Table 5. Japan Studies*

Citation	Design	Study Location	Study Period	Study Sample	Exposure	Health Outcome	Summary of Published Findings
Ando M, Shima M, Adachi M, et al. 2001. The role of intercellular adhesion molecule-1 (ICAM-1), vascular cell adhesion molecule-1 (VCAM-1), and regulated on activation, normal T-cell expressed and secreted (RANTES) in the relationship between air pollution and asthma among children. Arch Environ Health 56:227–233.	Cross section	Kimitsu, Obitsu, Osaka, Miyazaki	1994–1995	230 children (8–11 yr) from 5 elementary schools	PM_{10}, NO_2	Respiratory symptoms, adhesion molecules, chemokines	Adhesion molecules or chemokines were associated with asthma. Intercellular adhesion molecule-1 may play an important role between air pollution and the occurrence of asthma.
Choi KS, Inoue S, Shinozaki R. 1997. Air pollution, temperature, and regional differences in lung cancer mortality in Japan. Arch Environ Health 52:160–168.	Ecologic	47 prefectures	1970–1990	All lung cancer deaths	NO_2, SO_2, traffic emissions	Lung cancer mortality (every 5 years)	Regional differences in age-adjusted lung cancer death rates were explained by NO_2 and temperature. Temperature increased the effect of NO_2 on lung cancer deaths compared with NO_2 alone in 1 region.
Fuji Y, Shima M, Ando M, et al. 2002. Effect of air pollution and environmental tobacco smoke on serum hyaluronate concentrations in school children. Occup Environ Med 59:124–128.	Cross section	Kimitsu, Obitsu, Osaka, Miyazaki	1994–1995	1037 schoolchildren	Ambient air pollution (PM_{10}, SO_2, NO_2)	Serum hyaluronate concentration	Serum hyaluronate concentration was associated with the level of air pollution and exposure to environmental tobacco smoke. Children with asthma or wheeze and children with higher IgE concentrations might be more susceptible to environmental factors.
Honda Y, Nitta H, Ono M. 2003. Low level carbon monoxide and mortality of persons aged 65 or older in Tokyo, Japan, 1976–1990. J Health Sci 49:454–458.	Time series	Tokyo	1976–1990	Elderly people (≥ 65 yr)	SO_2, NO_2, NO, CO, oxidant	All-cause mortality	Higher CO levels were associated with increased mortality rates in persons ≥ 65 yr, even when the CO levels were lower than the National Air Quality Standard in Japan.
Honma S, Tanaka H, Teramoto S, et al. 2000. Effects of naturally-occurring acid fog on inflammatory mediators in airway and pulmonary functions in asthmatic patients. Respir Med 94:935–942.	Panel	Kushiro	1995 and 1996	26 asthmatic patients	Acid fog	Lung function, inflammatory mediators	Eosinophilic inflammation rather than hypo-osmolar effect of fog might contribute to respiratory deterioration by inhalation of naturally occurring acid fog.
Imai M, Yoshida K, Kitabatake M. 1986. Mortality from asthma and chronic bronchitis associated with changes in sulfur oxides air pollution. Arch Environ Health 41:29–35.	Cohort	Yokkaichi	1963–1983	260,000 residents	TSP, SO_2, photochemical oxidants	Mortality for bronchial asthma and chronic bronchitis	The fluctuation of annual mortality of bronchial asthma and chronic bronchitis seemed to follow the trend of air pollution levels. In the polluted area, mortality due to bronchial asthma in adults was higher when higher SO_2 levels were prevalent.
Kagamimori S, Katoh T, Naruse Y, et al. 1986. The changing prevalence of respiratory symptoms in atopic children in response to air pollution. Clin Allergy 16:299–308.	Cross section	Awara-machi	1970–1979	Schoolchildren (6–14 yr)	SPM, SO_2, NO_2, oxidants	Prevalence of respiratory symptoms	Children were divided into those who did and those who did not have a positive response to a skin test for dust mites. The positive group showed a more significant correlation between air pollution concentrations (SO_2 and NO_2) and the prevalence of respiratory symptoms.

* Last updated June 2005.

Table 5. Japan Studies*

Citation	Design	Study Location	Study Period	Study Sample	Exposure	Health Outcome	Summary of Published Findings
Kagamimori S, Katoh T, Naruse Y, et al. 1990. An ecological study on air pollution: changes in annual ring growth of the Japanese cedar and prevalence of respiratory symptoms in schoolchildren in Japanese rural districts. Environ Res 52:47–61.	Cross section	Awara-machi	1971–1979	Schoolchildren (6–14 yr)	Power plant emissions (SP, SO_2, NO_2)	Prevalence of wheezing and respiratory symptoms	The increase in prevalence of respiratory symptoms followed a deterioration of air quality.
Kimura K, Sakamoto T, Miyazaki M, et al. 2005. Effects of volcanic ash on ocular symptoms: results of a 10-year survey on schoolchildren. Ophthalmology 112:478–481.	Cross section	Sakurajima-cho, Eastern Kagoshima city	1994–2003	10,380 schoolchildren (6–15 yr)	Volcanic ash	Ocular symptoms	Ocular symptoms were significantly influenced by volcanic eruptions in the Mt. Sakurajima area, but direct influence was limited to those living in areas very near the volcano.
Kitabatake M, Manjurul H, Feng Yuan P, et al. 1995. Trends of air pollution versus those of consultation rate and mortality rate for bronchial asthma in individuals aged 40 years and above in the Yokkaichi region [in Japanese]. Nippon Eiseigaku Zasshi 50:737–747.	–	Yokkaichi	–	Residents	Ambient air pollution	Consultation rate and mortality rate for bronchial asthma	–
Kitabatake M, Piao F, Murase S, et al. 1995. Remission and recurrence of chronic obstructive lung disease in air pollution caused lung disease patients in the Yokkaichi area [in Japanese]. Nippon Koshu Eisei Zasshi 42:171–186.	Cohort	Yokkaichi	–	COPD patients in National Health Insurance	–	Recurrence and remission of asthmatic bronchitis and bronchial asthma	–
Maeda K, Nitta H, Nakai S. 1991–1992. Exposure to nitrogen oxides and other air pollutants from automobiles. Public Health Rev 19:61–72.	Cross section	Tokyo	1987–1990	2600 women (30–60 yr) 360 children (3–6 yr)	PM, NO_x, PAH	Respiratory symptoms, lung function, mutagenicity of SPM	Results suggest that exposure to automobile exhaust may be associated with respiratory symptoms but that pulmonary function did not show consistent variation overall.
Makino K. 2000. Association of school absence with air pollution in areas around arterial roads. J Epidemiol 10:292–299.	Cohort	Tokyo	1993–1997	Students in 2 elementary school	SPM, NO_2	School absence	Results from annual correlation analyses did not identify common findings for the 2 schools or for 5 years. The prevalence of absence did correlate positively with SPM, NO_2, and relative humidity; absence correlated negatively with atmospheric temperature.
Minowa M, Shigematsu I, Nagai M, et al. 1981. Geographical distribution of lung cancer mortality and environmental factors in Japan. Soc Sci Med [Med Geogr] 15D:225–231.	Ecologic	Japan	1969–1974	3297 basic autonomic units (wards, cities, towns, or villages)	Ambient air pollution	Mortality for lung cancer	Urbanization and industrialization were associated with geographical differences of lung cancer motality.
Miyao M, Furuta M, Ozawa K, et al. 1993. Morbidity of allergic rhinitis based on the National Health Insurance records of Japan. Tohoku J Exp Med 169:345–350.	Cross section	Japan	1981–1990	40,289,000 insurance policyholders	SPM, NO_2	Morbidity for allergic rhinitis	The annual level of SPM and NO_2 might be associated with morbidity of allergic rhinitis, but the pollen counts of Japanese cedars and Japanese cypresses might not.

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Citation	Design	Study Location	Study Period	Study Sample	Exposure	Health Outcome	Summary of Published Findings
Murata M, Takayama K, Fukuma S, et al. 1988. A comparative epidemiologic study on geographic distributions of cancers of the lung and the large intestine in Japan. Jpn J Cancer Res 79:1005–1016.	Ecologic	11 prefectures and 1 city (583 districts)	1975–1979	–	TSP, SO_2, NO_2, HC, traffic emissions	Morbidity and mortality for lung and colon cancer	Lung cancer was highly correlated with industrialization-related factors (such as localization of manufacturing industries, automobile traffic, and air pollution), whereas colon cancer was correlated with the population density of workers in the tertiary industries (such as services, trade, and government).
Nakai S, Nitta H, Maeda K. 1999. Respiratory health associated with exposure to automobile exhaust. III. Results of a cross-sectional study in 1987, and repeated pulmonary function tests from 1987 to 1990. Arch Environ Health 54:26–33.	Cross Section, Panel	Tokyo	1987–1990	1986 women (30–59 yr)	Traffic emissions	Lung function and respiratory symptoms	Exposure to automobile exhaust might be associated with respiratory symptoms, though repeated lung function measurements did not identify any consistent differences.
Nitta H, Sato T, Nakai S, et al. 1993. Respiratory health associated with exposure to automobile exhaust. I. Results of cross-sectional studies in 1979, 1982, and 1983. Arch Environ Health 48:53–58.	Cross section	Tokyo	1979, 1982, 1983	Women (40–59 yr) (1148 in 1979, 1758 in 1982, 1916 in 1983)	Traffic emissions	Respiratory symptoms	The exposure to automobile exhaust may be associated with an increased risk for certain respiratory symptoms, including chronic cough, chronic phlegm, chronic wheezing, and chest cold with phlegm.
Nohara M, Kagawa J, Shimizu S, et al. 2001. The relationships between the prevalence of asthmatic symptoms and environmental factors [in Japanese]. Arerugi 50:657–666.	Cross section	Yokohama	1986, 1988, 1991	13,306 students	Ambient air pollution	Prevalence of asthmatic symptoms	There was no association between asthma prevalence and air pollution levels.
Odajima, H, Hirose T, Nishima S. 1995. Air pollution (NO_2, suspended particulate material) and the number of acute hospitalization of patients with asthmatic attack [in Japanese]. Arerugi 44:160–169.	Time series	Minami-ku, Jonan-ku Fukuoka	1988–1991	3661 patients with asthmatic attacks	SPM, NO_2	Hospital admission for asthmatic attack	SPM and NO_2 levels were associated with numbers of hospital admissions for athmatic attacks in children < 6 yr. There was no such association in children 7–20 yr.
Omori T, Fujimoto G, Yoshimura I, et al. 2003. Effects of particulate matter on daily mortality in 13 Japanese cities. J Epidemiol 13:314–322.	Time series	13 largest cities in Japan	1990–1994	Elderly residents (≥ 65 yr)	SPM	Daily mortality	Each 10 $\mu g/m^3$ increase of SPM level was associated with increases in daily mortality for all causes (0.77%), for RespD (1.09%), and for CVD (0.91%).

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Ono M, Murakami M, Nitta H, et al. 1990. Epidemiological studies of air pollution and health effects in areas near roadways with heavy traffic in Tokyo [in Japanese]. Nippon Koshu Eisei Zasshi 37:321–332.	Panel	Tokyo	1987	Adults/children (805 homes)	SPM, NO_2	Respiratory symptoms	Health questionnaires were obtained from 805 homes. An SPM sampler and NO_2 filter badge were used to measure pollution levels in and outside 200 homes for 4 consecutive days within a 4-wk period. SPM and NO_2 varied widely depending on cigarette smoking, unventilated space heaters, and building air tightness. An association was observed between an increase in pollution levels and the distance from the roadway, but its effect was small compared to indoor source effects. Respiratory symptoms were more prevalent in areas nearest heavily trafficked roadways.
Oyama S, Masuko N, Tsuchiya S, et al. 1998. Analysis of air pollution and prevalence rate of allergic diseases among elementary school children in Kawaguchi and Hatogaya city [in Japanese]. Arerugi 47:1190–1197.	Cross section	Kawaguchi and Hatogaya city	1996	Elementary-school children	SPM, SO_2, NO_2	Prevalence of allergic diseases (bronchial asthma, atopic dermatitis, allergic rhinitis and/or conjunctivitis, urticaria, food allergy, and drug allergy)	No association was found between the prevalence of bronchial asthma, atopic dermatitis, allergic rhinitis, and/or conjunctivitis and air pollution, but these diseases was slightly associated with population density.
Piver WT, Ando M, Ye F, et al. 1999. Temperature and air pollution as risk factors for heat stroke in Tokyo, July and August 1980 1995. Environ Health Perspect 107:911 916.	Time series	Tokyo	1980–1995	11.8 million residents	PM_{10}, NO_2, O_3	Heat stroke	Same-day daily maximum temperature and NO_2 concentrations were the most significant risk factors for heat stroke in all age groups of men and women. Men > 65 yr were most at risk for heat stroke.
Sawaguchi T, Toro K, Sawaguchi A. 1997. Sudden infant death syndrome in relation to climatic temperature, climatic humidity and air pollution in Japan. Rom J Leg Med 5:21–24.	Time series	47 prefectures	1988–1994	–	SO_2, NO_2	Sudden infant death syndrome	No correlation was found between the incidence of sudden infant death syndrome and temperature, humidity, NO_2 level, or SO_2 level.
Sekine K, Shima M, Nitta Y, et al. 2004. Long term effects of exposure to automobile exhaust on the pulmonary function of female adults in Tokyo, Japan. Occup Environ Med 61:350–357.	Cohort	Tokyo	1987–1994	5682 women	Traffic emissions (SPM, NO_2)	Respiratory symptoms, lung function	Subjects living in areas with high levels of air pollution showed higher prevalence rates of respiratory symptoms and a larger decrease of FEV_1 compared with those living in areas with low levels of air pollution.
Setiani O. 1996. Trend of air pollution and its effect on human health in Hiroshima Prefecture: A retrospective study in the cities of Otake, Kure, Mihara, Takehara, Fukuyama and Kaita Town, 1977–1992. Hiroshima J Med Sci 45:43–50.	Cross section	Hiroshima area	1977–1992	13,836 adults (40–59 yr)	SPM, SO_2, NO_2, photochemical oxidants	Health symptoms	Comparison of questionnaire data and meterologic data identified a significant association between SO_2 and lacrimacy (symptoms of eye irritation), runny nose, and cough, and between photochemical oxidants and phlegm. NO_2 levels were negatively associated with phlegm.

* Last updated June 2005.

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Citation	Design	Study Location	Study Period	Study Sample	Exposure	Health Outcome	Summary of Published Findings
Shima M, Adachi M, Tanaka T, et al. 1999. Serum complement levels in children in communities with different levels of air pollution in Japan. Arch Environ Health 54:264–270.	Panel	Osaka, Miyazaki, Obitsu, Kimitsu	1994	1037 children (8–11 yr)	PM_{10}, SO_2, NO_2, NO	Serum concentration of complement components C3c and C4	In boys, serum levels of both C3c and C4 significantly increased as concentrations of air pollution increased in this urban population. In girls, the relation was not significant. C3c and C4 serum levels did not differ with respect to asthma or wheezing.
Shima M, Adachi M. 2000. Effect of outdoor and indoor nitrogen dioxide on respiratory symptoms in schoolchildren. Int J Epidemiol 29:862–870.	Cross section	7 communities in Chiba prefecture	1991–1993	842 children (9–10 yr)	NO_2	Morbidity: respiratory symptoms	Questionnaire responses and other data revealed a significant association between wheeze and asthma and outdoor NO_2 levels, but no such association with indoor NO_2 concentration. The data did suggest that girls may be more susceptible to indoor NO_2 than boys are.
Shima M, Nitta Y, Adachi M. 2003. Traffic-related air pollution and respiratory symptoms in children living along trunk roads in Chiba Prefecture, Japan. J Epidemiol 13:108–119.	Panel	Chiba prefecture	1991–1995	2506 schoolchildren (6–13 yr)	SPM, SO_2, NO_2	Asthma	For girls, the prevalence of asthma was higher among those living < 50 m from trunk roads and increased significantly with increases in the concentration of air pollution in each area. For boys, the prevalence of asthma did not differ in relation to distance from roads, although the rate was higher in urban areas than in rural areas.
Shima M, Nitta Y, Ando M, et al. 2002. Effects of air pollution on the prevalence and incidence of asthma in children. Arch Environ Health 57:529–535.	Panel	8 communities in Chiba prefecture	1989–1992	3049 children (6–13 yr)	PM_{10}, SO_2, NO_2	Respiratory symptoms	The prevalence of asthma among urban first-graders was not associated with air pollution concentrations in this prospective annual questionnaire study. In the followup period (second to sixth grades), however, asthma incidence was significantly associated with NO_2 levels. PM_{10} was associated with a higher incidence of asthma but not significantly.
Shimizu S, Kagawa J, Ishiguro M. 2001. The association between emergency clinic visits for asthmatic attacks and fluctuating environmental factors [in Japanese]. Arerugi 50:612–620.	Time series	Yokohama	1990–1991	–	SPM, SO_2, NO_2, NO	Nocturnal emergency-room visits for asthmatic attack	The number of emergency-room visits for asthma attacks positively correlated with increasing levels of pollutants. When both humidity and temperature decreased, the degree of correlation between hospital visits and pollution increased.
Shinkura R, Fujiyama C, Akiba S. 1999. Relationship between ambient sulfur dioxide levels and neonatal mortality near the Mt. Sakurajima volcano in Japan. J Epidemiol 9:344–349.	Time series	Yamashita public health district of Kagoshima City	1978–1988	Residents	SO_2	Neonatal mortality	Increased ambient SO_2 level was associated with excess neonatal mortality. However, more studies are needed to elucidate the mechanisms of excess neonatal mortality and ambient SO_2 levels.

* Last updated June 2005.

Table 5. Japan Studies*

Citation	Design	Study Location	Study Period	Study Sample	Exposure	Health Outcome	Summary of Published Findings
Tanaka H, Honma S, Nishi M, et al. 1996. Two-year follow-up study of the effect of acid fog on adult asthma patients. Intern Med 35:100–104.	Panel	Kushiro	1992–1993	102 patients	Acid fog	Hospital visits for asthma symptoms	Hospital visits for asthma symptoms increased on acid fog days in 8.8% of adult asthma patients. Inhalation of naturally occurring acid fog may be associated with adverse effects on the respiratory tract of asthmatic patients.
Tanaka H, Honma S, Nishi M, et al. 1998. Acid fog and hospital visits for asthma: An epidemiological study. Eur Respir J 11:1301–1306.	Time series	Kushiro	1992–1993	102 people with asthma (15–79 yr)	SPM, SO_2, NO_x, NO_2, NO, O_3, fog	Morbidity: asthma hospital visit	In nonatopic patients, fog, high O_3, and water vapor pressure, low day-to-day temperature differences, and low concentrations of atmospheric NO and NO_2 significantly contributed to increased hospital visits. In atopic patients, fog, high water vapor pressure, and low levels of atmospheric NO_2 and SO_2 contributed significantly to hospital visits.
Tango T. 1994. Effect of air pollution on lung cancer: A Poisson regression model based on vital statistics. Environ Health Perspect 102(Suppl 8):41–45.	Time series	Tokyo	1972–1988	Women (40–79 yr) from 23 wards of Tokyo	SO_2, NO_2	Mortality: lung cancer	NO_2 was positively associated with the rate of increase in lung cancer mortality. The association with SO_2 was weaker.
Yano E, Yokoyama Y, Higashi H, et al. 1990. Health effects of volcanic ash: a repeat study. Arch Environ Health 45:367–373.	Cross section	Kanoya, Tachiro	1985–1986	1991 women (30–59 yr)	Volcanic ash (SPM, SO_2, NO_2)	Prevalence of chronic bronchitis and other respiratory symptoms	There was no significant difference in non-specific respiratory symptoms and eye symptoms between area exposed to volcanic ash and control area.
Yano E, Yokoyama Y, Nishii S. 1986. Chronic pulmonary effects of volcanic ash: an epidemiologic study. Arch Environ Health 41:94–99.	Cross section	Kushira, Sakurajima, Oura	1980	2006 women (30–59 yr)	Volcanic ash (TSP, SO_2)	Prevalence of chronic bronchitis and other respiratory symptoms	In the highly exposed area, 9.9% of women experienced one or more respiratory symptoms, In the areas of medium and low exposure, 6.4% and 5.4% of women, respectively, experienced symptoms. Volcanic ash may be associated with prevalence of respiratory symptoms and diseases.
Ye F, Piver WT, Ando M, et al. 2001. Effects of temperature and air pollutants on cardiovascular and respiratory diseases for males and females older than 65 years of age in Tokyo, July and August 1980–1995. Environ Health Perspect 109:355–359.	Time series	Tokyo	July–Aug 1980–1995	Emergency transports (> 65 yr)	PM_{10}, SO_2, NO_2, CO, O_3	CVD (angina, cardiac insufficiency, hypertension, myocardial infarction) and RespD (asthma, acute and chronic bronchitis, pneumonia)	Concentrations of NO_2 or PM_{10} were associated with daily hospital emergency transports for angina, cardiac insufficiency, hyocardial infarction, asthma, acute and chronic bronchitis, and pneumonia for men and women.
Yokoyama E. 1992. Assessment of air pollution health effects on respiratory organs [in Japanese]. Nippon Eiseigaku Zasshi 47:890–900.	–	–	–	–	–	Chronic bronchitis, bronchial asthma, pulmonary cancer	–

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Yura A, Shimizu T. 2001. Trends in the prevalence of atopic dermatitis in school children: longitudinal study in Osaka Prefecture, Japan, from 1985 to 1997. Br J Dermatol 145:966–973.	Cross section	Osaka	1985–1997	4 million primary-school children (7–12 yr)	SPM, SO_2, NO_2	Prevalence of atopic dermatitis	The prevalence of atopic dermatitis increased from 15.0% in 1985 to 24.1% in 1993, but leveled off afterward. A significant inverse correlation between atopic dermatitis prevalence and air pollution was observed among Japanese primary-school children.

* Last updated June 2005.