Epidemiologic studies on health effects of air pollution in Japan

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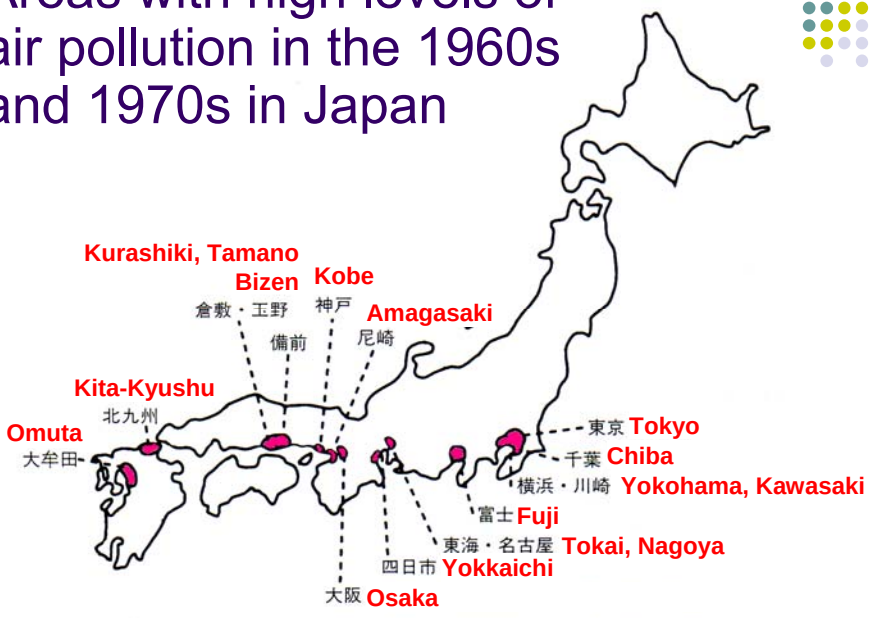
Outlines

- Air pollution and its health effects in the past
- Pollution control and its effects on human health
- Present status of air pollution in Japan
- Traffic-related air pollution and its health effects
  - Epidemiologic study in Chiba Prefecture
  - Ongoing study by the Ministry of Environment (the SORA projects)

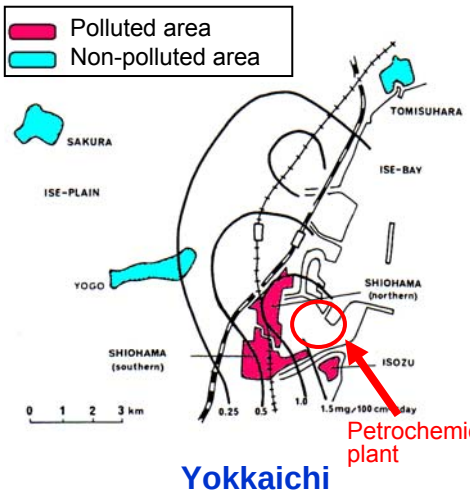
Air Pollution in the past in Japan

- Yokkaichi Asthma
  - Air pollution in the 1960s, due to petroleum complex in Yokkaichi, Japan
  - Prevalence of bronchial asthma and chronic bronchitis increased among people living in the vicinity of the complex.
- In Japan, from around 1960, the concentrations of air pollutants increased in many industrial cities, and health effects of air pollution had became a major concern in the cities, including Tokyo, Kawasaki, Chiba, Fuji, Osaka, Amagasaki, Kobe.

Areas with high levels of air pollution in the 1960s and 1970s in Japan

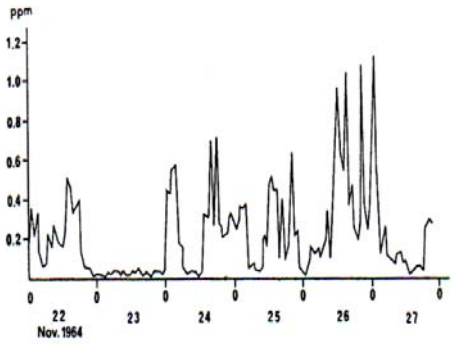


Concentrations of sulfur dioxide in Yokkaichi



Petrochemical plant

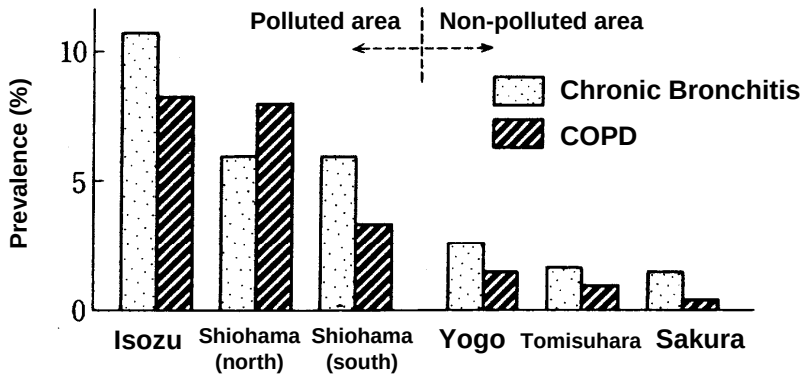
Yokkaichi



Concentrations of sulfur dioxide（1964.11.24-27）

(Yoshida, et al. Arch Environ Health 13: 763-768, 1966)

Prevalence of chronic bronchitis and COPD among adults in Yokkaichi

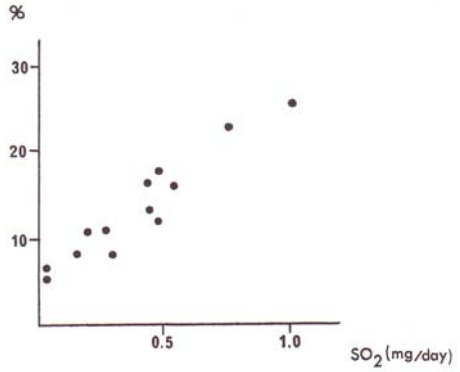


	Isozu	Shiohama (north)	Shiohama (south)	Yogo	Tomisuhara	Sakura
Sulfur oxides (mg/day)	1.9	0.9	0.6	0.2	0.2	0.1
Dust fall (ton/month)	13.5	15.1	12.6	5.2	7.6	2.3

(Yoshida, et al. J Jpn Hyg, 22: 323-335, 1967)

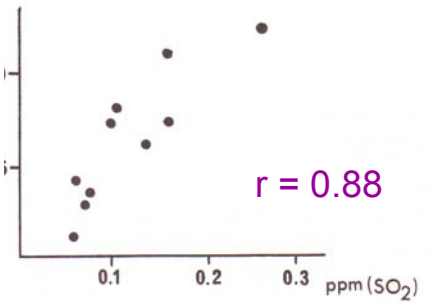
Asthma and sulfur dioxide in Yokkaichi

Relation between SO_2 and yearly accumulated prevalence of asthma in 13 districts



Age group over 50 yr;
April 1963 – March 1964

Relation between asthma attack and weekly average concentration of SO_2

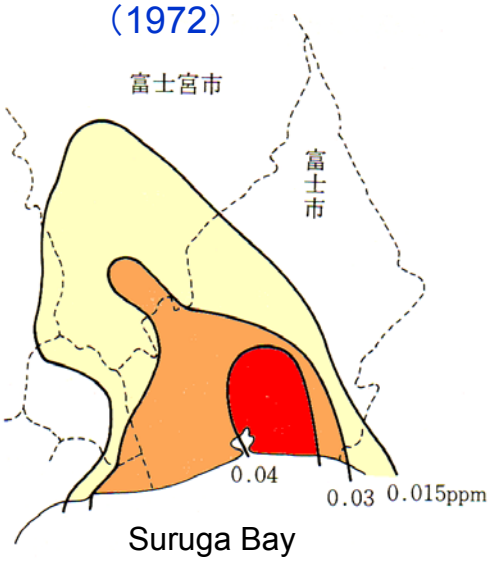


At Isozu 13 patients
January to March 1963

(Yoshida, et al. Arch Environ Health 13: 763-768, 1966)

Concentrations of sulfur oxides in Fuji

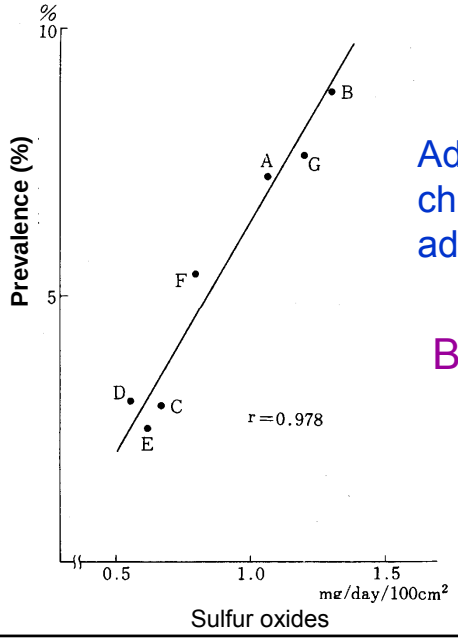
（1972）



Suruga Bay

(Tani, et al. J Jpn Public Health, 22: 431-438, 1975)

Chronic bronchitis and sulfur dioxide



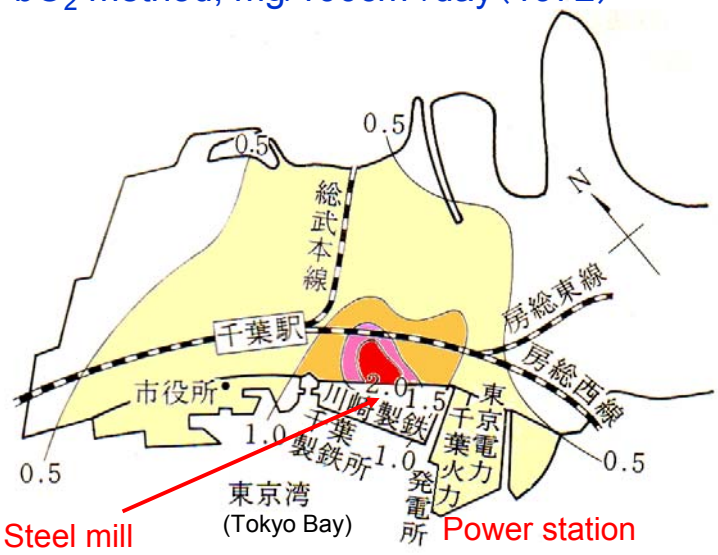
Adjusted prevalence of chronic bronchitis among adults aged ≥ 40 years

BMRC questionnaire

(Tani, et al. J Jpn Public Health, 22: 431-438, 1975)

Concentrations of sulfur oxides in Chiba

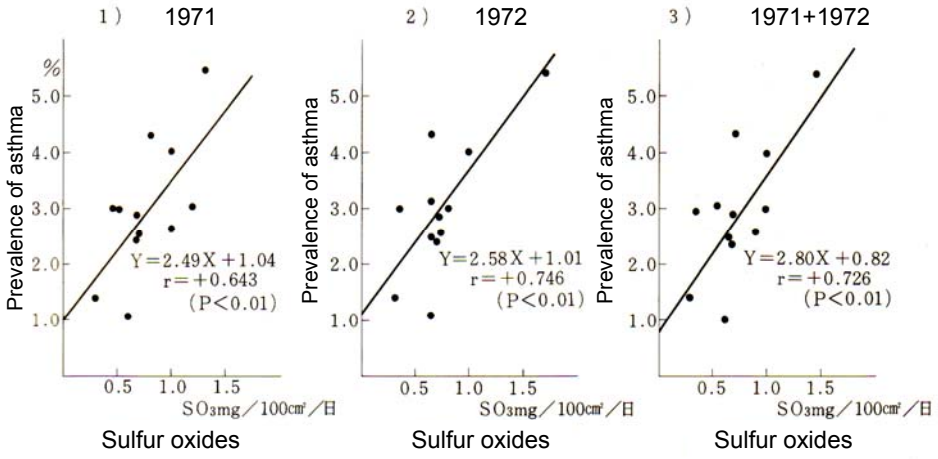
By PbO_2 method, mg/100cm²/day（1972）



(Motomiya, et al. J Jpn Public Health, 22: 397-402, 1975)

Relationship between prevalence of asthma and sulfur oxides

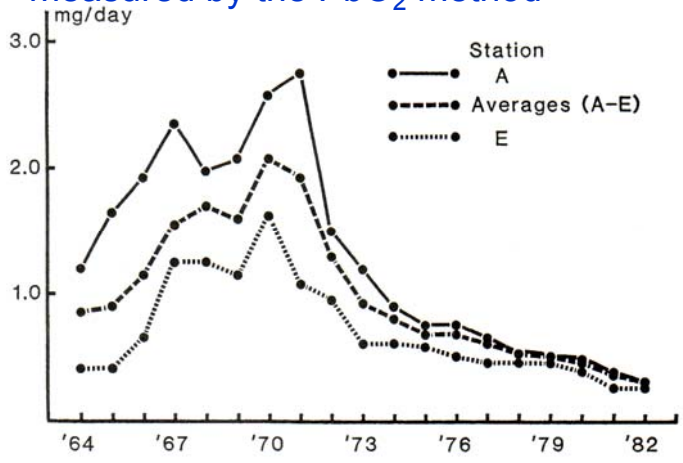
Boys in 12 elementary schools（1972）



(Motomiya, et al. J Jpn Public Health, 22: 397-402, 1975）

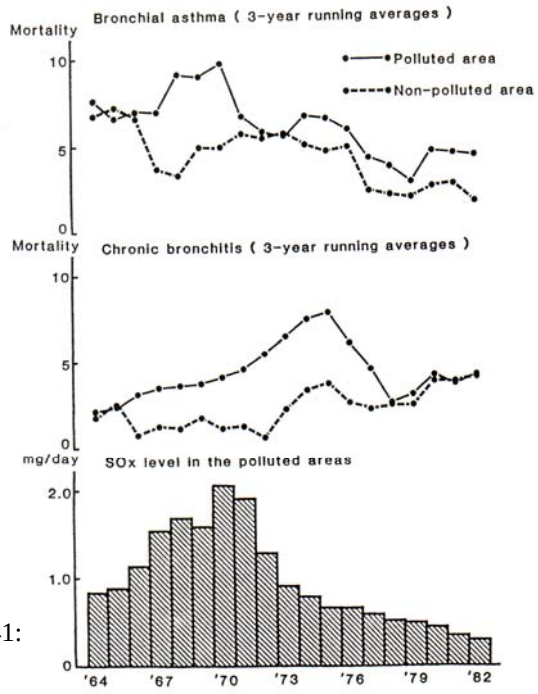
Change in concentrations of sulfur oxides in Yokkaichi

Annual average concentrations measured by the PbO_2 method



(Imai, et al. Arch Environ Health 41: 29-35, 1986)

Sulfur oxides levels and mortality due to respiratory diseases in Yokkaichi



Age-adjusted mortality

Top : Bronchial asthma

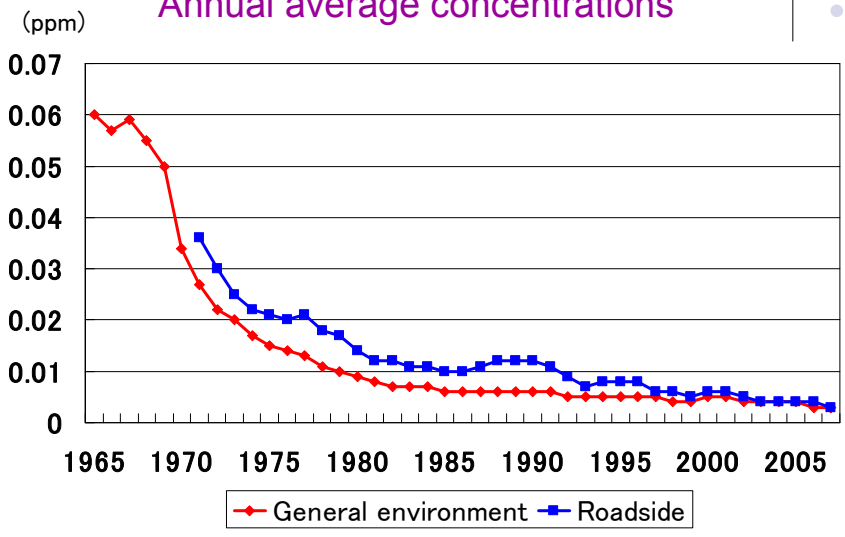
Middle : Chronic bronchitis

Bottom : Annual average concentration of sulfur oxides

(Imai, et al. Arch Environ Health 41: 29-35, 1986)

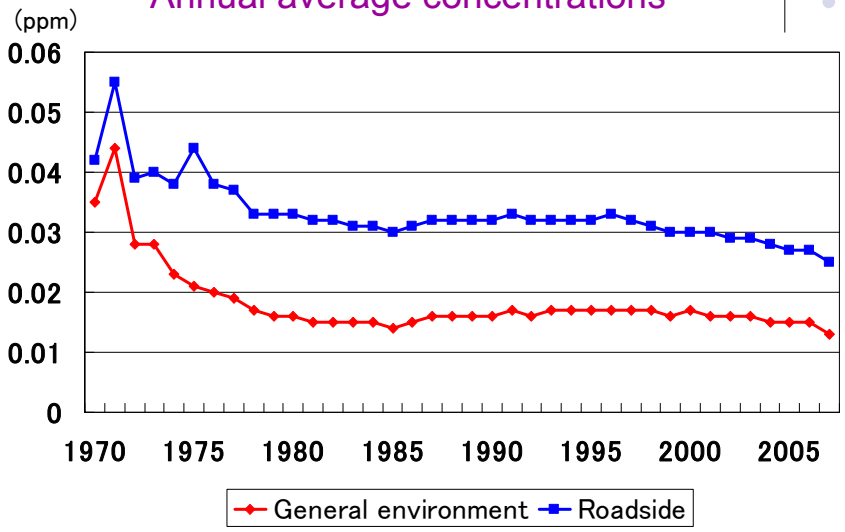
Concentrations of Sulfur Dioxide in Japan

Annual average concentrations



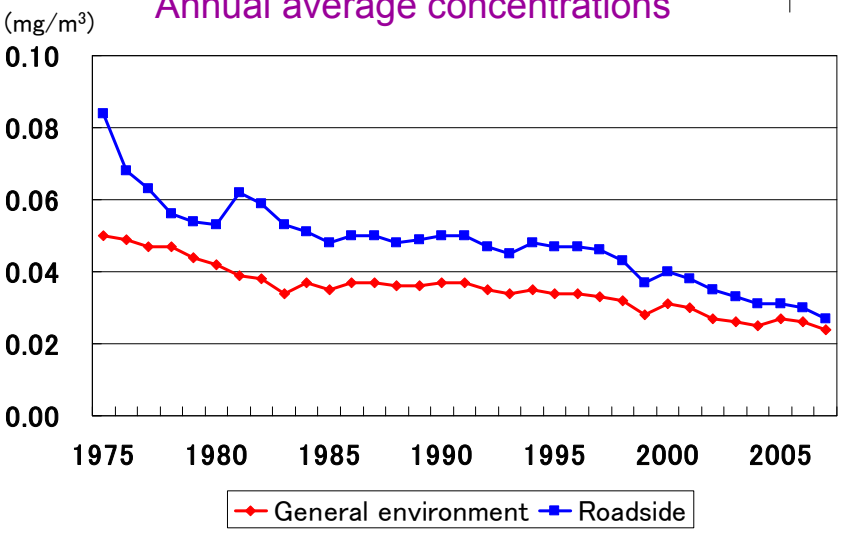
Concentrations of Nitrogen Dioxide in Japan

Annual average concentrations

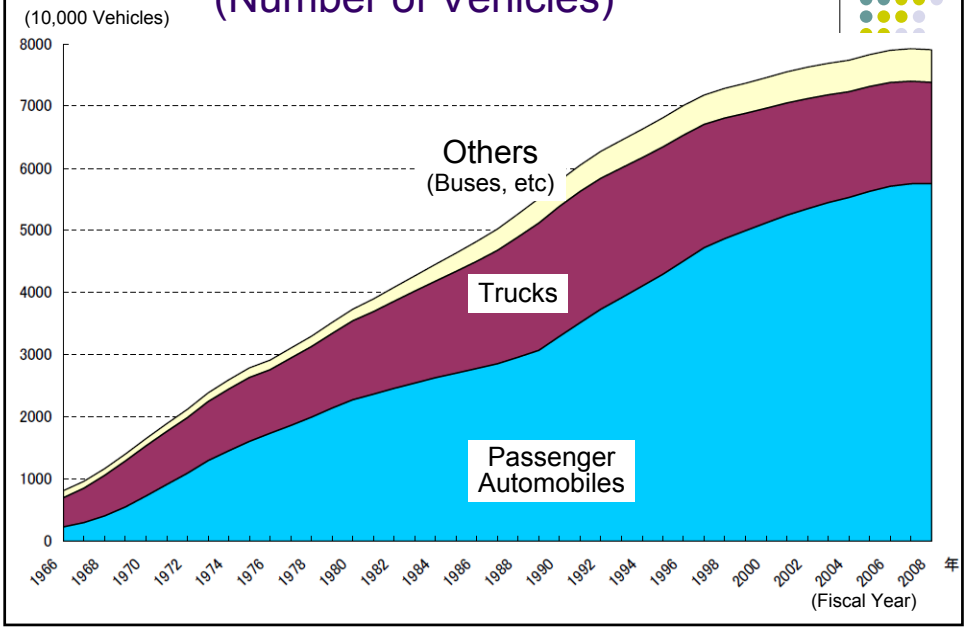


Concentrations of Suspended Particulate Matter (≤10μm in diameter) in Japan

Annual average concentrations



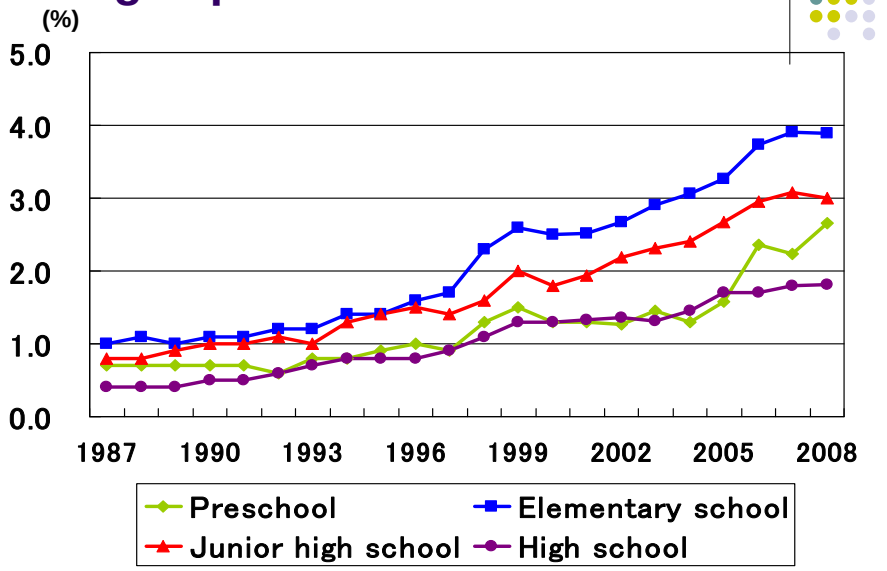
Changes in Automobile Ownership (Number of Vehicles)



Changes in the problems of Air Pollution

- Industrial air pollution (factories, etc.)
  → Urban/Domestic air pollution（vehicles, etc.）
- Gaseous pollutants → Particulate matters
  - Fine particles, Diesel exhaust particles, etc.
  - Uncontrolled toxic air pollutants
- High concentrations
  → Relatively low concentrations
- Wide areas around factories
  → Regional areas adjacent to major roads

Prevalence of bronchial asthma among Japanese children

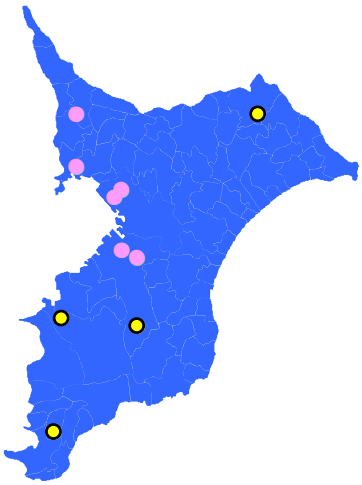


(School Health Survey in Japan)

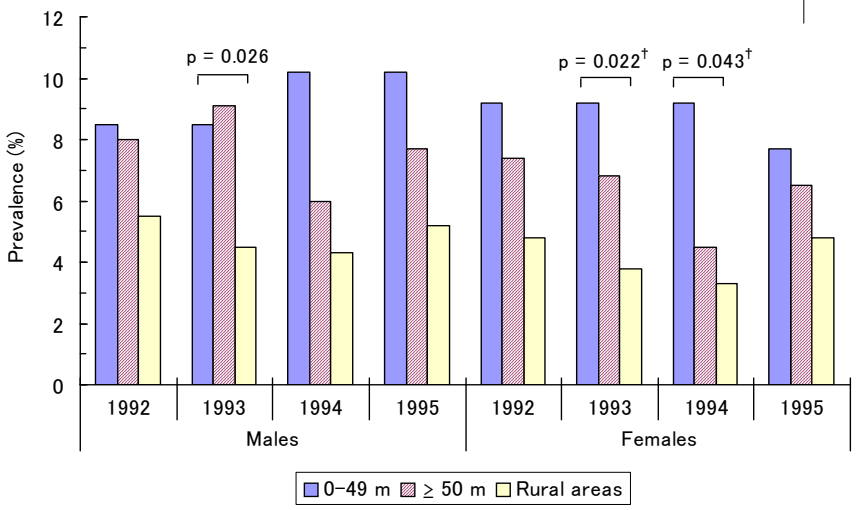
Health effects of automobile exhaust

Epidemiologic study in Chiba Prefecture (1985～2000)

- Study subjects
  - Children in 10 elementary schools (about 6,000)
    - Schools are located in urban areas, and their school districts are intersected by major trunk roads.
    - Schools are in rural areas, without major roads or factories.
- Questionnaire for respiratory symptoms
- Pulmonary function tests
- Blood sampling for allergic and inflammatory tests
- Measurements of indoor environments



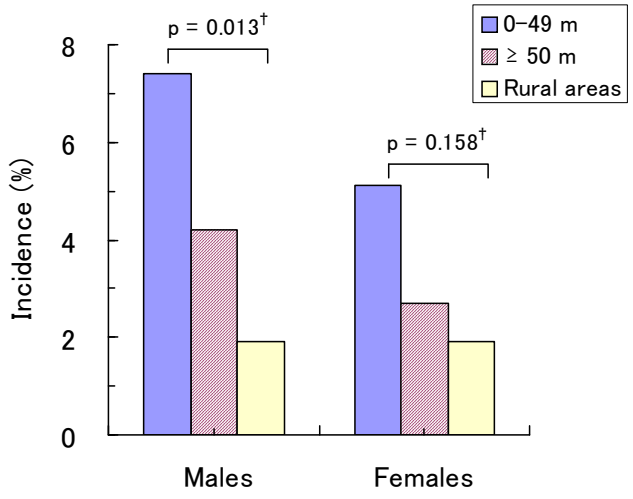
Prevalence of asthma



(Shima, et al. J Epidemiol, 13: 108-119, 2003)

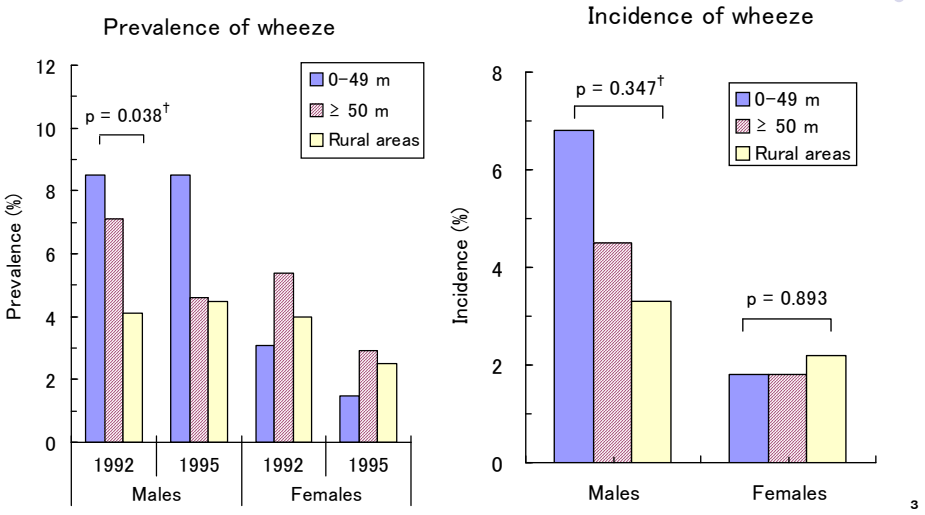
Incidence of asthma

1992～1995



(Shima, et al. J Epidemiol, 13: 108-119, 2003)

Prevalence and incidence of wheeze



(Shima, et al. J Epidemiol, 13: 108-119, 2003)

Odds ratios for various factors on the incidence of asthma

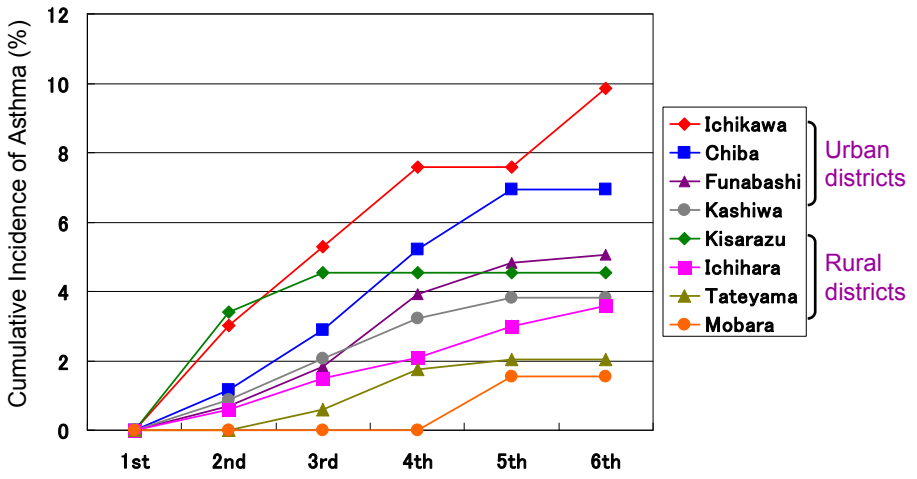
Adjusted for all variables using logistic regression model

		Males	Females
Areas	0-50 m	**3.77**	**4.03**
	> 50 m	**1.99**	**1.74**
	Rural areas	1.00	1.00
School grade, 1 grade increase		1.13	0.94
History of allergic diseases		**2.95**	**6.03**
Respiratory diseases before 2 yr		1.85	2.08
Breast feeding in infancy		1.42	0.60
Parental history of allergic diseases		2.82	1.20
Maternal smoking habits		1.74	2.15
House of steel or reinforced concrete		0.92	0.40
Use of unvented heaters in winter		1.47	0.77

(Shima, et al. J Epidemiol, 13: 108-119, 2003)

Incidence of asthma by school grade

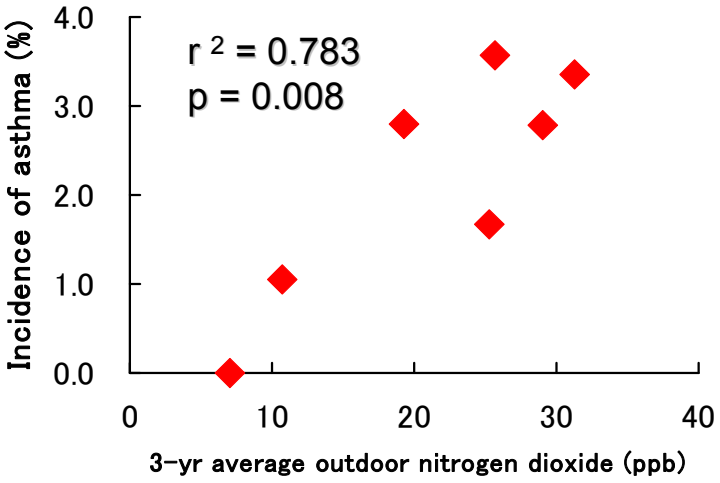
Follow-up from 1st grade to 6th grade



(Shima, et al. Arch Environ Health, 57: 529-535, 2002)

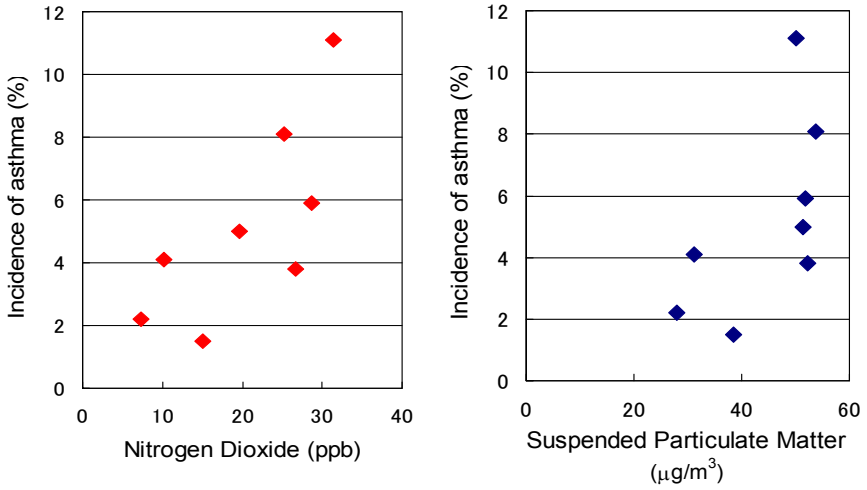
Incidence of asthma and outdoor nitrogen dioxide concentrations

(1992～1994)



(Shima, et al. Int J Epidemiol, 29: 862-870, 2000)

Associations between incidence of asthma and concentrations of NO_2 and SPM

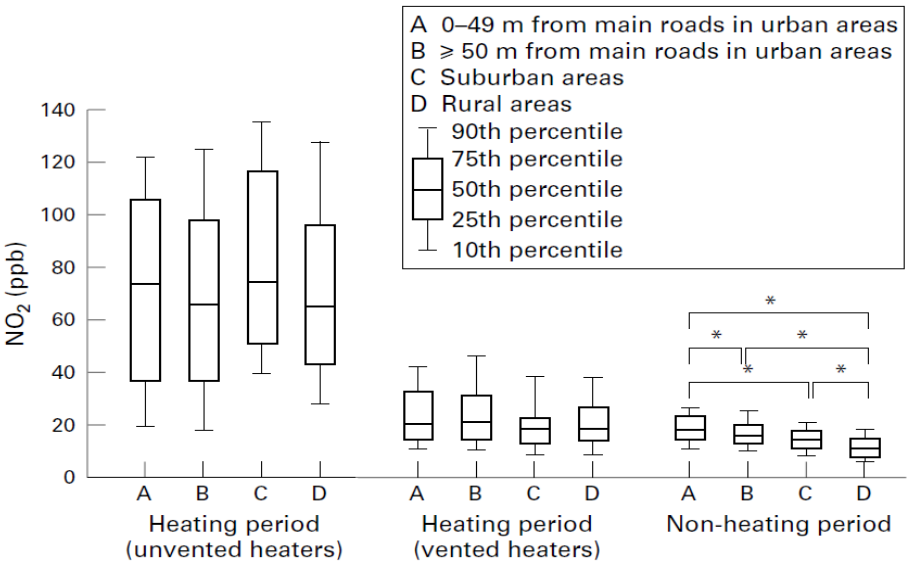


(Shima, et al. Arch Environ Health, 57: 529-535, 2002)

Measurement of Indoor nitrogen dioxide concentrations

- The concentrations of indoor NO_2 over 24 hours were measured in both the heating and non-heating periods in homes of pupils.
- The badge type passive samplers (Advantec, Tokyo, Japan) were used.
- Information on factors that could influence indoor environments was collected by questionnaire.

Indoor nitrogen dioxide concentrations



(Shima, et al. Occup Environ Med, 55: 428-433, 1998)

Odds ratios (OR) for various factors on the incidence of asthma

Adjusted for all variables using logistic regression model

	OR
Outdoor NO_2 concentration, 0.01 ppm increase	2.10
Indoor NO_2 concentration, 0.01 ppm increase	0.87
History of allergic diseases	7.96
Respiratory diseases before 2 yr	2.86
Breastfeeding in infancy	0.60
Parental history of allergic diseases	1.02
Maternal smoking habits	0.51
Use of unvented heaters in winter	1.26

(Shima, et al. Int J Epidemiol, 29: 862-870, 2000)

Summary of epidemiologic study in Chiba, Japan

- The prevalence and incidence of asthma increased among children living near major roads relative to rural areas.
- The incidence rates of asthma were significantly increased with increases of outdoor NO_2 concentrations.
- Multiple logistic regression analysis showed that 10 ppb increase of outdoor NO_2 concentrations was associated with an increased incidence of asthma (OR = 2.10).
- These findings suggest that traffic-related air pollution may be of particular importance in the development of asthma among children living near major roads with heavy traffic.

Epidemiologic study on traffic-related air pollution in Japan

Background

- Many epidemiologic studies have shown associations between traffic density and asthma prevalence or morbidity. However a few studies examine the relationship between asthma incidence and traffic-related exposures.
- Well-designed studies are needed to assess the association between exposure to traffic-related air pollution and the onset of asthma and chronic respiratory diseases.
- In view of this situation, the Japanese Ministry of the Environment has decided to launch the SORA projects (Study Of Respiratory diseases and Automobile exhaust).

Study On Respiratory disease and Automobile exhaust (SORA project)

"SORA" means sky in Japanese.

① Cohort study of school children（2005～ ）

② Nested case control study of pre-school children （2006～ ）

③ Survey of respiratory symptoms and pulmonary function among adults（2007～ ）

These studies are conducted to estimate the health effects of traffic-related air pollution in adjacent to major trunk roads in Japan.

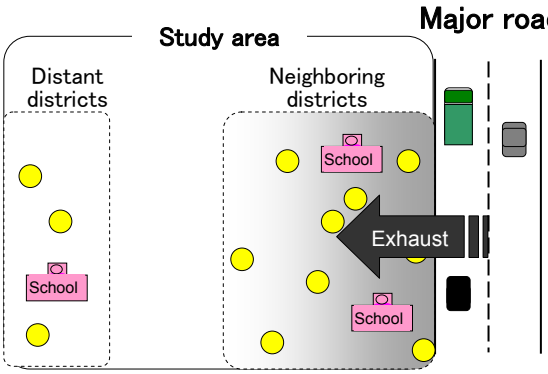
＊http://www.env.go.jp/chemi/sora/

Cohort study among schoolchildren living along trunk roads

- **A school-based prospective cohort study** have been conducted in the three metropolitan areas in Japan.
- In fall 2005, we enrolled 16,300 children (grades 1-3) in 57 primary schools.
- Of these schools, 49 schools are located in the districts with heavy traffic density (about 30,000-120,000 vehicles/day), and the other 8 schools are in the districts that were distant from major roads.

Schema of the study districts

Study subjects（◯）: 1st to 3rd schoolchildren (about 16,300)



Major roads with heavy traffic density (about 30,000-120,000 vehicles/day

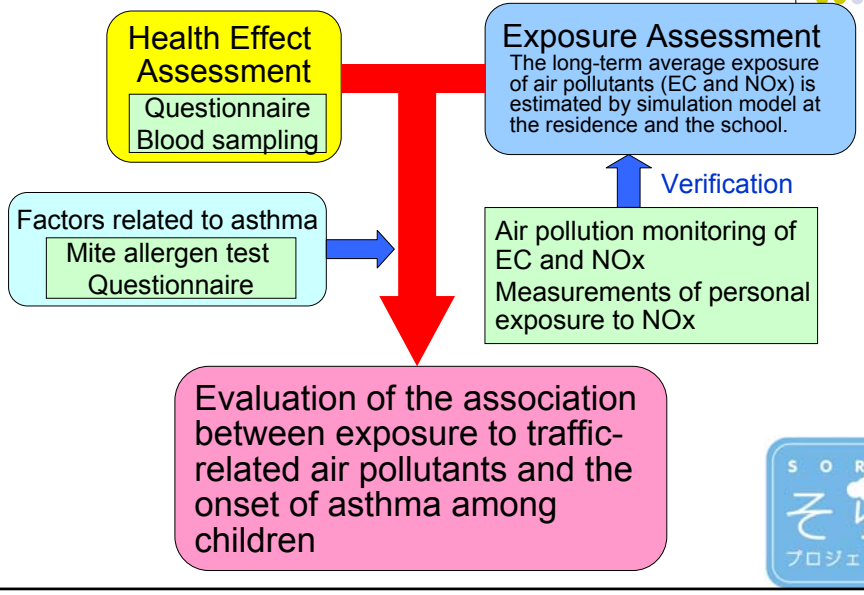
Schedule of the study

Year	2005	2006	2007	2008	2009
Questionnaire survey	Fall (grades 1-3)	Fall (grades 2-4)	Fall (grades 3-5)	Fall (grades 4-6)	Fall (grades 5-6)
Blood sampling	Fall or winter				
Mite allergen test	Fall				
Continuous air monitoring	←	—	—	—	→
Indoor and outdoor monitoring		four seasons			
Personal exposure monitoring*		four seasons			

*a part of subjects

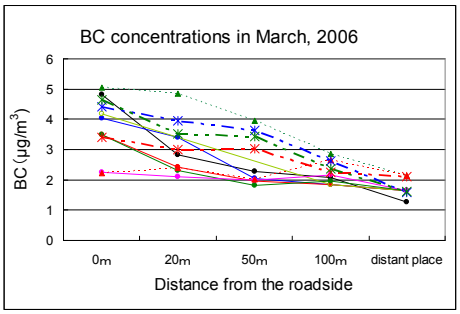
Data analysis will be performed before March, 2011.

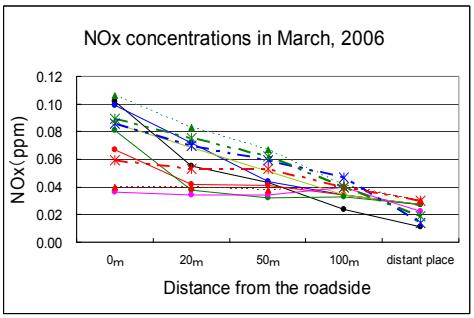
Schematic outline of the study



Provisional results of continuous air monitoring

- The concentrations of $PM_{2.5}$, black carbon (BC), and NOx have been continuously measured at 4 sites (0m, 20m, 50m, 100m) near each of 10 major roads and 7 sites distant from major roads.





Conclusions

- Various efforts during the past several decades have improved industrial air pollution.
- The problems of traffic-related air pollution have been rising in response to the increase of automobiles.
- Some studies suggest the health effects of traffic-related air pollution. However, the relationship between the incidence of asthma and traffic-related exposures should be further evaluated.
- Further studies are also needed to clarify the health effects of fine particles in relation to automobile traffic.