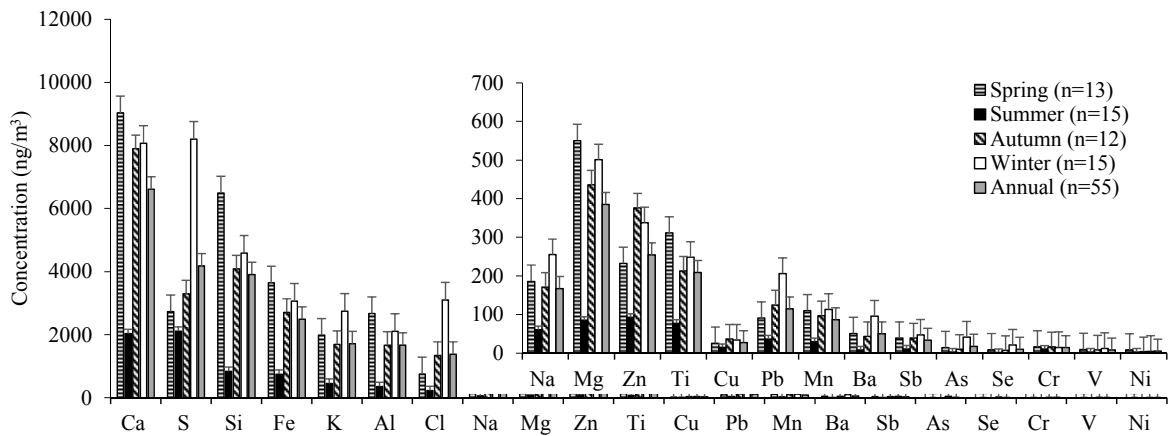


(e) XM

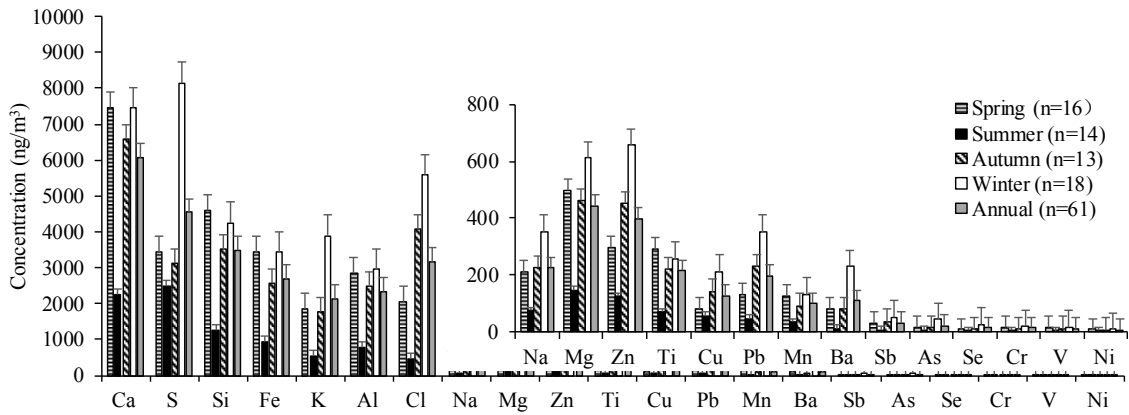
**Fig. S2.** Seasonal and annual concentrations of elements in PM<sub>2.5</sub> among the sampling sites in Zhengzhou in 2016.



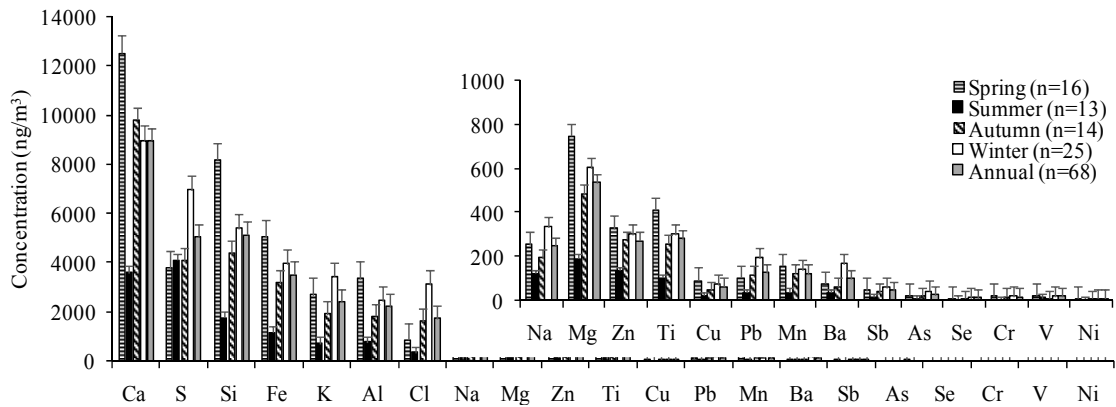
(a) ZM



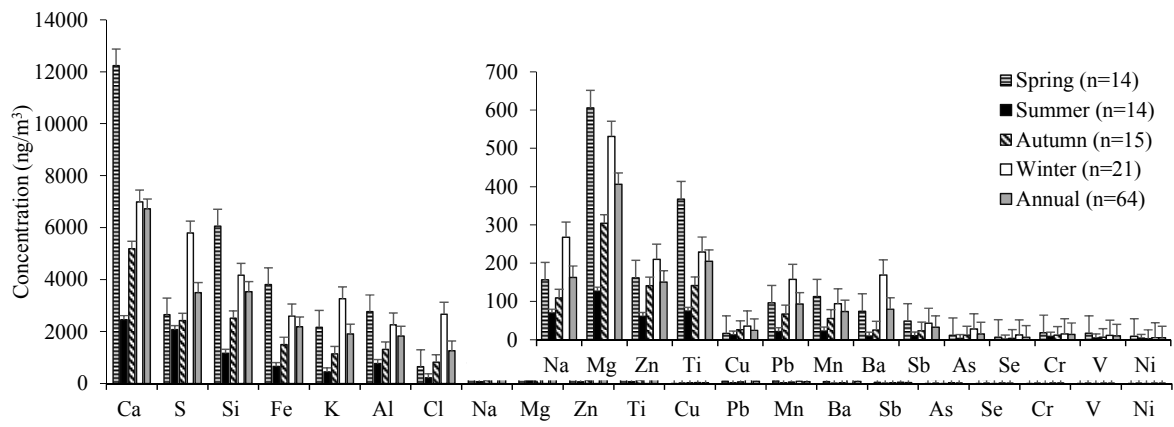
(b) HKG



(c) GY

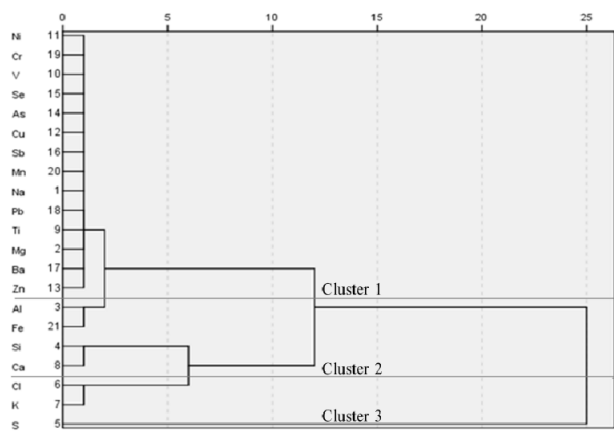


d) SSQ

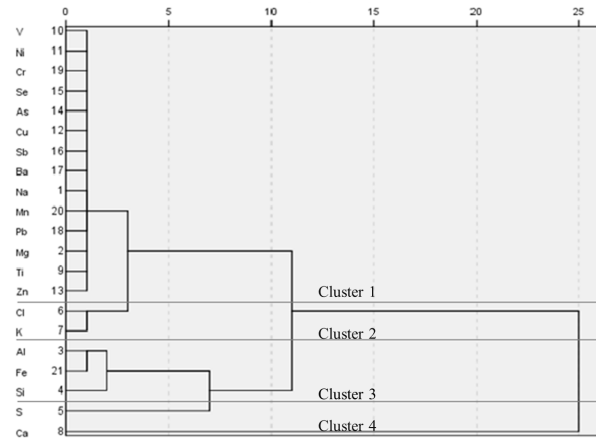


(e) XM

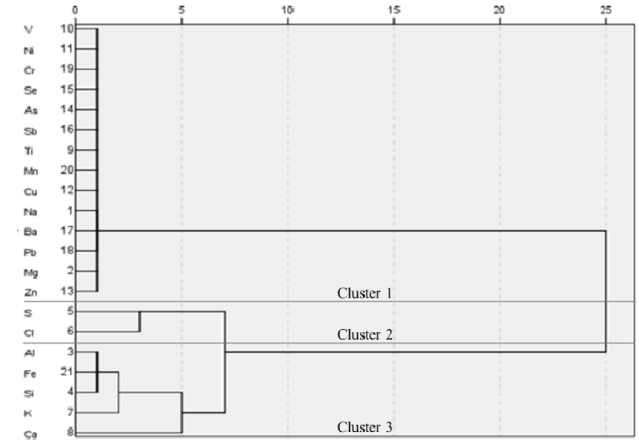
**Fig. S3.** Seasonal and annual concentrations of elements in  $\text{PM}_{10}$  among the sampling sites in Zhengzhou in 2016



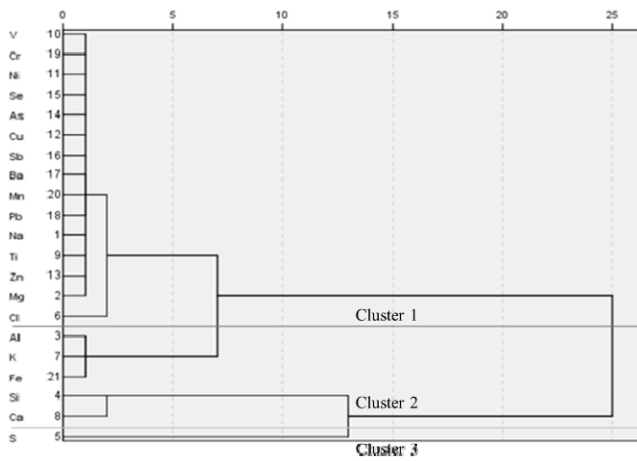
(a) ZM



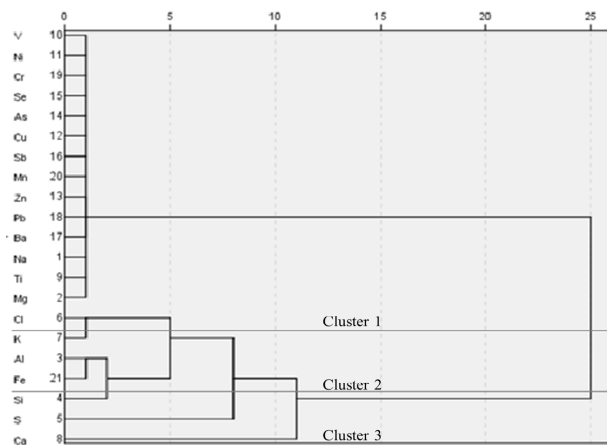
(b) HKG



(c) GY

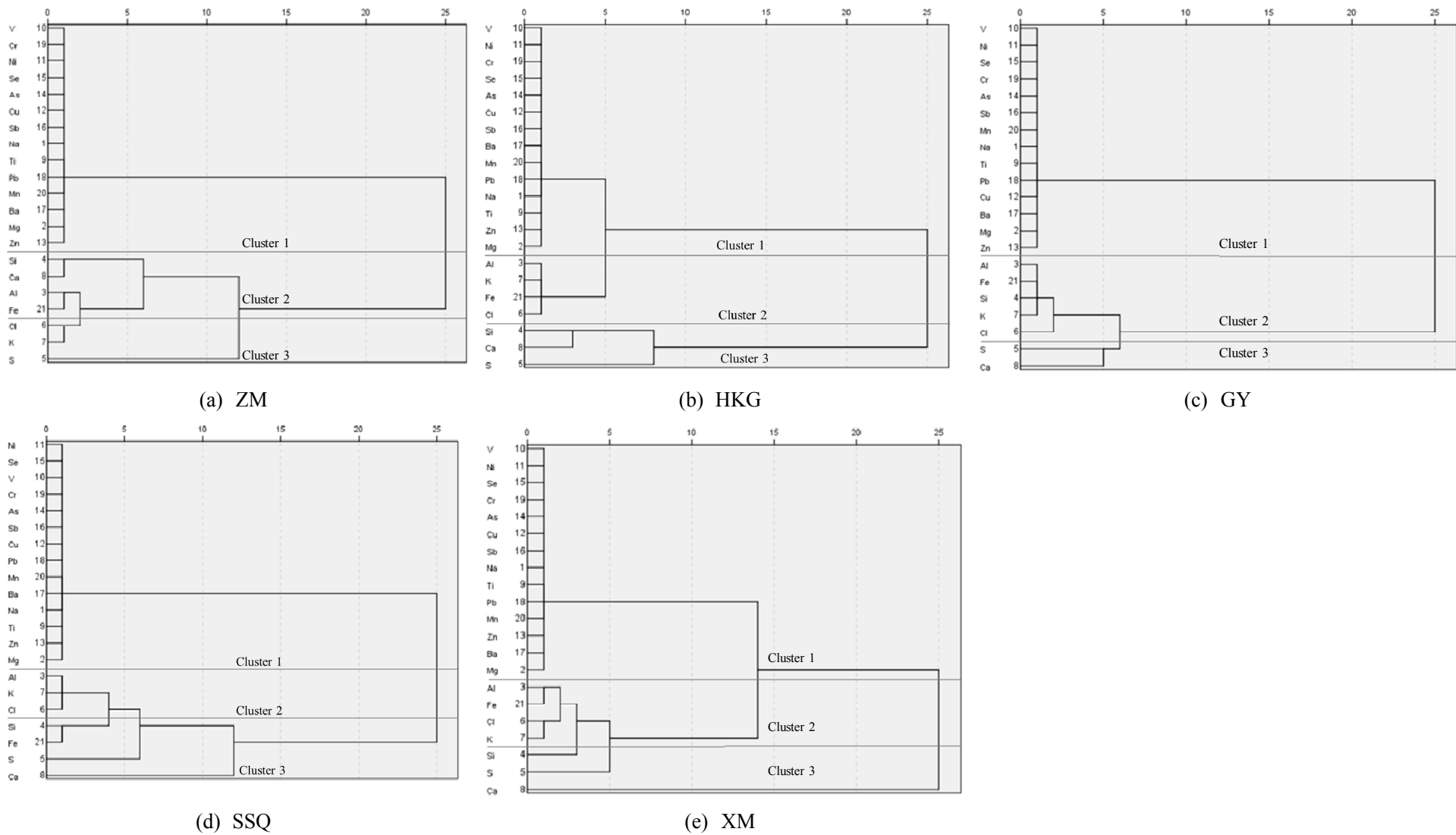


(d) SSQ



(e) XM

**Fig. S4.** Cluster analysis of elements in PM<sub>2.5</sub> among the sampling sites in Zhengzhou in 2016.



**Fig. S5.** Cluster analysis of elements in PM<sub>10</sub> among the sampling sites in Zhengzhou in 2016.



**Table S1** Detailed data on the evaluation of health risk posed by toxic elements through the inhalation pathway.

(a) ZM

Toxic elements	RfCi mg/m <sup>3</sup>	IUR (µg/m <sup>3</sup> ) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL ng/m <sup>3</sup>	EC µg/m <sup>3</sup>		95%UCL ng/m <sup>3</sup>	EC µg/m <sup>3</sup>					
				Carcinogenic			non -Carcinogenic					
				Children	Adults		Children	Adults				
V	1.00E-04		8.7	1.70E-04	6.79E-04	2.09E-03	2.09E-03	13.3	2.59E-04	1.04E-03	3.19E-03	3.19E-03
Cr			7.7	1.50E-04	6.00E-04	1.85E-03	1.85E-03	12.2	2.36E-04	9.45E-04	2.91E-03	2.91E-03
Cu			24.8	4.82E-04	1.93E-03	5.95E-03	5.95E-03	35.0	6.80E-04	2.72E-03	8.38E-03	8.38E-03
As	1.50E-05	4.30E-03	15.6	3.04E-04	1.22E-03	3.75E-03	3.75E-03	22.4	4.35E-04	1.74E-03	5.37E-03	5.37E-03
Mn	5.00E-05		45.6	8.87E-04	3.55E-03	1.09E-02	1.09E-02	78.6	1.53E-03	6.11E-03	1.88E-02	1.88E-02
Zn			261.9	5.09E-03	2.04E-02	6.28E-02	6.28E-02	335.0	6.51E-03	2.60E-02	8.03E-02	8.03E-02
Pb		1.20E-05	102.9	2.00E-03	8.00E-03	2.47E-02	2.47E-02	139.3	2.71E-03	1.08E-02	3.34E-02	3.34E-02
Ni	5.00E-05	2.40E-04	2.6	5.10E-05	2.04E-04	6.29E-04	6.29E-04	4.6	9.02E-05	3.61E-04	1.11E-03	1.11E-03
Sb			24.5	4.77E-04	1.91E-03	5.88E-03	5.88E-03	36.3	7.05E-04	2.82E-03	8.69E-03	8.69E-03

(b) HKG

Toxic elements	RfCi mg/m <sup>3</sup>	IUR (µg/m <sup>3</sup> ) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL ng/m <sup>3</sup>	EC µg/m <sup>3</sup>		95%UCL ng/m <sup>3</sup>	EC µg/m <sup>3</sup>					
				Carcinogenic			non -Carcinogenic					
				Children	Adults		Children	Adults				
V	1.00E-04		9.3	1.81E-04	7.24E-04	2.23E-03	2.23E-03	10.2	1.97E-04	7.90E-04	2.44E-03	2.44E-03
Cr			11.7	2.28E-04	9.12E-04	2.81E-03	2.81E-03	16.7	3.24E-04	1.30E-03	4.00E-03	4.00E-03
Cu			25.9	5.04E-04	2.02E-03	6.22E-03	6.22E-03	32.3	6.27E-04	2.51E-03	7.74E-03	7.74E-03
As	1.50E-05	4.30E-03	17.5	3.41E-04	1.36E-03	4.20E-03	4.20E-03	24.7	4.80E-04	1.92E-03	5.92E-03	5.92E-03
Mn	5.00E-05		94.8	1.84E-03	7.37E-03	2.27E-02	2.27E-02	100.3	1.95E-03	7.80E-03	2.40E-02	2.40E-02
Zn			248.2	4.82E-03	1.93E-02	5.95E-02	5.95E-02	309.1	6.01E-03	2.40E-02	7.41E-02	7.41E-02
Pb		1.20E-05	112.1	2.18E-03	8.71E-03	2.69E-02	2.69E-02	139.3	2.71E-03	1.08E-02	3.34E-02	3.34E-02
Ni	5.00E-05	2.40E-04	4.8	9.40E-05	3.76E-04	1.16E-03	1.16E-03	6.1	1.18E-04	4.71E-04	1.45E-03	1.45E-03
Sb			33.6	6.54E-04	2.62E-03	8.07E-03	8.07E-03	38.9	7.57E-04	3.03E-03	9.34E-03	9.34E-03

(c) GY

Toxic elements	RfCi mg/m <sup>3</sup>	IUR (µg/m <sup>3</sup> ) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL ng/m <sup>3</sup>	EC µg/m <sup>3</sup>		95%UCL ng/m <sup>3</sup>	EC µg/m <sup>3</sup>					
				Carcinogenic			non -Carcinogenic					
				Children	Adults		Children	Adults	Children	Adults	Children	Adults
V	1.00E-04		11.6	2.26E-04	9.03E-04	2.78E-03	2.78E-03	14.5	2.81E-04	1.12E-03	3.46E-03	3.46E-03
Cr			13.6	2.64E-04	1.06E-03	3.26E-03	3.26E-03	17.5	3.40E-04	1.36E-03	4.20E-03	4.20E-03
Cu			146.8	2.85E-03	1.14E-02	3.52E-02	3.52E-02	165.6	3.22E-03	1.29E-02	3.97E-02	3.97E-02
As	1.50E-05	4.30E-03	23.6	4.59E-04	1.84E-03	5.66E-03	5.66E-03	30.2	5.86E-04	2.34E-03	7.23E-03	7.23E-03
Mn	5.00E-05		87.0	1.69E-03	6.77E-03	2.09E-02	2.09E-02	114.9	2.23E-03	8.94E-03	2.76E-02	2.76E-02
Zn			432.8	8.41E-03	3.37E-02	1.04E-01	1.04E-01	485.3	9.43E-03	3.77E-02	1.16E-01	1.16E-01
Pb		1.20E-05	219.9	4.27E-03	1.71E-02	5.27E-02	5.27E-02	240.9	4.68E-03	1.87E-02	5.78E-02	5.78E-02
Ni	5.00E-05	2.40E-04	7.1	1.38E-04	5.50E-04	1.70E-03	1.70E-03	9.1	1.77E-04	7.10E-04	2.19E-03	2.19E-03
Sb			28.2	5.49E-04	2.19E-03	6.77E-03	6.77E-03	38.8	7.54E-04	3.02E-03	9.30E-03	9.30E-03

(d) SSQ

Toxic elements	RfCi mg/m <sup>3</sup>	IUR (µg/m <sup>3</sup> ) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL ng/m <sup>3</sup>	EC µg/m <sup>3</sup>		95%UCL ng/m <sup>3</sup>	EC µg/m <sup>3</sup>					
				Carcinogenic			non -Carcinogenic					
				Children	Adults		Children	Adults	Children	Adults	Children	Adults
V	1.00E-04		13.1	2.54E-04	1.01E-03	3.13E-03	3.13E-03	19.1	3.72E-04	1.49E-03	4.59E-03	4.59E-03
Cr			12.3	2.38E-04	9.52E-04	2.94E-03	2.94E-03	18.3	3.56E-04	1.42E-03	4.39E-03	4.39E-03
Cu			36.8	7.14E-04	2.86E-03	8.81E-03	8.81E-03	72.3	1.40E-03	5.62E-03	1.73E-02	1.73E-02
As	1.50E-05	4.30E-03	23.6	4.59E-04	1.84E-03	5.66E-03	5.66E-03	34.5	6.71E-04	2.68E-03	8.28E-03	8.28E-03
Mn	5.00E-05		94.4	1.84E-03	7.34E-03	2.26E-02	2.26E-02	137.3	2.67E-03	1.07E-02	3.29E-02	3.29E-02
Zn			206.3	4.01E-03	1.60E-02	4.95E-02	4.95E-02	313.2	6.09E-03	2.44E-02	7.51E-02	7.51E-02
Pb		1.20E-05	104.4	2.03E-03	8.12E-03	2.50E-02	2.50E-02	149.9	2.91E-03	1.17E-02	3.59E-02	3.59E-02
Ni	5.00E-05	2.40E-04	5.5	1.07E-04	4.29E-04	1.32E-03	1.32E-03	8.8	1.71E-04	6.84E-04	2.11E-03	2.11E-03
Sb			31.0	6.02E-04	2.41E-03	7.42E-03	7.42E-03	49.8	9.68E-04	3.87E-03	1.19E-02	1.19E-02

(e) XM

Toxic elements	RfCi mg/m <sup>3</sup>	IUR (µg/m <sup>3</sup> ) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL ng/m <sup>3</sup>	EC µg/m <sup>3</sup>		95%UCL ng/m <sup>3</sup>	EC µg/m <sup>3</sup>					
				Carcinogenic			non -Carcinogenic					
				Children	Adults		Children	Adults				
V	1.00E-04		9.0	1.75E-04	6.99E-04	2.16E-03	2.16E-03	11.9	2.31E-04	9.24E-04	2.85E-03	2.85E-03
Cr			9.7	1.89E-04	7.54E-04	2.33E-03	2.33E-03	15.9	3.08E-04	1.23E-03	3.80E-03	3.80E-03
Cu			23.8	4.63E-04	1.85E-03	5.72E-03	5.72E-03	29.3	5.70E-04	2.28E-03	7.04E-03	7.04E-03
As	1.50E-05	4.30E-03	16.4	3.19E-04	1.28E-03	3.93E-03	3.93E-03	19.3	3.74E-04	1.50E-03	4.62E-03	4.62E-03
Mn	5.00E-05		63.9	1.24E-03	4.97E-03	1.53E-02	1.53E-02	87.9	1.71E-03	6.83E-03	2.11E-02	2.11E-02
Zn			142.8	2.78E-03	1.11E-02	3.42E-02	3.42E-02	184.9	3.59E-03	1.44E-02	4.43E-02	4.43E-02
Pb		1.20E-05	97.7	1.90E-03	7.59E-03	2.34E-02	2.34E-02	114.0	2.22E-03	8.86E-03	2.73E-02	2.73E-02
Ni	5.00E-05	2.40E-04	3.4	6.61E-05	2.64E-04	8.15E-04	8.15E-04	6.2	1.21E-04	4.85E-04	1.49E-03	1.49E-03
Sb			26.9	5.22E-04	2.09E-03	6.44E-03	6.44E-03	38.3	7.45E-04	2.98E-03	9.19E-03	9.19E-03

**Table S2** Detailed data on the evaluation of health risk posed by toxic elements through the dermal absorption pathway.

(a) ZM

Toxic elements	RfDo mg/(kg*day)	SFo (mg/(kg*day)) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL mg/kg	DAD mg/(kg*day)				95%UCL mg/kg	DAD mg/(kg*day)			
				Carcinogenic		non -Carcinogenic			Carcinogenic		non -Carcinogenic	
				Children	Adults	Children	Adults		Children	Adults	Children	Adults
V	5.00E-03		128.1	3.72E-06	2.69E-06	4.59E-05	8.31E-06	96.6	2.80E-06	2.03E-06	3.46E-05	6.26E-06
Cr			103.1	2.99E-06	2.17E-06	3.69E-05	6.69E-06	90.6	2.63E-06	1.90E-06	3.24E-05	5.87E-06
Cu	4.00E-02		281.8	8.18E-06	5.93E-06	1.01E-04	1.83E-05	217.9	6.33E-06	4.58E-06	7.80E-05	1.41E-05
As	3.00E-04	1.50E+00	167.7	1.46E-05	1.06E-05	1.80E-04	3.26E-05	131.6	1.15E-05	8.31E-06	1.41E-04	2.56E-05
Mn	2.40E-02		595.7	1.73E-05	1.25E-05	2.13E-04	3.86E-05	543.7	1.58E-05	1.14E-05	1.95E-04	3.53E-05
Zn	3.00E-01		3360.2	9.75E-05	7.07E-05	1.20E-03	2.18E-04	2275.7	6.61E-05	4.79E-05	8.15E-04	1.48E-04
Pb	3.50E-03	8.50E-03	1109.2	3.22E-05	2.33E-05	3.97E-04	7.19E-05	814.3	2.36E-05	1.71E-05	2.92E-04	5.28E-05
Ni	1.10E-02	1.70E+00	38.0	1.10E-06	7.99E-07	1.36E-05	2.46E-06	35.0	1.01E-06	7.35E-07	1.25E-05	2.27E-06
Sb	4.00E-04		330.9	9.60E-06	6.96E-06	1.18E-04	2.15E-05	274.7	7.97E-06	5.78E-06	9.84E-05	1.78E-05

(b) HKG

Toxic elements	RfDo mg/(kg*day)	SFo (mg/(kg*day)) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL mg/kg	DAD mg/(kg*day)				95%UCL mg/kg	DAD mg/(kg*day)			
				Carcinogenic		non -Carcinogenic			Carcinogenic		non -Carcinogenic	
				Children	Adults	Children	Adults		Children	Adults	Children	Adults
V	5.00E-03		80.2	2.33E-06	1.69E-06	2.87E-05	5.20E-06	59.5	1.73E-06	1.25E-06	2.13E-05	3.86E-06
Cr			113.6	3.30E-06	2.39E-06	4.07E-05	7.37E-06	123.9	3.60E-06	2.61E-06	4.44E-05	8.04E-06
Cu	4.00E-02		267.5	7.77E-06	5.63E-06	9.58E-05	1.73E-05	211.8	6.15E-06	4.45E-06	7.58E-05	1.37E-05
As	3.00E-04	1.50E+00	123.5	1.08E-05	7.79E-06	1.33E-04	2.40E-05	108.7	9.47E-06	6.86E-06	1.17E-04	2.11E-05
Mn	2.40E-02		924.0	2.68E-05	1.94E-05	3.31E-04	5.99E-05	573.6	1.66E-05	1.21E-05	2.05E-04	3.72E-05
Zn	3.00E-01		2202.3	6.39E-05	4.63E-05	7.88E-04	1.43E-04	1726.1	5.01E-05	3.63E-05	6.18E-04	1.12E-04
Pb	3.50E-03	8.50E-03	863.6	2.51E-05	1.82E-05	3.09E-04	5.60E-05	686.7	1.99E-05	1.44E-05	2.46E-04	4.45E-05
Ni	1.10E-02	1.70E+00	43.8	1.27E-06	9.21E-07	1.57E-05	2.84E-06	43.6	1.26E-06	9.16E-07	1.56E-05	2.82E-06
Sb	4.00E-04		277.2	8.04E-06	5.83E-06	9.92E-05	1.80E-05	227.9	6.61E-06	4.79E-06	8.16E-05	1.48E-05

## (c) GY

Toxic elements	RfDo mg/(kg*day)	SFo (mg/(kg*day)) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL mg/kg	DAD mg/(kg*day)		95%UCL mg/kg	DAD mg/(kg*day)					
				non -Carcinogenic			non -Carcinogenic					
				Children	Adults		Children	Adults				
V	5.00E-03		91.8	2.67E-06	1.93E-06	3.29E-05	5.96E-06	80.7	2.34E-06	1.70E-06	2.89E-05	5.23E-06
Cr			107.7	3.13E-06	2.27E-06	3.86E-05	6.98E-06	100.8	2.93E-06	2.12E-06	3.61E-05	6.54E-06
Cu	4.00E-02		1116.7	3.24E-05	2.35E-05	4.00E-04	7.24E-05	915.8	2.66E-05	1.93E-05	3.28E-04	5.94E-05
As	3.00E-04	1.50E+00	169.7	1.48E-05	1.07E-05	1.82E-04	3.30E-05	141.4	1.23E-05	8.92E-06	1.52E-04	2.75E-05
Mn	2.40E-02		661.1	1.92E-05	1.39E-05	2.37E-04	4.29E-05	644.6	1.87E-05	1.36E-05	2.31E-04	4.18E-05
Zn	3.00E-01		2941.3	8.54E-05	6.19E-05	1.05E-03	1.91E-04	2374.9	6.89E-05	4.99E-05	8.50E-04	1.54E-04
Pb	3.50E-03	8.50E-03	1662.2	4.82E-05	3.50E-05	5.95E-04	1.08E-04	1223.4	3.55E-05	2.57E-05	4.38E-04	7.93E-05
Ni	1.10E-02	1.70E+00	62.7	1.82E-06	1.32E-06	2.24E-05	4.06E-06	58.3	1.69E-06	1.23E-06	2.09E-05	3.78E-06
Sb	4.00E-04		219.0	6.36E-06	4.61E-06	7.84E-05	1.42E-05	205.0	5.95E-06	4.31E-06	7.34E-05	1.33E-05

## (d) SSQ

Toxic elements	RfDo mg/(kg*day)	SFo (mg/(kg*day)) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL mg/kg	DAD mg/(kg*day)		95%UCL mg/kg	DAD mg/(kg*day)					
				non -Carcinogenic			non -Carcinogenic					
				Children	Adults		Children	Adults				
V	5.00E-03		118.5	3.44E-06	2.49E-06	4.24E-05	7.68E-06	133.4	3.87E-06	2.80E-06	4.77E-05	8.65E-06
Cr			89.1	2.59E-06	1.87E-06	3.19E-05	5.78E-06	102.8	2.98E-06	2.16E-06	3.68E-05	6.66E-06
Cu	4.00E-02		301.1	8.74E-06	6.33E-06	1.08E-04	1.95E-05	441.7	1.28E-05	9.29E-06	1.58E-04	2.86E-05
As	3.00E-04	1.50E+00	172.1	1.50E-05	1.09E-05	1.85E-04	3.35E-05	190.9	1.66E-05	1.20E-05	2.05E-04	3.71E-05
Mn	2.40E-02		697.3	2.02E-05	1.47E-05	2.50E-04	4.52E-05	775.0	2.25E-05	1.63E-05	2.77E-04	5.03E-05
Zn	3.00E-01		1575.2	4.57E-05	3.31E-05	5.64E-04	1.02E-04	1862.8	5.41E-05	3.92E-05	6.67E-04	1.21E-04
Pb	3.50E-03	8.50E-03	645.2	1.87E-05	1.36E-05	2.31E-04	4.18E-05	751.1	2.18E-05	1.58E-05	2.69E-04	4.87E-05
Ni	1.10E-02	1.70E+00	45.7	1.33E-06	9.62E-07	1.64E-05	2.96E-06	55.3	1.60E-06	1.16E-06	1.98E-05	3.58E-06
Sb	4.00E-04		234.9	6.82E-06	4.94E-06	8.41E-05	1.52E-05	282.4	8.20E-06	5.94E-06	1.01E-04	1.83E-05

## (e) XM

Toxic elements	RfDo mg/(kg*day)	SFo (mg/(kg* day)) <sup>-1</sup>	PM <sub>2.5</sub>					PM <sub>10</sub>				
			95%UCL mg/kg	DAD mg/(kg*day)				95%UCL mg/kg	DAD mg/(kg*day)			
				Carcinogenic		non -Carcinogenic			Carcinogenic		non -Carcinogenic	
				Children	Adults	Children	Adults		Children	Adults	Children	Adults
V	5.00E-03		97.9	2.84E-06	2.06E-06	3.51E-05	6.35E-06	90.7	2.63E-06	1.91E-06	3.25E-05	5.88E-06
Cr			135.8	3.94E-06	2.86E-06	4.86E-05	8.80E-06	132.1	3.83E-06	2.78E-06	4.73E-05	8.57E-06
Cu	4.00E-02		254.4	7.38E-06	5.35E-06	9.11E-05	1.65E-05	212.1	6.16E-06	4.46E-06	7.59E-05	1.38E-05
As	3.00E-04	1.50E+00	139.0	1.21E-05	8.77E-06	1.49E-04	2.70E-05	115.2	1.00E-05	7.27E-06	1.24E-04	2.24E-05
Mn	2.40E-02		618.0	1.79E-05	1.30E-05	2.21E-04	4.01E-05	562.5	1.63E-05	1.18E-05	2.01E-04	3.65E-05
Zn	3.00E-01		1444.9	4.19E-05	3.04E-05	5.17E-04	9.37E-05	1093.9	3.18E-05	2.30E-05	3.92E-04	7.09E-05
Pb	3.50E-03	8.50E-03	847.8	2.46E-05	1.78E-05	3.03E-04	5.50E-05	618.2	1.79E-05	1.30E-05	2.21E-04	4.01E-05
Ni	1.10E-02	1.70E+00	61.0	1.77E-06	1.28E-06	2.18E-05	3.95E-06	51.9	1.51E-06	1.09E-06	1.86E-05	3.37E-06
Sb	4.00E-04		233.5	6.78E-06	4.91E-06	8.36E-05	1.51E-05	251.9	7.31E-06	5.30E-06	9.02E-05	1.63E-05

**Table S3** Detailed data on the evaluation of health risk posed by toxic elements through the daily intake pathway.

(a) ZM

Toxic elements	RfDo mg/(kg*day)	SFo (mg/(kg*day)) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL mg/kg	CDI mg/(kg*day)				95%UCL mg/kg	CDI mg/(kg*day)			
				Carcinogenic		non-Carcinogenic			Carcinogenic		non-Carcinogenic	
				Children	Adults	Children	Adults		Children	Adults	Children	Adults
V	5.00E-03		128.1	1.33E-04	6.75E-05	1.64E-03	2.08E-04	96.6	1.00E-04	5.09E-05	1.23E-03	1.57E-04
Cr			103.1	1.07E-04	5.44E-05	1.32E-03	1.68E-04	90.6	9.39E-05	4.77E-05	1.16E-03	1.47E-04
Cu	4.00E-02		281.8	2.92E-04	1.49E-04	3.60E-03	4.58E-04	217.9	2.26E-04	1.15E-04	2.79E-03	3.54E-04
As	3.00E-04	1.50E+00	167.7	1.74E-04	8.84E-05	2.14E-03	2.73E-04	131.6	1.36E-04	6.94E-05	1.68E-03	2.14E-04
Mn	2.40E-02		595.7	6.18E-04	3.14E-04	7.62E-03	9.68E-04	543.7	5.64E-04	2.87E-04	6.95E-03	8.84E-04
Zn	3.00E-01		3360.2	3.48E-03	1.77E-03	4.30E-02	5.46E-03	2275.7	2.36E-03	1.20E-03	2.91E-02	3.70E-03
Pb	3.50E-03	8.50E-03	1109.2	1.15E-03	5.85E-04	1.42E-02	1.80E-03	814.3	8.44E-04	4.29E-04	1.04E-02	1.32E-03
Ni	1.10E-02	1.70E+00	38.0	3.94E-05	2.00E-05	4.86E-04	6.17E-05	35.0	3.62E-05	1.84E-05	4.47E-04	5.68E-05
Sb	4.00E-04		330.9	3.43E-04	1.74E-04	4.23E-03	5.38E-04	274.7	2.85E-04	1.45E-04	3.51E-03	4.47E-04

(b) HKG

Toxic elements	RfDo mg/(kg*day)	SFo (mg/(kg*day)) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL mg/kg	CDI mg/(kg*day)				95%UCL mg/kg	CDI mg/(kg*day)			
				Carcinogenic		non-Carcinogenic			Carcinogenic		non-Carcinogenic	
				Children	Adults	Children	Adults		Children	Adults	Children	Adults
V	5.00E-03		80.2	8.32E-05	4.23E-05	1.03E-03	1.30E-04	59.5	6.17E-05	3.14E-05	7.61E-04	9.67E-05
Cr			113.6	1.18E-04	5.99E-05	1.45E-03	1.85E-04	123.9	1.28E-04	6.53E-05	1.58E-03	2.01E-04
Cu	4.00E-02		267.5	2.77E-04	1.41E-04	3.42E-03	4.35E-04	211.8	2.20E-04	1.12E-04	2.71E-03	3.44E-04
As	3.00E-04	1.50E+00	123.5	1.28E-04	6.51E-05	1.58E-03	2.01E-04	108.7	1.13E-04	5.73E-05	1.39E-03	1.77E-04
Mn	2.40E-02		924.0	9.58E-04	4.87E-04	1.18E-02	1.50E-03	573.6	5.95E-04	3.02E-04	7.33E-03	9.32E-04
Zn	3.00E-01		2202.3	2.28E-03	1.16E-03	2.82E-02	3.58E-03	1726.1	1.79E-03	9.10E-04	2.21E-02	2.81E-03
Pb	3.50E-03	8.50E-03	863.6	8.95E-04	4.55E-04	1.10E-02	1.40E-03	686.7	7.12E-04	3.62E-04	8.78E-03	1.12E-03
Ni	1.10E-02	1.70E+00	43.8	4.54E-05	2.31E-05	5.60E-04	7.12E-05	43.6	4.52E-05	2.30E-05	5.57E-04	7.08E-05
Sb	4.00E-04		277.2	2.87E-04	1.46E-04	3.54E-03	4.50E-04	227.9	2.36E-04	1.20E-04	2.91E-03	3.70E-04

## (c) GY

Toxic elements	RfDo mg/(kg*day)	SFo (mg/(kg*day)) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL mg/kg	CDI mg/(kg*day)		95%UCL mg/kg	CDI mg/(kg*day)					
				Carcinogenic			non-Carcinogenic					
				Children	Adults		Children	Adults				
V	5.00E-03		91.8	9.52E-05	4.84E-05	1.17E-03	1.49E-04	80.7	8.36E-05	4.25E-05	1.03E-03	1.31E-04
Cr			107.7	1.12E-04	5.68E-05	1.38E-03	1.75E-04	100.8	1.05E-04	5.31E-05	1.29E-03	1.64E-04
Cu	4.00E-02		1116.7	1.16E-03	5.89E-04	1.43E-02	1.81E-03	915.8	9.49E-04	4.83E-04	1.17E-02	1.49E-03
As	3.00E-04	1.50E+00	169.7	1.76E-04	8.94E-05	2.17E-03	2.76E-04	141.4	1.47E-04	7.45E-05	1.81E-03	2.30E-04
Mn	2.40E-02		661.1	6.85E-04	3.48E-04	8.45E-03	1.07E-03	644.6	6.68E-04	3.40E-04	8.24E-03	1.05E-03
Zn	3.00E-01		2941.3	3.05E-03	1.55E-03	3.76E-02	4.78E-03	2374.9	2.46E-03	1.25E-03	3.04E-02	3.86E-03
Pb	3.50E-03	8.50E-03	1662.2	1.72E-03	8.76E-04	2.13E-02	2.70E-03	1223.4	1.27E-03	6.45E-04	1.56E-02	1.99E-03
Ni	1.10E-02	1.70E+00	62.7	6.50E-05	3.30E-05	8.01E-04	1.02E-04	58.3	6.05E-05	3.07E-05	7.46E-04	9.48E-05
Sb	4.00E-04		219.0	2.27E-04	1.15E-04	2.80E-03	3.56E-04	205.0	2.13E-04	1.08E-04	2.62E-03	3.33E-04

## (d) SSQ

Toxic elements	RfDo mg/(kg*day)	SFo (mg/(kg*day)) <sup>-1</sup>	PM <sub>2.5</sub>				PM <sub>10</sub>					
			95%UCL mg/kg	CDI mg/(kg*day)		95%UCL mg/kg	CDI mg/(kg*day)					
				Carcinogenic			non-Carcinogenic					
				Children	Adults		Children	Adults				
V	5.00E-03		118.5	1.23E-04	6.25E-05	1.51E-03	1.93E-04	133.4	1.38E-04	7.03E-05	1.70E-03	2.17E-04
Cr			89.1	9.24E-05	4.70E-05	1.14E-03	1.45E-04	102.8	1.07E-04	5.42E-05	1.31E-03	1.67E-04
Cu	4.00E-02		301.1	3.12E-04	1.59E-04	3.85E-03	4.89E-04	441.7	4.58E-04	2.33E-04	5.65E-03	7.18E-04
As	3.00E-04	1.50E+00	172.1	1.78E-04	9.07E-05	2.20E-03	2.80E-04	190.9	1.98E-04	1.01E-04	2.44E-03	3.10E-04
Mn	2.40E-02		697.3	7.23E-04	3.68E-04	8.92E-03	1.13E-03	775.0	8.03E-04	4.09E-04	9.91E-03	1.26E-03
Zn	3.00E-01		1575.2	1.63E-03	8.30E-04	2.01E-02	2.56E-03	1862.8	1.93E-03	9.82E-04	2.38E-02	3.03E-03
Pb	3.50E-03	8.50E-03	645.2	6.69E-04	3.40E-04	8.25E-03	1.05E-03	751.1	7.79E-04	3.96E-04	9.60E-03	1.22E-03
Ni	1.10E-02	1.70E+00	45.7	4.74E-05	2.41E-05	5.85E-04	7.43E-05	55.3	5.73E-05	2.91E-05	7.07E-04	8.98E-05
Sb	4.00E-04		234.9	2.44E-04	1.24E-04	3.00E-03	3.82E-04	282.4	2.93E-04	1.49E-04	3.61E-03	4.59E-04



## (e) XM

Toxic elements	RfDo mg/(kg*day)	SFo (mg/(kg*day)) <sup>-1</sup>	PM <sub>2.5</sub>					PM <sub>10</sub>				
			95%UCL mg/kg	CDI mg/(kg*day)				95%UCL mg/kg	CDI mg/(kg*day)			
				Carcinogenic		non-Carcinogenic			Carcinogenic		non-Carcinogenic	
				Children	Adults	Children	Adults		Children	Adults	Children	Adults
V	5.00E-03		97.9	1.02E-04	5.16E-05	1.25E-03	1.59E-04	90.7	9.40E-05	4.78E-05	1.16E-03	1.47E-04
Cr			135.8	1.41E-04	7.16E-05	1.74E-03	2.21E-04	132.1	1.37E-04	6.96E-05	1.69E-03	2.15E-04
Cu	4.00E-02		254.4	2.64E-04	1.34E-04	3.25E-03	4.13E-04	212.1	2.20E-04	1.12E-04	2.71E-03	3.45E-04
As	3.00E-04	1.50E+00	139.0	1.44E-04	7.32E-05	1.78E-03	2.26E-04	115.2	1.19E-04	6.07E-05	1.47E-03	1.87E-04
Mn	2.40E-02		618.0	6.41E-04	3.26E-04	7.90E-03	1.00E-03	562.5	5.83E-04	2.97E-04	7.19E-03	9.14E-04
Zn	3.00E-01		1444.9	1.50E-03	7.62E-04	1.85E-02	2.35E-03	1093.9	1.13E-03	5.77E-04	1.40E-02	1.78E-03
Pb	3.50E-03	8.50E-03	847.8	8.79E-04	4.47E-04	1.08E-02	1.38E-03	618.2	6.41E-04	3.26E-04	7.90E-03	1.00E-03
Ni	1.10E-02	1.70E+00	61.0	6.32E-05	3.21E-05	7.79E-04	9.91E-05	51.9	5.38E-05	2.74E-05	6.64E-04	8.44E-05
Sb	4.00E-04		233.5	2.42E-04	1.23E-04	2.99E-03	3.79E-04	251.9	2.61E-04	1.33E-04	3.22E-03	4.09E-04

**Table S4** Carcinogenic and noncarcinogenic risks for each element in PM<sub>2.5</sub> and PM<sub>10</sub> through the inhalation pathway among the sampling sites in Zhengzhou.

(a) ZM

Toxic elements	PM <sub>2.5</sub>				PM <sub>10</sub>			
	Carcinogenic risk		Non-Carcinogenic risk		Carcinogenic risk		Non-Carcinogenic risk	
	Children	Adults	Children	Adults	Children	Adults	Children	Adults
V			2.09E-02	2.09E-02			3.19E-02	3.19E-02
As	1.31E-06	5.22E-06	2.50E-01	2.50E-01	1.87E-06	7.49E-06	3.58E-01	3.58E-01
Mn			2.19E-01	2.19E-01			3.77E-01	3.77E-01
Pb	2.40E-08	9.60E-08			3.25E-08	1.30E-07		
Ni	1.22E-08	4.90E-08	1.26E-02	1.26E-02	2.16E-08	8.66E-08	2.22E-02	2.22E-02
HI			5.02E-01	5.02E-01			7.89E-01	7.89E-01

(b) HKG

Toxic elements	PM <sub>2.5</sub>				PM <sub>10</sub>			
	Carcinogenic risk		Non-Carcinogenic risk		Carcinogenic risk		Non-Carcinogenic risk	
	Children	Adults	Children	Adults	Children	Adults	Children	Adults
V			2.23E-02	2.23E-02			2.44E-02	2.44E-02
As	1.47E-06	5.86E-06	2.80E-01	2.80E-01	2.07E-06	8.26E-06	3.95E-01	3.95E-01
Mn			4.55E-01	4.55E-01			4.81E-01	4.81E-01
Pb	2.61E-08	1.05E-07			3.25E-08	1.30E-07		
Ni	2.26E-08	9.02E-08	2.32E-02	2.32E-02	2.82E-08	1.13E-07	2.90E-02	2.90E-02
HI			7.80E-01	7.80E-01			9.29E-01	9.29E-01

(c) GY

Toxic elements	PM <sub>2.5</sub>				PM <sub>10</sub>			
	Carcinogenic risk		Non-Carcinogenic risk		Carcinogenic risk		Non-Carcinogenic risk	
	Children	Adults	Children	Adults	Children	Adults	Children	Adults
V			2.78E-02	2.78E-02			3.46E-02	3.46E-02
As	1.97E-06	7.90E-06	3.77E-01	3.77E-01	2.52E-06	1.01E-05	4.82E-01	4.82E-01
Mn			4.17E-01	4.17E-01			5.51E-01	5.51E-01
Pb	5.13E-08	2.05E-07			5.62E-08	2.25E-07		
Ni	3.30E-08	1.32E-07	3.39E-02	3.39E-02	4.26E-08	1.70E-07	4.38E-02	4.38E-02
HI			8.56E-01	8.56E-01			1.11E+00	1.11E+00

## (d) SSQ

Toxic elements	PM <sub>2.5</sub>				PM <sub>10</sub>			
	Carcinogenic risk		Non-Carcinogenic risk		Carcinogenic risk		Non-Carcinogenic risk	
	Children	Adults	Children	Adults	Children	Adults	Children	Adults
V			3.13E-02	3.13E-02			4.59E-02	4.59E-02
As	1.97E-06	7.90E-06	3.77E-01	3.77E-01	2.89E-06	1.15E-05	5.52E-01	5.52E-01
Mn			4.53E-01	4.53E-01			6.58E-01	6.58E-01
Pb	2.43E-08	9.74E-08			3.50E-08	1.40E-07		
Ni	2.57E-08	1.03E-07	2.64E-02	2.64E-02	4.11E-08	1.64E-07	4.22E-02	4.22E-02
HI			8.88E-01	8.88E-01			1.30E+00	1.30E+00

## (e) XM

Toxic elements	PM <sub>2.5</sub>				PM <sub>10</sub>			
	Carcinogenic risk		Non-Carcinogenic risk		Carcinogenic risk		Non-Carcinogenic risk	
	Children	Adults	Children	Adults	Children	Adults	Children	Adults
V			2.16E-02	2.16E-02			2.85E-02	2.85E-02
As	1.37E-06	5.49E-06	2.62E-01	2.62E-01	1.61E-06	6.44E-06	3.08E-01	3.08E-01
Mn			3.06E-01	3.06E-01			4.21E-01	4.21E-01
Pb	2.28E-08	9.11E-08			2.66E-08	1.06E-07		
Ni	1.59E-08	6.34E-08	1.63E-02	1.63E-02	2.91E-08	1.16E-07	2.99E-02	2.99E-02
HI			6.06E-01	6.06E-01			7.88E-01	7.88E-01

**Table S5** Carcinogenic and noncarcinogenic risks for each element in PM<sub>2.5</sub> and PM<sub>10</sub> through the dermal absorption pathway among the sampling sites in Zhengzhou.

(a) ZM

Toxic elements	PM <sub>2.5</sub>				PM <sub>10</sub>			
	Carcinogenic risk		Non-Carcinogenic risk		Carcinogenic risk		Non-Carcinogenic risk	
	Children	Adults	Children	Adults	Children	Adults	Children	Adults
V			3.53E-01	6.39E-02			2.66E-01	4.82E-02
Cu			2.52E-03	4.57E-04			1.95E-03	3.53E-04
As	2.19E-05	1.59E-05	6.00E-01	1.09E-01	1.72E-05	1.25E-05	4.71E-01	8.54E-02
Mn			2.22E-01	4.02E-02			2.03E-01	3.67E-02
Zn			4.01E-03	7.26E-04			2.72E-03	4.92E-04
Pb	2.74E-07	1.98E-07	1.13E-01	2.06E-02	2.01E-07	1.46E-07	8.33E-02	1.51E-02
Ni	4.69E-05	3.40E-05	3.09E-02	5.60E-03	4.31E-05	3.12E-05	2.84E-02	5.15E-03
Sb			1.97E+00	3.58E-01			1.64E+00	2.97E-01
HI			1.94E+00	5.82E-01			2.70E+00	4.88E-01

(b) HKG

Toxic elements	PM <sub>2.5</sub>				PM <sub>10</sub>			
	Carcinogenic risk		Non-Carcinogenic risk		Carcinogenic risk		Non-Carcinogenic risk	
	Children	Adults	Children	Adults	Children	Adults	Children	Adults
V			2.21E-01	4.00E-02			1.64E-01	2.97E-02
Cu			2.39E-03	4.34E-04			1.90E-03	3.43E-04
As	1.61E-05	1.17E-05	4.42E-01	8.01E-02	1.42E-05	1.03E-05	3.89E-01	7.05E-02
Mn			3.45E-01	6.24E-02			2.14E-01	3.87E-02
Zn			2.63E-03	4.76E-04			2.06E-03	3.73E-04
Pb	2.13E-07	1.54E-07	8.83E-02	1.60E-02	1.69E-07	1.23E-07	7.02E-02	1.27E-02
Ni	5.40E-05	3.92E-05	3.56E-02	6.46E-03	5.37E-05	3.89E-05	3.54E-02	6.42E-03
Sb			1.65E+00	3.00E-01			1.36E+00	2.46E-01
HI			2.79E+00	5.05E-01			2.24E+00	4.05E-01

(c) GY

Toxic elements	PM <sub>2.5</sub>				PM <sub>10</sub>			
	Carcinogenic risk		Non-Carcinogenic risk		Carcinogenic risk		Non-Carcinogenic risk	
	Children	Adults	Children	Adults	Children	Adults	Children	Adults
V			2.53E-01	4.58E-02			2.22E-01	4.02E-02
Cu			9.99E-03	1.81E-03			8.20E-03	1.48E-03
As	2.22E-05	1.61E-05	6.07E-01	1.10E-01	1.85E-05	1.34E-05	5.06E-01	9.17E-02
Mn			2.47E-01	4.47E-02			2.40E-01	4.35E-02
Zn			3.51E-03	6.36E-04			2.83E-03	5.13E-04
Pb	4.10E-07	2.97E-07	1.70E-01	3.08E-02	3.02E-07	2.19E-07	1.25E-01	2.27E-02
Ni	7.73E-05	5.60E-05	5.10E-02	9.23E-03	7.19E-05	5.21E-05	4.74E-02	8.59E-03
Sb			1.31E+00	2.37E-01			1.22E+00	2.22E-01
HI			2.65E+00	4.80E-01			2.38E+00	4.30E-01

## (d) SSQ

Toxic elements	PM <sub>2.5</sub>				PM <sub>10</sub>			
	Carcinogenic risk		Non-Carcinogenic risk		Carcinogenic risk		Non-Carcinogenic risk	
	Children	Adults	Children	Adults	Children	Adults	Children	Adults
V			3.26E-01	5.91E-02			3.67E-01	6.65E-02
Cu			2.69E-03	4.88E-04			3.95E-03	7.16E-04
As	2.25E-05	1.63E-05	6.16E-01	1.12E-01	2.49E-05	1.81E-05	6.84E-01	1.24E-01
Mn			2.60E-01	4.71E-02			2.89E-01	5.24E-02
Zn			1.88E-03	3.40E-04			2.22E-03	4.03E-04
Pb	1.59E-07	1.15E-07	6.60E-02	1.20E-02	1.85E-07	1.34E-07	7.68E-02	1.39E-02
Ni	5.64E-05	4.09E-05	3.72E-02	6.74E-03	6.82E-05	4.94E-05	4.50E-02	8.14E-03
Sb			1.40E+00	2.54E-01			1.69E+00	3.05E-01
HI			2.71E+00	4.91E-01			3.15E+00	5.71E-01

## (e) XM

Toxic elements	PM <sub>2.5</sub>				PM <sub>10</sub>			
	Carcinogenic risk		Non-Carcinogenic risk		Carcinogenic risk		Non-Carcinogenic risk	
	Children	Adults	Children	Adults	Children	Adults	Children	Adults
V			2.70E-01	4.89E-02			2.50E-01	4.52E-02
Cu			2.28E-03	4.12E-04			1.90E-03	3.44E-04
As	1.82E-05	1.32E-05	4.97E-01	9.01E-02	1.50E-05	1.09E-05	4.12E-01	7.47E-02
Mn			2.30E-01	4.17E-02			2.10E-01	3.80E-02
Zn			1.72E-03	3.12E-04			1.31E-03	2.36E-04
Pb	2.09E-07	1.52E-07	8.67E-02	1.57E-02	1.53E-07	1.11E-07	6.32E-02	1.15E-02
Ni	7.52E-05	5.45E-05	4.96E-02	8.98E-03	6.41E-05	4.64E-05	4.22E-02	7.65E-03
Sb			1.39E+00	2.52E-01			1.50E+00	2.72E-01
HI			2.53E+00	4.58E-01			2.48E+00	4.50E-01