Supplementary Information for

Differing Toxicity of Ambient Particulate Matter (PM)

 in Global Cities

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**This PDF file includes:**

Tables S1 to S5

Figures S1 to S3

Captions for Excel files S1 to S2

**Other Supplementary Materials for this manuscript include the following:**

Excel files S1 to S2

**Supplementary Tables**

**Table S1** Meteorological information in 19 sampling cities acquired from ClimaTemps (<http://www.climatemps.com/>)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| City | Daily min. temp. (°C) | Daily max. temp. (°C) | Relative humidity (%) | Annual Precipitation (mm) |
| Seoul-KR | 8.21 | 16.88 | 68.5 | 1344 |
| Beijing-CN | 6.49 | 17.67 | 55 | 548 |
| Shanghai-CN | 12.45 | 19.85 | 68 | 1112 |
| Guangzhou-CN | 18.66 | 26.23 | 81 | 1683 |
| Hong Kong-CN | 21.37 | 25.6 | 78 | 2398 |
| Brisbane-AU | 16 | 25 | 66.8 | 1225 |
| Florianopolis-BR | 17.45 | 24.15 | 80 | 1544 |
| Haikou-CN | 21.03 | 27.83 | 82 | 1625 |
| Chennai-IN | 24.18 | 32.88 | 69.8 | 1312 |
| Stolberg-DE | 5.58 | 13.22 | 65.5 | 663 |
| Paris-FR | 8.54 | 15.52 | 78.1 | 650 |
| Zurich-CH | 4.93 | 12.65 | 78.6 | 1086 |
| Melbourne-AU | 11 | 20 | 55.8 | 639 |
| Tours-FR | 6.9 | 15.4 | 79.6 | 684 |
| Warsaw-PL | 4 | 12 | 78.3 | 515 |
| Johannesburg-ZA | 10.08 | 21.9 | 59.2 | 713 |
| Singapore-SGP | 23.92 | 30.86 | 80.4 | 2150 |
| Bandung-ID | 18.6 | 27.8 | 80.6 | 1838 |
| San Francisco-US | 9 | 19 | 68.3 | 500 |

**Table S2** Spearman’s correlations of endotoxin fractions in PM with bacteria/fungal levels and the mass concentrations of PM2.5 and PM10 across world cities.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Spearman’s correlation | Total bacteria (cells/mg) | Culturable bacteria (CFU/mg) | Culturable fungi (CFU/mg) | PM2.5 mass conc. (μg/m3) | PM10 mass conc. (μg/m3) |
| Endotoxin (EU/mg) | Coef. | **0.489\*** | 0.172 | 0.163 | **0.560\*** | **0.459\*** |
| Sig. | 0.033 | 0.475 | 0.498 | 0.013 | 0.047 |

\**p-*value < 0.05.

**Table S3** Spearman’s correlations of NIOG values with biological fractions and the mass concentrations of PM2.5 and PM10 across world cities.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Spearman’s correlation | Endotoxin (EU/mg) | Total bacteria (cells/mg) | Culturable bacteria (CFU/mg) | Culturable fungi (CFU/mg) | PM2.5 mass conc. (μg/m3) | PM10 mass conc. (μg/m3) |
| NIOG | Coef. | 0.009 | -0.112 | -0.258 | **-0.481\*** | 0.296 | 0.202 |
| Sig. | 0.968 | 0.641 | 0.281 | 0.037 | 0.213 | 0.401 |

\**p-*value < 0.05.

**Table S4** Friedman Tests of Xi’an PM2.5-contained trace elements in PM2.5 samples among 2004, 2009 and 2014 during summer and winter, respectively.

|  |  |
| --- | --- |
|  | **Friedman Tests Sig.** |
| **Summer (2004, 2009, 2014)** | **Winter(2004, 2009, 2014)** |
| P | 0.074  | 0.311  |
| Ca | 0.247  | 0.311  |
| Ti | 0.247  | 0.311  |
| V | 0.247  | 0.223  |
| Cr | 0.549  | 0.846  |
| Co | 0.819  | 0.607  |
| Ni | 0.165  | 0.846  |
| Cu | 0.549  | 0.311  |
| Zn | 0.449  | 0.223  |
| As | 0.247  | 0.311  |
| Se | 0.282  | **0.011\***  |
| Mo | 0.247  | 0.069  |
| Cd | **0.007\***  | 0.069  |
| Tl | 0.074  | 0.135  |
| Pb | **0.007\***  | 0.115  |
| Th | 0.327  | 0.834  |
| U | **0.015\***  | 0.311  |
| Na | **0.022\***  | 0.513  |
| Mg | 0.165  | 0.115  |
| Al | 0.232  | 0.070  |
| K | 0.091  | 0.846  |
| Mn | 1.000  | 0.846  |
| Fe | 0.449  | 0.311  |
| Ba | 0.247  | 0.115  |

\**p-*value < 0.05.

**Table S5** Spearman’s correlations of Xi’an PM2.5 NIOG values with PM2.5-borne bacteria (PM2.5 sample size: 72) and different PM2.5-borne trace elements in summer and winter (PM2.5 sample size: 36)

|  |  |
| --- | --- |
|  | **Spearman’s correlations** |
| **Coef.** | **Sig.** |
| Total bacteria | **0.250\*** | 0,038 |
| P | **0.346\*** | 0.045  |
| Ca | 0.329 | 0.057  |
| Ti | 0.318 | 0.066  |
| V | -0.045 | 0.798  |
| Cr | **0.373\*** | 0.030  |
| Co | 0.021 | 0.907  |
| Ni | 0.018 | 0.919  |
| Cu | 0.125 | 0.477  |
| Zn | 0.242 | 0.166  |
| As | -0.035 | 0.841  |
| Se | -0.293 | 0.092  |
| Mo | 0.365 | 0.034  |
| Cd | 0.119 | 0.499  |
| Tl | 0.016 | 0.927  |
| Pb | 0.106 | 0.546  |
| Th | -0.077 | 0.663  |
| U | 0.113 | 0.520  |
| Na | **0.459\*** | 0.007  |
| Mg | 0.319 | 0.065  |
| Al | -0.337 | 0.051  |
| K | 0.062 | 0.725  |
| Mn | 0.183 | 0.298  |
| Fe | 0.215 | 0.220  |
| Ba | 0.225 | 0.200  |

\**p-*value < 0.05.

**Supplementary Figures**

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**Fig. S1** Thecorrelation of the average ratio of culturable bacteria to fungi (B/F ratio) in ambient PM samples from 19 cities with annual average relative humidity (RH) and annual precipitation of these 19 cities.

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**Fig. S2** 24-hour average PM2.5 mass concentrations in 2004, 2009 and 2014; solid line: population density of Xi’an city in 2004, 2009 and 2014 according to Xi’an Statistical Yearbook (2005, 2010 and 2015)3; shadow zone: the yearly heating seasons (from November 15 to March 15) in Xi’an.

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**Fig. S3** Concentrations of PM2.5-borne total bacteria in 2004, 2009 and 2014; shadow zone: the yearly heating seasons (from November 15 to March 15) in Xi’an.

**Captions for Excel files S1 to S2**

**Excel file S1**

The information of total PM2.5 samples collected in Xi’an, China.

**Excel file S2**

The statistical data for energy consumption and the permanent population in Xi’an, China from 2004 to 2014.