

## FY2016 Annual Report of Environmental Health Surveillance for Air Pollution (Overview)

### 1. Method

Health survey and exposure assessment were conducted to analyze and evaluate the correlation between air pollutant concentrations and prevalence respiratory symptoms such as asthma in the 3-year-old and 6-year-old survey.

In the follow-up analysis, the correlation between the air pollutant concentrations and incidence of asthma was analyzed and assessed: among the 6-year-old survey in FY2016 in 36 survey areas where follow-up was possible, those who had responded to the prior 3-year-old survey in FY2012 or FY2013 were analyzed; children who did not have asthma at the time of the 3-year-old survey but had asthma at the time of the 6-year-old survey were considered to have developed asthma.

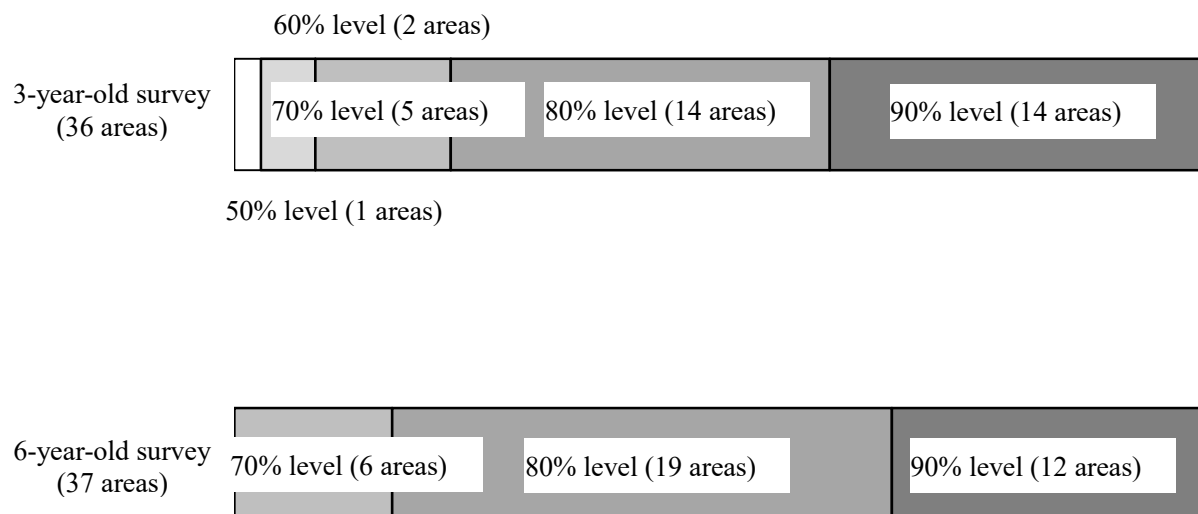
|                     | 3-year-old survey   | 6-year-old survey   |
|---------------------|---|---|
| Health survey       | ATS-DLD simplified questionnaires (MOE version) were sent to all households with 3-year-old children in the survey areas to be filled out by their parents and then collected; delegated to 36 local municipalities.  | ATS-DLD simplified questionnaires (MOE version) were sent to all households with first-grade children going to public primary schools in each school district of the 3-year old survey area to be filled out by their parents and then collected; delegated to 37 local municipalities. |
| Exposure assessment | Air pollutant background concentrations were estimated at the residence of each children, using three-year average of the annual average concentrations of NO <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub> and SPM, at ambient air pollution monitoring stations in and around the study areas between FY2013 and FY2015. |   |

## 2. Results

### (1) Number of children surveyed and response rate

The 3-year-old survey targeted 83,279 children, and their responses were obtained from 70,953 children, with a response rate of 85.20%. The 6-year-old survey targeted 82,236 children, and their responses were obtained from 71,365 children, with a response rate of 86.78%.

Response rate and number of areas



In the survey areas where follow-up was possible, 70,394 children with 6-year-old responded to the survey. Among them, 48,465 children were followed up (68.85%).

## (2) Results of single-year analysis of the 3-year-old and 6-year-old surveys

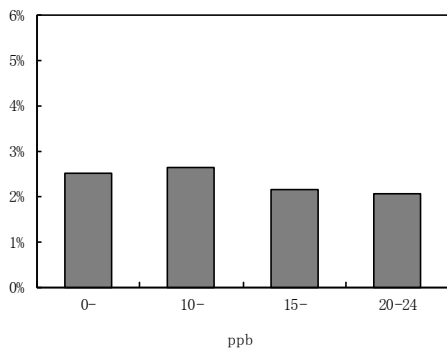
### 1) Prevalence of respiratory symptoms according to background concentration level

Prevalence of respiratory symptoms was analyzed according to background concentration level of air pollutants for all children. There is no tendency observed with the increase of asthma prevalence associated with the increase of air pollutant concentrations both in the 3-year-old or 6-year-old survey.

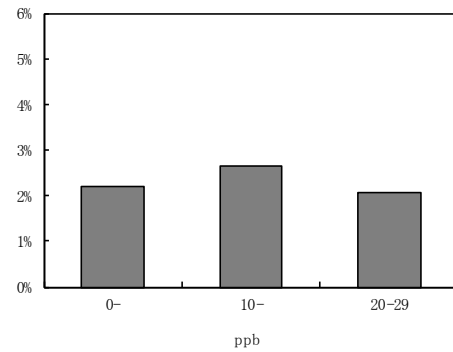
Regarding SO<sub>2</sub>, the background concentration range was considered insufficient for this analysis.

#### 3-year-old survey

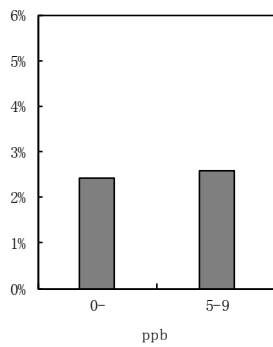
Asthma prevalence by NO<sub>2</sub> concentration



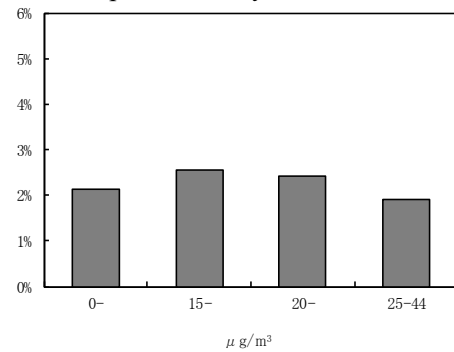
Asthma prevalence by NO<sub>x</sub> concentration



Asthma prevalence by SO<sub>2</sub> concentration

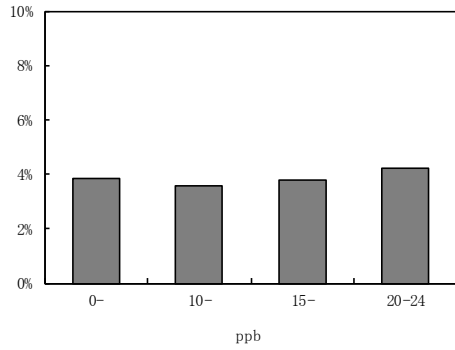


Asthma prevalence by SPM concentration

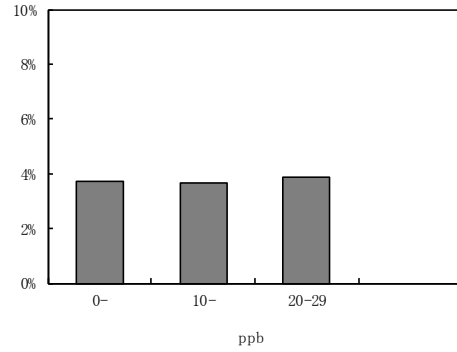


## 6-year-old survey

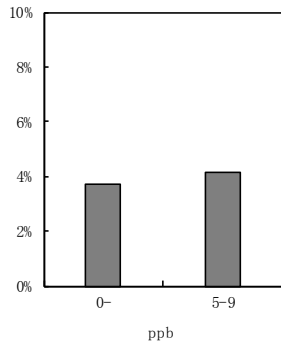
Asthma prevalence by NO<sub>2</sub> concentration



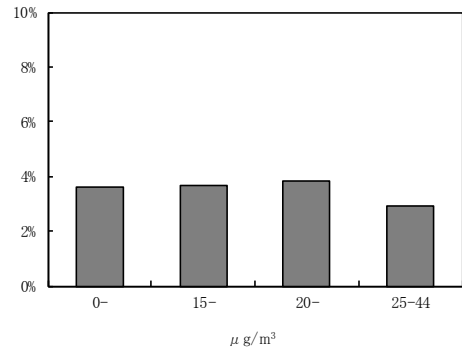
Asthma prevalence by NO<sub>x</sub> concentration



Asthma prevalence by SO<sub>2</sub> concentration



Asthma prevalence by SPM concentration

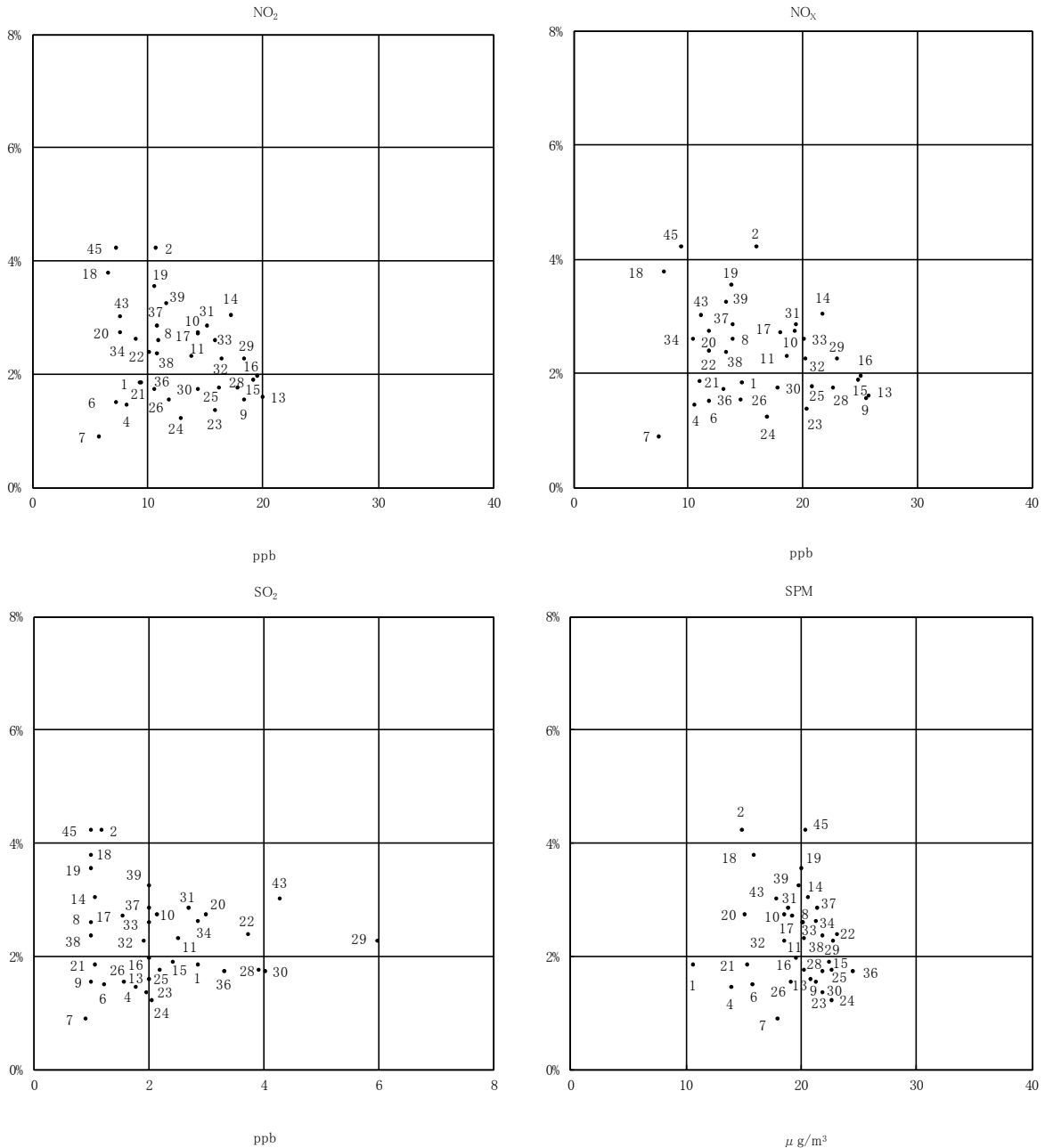


**2) Average background concentration and prevalence of respiratory symptoms in each survey area**

The correlation between the average background concentration and prevalence of respiratory symptoms was analyzed in each survey area. There is no tendency observed with the increase of asthma prevalence associated with the increase of air pollutant concentrations both in the 3-year-old or 6-year-old survey.

**3-year-old survey**

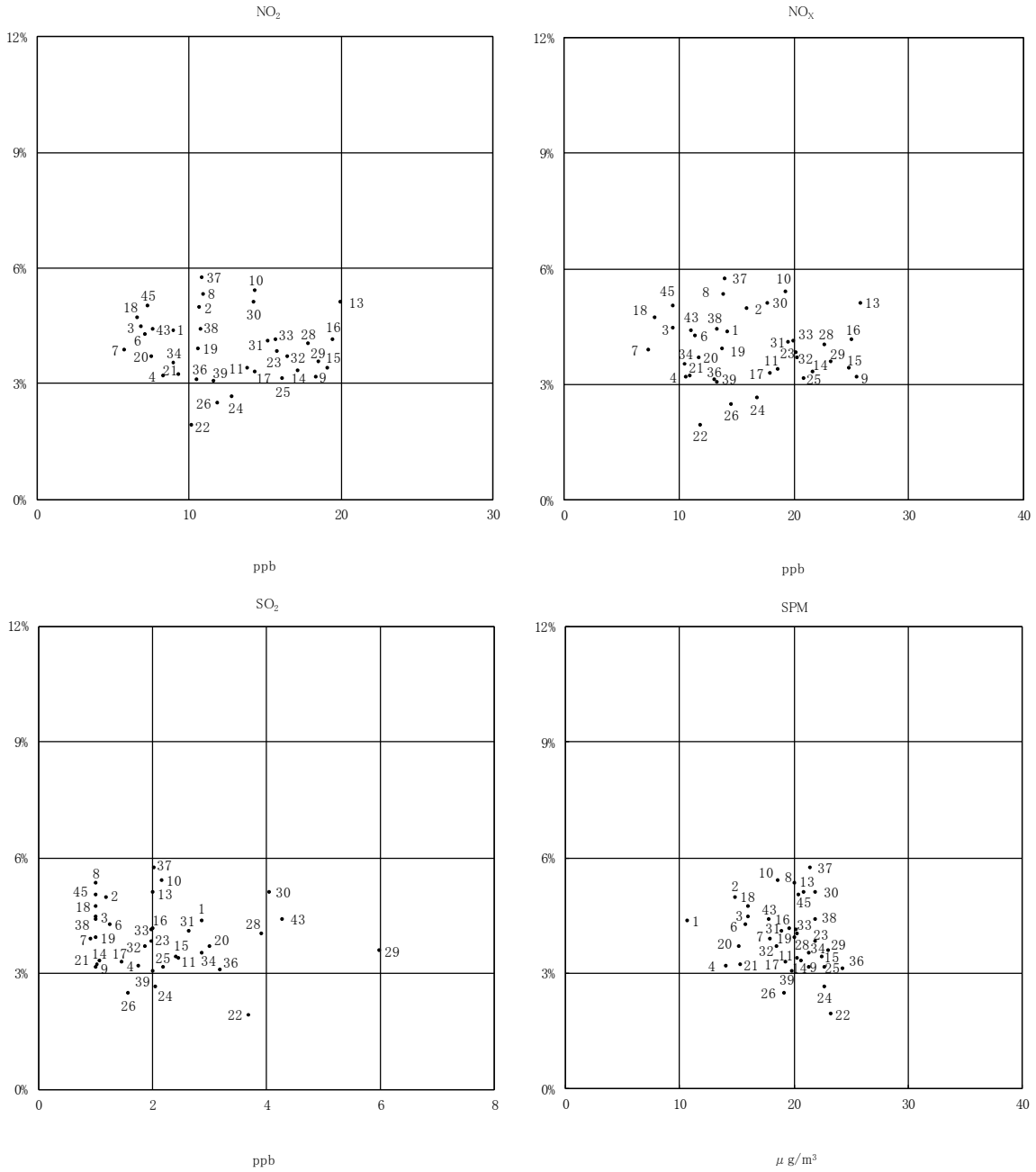
Correlation between air pollutant concentrations and asthma prevalence (adjusted rate) – All children (boys + girls)



\*1 Numbers in the graph indicate their survey areas. See <Reference> FY2016 survey areas (on page 13).  
 \*2 The adjusted rate means prevalence of asthma adjusted for the composition ratio of the types of allergy history in all children.

### 6-year-old survey

Correlation between air pollutant concentrations and asthma prevalence (adjusted rate) –  
All children (boys + girls)



\*1 Numbers in the graph indicate their survey areas. See <Reference> FY2016 survey areas (on page 13).

\*2 The adjusted rate means prevalence of asthma adjusted for the composition ratio of the types of allergy history in all children.

### 3) Evaluation according to the odds ratio

Contributing factor of asthma prevalence was investigated. Its positive correlation was obtained with sex (male), family smoking (mother), pets (present), daytime caretaker (nursery center), feeding during the first 3 months after birth (milk only), and allergy history of the children and their parents (present) in the 3-year-old survey; and with sex (male), family smoking (mother), pets (present), and allergy history of the children and their parents (present) in the 6-year-old survey. No significantly positive correlation was found with air pollutant concentrations.

Results of Odds Ratios related to Asthma Prevalence

|   |                                   | 3-year-old survey |   | 6-year-old survey |           |
|---|-----------------------------------|-------------------|---|-------------------|-----------|
| NO <sub>2</sub>                               | Per 10 ppb increase               | 0.82              | * | 0.95              |           |
| NO <sub>x</sub>                               | Per 10 ppb increase               | 0.86              | * | 0.99              |           |
| SO <sub>2</sub>                               | Per 10 ppb increase               | 0.79              |   | 0.83              |           |
| SPM   | Per 10 µg/m <sup>3</sup> increase | 0.90              |   | 0.91              |           |
| Sex   | Male                              | 1.58~1.59         | * | 1.51              | *         |
|   | Female                            | 1.00              |   | 1.00              |           |
| Family smoking                                | Mother                            | 1.55~1.56         | * | 1.62              | *         |
|   | Except mother                     | 0.96              |   | 1.02~1.03         |           |
|   | No smoker                         | 1.00              |   | 1.00              |           |
| Housing structure                             | Wooden house, wooden frame        | 0.96~0.97         |   | 1.01~1.02         |           |
|   | Wooden house, metal frame         | 0.83~0.85         | * | 0.90~0.91         | *         |
|   | Reinforcing steel, steel frame    | 1.00              |   | 1.00              |           |
| Heating method                                | No exhaust system                 | 0.91~0.93         |   | 1.03              |           |
|   | Exhaust system                    | 1.00              |   | 1.00              |           |
| Dwelling period                               | Since birth                       | 0.93~0.94         |   | Since birth       | 0.94      |
|   | More than 1 year                  | 0.93~0.94         |   | More than 3 years | 0.95~0.96 |
|   | Less than 1 year                  | 1.00              |   | Less than 3 years | 1.00      |
| Pets  | Present                           | 1.30              | * | 1.11              | *         |
|   | No                                | 1.00              |   | 1.00              |           |
| Daytime caretaker                             | Nursery center                    | 1.38~1.40         | * |                   |           |
|   | Others                            | 1.00              |   |                   |           |
| Feeding during the first 3 months after birth | Milk only                         | 1.21~1.22         | * | 0.99              |           |
|   | Breast feeding and milk           | 1.02~1.03         |   | 0.90              | *         |
|   | Breast feeding only               | 1.00              |   | 1.00              |           |
| History of allergies (children)               | Yes                               | 2.03              | * | 2.15              | *         |
|   | No                                | 1.00              |   | 1.00              |           |
| History of allergies (parents)                | Yes                               | 2.53~2.56         | * | 2.35~2.36         | *         |
|   | No                                | 1.00              |   | 1.00              |           |

\* All odds ratios estimated for each air pollutant (NO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, and SPM) are statistically significant (P<0.05).

(Note 1) The numerical ranges in the above chart indicate the range between the minimum and maximum odds ratios estimated for each air pollutants (NO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, and SPM).

(Note 2) To examine the correlation between asthma prevalence and major factors (from “sex” to “history of allergies (parents)” above) in detail, odds ratios were estimated by multiple logistic regression analysis using these major factors and air pollutant concentrations as explanatory variables.

### **(3) Results of longitudinal and comprehensive data analysis in the 3-year-old survey\***

In the longitudinal analysis of data from FY1997 to FY2016, some areas show increase or decrease in asthma prevalence. Both the air pollutant concentrations and asthma prevalence reveal downward trend in all survey areas.

In the comprehensive analysis of integrated data from FY1997 to FY2016, with regard to prevalence of respiratory symptoms according to background concentration level and with regard to the average background concentration and prevalence of respiratory symptoms according to each survey area, there is no tendency observed with the increase of asthma prevalence associated with the increase of air pollutant concentrations. Even in those areas with low air pollutant concentrations, some areas show similar or even higher asthma prevalence as in these areas of high air pollutant concentrations. On examination of odds ratios no significant positive correlation was obtained.

\* Asthma prevalence in FY1996, the first year of the survey, was regarded only as a reference in the longitudinal and comprehensive analyses because the value was undoubtedly lower than those in other years.

### **(4) Results of longitudinal and comprehensive data analysis in the 6-year-old survey**

In the longitudinal analysis of data from FY2004 to FY2016, some areas show increase or decrease in asthma prevalence. Both the air pollutant concentrations and asthma prevalence reveal downward trend in all survey areas.

In the comprehensive analysis of integrated data from FY2004 to FY2016, with regard to prevalence of respiratory symptoms according to background concentration level and with regard to average background concentration and prevalence of respiratory symptoms according to each survey area, there is no tendency observed with the increase of asthma prevalence associated with the increase of air pollutant concentrations. Even in those areas with low air pollutant concentrations, some areas show similar or even higher asthma prevalence as in these areas of high air pollutant concentrations. On examination of odds ratios, no significant positive correlation was obtained.



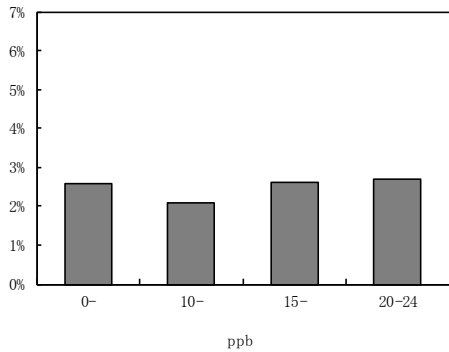
## (5) Results of the follow-up analysis

### 1) Asthma incidence according to background concentration level

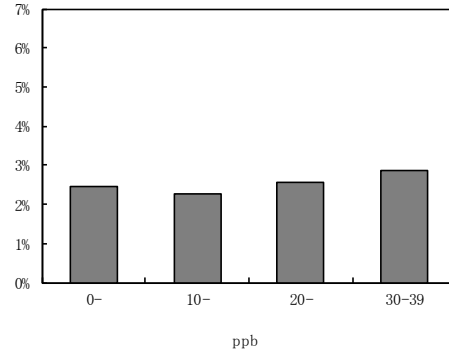
Asthma incidence was analyzed according to background air pollutant concentrations for all children. There is no tendency observed with the increase of asthma incidence associated with the increase of air pollutant concentrations.

Regarding SO<sub>2</sub>, the background concentration was considered insufficient for this analysis.

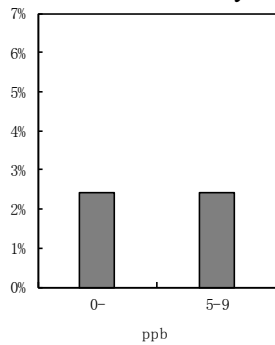
Asthma incidence by NO<sub>2</sub> concentration



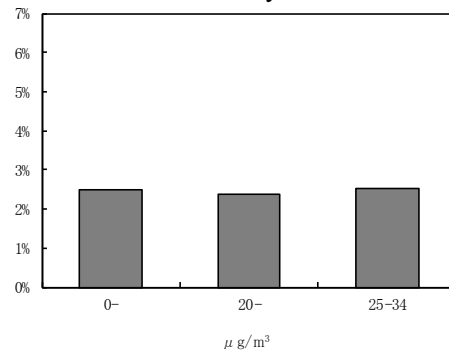
Asthma incidence by NO<sub>x</sub> concentration



Asthma incidence by SO<sub>2</sub> concentration



Asthma incidence by SPM concentration

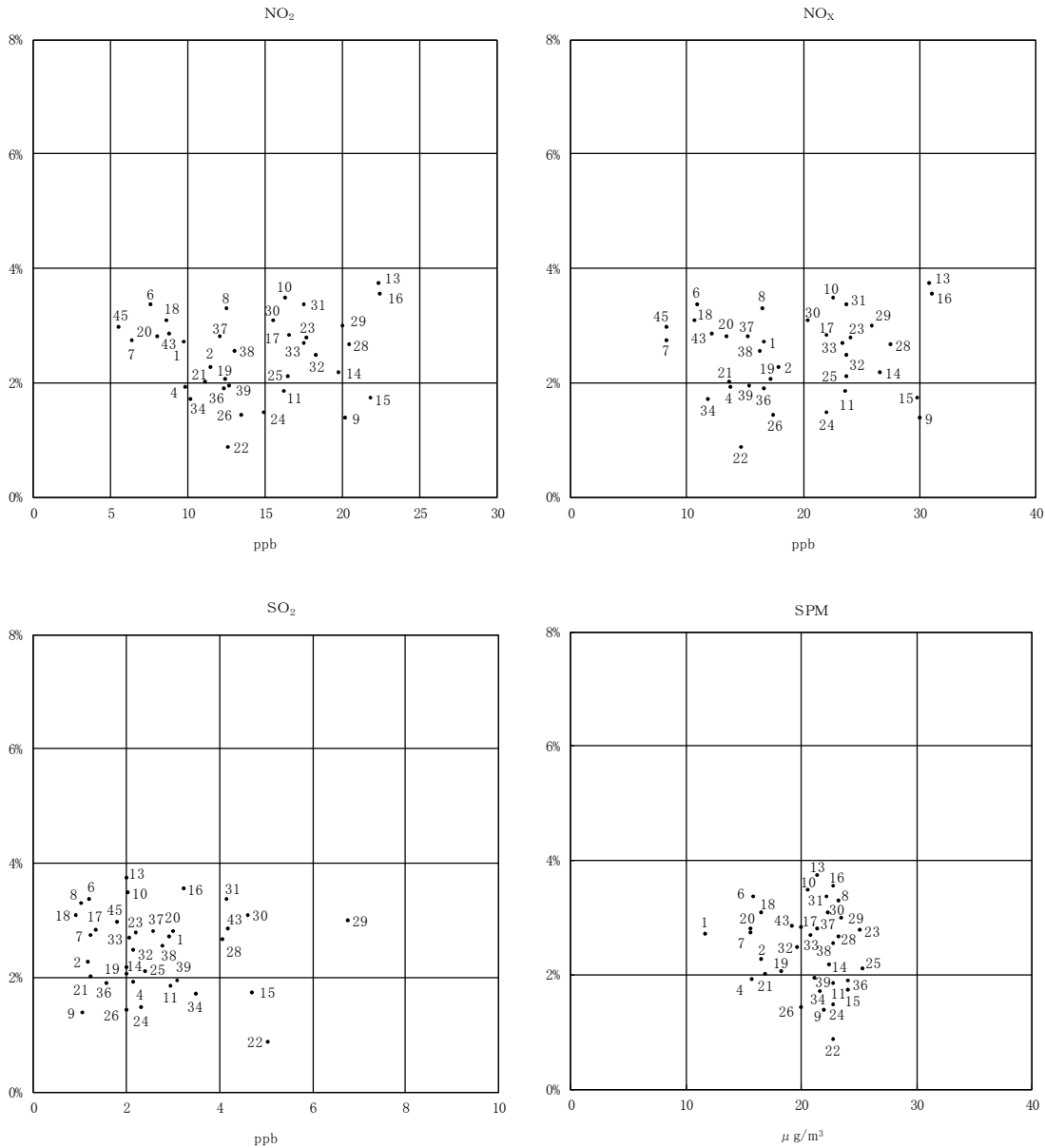


## 2) Average background concentration and asthma incidence in each survey area

The correlation between the average background concentration and asthma incidence was analyzed in each survey area. There is no tendency observed with the increase of asthma incidence associated with the increase of air pollutant concentrations. Even in those areas with low air pollutant concentrations, some areas show similar or even higher asthma incidence as in these areas of high air pollutant concentrations.

Correlation between air pollutant concentrations and asthma incidence (adjusted rate) –

All children (boys + girls)



- \*1 Numbers in the graph indicate their survey areas. See <Reference> FY2016 survey areas (on page 13).
- \*2 The adjusted rate means incidence of asthma adjusted for the composition ratio of the types of allergy history and the follow-up period for all children in the 3-year-old survey.
- \*3 The background concentration level in each survey area was the value at the time of the 3-year-old survey.

### 3) Evaluation according to the odds ratio

Contributing factor of asthma incidence was investigated. Its positive correlation was obtained with sex (male), pets (present), and allergy history of the children and parents (present). No significantly positive correlation was found in the air pollutant concentrations.

Odds Ratios of Factors Influencing Asthma Incidence

|   |                                   |           |   |
|---|-----------------------------------|-----------|---|
| NO <sub>2</sub>                               | Per 10 ppb increase               | 1.08      |   |
| NO <sub>x</sub>                               | Per 10 ppb increase               | 1.07      |   |
| SO <sub>2</sub>                               | Per 10 ppb increase               | 0.85      |   |
| SPM   | Per 10 µg/m <sup>3</sup> increase | 0.90      |   |
| Sex   | Male                              | 1.52~1.53 | * |
|   | Female                            | 1.00      |   |
| Family smoking                                | Mother                            | 1.23~1.24 |   |
|   | Except member                     | 1.04      |   |
|   | No smoker                         | 1.00      |   |
| Housing structure                             | Wooden house, wooden frame        | 1.02~1.04 |   |
|   | Wooden house, metal frame         | 0.87~0.89 |   |
|   | Reinforced steel, steel frame     | 1.00      |   |
| Heating method                                | No exhaust system                 | 0.95      |   |
|   | Exhaust system                    | 1.00      |   |
| Address change                                | Change of address                 | 1.06~1.09 |   |
|   | Same address                      | 1.00      |   |
| Pets  | Present                           | 1.23~1.25 | * |
|   | No                                | 1.00      |   |
| Daytime caretaker                             | Nursery center                    | 0.94~0.97 |   |
|   | Others                            | 1.00      |   |
| Feeding during the first 3 months after birth | Milk only                         | 0.93      |   |
|   | Breast feeding and milk           | 0.87~0.89 |   |
|   | Breast feeding only               | 1.00      |   |
| History of allergies (children)               | Yes                               | 1.75~1.77 | * |
|   | No                                | 1.00      |   |
| History of allergies (parents)                | Yes                               | 2.06~2.12 | * |
|   | No                                | 1.00      |   |

\*All odds ratios estimated for each air pollutant (NO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, and SPM) are statistically significant (P<0.05).

(Note 1) The numerical ranges in the above chart indicate the range between the minimum and maximum odds ratios estimated for each air pollutants (NO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, and SPM).

(Note 2) To examine the correlation between asthma incidence and major factors (from “sex” to “history of allergies (parents)” above) in detail, odds ratios were estimated by multiple logistic regression analysis using these major factors and air pollutant concentrations as explanatory variables.

## **(6) Results of analysis of follow-up longitudinal data**

In the longitudinal analysis of data from FY1997 to FY2016, some areas show increase or decrease in asthma prevalence. Both air pollutant concentrations and asthma prevalence reveal downward trend in all survey areas.