**eAppendix 1. Explanation of the air pollution data in the Seven Northeastern Cities Study**

The operation of the monitoring stations follows the quality assurance/quality control (QA/QC) procedure set by the State Environmental Protection Administration of China (SEPA, 2012). The environmental monitoring centers in each of the seven cities conduct regularly scheduled performance audits and precision checks on the air-monitoring equipment. Quarterly performance audits are conducted to assess data accuracy on PM10, SO2, NO2, and O3 monitoring systems.

1) The calculation method

The calculation method is done according to Chinese National standards (GB8170-87). The unit of monitored pollutants is mg/m3 accurate to the third decimal (0.000). The units can also be expressed as μg/m3, depending on the pollutant's concentration. For concentrations too low to be measured, half of the lowest checking limit of the equipment will be used as the measured value.

2) Outliers

When the measured concentration is too low (e.g. background value), a negative value can be obtained because of the zero drift of the monitor. There is no physical meaning to this value. This negative value can be regarded as a value of "unable to measure."

For the monitoring stations with an automatic calibration system, if equipment zero drift/span drift exceeds the control range during the period of zero/span calibration, the data from the time its measurements are out of control until the equipment is recovered should be regarded as invalid data. The data cannot be used statistically.

The data during the period of zero calibration/span calibration should be regarded as invalid data. It cannot be used statistically, but a flag should be made on these data and the records stored as evidence.

When values are missing because of a loss of power, any data received by the central control station during the period of the loss of power should be regarded as invalid data. The period of loss of power should be counted at the start of power outage until complete warm-up of equipment. The data cannot be used statistically.

Because pollutant concentrations change over time and change slowly, there should be no rapid change in pollutant concentration in the results of normal monitoring. Either a rapid change or no change indicates that there is an equipment problem. The problem should be identified, and the data between the start of problem to recovery should be regarded as outliers. These data cannot be used statistically.

3) Statistics of monitoring data

One-time value

The central control station uses an average of 15 minutes of pollutant concentrations measured at the branch station as a one-time value. The central control modifies this value and judge whether this value is an outlier using the report software.

One-hour average mean value

At least 75% of the one-time values should be used to calculate the one-hour average mean value. One-hour average mean value is calculated by averaging all the valid one-time values within one hour.

Daily average mean

For PM10 at least 12 valid hourly mean values are needed to calculate the daily mean value (using the calendar as the valid time frame), using all available valid hourly mean values. For SO2 and NO2 at least 18 hourly mean values everyday are needed to calculate valid daily mean value (using the calendar as the valid time frame). For O3, at least six hourly concentrations of O3 per day are needed for calculating the 8-hour average concentration of O3. All of the valid hourly mean values are used to calculate the daily mean. (National Environmental Air Quality Standard GB3095-2012)

Monthly mean values are the arithmetic means of all valid daily mean values within the month. Seasonal mean values are the arithmetic means of all valid daily mean values within the given season. Yearly mean values are the arithmetic means of all valid daily mean values within the year. District daily mean values are calculated using the monthly mean value, the seasonal mean value, and the yearly mean value from the available stations in the district.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| eTable 1 Correlation coefficients of ambient air pollutants across 24 districts | | | | |
|  | PM10a | SO2a | NO2a | O3a |
| PM10 | 1.00 | 0.58b | 0.47b | 0.85b |
| SO2 |  | 1.00 | 0.21 | 0.60b |
| NO2 |  |  | 1.00 | 0.33 |
| O3 |  |  |  | 1.00 |

aPM10, particle with aerodynamic diameter 10μm or less; SO2, sulfur dioxide; NO2, nitrogen dioxide; O3, Ozone.

b*p*<0.05

eTable 2. Adjusted OR and 95% CI for the Effect of Exposure to Air Pollution on Hypertension and Estimated Absolute Increase in Arterial BP (mmHg) Modified by Obesity among Children Stratified by School Agea

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Elementary school children |  | Middle school children | Interaction |
|  | OR/Estimateb (95% CI) |  | OR/Estimateb (95% CI) | *p*-value |
| Hypertension | | | | |
| PM10 | 1.65 (1.44-1.90) |  | 1.55 (1.35-1.79) | 0.539 |
| SO2 | 1.25 (1.09-1.42) |  | 1.08 (0.93-1.25) | 0.149 |
| NO2 | 1.43 (1.27-1.62) |  | 1.09 (0.97-1.23) | 0.001 |
| O3 | 1.12 (1.09-1.15) |  | 1.08 (1.05-1.10) | 0.031 |
| Systolic Blood Pressure | | | | |
| PM10 | 1.60 (1.11-2.09) |  | 2.00 (1.28-2.73) | 0.101 |
| SO2 | 1.14 (0.68-1.60) |  | 0.62 (-0.15-1.38) | 0.001 |
| NO2 | 0.70 (0.28-1.12) |  | 0.36 (-0.27-0.98) | 0.043 |
| O3 | 0.21 (0.09-0.32) |  | 0.41 (0.26-0.55) | 0.793 |
| Diastolic Blood Pressure | | | | |
| PM10 | 1.45 (1.02-1.87) |  | 1.23 (0.74-1.71) | 0.001 |
| SO2 | 0.65 (0.24-1.05) |  | 0.16 (-0.34-0.67) | 0.001 |
| NO2 | 0.73 (0.36-1.09) |  | 0.53 (0.12-0.94) | 0.014 |
| O3 | 0.36 (0.27-0.46) |  | 0.43 (0.34-0.52) | 0.809 |

aAdjusted for age, sex, BMI, parental education, low birth weight, premature birth, breastfeeding, income, passive smoking exposure, home coal use, exercise time, area residence per person, family history of hypertension, distance from the monitor to school, distance from the children’s home to school, temperature, and district.

bOR and Estimate were scaled to the interquartile Range width (IQRw) for each pollutant (30.6 μg/m3 for PM10, 23.4 μg/m3 for SO2, 13.0 μg/m3 for NO2, 46.3 μg/m3 for O3)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| eTable 3. Estimated absolute increase in arterial BP (mmHg) and 95% CI per interquartile range of long-term exposure to air pollutants modified by BMI among children stratified by school agea | | | | | | | |
|
| Pollutant (ug/m3) | Elementary school aged children (N=5762) | | Interaction *p* value |  | Middle school aged children (N=3592) | | Interaction *p* value |
| Normal weight | Overweight or obese |  | Normal weight | Overweight or obese |
| OR/Estimate  (95% CI)b | OR/Estimate  (95% CI)b |  | OR/Estimate  (95% CI)b | OR/Estimate  (95% CI)b |
| Hypertension | | | | | | | |
| PM10 | 1.16 (0.97-1.38) | 3.09 (2.41-3.96) | <0.001 |  | 1.27 (1.06-1.53) | 2.18 (1.73-2.75) | <0.001 |
| SO2 | 0.92 (0.78-1.08) | 2.16 (1.72-2.72) | <0.001 |  | 0.74 (0.60-0.90) | 2.04 (1.59-2.63) | <0.001 |
| NO2 | 1.31 (1.12-1.53) | 1.71 (1.39-2.10) | 0.036 |  | 1.14 (0.96-1.34) | 1.08 (0.90-1.30) | 0.675 |
| O3 | 1.14 (1.10-1.18) | 1.20 (1.15-1.25) | 0.015 |  | 1.06 (1.02-1.10) | 1.15 (1.10-1.19) | 0.002 |
| Systolic Blood Pressure | | | | | | | |
| PM10 | 1.13 (0.59-1.67) | 2.53 (1.63-3.43) | <0.001 |  | 1.16 (0.40-1.91) | 2.12 (0.77-3.48) | 0.002 |
| SO2 | -0.05 (-0.56-0.45) | 3.44 (2.58-4.30) | <0.001 |  | -1.01 (-2.01-0.02) | 2.50 (1.09-3.91) | <0.001 |
| NO2 | 0.27 (-0.19-0.72) | 1.48 (0.69-2.26) | <0.001 |  | 0.50 (-0.15-1.15) | -0.16 (-1.32-1.00) | 0.646 |
| O3 | 0.21 (0.09-0.33) | 0.48 (0.26-0.70) | 0.001 |  | 0.31 (0.16-0.45) | 0.54 (0.28-0.81) | 0.002 |
| Diastolic Blood Pressure | | | | | | | |
| PM10 | 1.11 (0.61-1.60) | 2.14 (1.34-2.94) | 0.001 |  | 0.94 (0.40-1.49) | 1.39 (0.45-2.34) | 0.006 |
| SO2 | -0.03 (-0.49-0.43) | 2.00 (1.23-2.77) | <0.001 |  | -0.64 (-1.23-0.02) | 1.51 (0.52-2.50) | <0.001 |
| NO2 | 0.40 (-0.02-0.82) | 1.39 (0.69-2.09) | 0.014 |  | 0.56 (0.09-1.02) | 0.39 (-0.42-1.20) | 0.534 |
| O3 | 0.35 (0.23-0.46) | 0.51 (0.32-0.71) | 0.083 |  | 0.32 (0.22-0.43) | 0.67 (0.48-0.85) | <0.001 |

aAdjusted for age, sex, parental education, low birth weight, premature birth, breastfeeding, income, passive smoking exposure, home coal use, exercise time, area residence per person, family history of hypertension, distance from the monitor to school, distance from the children’s home to school, temperature, and district.

bEstimate was scaled to the interquartile range width (IQRw) for each pollutant (30.6 μg/m3 for PM10, 23.4 μg/m3 for SO2, 13.0 μg/m3 for NO2, 46.3 μg/m3 for O3).

eTable 4. Adjusted OR and 95% CI for the Effect of Short-term Air Pollution Exposure (5-day mean) on Hypertension and Estimated Absolute Increase in Arterial BP (mmHg) among Childrena

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Pollutants, (μg/m3) | Hypertension |  | Systolic BP |  | Diastolic BP |
| OR(95% CI)b |  | Estimate(95% CI)b | Estimate(95% CI)b |
| PM10 | 1.15 (1.12-1.17) |  | 0.24 (0.15-0.33) |  | 0.32 (0.25-0.39) |
| SO2 | 1.05 (1.02-1.09) |  | 0.38 (0.23-0.52) |  | -0.04 (-0.15-0.08) |
| NO2 | 1.09 (1.04-1.14) |  | 0.12 (-0.07-0.32) |  | 0.02 (-0.14-0.18) |
| O3 | 1.19 (1.16-1.22) |  | 0.47 (0.37-0.57) |  | 0.45 (0.37-0.53) |

aAdjusted for age, sex, BMI, parental education, low birth weight, premature birth, breastfeeding, income, passive smoking exposure, exercise time, area residence per person, family history of hypertension, distance from the monitor to school, distance from the children’s home to school, temperature, and district.

bOR and Estimate were scaled to an increase of 10μg/m3 for each pollutant.

eTable 5. Adjusted OR and 95% CI for the Effect of Short-term Air Pollution Exposure (5-day mean) on Hypertension and Estimated Absolute Increase in Arterial BP (mmHg) Stratified by BMI among Childrena

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Pollutants, (μg/m3) | Normal Weight |  | Overweight |  | Obesity | Interaction  *p*-value |
| OR/Estimate  (95% CI)b | OR/Estimate  (95% CI)b | OR/Estimate  (95% CI)b |
| Hypertension |  |  |  |  |  |  |
| PM10 | 1.11(1.08-1.14) |  | 1.18(1.13-1.24) |  | 1.24(1.19-1.29) | <0.001 |
| SO2 | 1.01(0.97-1.06) |  | 1.08(1.01-1.16) |  | 1.15(1.08-1.23) | 0.002 |
| NO2 | 1.05(0.99-1.12) |  | 1.12(1.02-1.24) |  | 1.13(1.03-1.23) | 0.326 |
| O3 | 1.13(1.10-1.17) |  | 1.21(1.15-1.28) |  | 1.32(1.26-1.39) | <0.001 |
| Systolic BP |  |  |  |  |  |  |
| PM10 | 0.18(0.08-0.28) |  | 0.53(0.33-0.72) |  | 0.42(0.20-0.65) | <0.001 |
| SO2 | 0.13(-0.03-0.29) |  | 0.44(0.11-0.76) |  | 0.60(0.24-0.96) | <0.001 |
| NO2 | 0.04(-0.18-0.26) |  | 0.21(-0.22-0.64) |  | 0.17(-0.31-0.65) | 0.009 |
| O3 | 0.39(0.28-0.50) |  | 0.58(0.35-0.81) |  | 0.77(0.51-1.03) | <0.001 |
| Diastolic BP |  |  |  |  |  |  |
| PM10 | 0.26(0.18-0.34) |  | 0.50(0.32-0.68) |  | 0.46(0.28-0.65) | <0.001 |
| SO2 | -0.12(-0.25-0.03) |  | 0.04(-0.25-0.34) |  | -0.04(-0.34-0.26) | 0.124 |
| NO2 | -0.11(-0.29-0.08) |  | 0.38(-0.01-0.77) |  | 0.10(-0.30-0.50) | 0.042 |
| O3 | 0.39(0.30-0.49) |  | 0.53(0.32-0.74) |  | 0.63(0.41-0.85) | 0.003 |

aAdjusted for age, sex, parental education, low birth weight, premature birth, breastfeeding, income, passive smoking exposure, home coal use, exercise time, area residence per person, family history of hypertension, distance from the monitor to school, distance from the children’s home to school, temperature, and district.

bOR and Estimate were scaled to an increase of 10μg/m3 for each pollutant.

eTable 6. Adjusted OR and 95% CI for the Effect of Home Coal Use on Hypertension and Estimated Absolute Increase in Arterial BP (mmHg) among Childrena

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Home Coal Use | Univariate Analysis | |  | Multivariate Analyses\* | |
| OR/Estimate (95% CI) | *p* value | OR/Estimate (95% CI) | *p* value |
| Male |  |  |  |  |  |
| Hypertension | 1.40 (1.08-1.80) | 0.010 |  | 1.31 (1.00-1.73) | 0.050 |
| Systolic BP | 0.87 (-0.57-2.30) | 0.236 |  | 1.11 (-0.38-2.60) | 0.143 |
| Diastolic BP | 0.31 (-0.65-1.27) | 0.530 |  | 0.22 (-0.78-1.21) | 0.672 |
| Female |  |  |  |  |  |
| Hypertension | 1.24 (0.94-1.63) | 0.123 |  | 1.22 (0.91-1.63) | 0.194 |
| Systolic BP | 1.57 (0.29-2.86) | 0.017 |  | 1.49 (0.16-2.82) | 0.028 |
| Diastolic BP | 0.21 (-0.75-1.17) | 0.674 |  | 0.04 (-0.95-1.03) | 0.939 |
| Overall |  |  |  |  |  |
| Hypertension | 1.32 (1.10-1.59) | 0.003 |  | 1.27 (1.04-1.55) | 0.021 |
| Systolic BP | 1.24 (0.27-2.21) | 0.012 |  | 1.32 (0.31-2.32) | 0.011 |
| Diastolic BP | 0.25 (-0.43-0.93) | 0.478 |  | 0.11 (-0.60-0.81) | 0.766 |

aAdjusted for age, sex, BMI, parental education, low birth weight, premature birth, breastfeeding, income, passive smoking exposure, exercise time, area residence per person, family history of hypertension, distance from the monitor to school, distance from the children’s home to school, temperature, and district.

eTable 7. Adjusted OR and 95% CI for the Effect of Home Coal Use on Hypertension and Estimated Absolute Increase in Arterial BP (mmHg) among Children Stratified by BMIa

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Home Coal Use | Normal Weight |  | Overweight/Obese | Interaction  *p* value |
| OR/Estimate(95% CI) |  | OR/Estimate (95% CI) |
| Male |  |  |  |  |
| Hypertension | 0.96 (0.66-1.40) |  | 1.71 (1.15-2.53) | 0.034 |
| Systolic BP | 0.39 (-1.02-1.79) |  | 0.55 (-1.61-2.69) | 0.488 |
| Diastolic BP | 0.20 (-0.99-1.38) |  | 0.25 (-1.48-1.98) | 0.721 |
| Female |  |  |  |  |
| Hypertension | 0.91 (0.63-1.33) |  | 1.89 (1.18-3.03) | 0.015 |
| Systolic BP | 0.67 (-0.57-1.91) |  | 2.08 (-0.52-4.69) | 0.268 |
| Diastolic BP | -0.42 (-1.47-0.64) |  | 1.22 (-1.05-3.50) | 0.287 |
| Overall |  |  |  |  |
| Hypertension | 0.93 (0.71-1.21) |  | 1.79 (1.33-2.42) | 0.001 |
| Systolic BP | 0.54 (-0.39-1.47) |  | 1.17 (-0.50-2.85) | 0.224 |
| Diastolic BP | -0.16 (-0.96-0.63) |  | 0.60 (-0.79-1.98) | 0.275 |

aAdjusted for age, sex, BMI, parental education, low birth weight, premature birth, breastfeeding, income, passive smoking exposure, exercise time, area residence per person, family history of hypertension, distance from the monitor to school, distance from the children’s home to school, temperature, and district.