FY2013 Annual Report of Environmental Health Surveillance for Air Pollution (Overview)

1. Method

In both the 3-year-old survey and the 6-year-old survey, a health survey and exposure assessment were conducted as shown below, to analyze and assess the correlation between the concentration of air pollutants and prevalence of asthma and other respiratory symptoms.

In the follow-up analysis, the correlation between air pollutant concentration and asthma incidence was analyzed and assessed. Among the subjects of the FY2013 6-year-old survey implemented in 37 survey areas where a follow-up analysis was feasible, the analysis targeted those who also responded to a 3-year-old survey held in FY2009 and FY2010. Children who did not have asthma at the time of the 3-year-old survey but displayed asthma symptoms later at the time of the 6-year-old survey were deemed to have developed asthma.
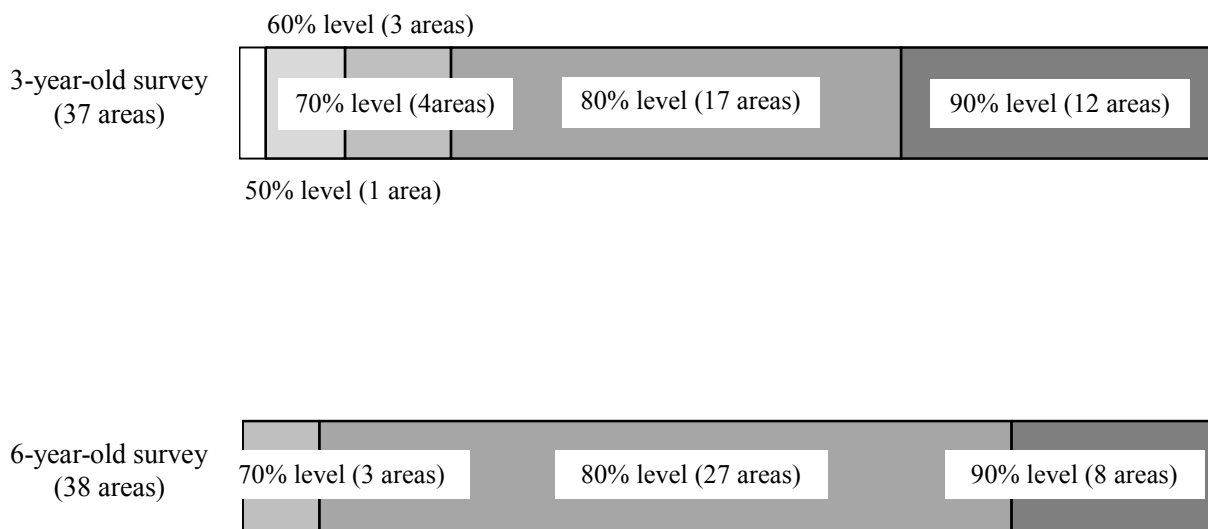
	3-year-old survey	6-year-old survey
Health survey	ATS-DLD simplified questionnaires (MOE version) were sent to all households with 3-year-old children in the survey areas. They were filled out by the children's parents and collected by staff of 37 local municipalities.	ATS-DLD simplified questionnaires (MOE version) were sent to all households with first-grade children who attend a public primary school in a school district that includes the survey area of the 3-year-old survey. They were filled out by the children's parents and collected by staff of 38 local municipalities.
Exposure assessment	Using the three-year average of annual average concentrations of NO_2, NO_x, SO_2 and SPM at ambient air pollution monitoring stations in and surrounding the study areas between FY2010 and FY2012, the concentration of these pollutants at residential points of all study subjects was estimated.	

2. Results

(1) Number of children surveyed and response rate

The 3-year-old survey targeted 87,072 children and obtained 73,085 responses, corresponding to a response rate of 83.94%. The 6-year-old survey targeted 84,735 children and obtained 73,781 responses, corresponding to a response rate of 87.07%.

Response rate and number of areas

The follow-up analysis targeted 48,063 children, corresponding to 66.18% of the 72,623 respondents of the 6-year-old survey implemented in areas where a follow-up analysis was feasible.

(2) Results of the cross-sectional analysis of the 3-year-old survey and 6-year-old survey

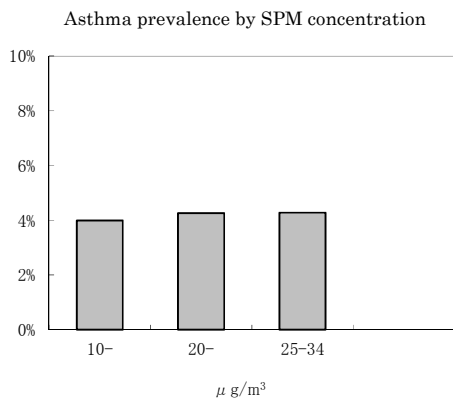**1) Prevalence of respiratory symptoms at each background concentration level for each subject group**
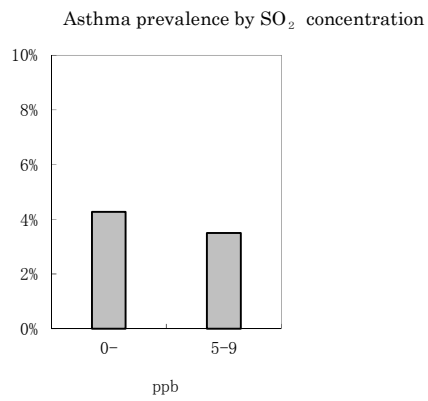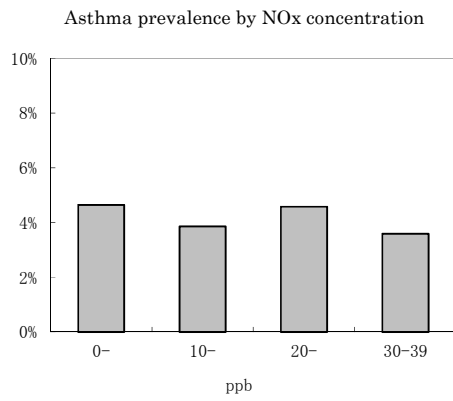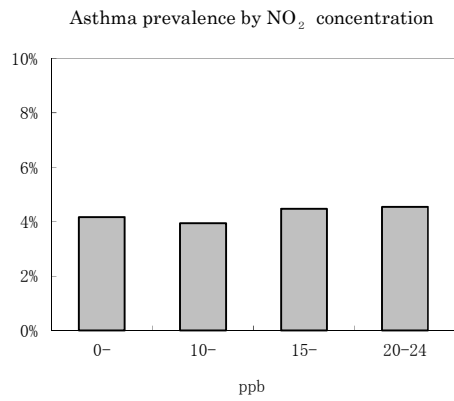
The prevalence of respiratory symptoms was analyzed by background concentration level of air pollutants with respect to each subject group, with the result showing no tendency for asthma prevalence to be higher in areas with higher concentrations of air pollutants in the 3-year-old survey, but a positive tendency for asthma prevalence to be slightly higher in areas with higher concentrations of SPM in the 6-year-old survey.

3-year-old survey

Asthma prevalence by NO_2 concentration

Asthma prevalence by NOx concentration

Asthma prevalence by SO_2 concentration

Asthma prevalence by SPM concentration
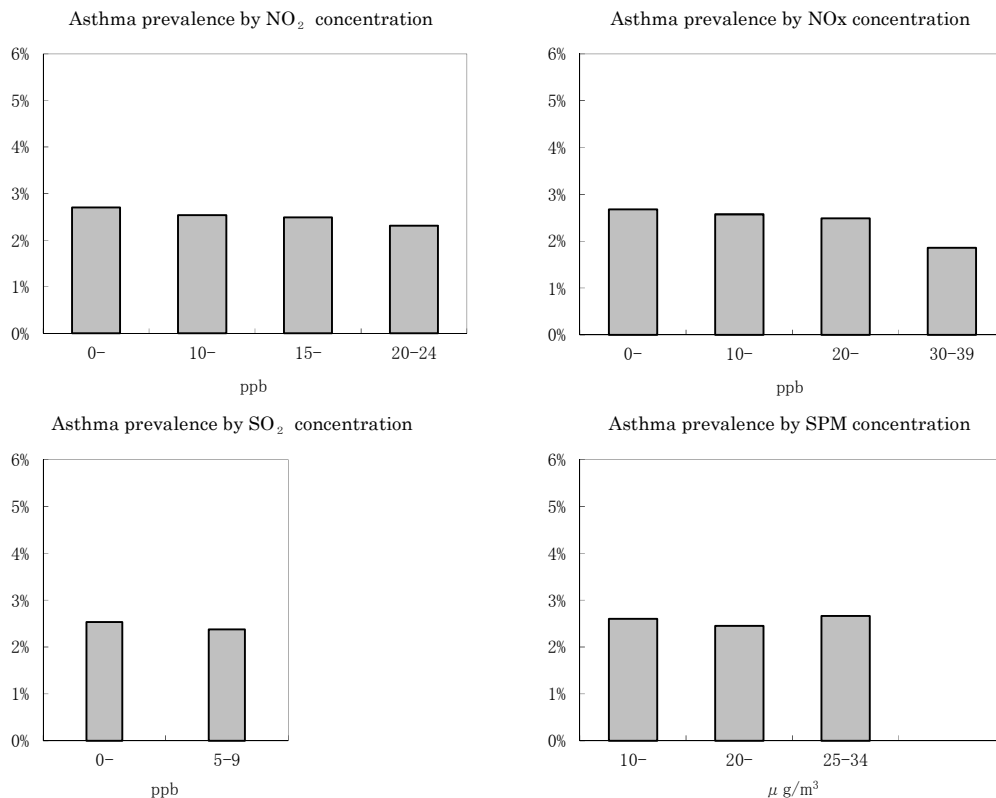
(Note) Background SPM concentration in Naha city was treated as missing, as SPM measurement results for FY2010 – 2012 could not be obtained from the Naha monitoring station (also applies to survey results shown below).

6-year-old survey

Asthma prevalence by NO_2 concentration

Asthma prevalence by NOx concentration

Asthma prevalence by SO_2 concentration

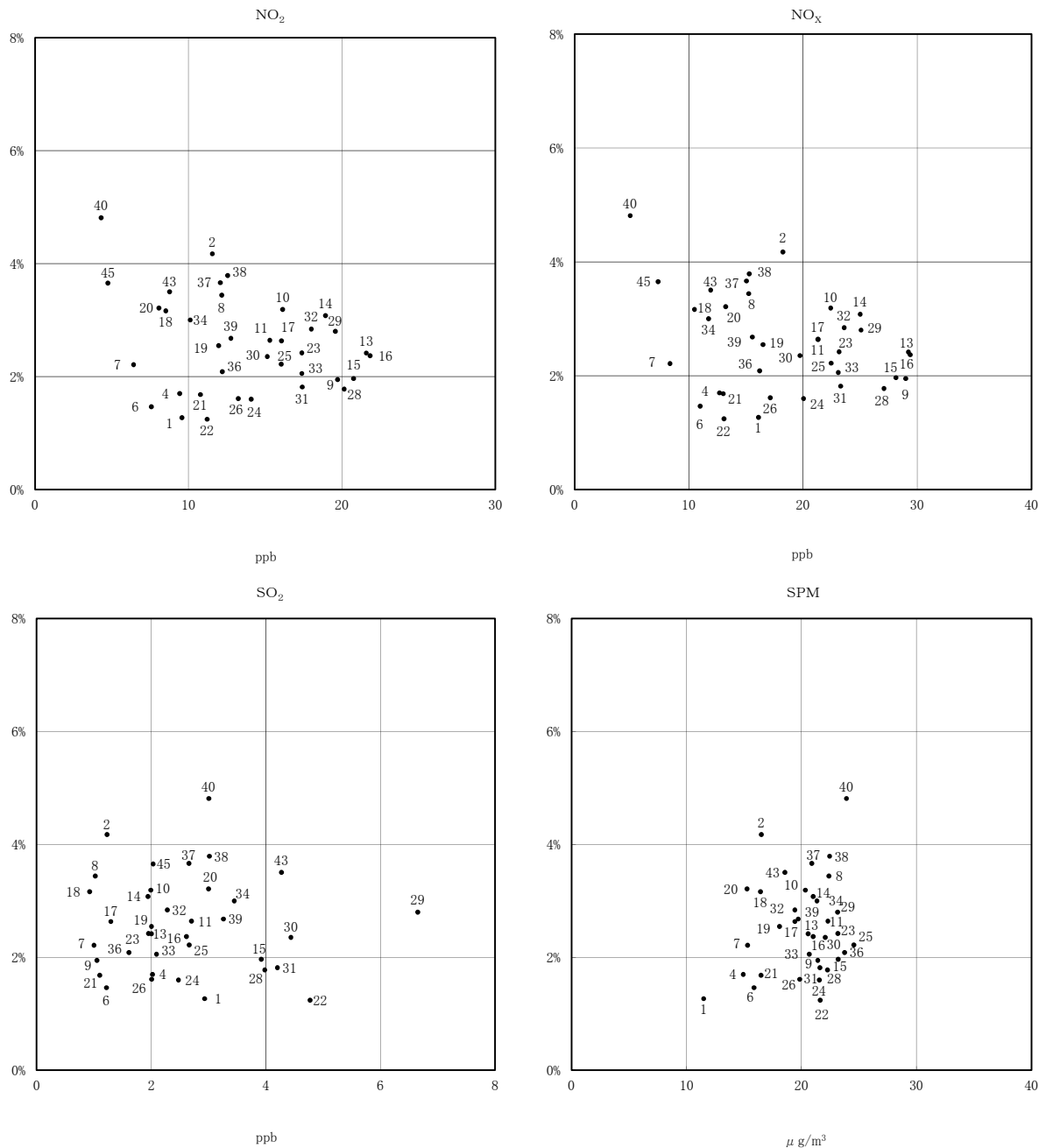### Asthma prevalence by SPM concentration

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2) Average background concentration and respiratory symptom prevalence in each survey area for each subject group

The correlation between average background concentration and the prevalence of respiratory symptoms was analyzed by survey area with respect to each subject group, but neither the 3-year-old survey nor 6-year-old survey indicated a tendency for asthma prevalence to be higher in areas with higher air pollutant concentrations.

3-year-old survey

Correlation between air pollutant concentration and asthma prevalence (adjusted rates) –
All subjects (boys + girls)

*1   Numbers in the graph indicate survey areas. See <Reference> FY2013 Survey areas.
    *2   The adjusted rates are the prevalence of asthma after factoring in the allergic history of all subjects by the composition ratio of each type of allergy.

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6-year-old survey

Correlation between air pollutant concentration and asthma prevalence (adjusted rates) –
All subjects (boys + girls)
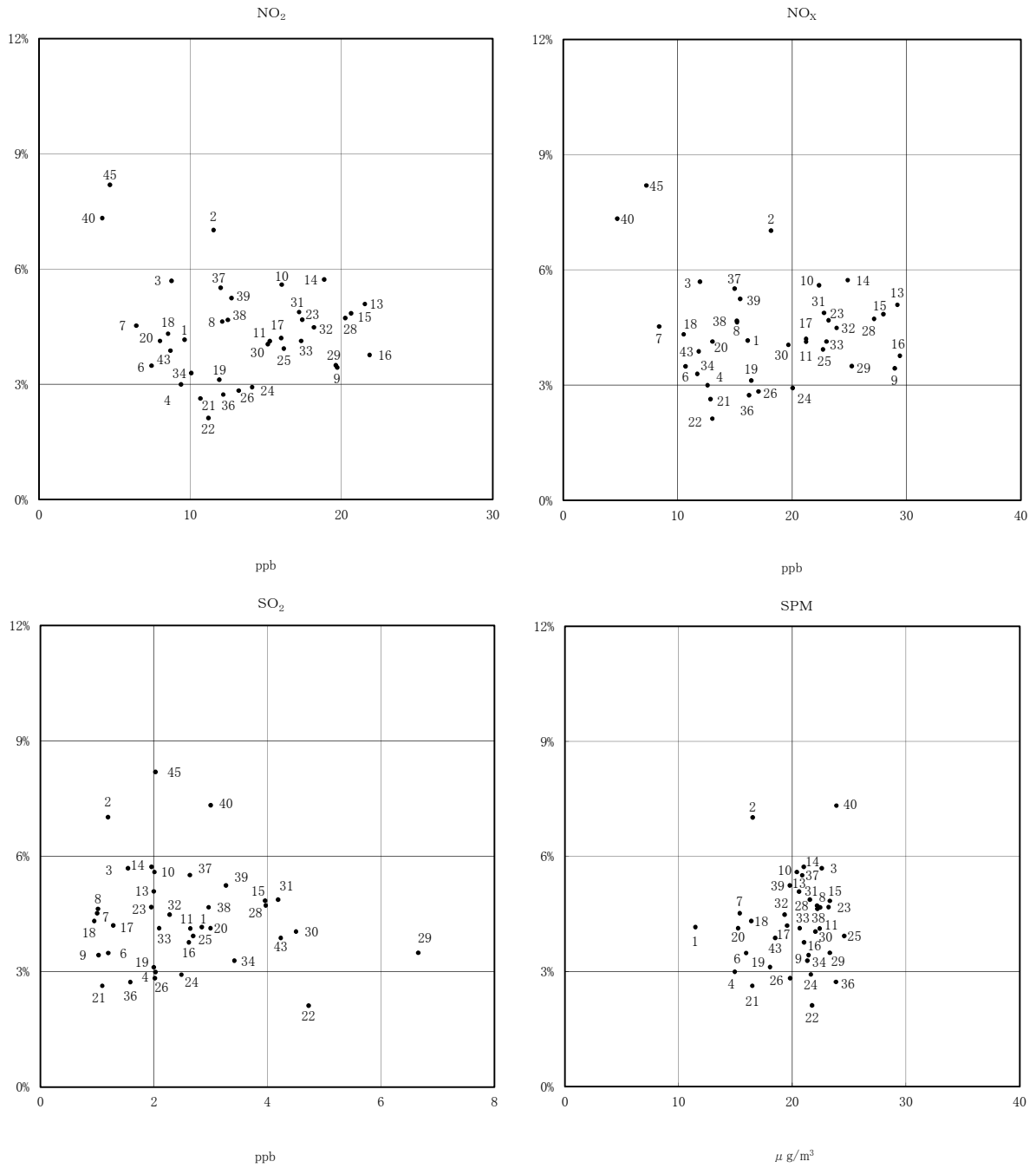

NO₂

NOₓ

SO₂

SPM

*1 Numbers in the graph indicate survey areas. See <Reference> FY2013 Survey areas.
*2 The adjusted rates are the prevalence of asthma after factoring in the allergic history of all subjects by the composition ratio of each type of allergy.

3) Study of factors influencing asthma prevalence

In the 3-year-old survey, the study indicated that the following factors contribute to the prevalence of asthma symptoms: gender (male), smoking habits of family members at home (mother and other members), the presence of pets (present), daytime caretaker (nursery center), feeding during the first 3 months after birth (milk only) and allergic history of subject and parents (positive history). In the 6-year-old survey, the influencing factors were: gender (boys), smoking habits of family members (mother), dwelling period (since birth and more than 3 years), and allergic history of the subject and parents (positive history). With regard to air pollutants, a significant positive correlation was observed between air pollution (SPM) and asthma in the 3-year-old survey (odds ratio: 1.18, 95% confidence interval: 1.01 – 1.39).

Odds Ratios of Factors Influencing Asthma Prevalence

		3-year-old survey			6-year-old survey	
NO_2	Per 10ppb increase	0.88	*		0.97	
NOx	Per 10ppb increase	0.92	*		0.99	
SO_2	Per 10ppb increase	1.37			0.83	
SPM	Per10μg/m3 increase	1.18	*		1.13	
Gender	Male	1.57〜1.60	*		1.51〜1.54	*
	Female	1.00			1.00	
Smoking habits of family members	Mother	1.53〜1.55	*		1.62〜1.64	*
	Other member	1.20〜1.21	*		1.06	
	No smoker	1.00			1.00	
Housing structure	Wooden with wooden frame	1.01〜1.06			0.88〜0.92	
	Wooden with metal frame	0.96〜1.01			0.91〜0.96	
	Reinforced concrete	1.00			1.00	
Heating method	No exhaust system	1.01〜1.03			0.98〜1.00	
	Exhaust system	1.00			1.00	
Dwelling period	Since birth	1.03〜1.04		Since birth	0.87〜0.88	*
	More than 1 year	1.06		More than 3 years	0.87〜0.88	*
	Less than 1 year	1.00		Less than 3 years	1.00	
Pets	Yes	1.25〜1.27	*		1.09〜1.10	
	No	1.00			1.00	
Daytime caretaker	Nursery center	1.26〜1.29	*			
	Others	1.00				
Feeding during the first 3 months after birth	Milk only	1.27〜1.28	*		1.06〜1.07	
	Breast feeding & milk	0.95〜0.97			0.96〜0.97	
	Breast feeding only	1.00			1.00	
History of allergies (subject)	Yes	1.94〜1.97	*		2.27〜2.30	*
	No	1.00			1.00	
History of allergies (parents)	Yes	2.22〜2.29	*		2.14	*
	No	1.00			1.00	

* All odds ratios estimated for each air pollutant (NO_2, NOx, SO_2, SPM) are statistically significant (P<0.05)

(Note 1) The numerical ranges shown in the above chart indicate the range between the minimum and maximum odds ratios that have been estimated for each air pollutant (NO_2, NOx, SO_2, SPM).

(Note 2) To examine the correlation between asthma prevalence and major factors (items between "gender" and "history of allergies (parents)" above) in detail, odds ratios were estimated by logistic regression analysis using the major factors and air pollutant concentrations as explanatory variables.

(3) Longitudinal and comprehensive analysis of 3-year-old survey data*

In the longitudinal analysis of data from FY1997 to FY2013, a number of survey areas showed an increase or decrease in asthma prevalence during that time period. In areas where asthma prevalence increased, no increases in the concentration of air pollutants were observed, but careful observations of any correlation between asthma prevalence and air pollution needs to be continued.

In the comprehensive analysis of integrated data from FY1997 to FY2013, the examination of odds ratio showed an odds ratio of 1.02 for asthma-related SPM (per increase of $10\mu g/m^3$), but neither the prevalence of respiratory symptoms at each background concentration level for each subject group nor the correlation between average background concentration for each subject group and respiratory symptom prevalence in each survey area showed a tendency for asthma prevalence to be higher at higher air pollutant concentrations.

   * The data on asthma prevalence obtained in FY1996, the first year of the survey, was simply used as reference in the longitudinal and comprehensive analyses, because it showed values that were distinctly lower than data from other years.

**(4) Longitudinal and comprehensive analysis of 6-year-old survey data**

In the longitudinal analysis of data from FY2004 to FY2013, a number of survey areas showed an increase or decrease in asthma prevalence during that time period. In areas where asthma prevalence increased, no increases in the concentration of air pollutants were observed, but careful observations of any correlation between asthma prevalence and air pollution needs to be continued.

In the comprehensive analysis of integrated data from FY2004 to FY2013, the examination of the odd ratio yielded a ratio of 1.04 for asthma-related SPM (per increase of $10\mu g/m^3$), but neither the prevalence of respiratory symptoms at each background concentration level for each subject group, nor the correlation between average background concentration and respiratory symptom prevalence in each survey area for each subject group showed a tendency for asthma prevalence to be higher at higher air pollutant concentrations.

(5) Results of the follow-up analysis

1) Asthma incidence at each background concentration level

Asthma incidence was analyzed by background concentration of air pollutants with respect to each subject group, with the result that asthma incidence at each background concentration level of NO_2 tended to be higher at higher air pollutant concentrations.

Asthma incidence by NO_2 concentration

Asthma incidence by NOx concentration

Asthma incidence by SO_2 concentration

Asthma incidence by SPM concentration
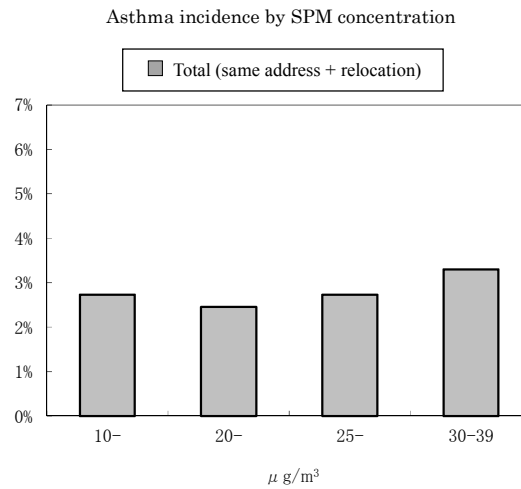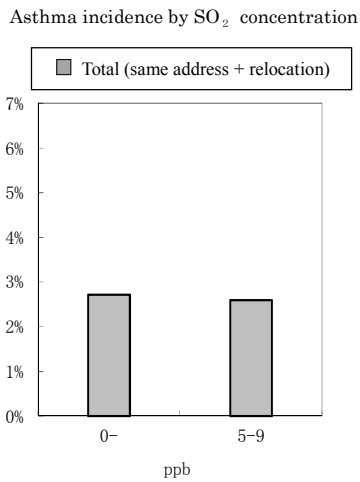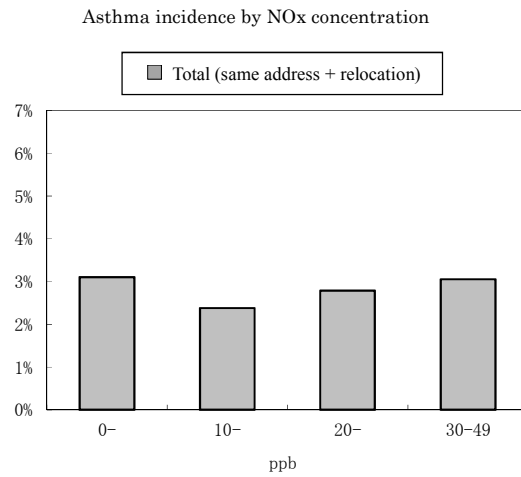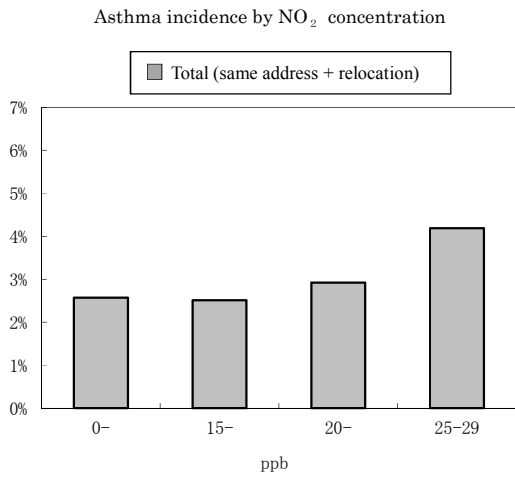
2) Average background concentration and asthma incidence in each survey area

The correlation between average background concentration and asthma incidence was analyzed by survey area with respect to each subject group, but asthma incidence did not tend to be higher in areas with higher air pollutant concentrations compared to areas with lower concentrations. In fact, some areas with low air pollutant concentrations had the same or higher incidence of asthma compared to areas with high air pollutant concentrations.

Correlation between air pollutant concentration and asthma incidence (adjusted rates) –
All subjects (boys + girls)
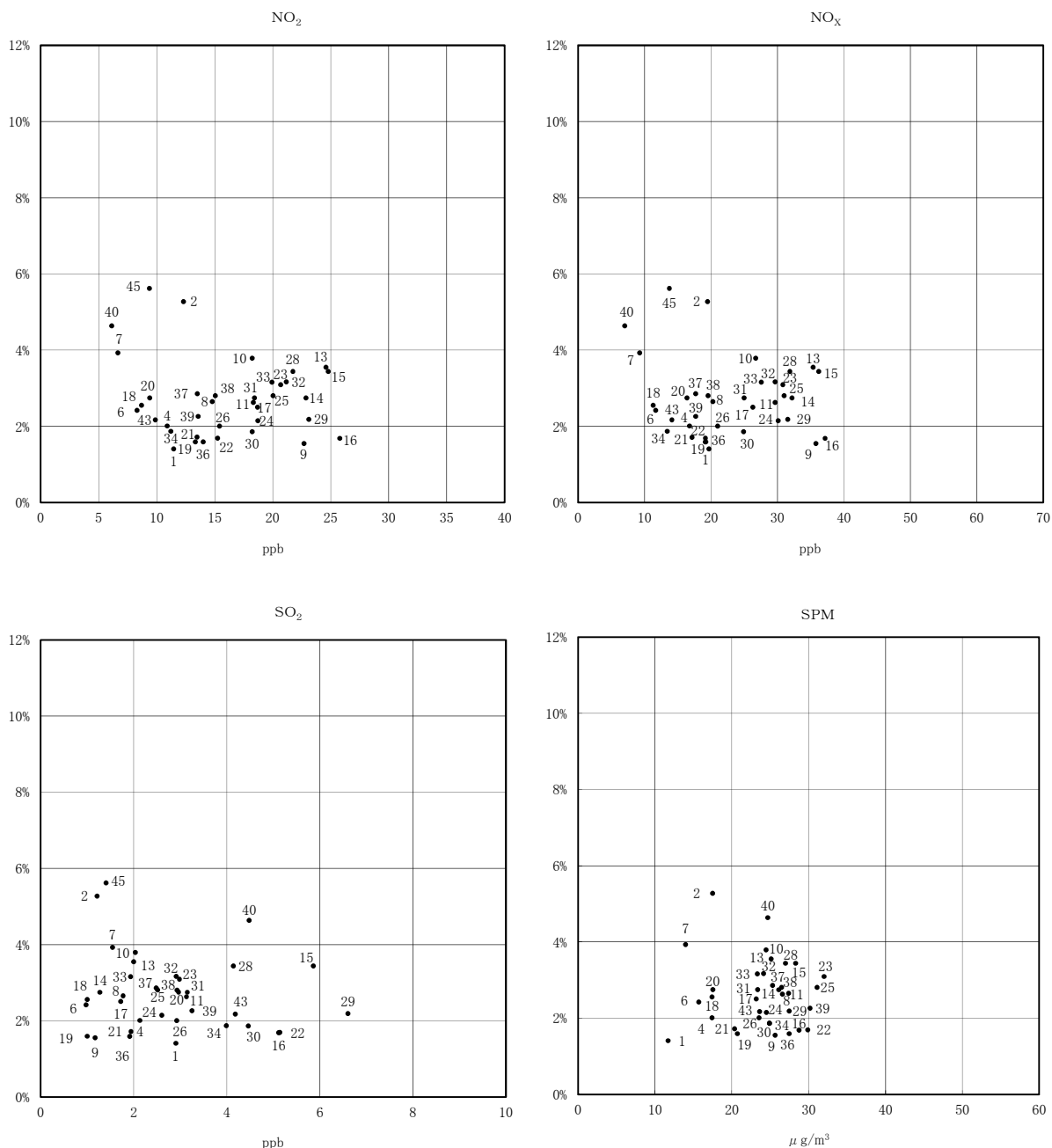
*1   Numbers in the graph indicate survey areas. See <Reference> FY2013 Survey areas..
*2   The adjusted rates are the incidence of asthma after factoring in the allergic history of all subjects of the 3-year-old survey by the composition ratio of each type of allergy and the average of the follow-up analysis
*3   The background concentration level for each subject group in each survey area was taken from the background concentration level measured at the time of the 3-year-old survey.

3) Study of factors influencing asthma incidence

The study indicated that the following factors contribute to the incidence of asthma: gender (male), daytime caretaker (nursery center), and allergic history of the subject and parents (positive history). With regard to air pollutants, a significant correlation was observed between air pollution (NO_2, NO_x) and asthma incidence (NO_2 odds ratio: 1.13, 95% confidence interval: 1.01 − 1.27; NO_x odds ratio: 1.10, 95% confidence interval: 1.03 − 1.19).

Odds Ratios of Factors Influencing Asthma Incidence

NO_2	Per 10ppb increase	1.13	*
NOx	Per 10ppb increase	1.10	*
SO_2	Per 10ppb increase	0.81	
SPM	Per10μg/m3 increase	1.07	
Gender	Male	1.34～1.36	*
	Female	1.00	
Smoking habits of family members	Mother	1.26～1.29	
	Other member	1.13～1.15	
	No smoker	1.00	
Housing structure	Wooden with wooden frame	1.04～1.09	
	Wooden with metal frame	0.93～0.96	
	Reinforced concrete	1.00	
Heating method	No exhaust system	1.07～1.08	
	Exhaust system	1.00	
Address change	Change of address	1.11～1.13	
	Same address	1.00	
Pets	Yes	1.11～1.12	
	No	1.00	
Daytime caretaker	Nursery center	0.84～0.88	*
	Others	1.00	
Feeding during the first 3 months after birth	Milk only	0.97～1.00	
	Breast feeding & milk	0.93～0.95	
	Breast feeding only	1.00	
History of allergies (subject)	Yes	1.93～2.00	*
	No	1.00	
History of allergies (parents)	Yes	1.79～1.85	*
	No	1.00	

*All odds ratios estimated for each air pollutant (NO_2, NOx, SO_2, SPM) are statistically significant (P<0.05)

(Note 1) The numerical ranges shown in the above chart indicate the range between the minimum and maximum odds ratios that have been estimated for each air pollutant (NO_2, NOx, SO_2, SPM).

(Note 2) To examine the correlation between asthma incidence and major factors (items between "gender" and "history of allergies (parents)" above) in detail, odds ratios were estimated by logistic regression analysis using the major factors and air pollutant concentrations as explanatory variables