

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 FY2017 in 36 survey areas where follow-up was possible, those who had responded to the prior 3-year-old survey in FY2013 or FY2014 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.

The single-year analysis and assessment of photochemical oxidants (Ox) was performed based on the FY2017 report. The oxidant indices used were the three-year average of the annual average concentrations (OxY) and the three-year average of the annual average 8-hour daily maximum concentrations (Ox8).

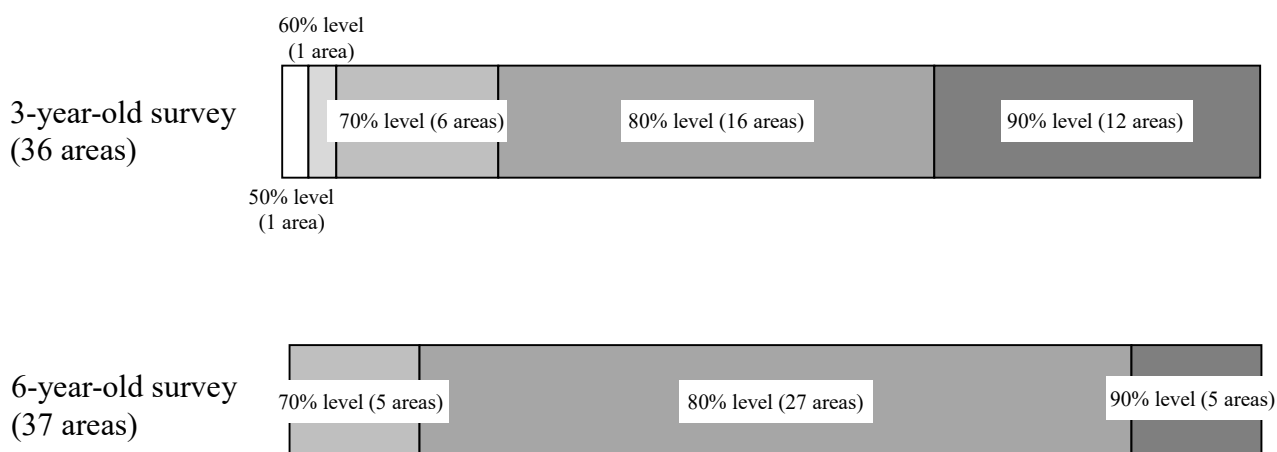
	3-year-old survey	6-year-old survey
Health survey	ATS-DLD simplified questionnaires (MOE version) were sent to all households with 3-year-old children in the survey areas to be filled out by their parents and then collected; delegated to 36 local municipalities.	ATS-DLD simplified questionnaires (MOE 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 (NO ₂ , NO _x , SO ₂ , SPM, OxY and Ox8), at ambient air pollution monitoring stations in and around the study areas between FY2014 and FY2016.	

2. Results

(1) Number of children surveyed and response rate

The 3-year-old survey targeted 83,265 children, and their responses were obtained from 71,275 children, with a response rate of 85.60%. The 6-year-old survey targeted 83,954 children, and their responses were obtained from 71,443 children, with a response rate of 85.10%.

Response rate and number of areas



In the survey areas where follow-up was possible, 70,423 children with 6-year-old responded to the survey. Among them, 48,256 children were followed up (68.52%).

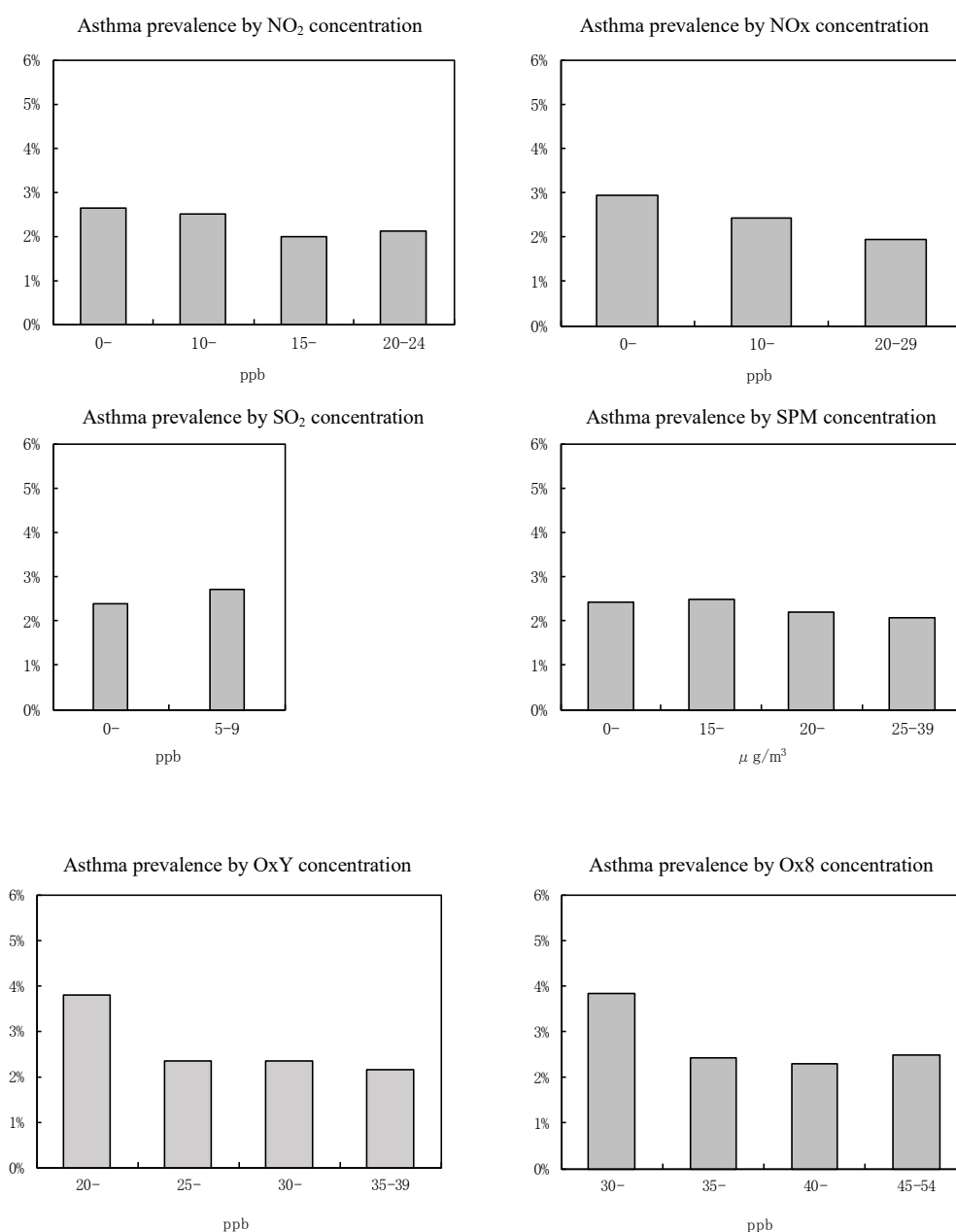
(2) Results of single-year analysis of the 3-year-old and 6-year-old surveys

1) Prevalence of respiratory symptoms according to background concentration level

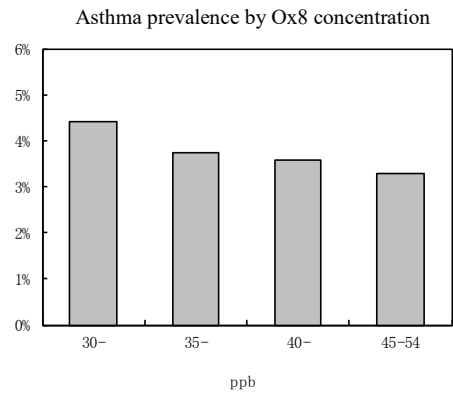
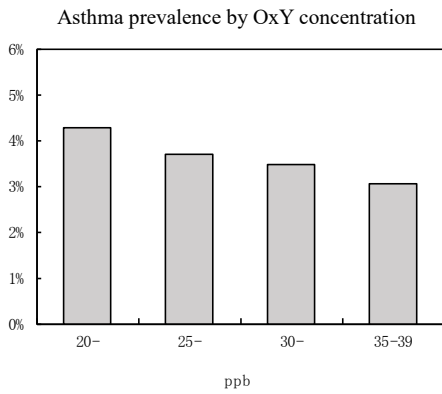
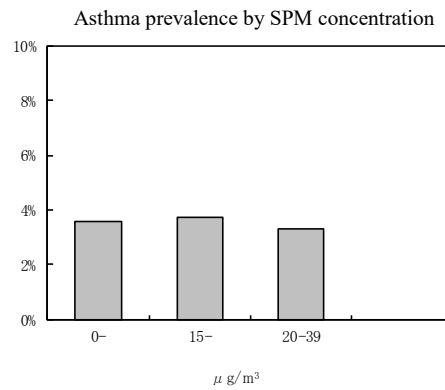
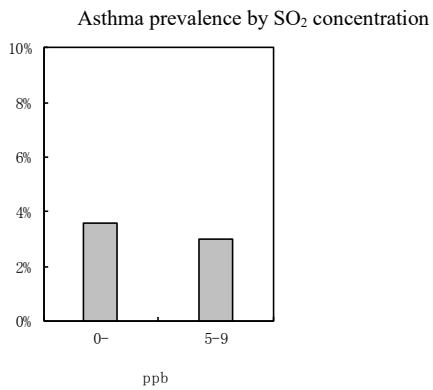
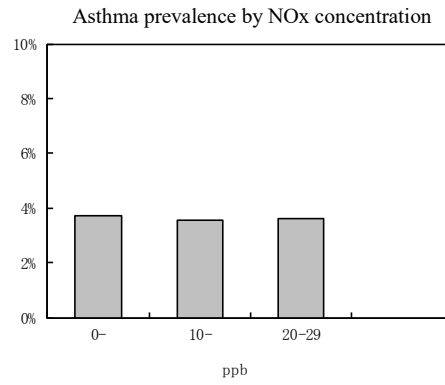
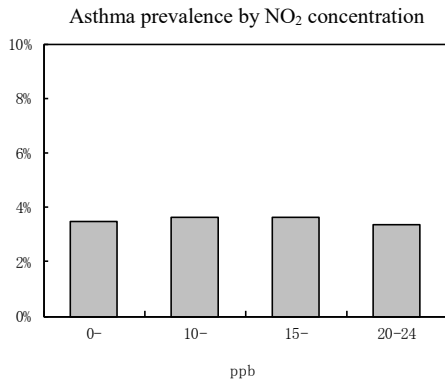
Prevalence of respiratory symptoms was analyzed according to background concentration level of air pollutants for all children. There is no tendency observed with the increase of asthma prevalence associated with the increase of air pollutant concentrations both in the 3-year-old or 6-year-old survey.

Regarding SO₂, the background concentration range was considered insufficient for this analysis.

3-year-old survey



6-year-old survey

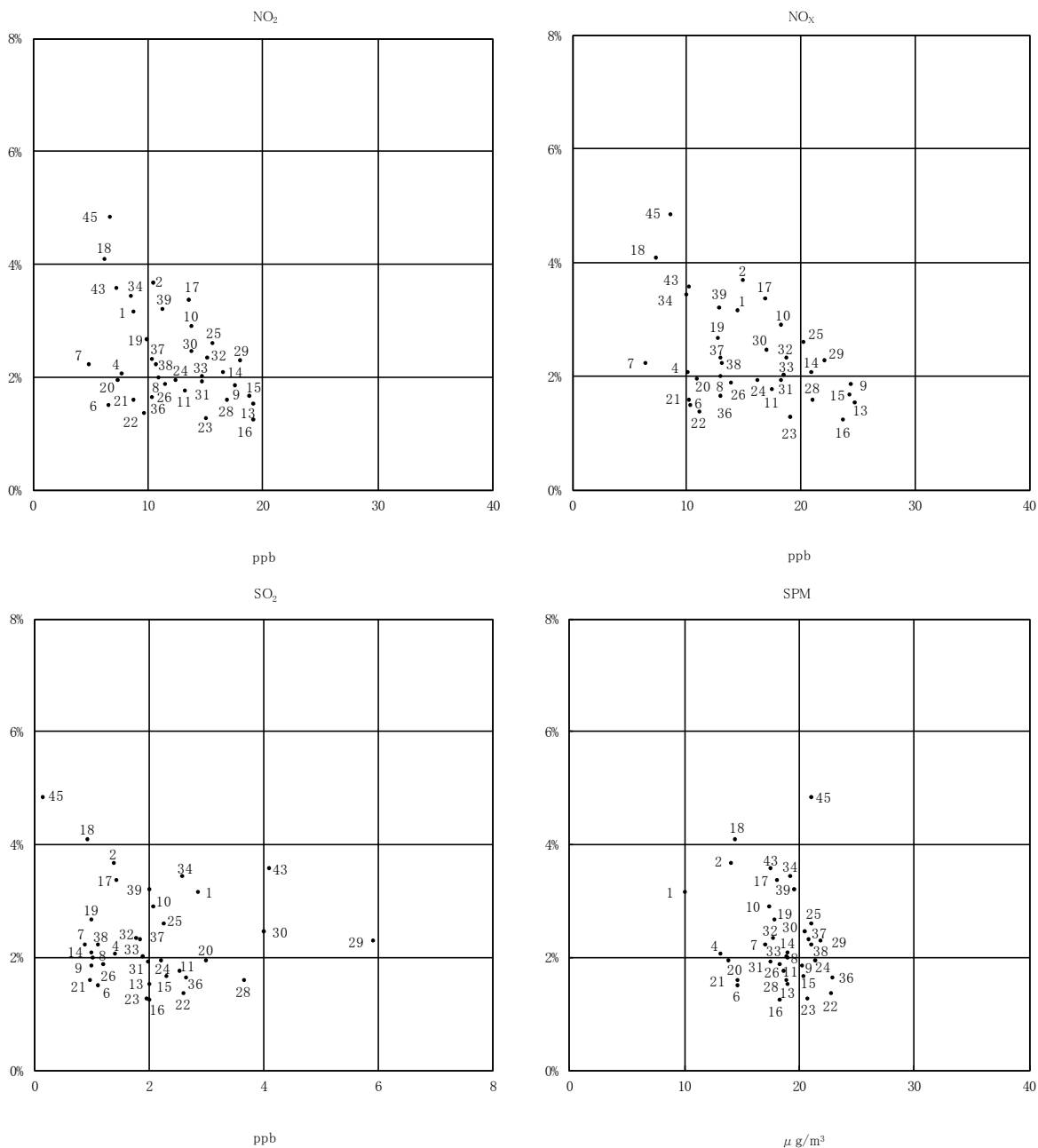


2) Average background concentration and prevalence of respiratory symptoms in each survey area

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.

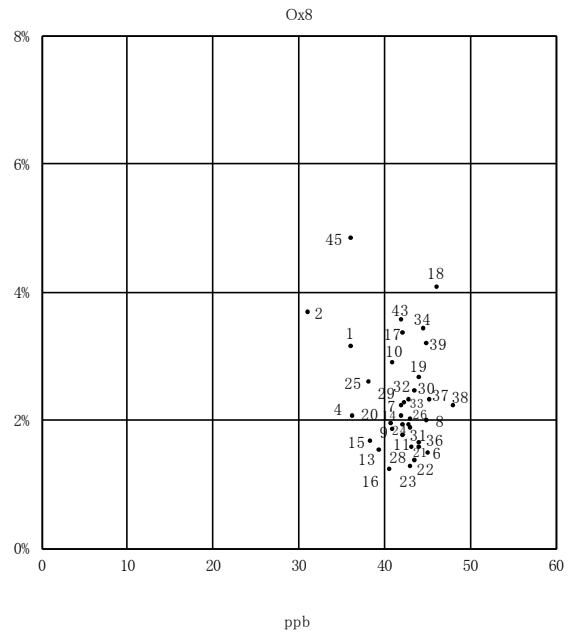
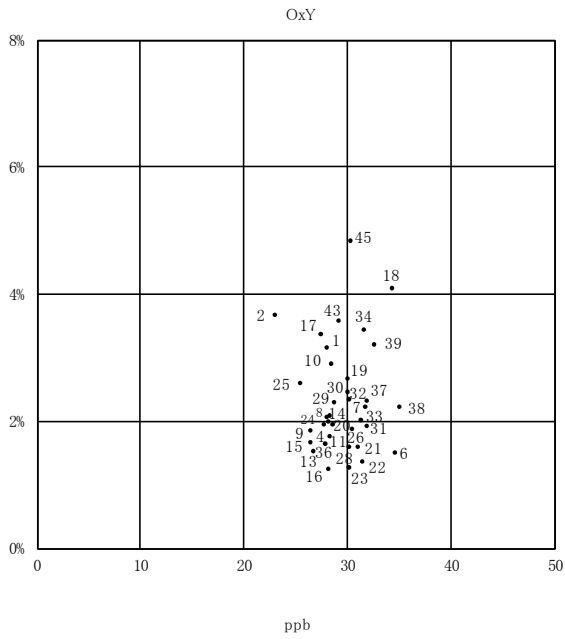
3-year-old survey

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> FY2017 survey areas (on page 15).

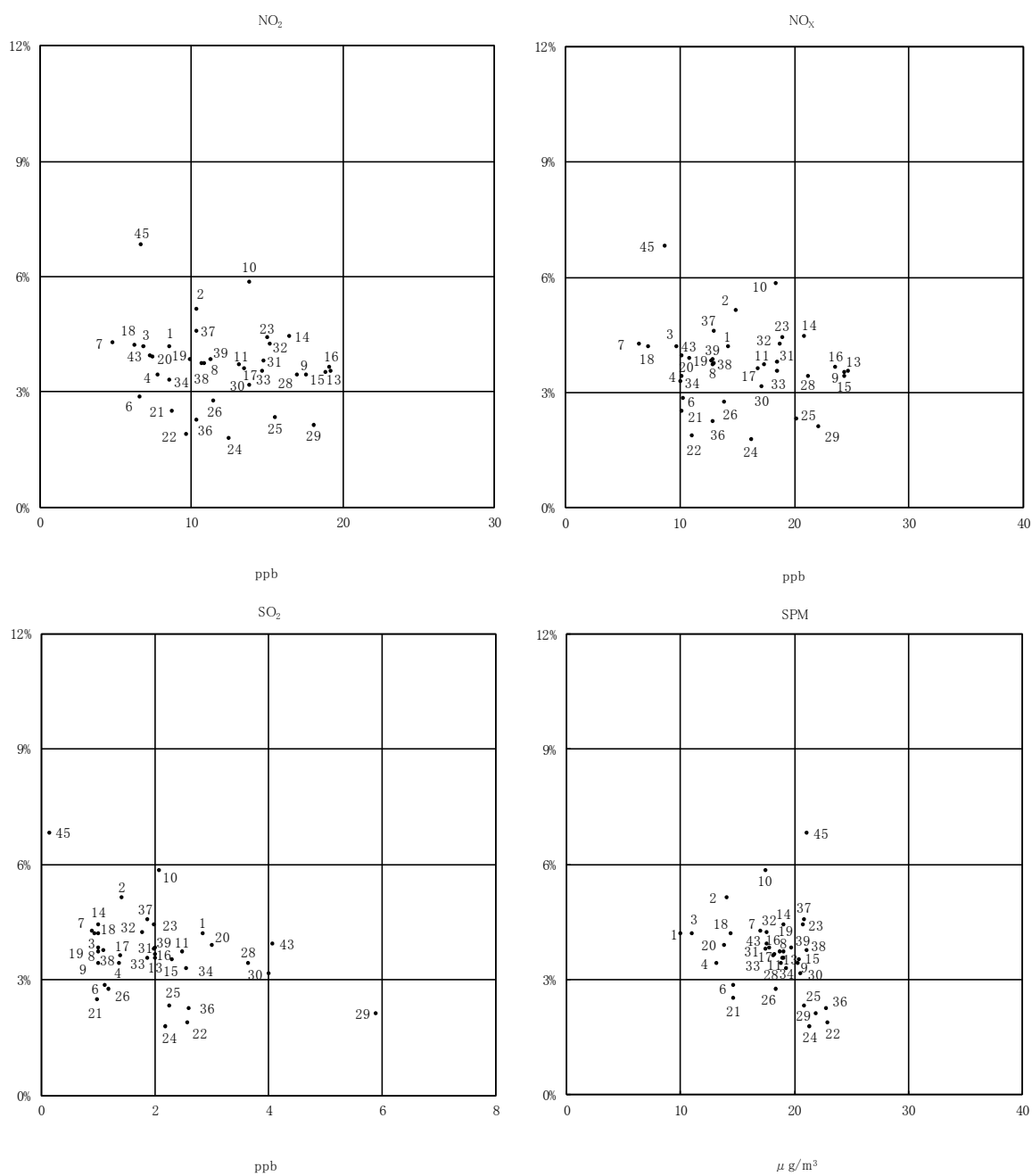
*2 The adjusted rate means prevalence of asthma adjusted for the composition ratio of the types of allergy history in all children.



- *1 Numbers in the graph indicate their survey areas. See <Reference> FY2017 survey areas (on page 15).
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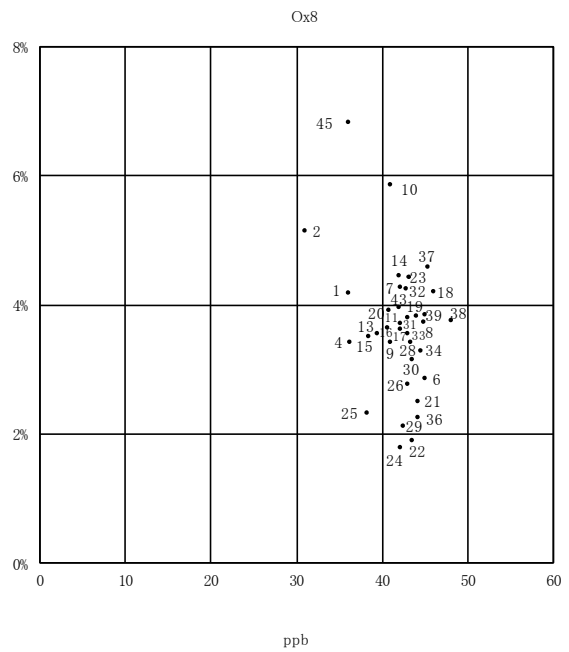
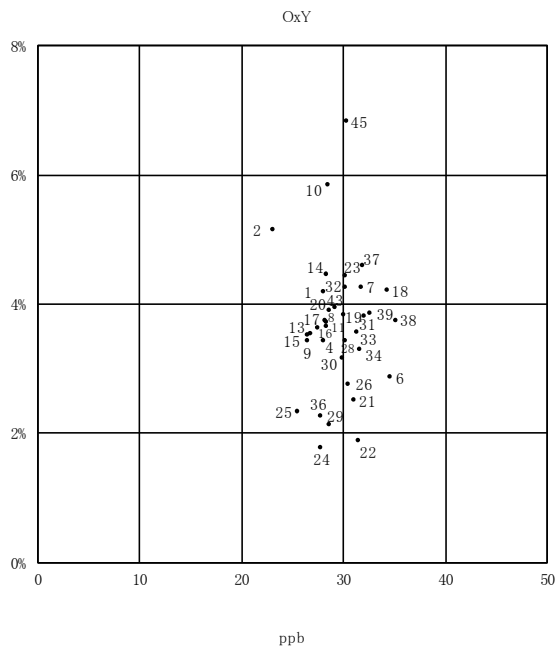
6-year-old survey

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> FY2017 survey areas (on page 15).

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



- *1 Numbers in the graph indicate their survey areas. See <Reference> FY2017 survey areas (on page 15).
- *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 factors of asthma prevalence were investigated. Its positive correlation was obtained with sex (male), family smoking, 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	
NO₂	Per 10 ppb increase	0.74	*	0.99	
NO_x	Per 10 ppb increase	0.79	*	1.02	
SO₂	Per 10 ppb increase	0.93		0.57	*
SPM	Per 10 µg/m ³ increase	0.90		0.89	
O_xY	Per 10 ppb increase	0.90		0.91	
O_x8	Per 10 ppb increase	0.79	*	0.73	*
Sex	Male	1.55	*	1.44–1.46	*
	Female	1.00		1.00	
Family smoking	Mother	1.42–1.45	*	1.54–1.56	*
	Except mother	1.20–1.21	*	1.02	
	No smoker	1.00		1.00	
Housing structure	Wooden house, wooden frame	1.21–1.25		1.13–1.14	
	Wooden house, metal frame	0.91–0.94		0.93–0.94	
	Reinforcing steel, steel frame	1.00		1.00	
Heating method	No exhaust system	0.95–1.00		0.92–0.94	
	Exhaust system	1.00		1.00	
Dwelling period	Since birth	0.84–0.86	*	Since birth	0.87–0.88
	More than 1 year	0.91–0.92		More than 3 years	0.89–0.90
	Less than 1 year	1.00		Less than 3 years	1.00
Pets	Present	1.28	*	1.32–1.33	*
	No	1.00		1.00	
Daytime caretaker	Nursery center	1.35–1.40	*		
	Others	1.00			
Feeding during the first 3 months after birth	Milk only	1.30–1.32	*	1.09–1.10	
	Breast feeding and milk	1.07		0.92–0.93	
	Breast feeding only	1.00		1.00	
History of allergies (children)	Yes	1.85	*	2.06–2.08	*
	No	1.00		1.00	
History of allergies (parents)	Yes	2.47–2.53	*	2.44–2.48	*
	No	1.00		1.00	

*: All odds ratios estimated for each air pollutant (NO₂, NO_x, SO₂, SPM, O_xY, and O_x8) 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 (NO₂, NO_x, SO₂, SPM, O_xY, and O_x8).

(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 FY2017, 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 FY2017, 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 FY2017, some areas show increase or decrease in asthma prevalence. Both the air pollutant concentrations and asthma prevalence reveal downward trend in all survey areas.

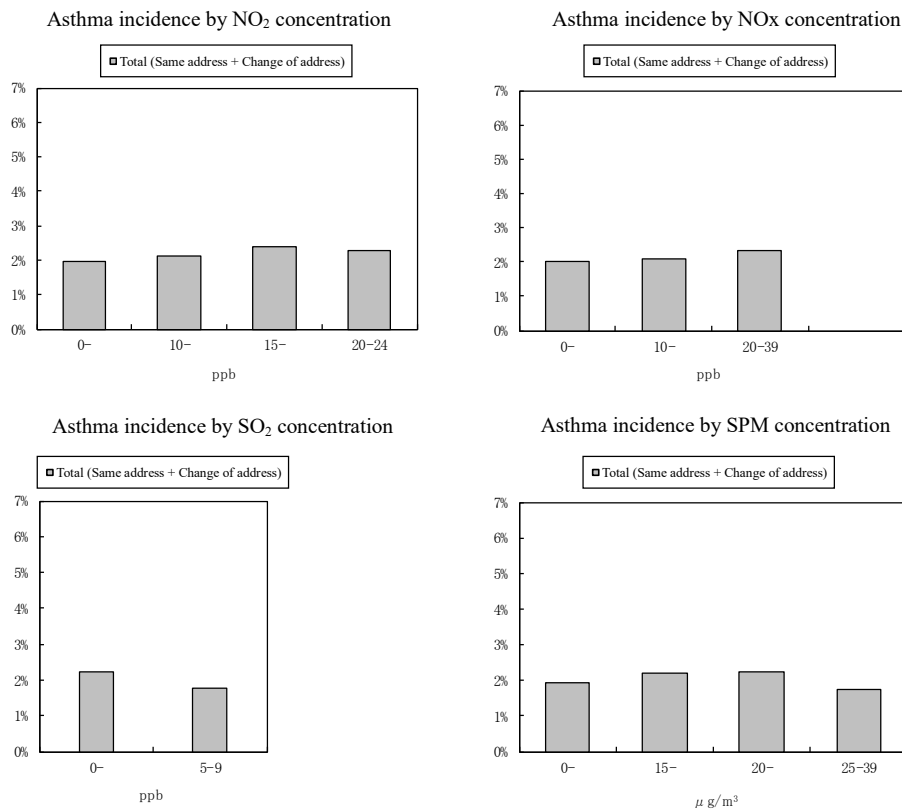
In the comprehensive analysis of integrated data from FY2004 to FY2017, with regard to prevalence of respiratory symptoms according to background concentration level and with regard to average background concentration and prevalence of respiratory symptoms according to each survey area, there is no tendency 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 concentration level of air pollutants for all children. Although there is some variation, there is a slight tendency observed with the increase of asthma incidence associated with the increase in the NO_x concentration level. For other air pollutants, there is no tendency observed with the increase of asthma incidence associated with the increase of the air pollutant concentration level.

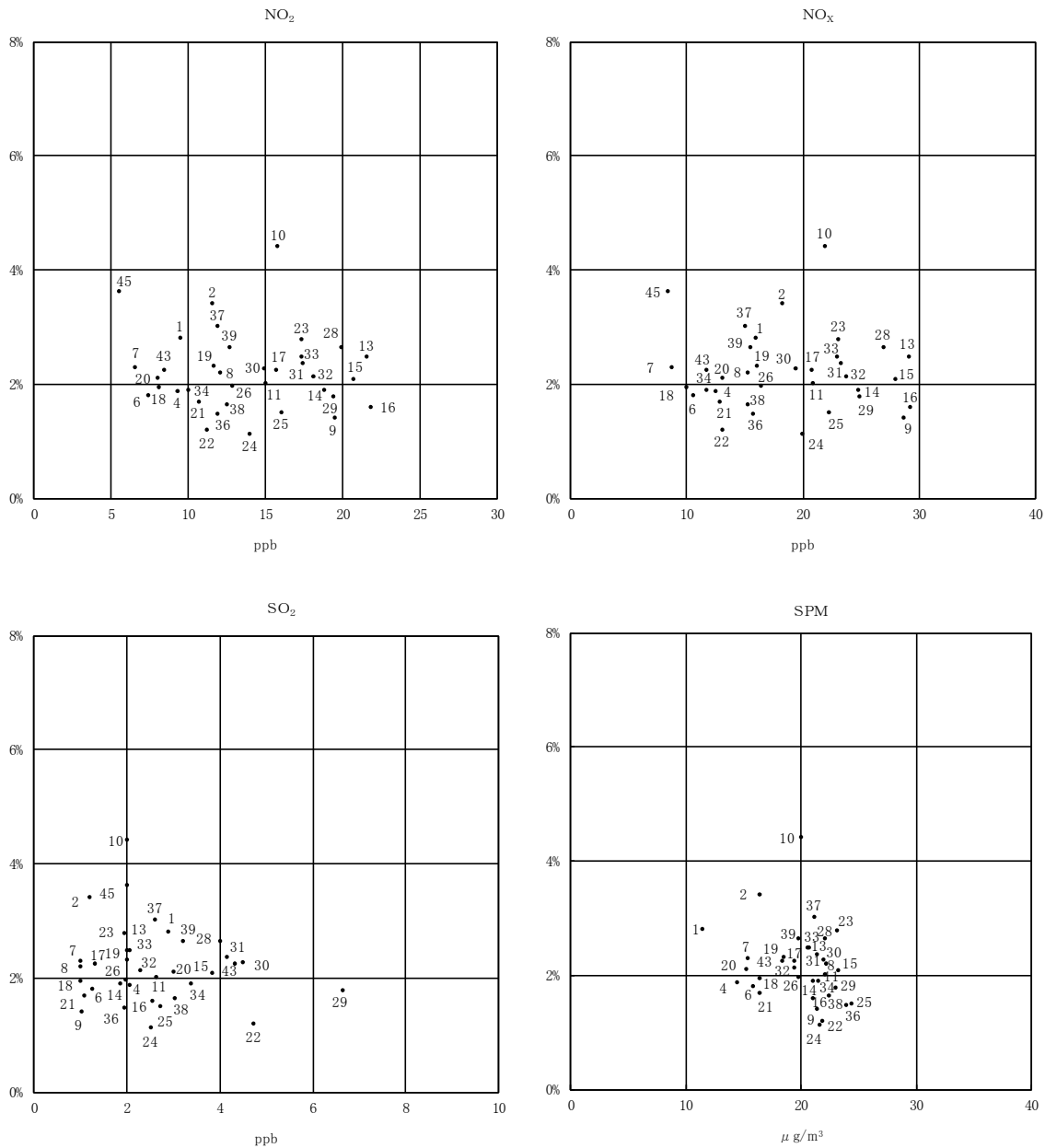
Regarding SO₂, the background concentration was considered insufficient for this analysis.



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> FY2017 survey areas (on page 15).
- *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 factors of asthma incidence were 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

NO₂	Per 10 ppb increase	1.09	
NO_x	Per 10 ppb increase	1.10	
SO₂	Per 10 ppb increase	0.66	
SPM	Per 10 µg/m ³ increase	1.02	
Sex	Male	1.40–1.42	*
	Female	1.00	
Family smoking	Mother	1.18–1.21	
	Except member	0.97–0.98	
	No smoker	1.00	
Housing structure	Wooden house, wooden frame	0.75–0.77	
	Wooden house, metal frame	0.92–0.95	
	Reinforced steel, steel frame	1.00	
Heating method	No exhaust system	0.91–0.92	
	Exhaust system	1.00	
Address change	Change of address	1.13–1.14	
	Same address	1.00	
Pets	Present	1.39–1.41	*
	No	1.00	
Daytime caretaker	Nursery center	1.00–1.04	
	Others	1.00	
Feeding during the first 3 months after birth	Milk only	1.20–1.25	
	Breast feeding and milk	0.98–0.99	
	Breast feeding only	1.00	
History of allergies (children)	Yes	1.92–1.93	*
	No	1.00	
History of allergies (parents)	Yes	2.20–2.23	*
	No	1.00	

* All odds ratios estimated for each air pollutant (NO₂, NO_x, SO₂, 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 (NO₂, NO_x, SO₂, 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 FY2017, some areas show increase or decrease in asthma prevalence. Both air pollutant concentrations and asthma prevalence reveal downward trend in all survey areas.