

**Table 3. Research in Japan\***

Citation	Design	Study Location	Study Period	Study Sample	Pollutants	Health Outcomes	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 sectional	Japan Kimitsu Obitsu Osaka Miyazaki	1994– 1995	230 children (8–11 yr) from 5 elementary schools	PM <sub>10</sub> , NO <sub>2</sub>	Respiratory symptoms, adhesion molecules, chemokines	Adhesion molecules or chemokines were associated with asthma. Intracellular adhesion molecule 1 might play an important role in the relationship 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	Japan 47 prefectures	1970– 1990	Lung cancer deaths	NO <sub>2</sub> , SO <sub>2</sub> , traffic emissions	Mortality from lung cancer	Regional differences in age-adjusted rates of lung cancer death were explained by NO <sub>2</sub> and temperature. In one region, higher temperatures increased the effect of NO <sub>2</sub> on lung cancer deaths compared with NO <sub>2</sub> alone.
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 sectional	Japan Kimitsu Obitsu Osaka Miyazaki	1994– 1995	1037 school-children	Ambient air pollution (PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> )	Serum hyaluronate concentration	Serum hyaluronate concentration was associated with the concentration of air pollution and exposure to environmental tobacco smoke. Children with asthma or wheezing and children with higher IgE concentrations might be more susceptible to environmental factors.
Higashino H, Mita K, Yoshikado H, et al. 2007. Exposure and risk assessment of 1,3-butadiene in Japan. Chem Biol Interact 166:52–62.	Health impact	Japan	1997– 1999, 2002– 2003	126 million residents of Japan	1,3-Butadiene	Lifetime cancer risk	The majority of the population of Japan has an excess lifetime cancer risk < 10 <sup>-5</sup> . But the study found that a small number of people living close to sources of industrial pollution had a risk > 10 <sup>-5</sup> ; 2.0 excess cancer cases per year are expected.
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	Japan Tokyo	1976– 1990	Elderly residents (≥65 yr)	SO <sub>2</sub> , NO <sub>2</sub> , NO, CO, oxidant	Mortality (all-cause)	Higher CO concentrations were associated with increased mortality rates in people ≥65 yr even when the concentrations were lower than Japan's National Air Quality Standard.

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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. <i>Respir Med</i> 94:935–942.	Panel	Japan Kushiro	1995, 1996	26 asthma patients	Acid fog	Lung function, inflammatory mediators	Eosinophilic inflammation, rather than the hypo-osmolar effect of fog, might contribute to respiratory deterioration from inhalation of naturally occurring acid fog.
Ikeda M, Zhang ZW, Shimbo S, et al. 2000. Exposure of women in general populations to lead via food and air in East and Southeast Asia. <i>Am J Ind Med</i> 38:271–280.	Cross sectional	Southeast Asia China Japan South Korea	1991– 1997	20–50 women from each of 11 cities	Lead	Blood, food, and urine lead concentrations	Average blood lead concentrations in 11 cities in East and Southeast Asia ranged from 3.2 to 6.5 µg/dL. Average concentrations for Tokyo and Kyoto (3.8 µg/dL) were lower than those for the other Asian cities. The overall average for Japan (including both urban and rural areas) was even lower (1.9 µg/dL).
Imai M, Yoshida K, Kitabatake M. 1986. Mortality from asthma and chronic bronchitis associated with changes in sulfur oxides air pollution. <i>Arch Environ Health</i> 41:29–35.	Cohort	Japan Yokkaichi	1963– 1983	260,000 residents of Yokkaichi	TSP, SO <sub>2</sub> , photochemical oxidants	Mortality (bronchial asthma, chronic bronchitis)	Fluctuations in annual mortality from bronchial asthma and chronic bronchitis seemed to follow the trend of air pollution concentrations. In the polluted area, mortality from bronchial asthma in adults was higher when SO <sub>2</sub> concentrations were higher.
Imai M, Yoshida K, Tomita Y, et al. 1980. A change in air pollution and its influence on the human body in Yokkaichi City: On the prevalence rate of respiratory symptoms. <i>Mie Med J</i> 30:129–138.	Cross sectional	Japan Yokkaichi Mihama Kusu	1973– 1974, 1978	Residents (>40 yr)	SPM, SO <sub>x</sub> , NO <sub>x</sub>	Chronic bronchitis, asthma	The prevalence of chronic bronchitis and asthma was positively correlated with concentrations of SPM, SO <sub>2</sub> , and NO <sub>x</sub> .
Imai M, Yoshida K, Tomita Y, et al. 1981. Air pollution levels and death from chronic obstructive lung diseases in Yokkaichi [in Japanese]. <i>Nippon Eiseigaku Zasshi [Japanese Journal of Hygiene]</i> 36:671–677.	Ecologic	Japan Yokkaichi	1963– 1979	Residents of Yokkaichi	Ambient air pollution	COPD, asthma, bronchitis, emphysema, mortality	Pollution-control measures led to reductions, first in asthma, then in chronic bronchitis and emphysema, to rates similar to those in a control area.

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Iwai K, Mizuno S, Miyasaka Y, et al. 2005. Correlation between suspended particles in the environmental air and causes of disease among inhabitants: Cross-section studies using the vital statistics and air pollution data in Japan. <i>Environ Res</i> 99:106–117.	Cross sectional	Japan	2000	Residents of Japan	PM <sub>10</sub> , PM <sub>2.5</sub>	Age-adjusted mortality	A significant correlation was observed between both SPM and converted PM <sub>2.5</sub> concentrations and age-adjusted death rates from ischemic heart disease or hypertensive heart disease in both males and females.
Kagamimori S, Katoh T, Naruse Y, et al. 1986. The changing prevalence of respiratory symptoms in atopic children in response to air pollution. <i>Clin Allergy</i> 16:299–308.	Cross sectional	Japan Awara-machi	1970– 1979	School-children (6–14 yr)	SPM, SO <sub>2</sub> , NO <sub>2</sub> , oxidants	Prevalence of respiratory symptoms	Children with a positive response to a skin test for dust mites showed a more significant correlation between SO <sub>2</sub> and NO <sub>2</sub> concentrations and the prevalence of respiratory symptoms than did children who did not have a positive response.
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. <i>Environ Res</i> 52:47–61.	Cross sectional	Japan Awara-machi	1971– 1979	School-children (6–14 yr)	Power-plant emissions (SPM, SO <sub>2</sub> , NO <sub>2</sub> )	Wheezing, respiratory symptoms	An increase in the 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. <i>Ophthalmology</i> 112:478–481.	Cross sectional	Japan Sakurajima-cho Eastern Kagoshima City	1994– 2003	10,380 school-children (6–15 yr)	Volcanic ash	Ocular symptoms	Ocular symptoms were significantly influenced by volcanic eruptions in the Mt. Sakurajima area, but direct influences were limited to those living in areas very near the volcano.

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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]. <i>Nippon Eiseigaku Zasshi [Japanese Journal of Hygiene]</i> 50:737–747.	Ecologic	Japan Yokkaichi	—	Residents of Yokkaichi	Ambient air pollution	Consultation rate and mortality rate for bronchial asthma	Consultation rates were not associated with air pollution concentrations in children (< 10 yr), but the influence of past air pollution was evident in adults > 40 yr. A significant correlation was observed between the consultation rate for the females in each age group and the rate of patients receiving public assistance. The mortality rate from bronchial asthma in the polluted area increased rapidly, with a time lag of several years after the peak of air pollution, but decreased gradually thereafter with subsequent improvements in air quality.
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]. <i>Nippon Koshu Eisei Zasshi [Japanese Journal of Public Health]</i> 42:171–186.	Cohort	Japan Yokkaichi	—	COPD patients in National Health Insurance	—	Recurrence and remission of asthmatic bronchitis and bronchial asthma	The overall incidence of recurrence after remission in asthmatic bronchitis and bronchial asthma was 25% among patients with diseases legally recognized as being caused by air pollution (Group A) and 18% among patients with diseases not legally recognized as being caused by air pollution (Group B), although differences varied with age. Total remission rates for patients who had remission without recurrence and those who had remission after recurrence of bronchial asthma were approximately 39% in Group A and 77% in Group B.
Maeda K, Nitta H, Nakai S. 1991–1992. Exposure to nitrogen oxides and other air pollutants from automobiles. <i>Public Health Rev</i> 19:61–72.	Cross sectional	Japan Tokyo	1987– 1990	2600 women (30–60 yr), 360 children (3–6 yr)	PM, NO <sub>x</sub> , PAH	Respiratory symptoms, lung function, mutagenicity of SPM	Exposure to automobile exhaust might be associated with respiratory symptoms, but lung function did not show consistent variation overall.

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Maeda Y, Shida T, Akiyama K. 2005. Childhood onset adult asthma: A comparison of asthma development with exposure to high and reduced levels of air pollution. <i>Allergol Int</i> 54:435–441.	Cohort	Japan Sagamihara	1972– 1995	10,823 children	SPM, SO <sub>2</sub> , NO <sub>2</sub>	Asthma	Airway hypersensitivity of infantile-asthma patients born in the 1960s (when air pollution concentrations were high) was much more pronounced than that of infantile-asthma patients born in the 1970s (when air pollution concentrations were lower). The air pollution of the 1960s might have accelerated the development of infancy-onset asthma.
Makino K. 2000. Association of school absence with air pollution in areas around arterial roads. <i>J Epidemiol</i> 10:292–299.	Cohort	Japan Tokyo	1993– 1997	Students in 2 elementary schools	SPM, NO <sub>2</sub>	School absences	Results from annual correlation analyses did not identify common findings for the two schools or the five years of the study period. The prevalence of school absences correlated positively with SPM, NO <sub>2</sub> , and relative humidity and negatively with temperature.
Minowa M, Shigematsu I, Nagai M, et al. 1981. Geographical distribution of lung cancer mortality and environmental factors in Japan. <i>Soc Sci Med [Med Geogr]</i> 15D:225–231.	Ecologic	Japan	1969– 1974	3297 wards, cities, towns, and villages	Ambient air pollution	Mortality from lung cancer	Urbanization and industrialization were associated with geographic differences in mortality from lung cancer.
Miyao M, Furuta M, Ozawa K, et al. 1993. Morbidity of allergic rhinitis based on the National Health Insurance records of Japan. <i>Tohoku J Exp Med</i> 169:345–350.	Cross sectional	Japan	1981– 1990	40,289,000 insurance policyholders	SPM, NO <sub>2</sub>	Morbidity (allergic rhinitis)	Annual concentrations of SPM and NO <sub>2</sub> might be associated with morbidity from allergic rhinitis, but pollen counts for Japanese cedars and cypresses might not be.
Murakami Y, Ono M. 2006. Myocardial infarction deaths after high level exposure to particulate matter. <i>J Epidemiol Community Health</i> 60:262–266.	Time series	Japan Metropolitan Tokyo	1990– 1994	11.8 million residents of Tokyo	SPM	Myocardial infarction, mortality	An increased rate ratio of deaths from myocardial infarction was seen within a few hours of exposure to high SPM concentrations. If the exposure was less than 6 hours long, a gradual increase in the rate ratio was seen with increases in SPM exposure.

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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. <i>Jpn J Cancer Res</i> 79:1005–1016.	Ecologic	Japan 11 prefectures and 1 city	1975– 1979	—	TSP, SO <sub>2</sub> , NO <sub>2</sub> , hydrocarbons, 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). Colon cancer was correlated with the population density of workers in 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-section study in 1987, and repeated pulmonary function tests from 1987 to 1990. <i>Arch Environ Health</i> 54:26–33.	Panel	Japan Tokyo	1987– 1990	1986 women (30–59 yr)	Traffic emissions	Lung function, respiratory symptoms	Exposure to automobile exhaust might be associated with respiratory symptoms, though no consistent differences of repeated lung function measurements by exposure were identified.
Nakatsuka H, Watanabe T, Ikeda M, et al. 1991. Comparison of the health effects between indoor and outdoor air pollution in northeastern Japan. <i>Environ Int</i> 17:51–59.	Cross sectional	Japan Miyagi	1984	≥ 30,000 city residents (≥40 yr)	Pollutants from indoor space heaters and heavy road traffic	Respiratory and ophthalmic symptoms	Respiratory and ophthalmic symptoms were found to be significantly more prevalent in households that used unvented indoor space heaters than those that used vented heaters. Symptom prevalence was also increased among those who lived closer to roads with heavy traffic. Proximity to traffic had a stronger effect on symptom prevalence than the use of unvented space heaters.
Nitta H, Sato T, Nakai S, et al. 1993. Respiratory health associated with exposure to automobile exhaust. I. Results of cross-section studies in 1979, 1982, and 1983. <i>Arch Environ Health</i> 48:53–58.	Cross sectional	Japan Tokyo	1979, 1982, 1983	Women (40– 59 yr): 1148 in 1979, 1758 in 1982, 1916 in 1983	Traffic emissions	Respiratory symptoms	Exposure to automobile exhaust might be associated with an increased risk of 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]. <i>Arerugi [Allergy]</i> 50:657–666.	Cross sectional	Japan Yokohama	1986, 1988, 1991	13,306 students	Ambient air pollution	Prevalence of asthma symptoms	No association was found between the prevalence of asthma symptoms and air pollution concentrations.

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Odajima H, Baba M. 1987. Relation between the incidence of mediastinal and subcutaneous emphysema complicating bronchial asthma and the concentration of NO <sub>2</sub> in the atmosphere [in Japanese]. <i>Nihon Kyobu Shikkan Gakkai Zasshi</i> 25:1278–1283.	Ecologic	Japan Tokyo	1973– 1984	Cases of moderate to severe asthma attacks	NO <sub>2</sub> , NO <sub>x</sub>	Mediastinal and subcutaneous emphysema, asthma	No relationship was found between the incidence of mediastinal and subcutaneous emphysema complications in cases of bronchial asthma and concentrations of NO <sub>2</sub> and NO <sub>x</sub> . A significant relationship was found between the incidence of these two complications and cases of asthma attack when NO <sub>2</sub> concentrations were between 0.02 and 0.04 ppm.
Odajima H, Hirose T, Nishima S. 1995. Air pollution (NO <sub>2</sub> , suspended particulate material) and the number of acute hospitalization of patients with asthmatic attack [in Japanese]. <i>Arerugi [Allergy]</i> 44:160–169.	Time series	Japan Minami-ku Jonan-ku Fukuoka	1988– 1991	3661 patients with asthma attacks	SPM, NO <sub>2</sub>	Hospital admissions for asthma attack	SPM and NO <sub>2</sub> concentrations were associated with the number of hospital admissions for asthma attacks in children <6 yr. No such association was found for persons 7–20 yr.
Omori T, Fujimoto G, Yoshimura I, et al. 2003. Effects of particulate matter on daily mortality in 13 Japanese cities. <i>J Epidemiol</i> 13:314–322.	Time series	Japan 13 largest cities	1990– 1994	Elderly residents (≥65 yr)	SPM	Daily mortality	Each 10-μg/m <sup>3</sup> increase in SPM concentration was associated with increases in daily mortality from all causes (0.77%), respiratory disease (1.09%), and cardiovascular disease (0.91%).
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]. <i>Nippon Koshu Eisei Zasshi [Japanese Journal of Public Health]</i> 37:321–332.	Panel	Japan Tokyo	1987	Adults and children (805 homes)	SPM, NO <sub>2</sub>	Respiratory symptoms	An association was observed between an increase in pollution concentrations and distance from roadways with heavy traffic. But its effect was small compared with indoor source effects, such as cigarette smoking and unventilated space heaters. Respiratory symptoms were more prevalent in areas nearest the roadways.
Ono M, Omori T, Nitta H. 2007. Is the midnight-to-midnight average concentration of pollutants an appropriate exposure index for a daily mortality study? <i>J Expo Sci Environ Epidemiol</i> 17:84–87.	Time series	Japan 13 major cities	1990– 1994	Residents	SPM, SO <sub>2</sub> , NO <sub>2</sub> , CO, oxidants	Daily mortality (all-cause, cardiovascular disease, respiratory disease)	A new exposure index was introduced that takes into account the average exposure in the 24 hours prior to the time of death instead of simply the previous day's midnight-to-midnight exposure. Risk ratios calculated using the new index (at lag 0) are greater.

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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]. <i>Arerugi [Allergy]</i> 47:1190–1197.	Cross sectional	Japan Kawaguchi Hatogaya	1996	Elementary school children	SPM, SO <sub>2</sub> , NO <sub>2</sub>	Prevalence of allergic diseases (bronchial asthma, atopic dermatitis, allergic rhinitis and/or conjunctivitis, urticaria, food allergy, drug allergy)	No association was found between air pollution and the prevalence of bronchial asthma, atopic dermatitis, or allergic rhinitis and/or conjunctivitis. But population density was slightly associated with these diseases.
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. <i>Environ Health Perspect</i> 107:911–916.	Time series	Japan Tokyo	1980–1995	11.8 million residents of Tokyo	PM <sub>10</sub> , NO <sub>2</sub> , O <sub>3</sub>	Heat stroke	Same-day daily maximum temperature and NO <sub>2</sub> 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. <i>Rom J Leg Med</i> 5:21–24.	Time series	Japan 47 prefectures	1988–1994	—	SO <sub>2</sub> , NO <sub>2</sub>	Sudden infant death syndrome (SIDS)	No correlation was found between NO <sub>2</sub> concentrations, SO <sub>2</sub> concentrations, temperature, or humidity and the incidence of SIDS.
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. <i>Occup Environ Med</i> 61:350–357.	Cohort	Japan Tokyo	1987–1994	5682 women	Traffic emissions (SPM, NO <sub>2</sub> )	Respiratory symptoms, lung function	Subjects living in areas with high concentrations of air pollution showed higher prevalence rates of respiratory symptoms and a larger decrease in FEV <sub>1</sub> than those living in areas with low concentrations 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. <i>Hiroshima J Med Sci</i> 45:43–50.	Cross sectional	Japan Hiroshima area	1977–1992	13,836 adults (40–59 yr)	SPM, SO <sub>2</sub> , NO <sub>2</sub> , photochemical oxidants	Health symptoms	A comparison of questionnaire responses and meteorologic data identified significant associations between SO <sub>2</sub> and lacrimacy (symptoms of eye irritation), runny nose, and cough and between photochemical oxidants and phlegm. NO <sub>2</sub> concentrations were negatively associated with phlegm.

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Shima M, Adachi M. 1996. Serum immunoglobulin E and hyaluronate levels in children living along major roads. Arch Environ Health 51:425–430.	Cross sectional	Japan Chiba prefecture	1992–1993	236 school-children (blood samples collected from 185)	Motor vehicle exhaust (estimated from traffic density)	Total IgE and hyaluronate serum concentrations	Serum hyaluronate concentrations were higher in schoolchildren who lived < 50 m from a major road than those who lived farther away. Children with high serum IgE concentrations appeared to be particularly susceptible to the effects of motor vehicle exhaust.
Shima M, Adachi M. 2000. Effect of outdoor and indoor nitrogen dioxide on respiratory symptoms in school-children. Int J Epidemiol 29:862–870.	Cross sectional	Japan 7 communities in Chiba prefecture	1991–1993	842 children (9–10 yr)	NO <sub>2</sub>	Morbidity (respiratory symptoms)	Questionnaire responses and other data revealed a significant association between outdoor NO <sub>2</sub> concentrations and wheezing and asthma but no association between indoor NO <sub>2</sub> and these respiratory symptoms. Girls might be more susceptible to indoor NO <sub>2</sub> than boys are.
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	Japan Osaka Miyazaki Obitsu Kimitsu	1994	1037 children (8–11 yr)	PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> , NO	Serum concentrations of complement components C3c and C4	In boys, serum concentrations of C3c and C4 significantly increased as concentrations of air pollution increased in this urban population. In girls, the relation was not significant. Serum concentrations of C3c and C4 did not differ with respect to asthma or wheezing.
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	Japan Chiba prefecture	1991–1995	2506 school-children (6–13 yr)	SPM, SO <sub>2</sub> , NO <sub>2</sub>	Asthma	For girls, the prevalence of asthma was higher among those living < 50 m from major roads and increased significantly with increases in the concentration of air pollution in each area. For boys, the prevalence of asthma did not differ with distance from roads, although it was higher in urban areas than in rural areas.

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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	Japan 8 communities in Chiba prefecture	1989– 1992	3049 children (6–13 yr)	PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub>	Respiratory symptoms	In this prospective annual questionnaire study, the prevalence of asthma among urban first-graders was not associated with air pollution concentrations. In a follow-up period (2nd to 6th grades), however, asthma incidence was significantly associated with NO <sub>2</sub> concentrations. PM <sub>10</sub> was associated with a higher incidence of asthma, but the association was not significant.
Shimizu S, Kagawa J, Ishiguro M. 2001. The association between emergency clinic visits for asthmatic attacks and fluctuating environmental factors [in Japanese]. Arerugi [Allergy] 50:612–620.	Time series	Japan Yokohama	1990– 1991	—	SPM, SO <sub>2</sub> , NO <sub>2</sub> , NO	Nighttime emergency- department visits for asthma attack	The number of emergency-department visits for asthma attacks was correlated with increasing concentrations of pollutants. When both humidity and temperature decreased, the degree of correlation between the visits and the pollutants 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	Japan Yamashita public health district of Kagoshima City	1978– 1988	Residents	SO <sub>2</sub>	Neonatal mortality	Increased ambient SO <sub>2</sub> concentrations were associated with excess neonatal mortality. However, more studies are needed to elucidate the mechanisms.
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	Japan Kushiro	1992– 1993	102 asthma 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 might be associated with adverse effects on the respiratory tract of asthma 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	Japan Kushiro	1992– 1993	102 people with asthma (15–79 yr)	SPM, SO <sub>2</sub> , NO <sub>x</sub> , NO <sub>2</sub> , NO, O <sub>3</sub> , fog	Morbidity (hospital visits for asthma)	In nonatopic patients, fog, high O <sub>3</sub> , high humidity, low day-to-day temperature differences, and low concentrations of atmospheric NO and NO <sub>2</sub> significantly contributed to increased hospital visits. In atopic patients, only fog, high humidity, and low concentrations of atmospheric NO <sub>2</sub> and SO <sub>2</sub> contributed significantly to hospital visits.

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Tango T. 1994. Effect of air pollution on lung cancer: A Poisson regression model based on vital statistics. <i>Environ Health Perspect</i> 102(Suppl 8):41–45.	Time series	Japan Tokyo	1972–1988	Women from 23 wards of Tokyo (40–79 yr)	SO <sub>2</sub> , NO <sub>2</sub>	Mortality (lung cancer)	NO <sub>2</sub> was positively associated with the rate of increase in mortality from lung cancer. The association with SO <sub>2</sub> was weaker.
Voorhees AS, Araki S, Sakai R, et al. 2000. An ex post cost-benefit analysis of the nitrogen dioxide air pollution control program in Tokyo. <i>J Air Waste Manag Assoc</i> 50:391–410.	Health impact	Japan Tokyo	1973–1994	All residents of Tokyo	Costs and benefits of Tokyo's NO <sub>2</sub> -control programs (1973–1994)	Medical costs, cost of lost wages	Net estimates of the averted medical costs of pollution-related phlegm and sputum in adults and of respiratory illnesses in children were U.S.\$6.08 billion and U.S.\$775 million, respectively. Net estimates of the averted costs of lost wages in workers and in mothers caring for sick children were U.S.\$6.33 billion and U.S.\$833 million, respectively.
Yamazaki S, Nitta H, Fukuhara S. 2006. Associations between exposure to ambient photochemical oxidants and the vitality or mental health domain of the health related quality of life. <i>J Epidemiol Community Health</i> 60:173–179.	Cross sectional	Japan	2002	2896 people (> 20 yr)	SPM, NO <sub>x</sub> , oxidants	Vitality, mental health	Vitality was associated with mean oxidant concentrations over the previous two months.
Yamazaki S, Nitta H, Murakami Y, Fukuhara S. 2005. Association between ambient air pollution and health-related quality of life in Japan: Ecological study. <i>Int J Environ Health Res</i> 15:383–391.	Cross sectional	Japan	—	3395 people (> 16 yr)	SPM, NO <sub>x</sub>	Vitality, mental health	The study suggested that health-related quality of life (HRQOL) can be used to assess the adverse effects of air pollution on health.

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Yamazaki S, Nitta H, Ono M, et al. 2007. Intracerebral haemorrhage associated with hourly concentration of ambient particulate matter: Case–crossover analysis. <i>Occup Environ Med</i> 64:17–24.	Case–crossover	Japan Chiba Fukuoka Hiroshima Kawasaki Kitakyushu Kobe Kyoto Nagoya Osaka Sapporo Sendai Metropolitan Tokyo Yokohama	1990–1994	City residents (≥65 yr)	PM <sub>7</sub> , NO <sub>2</sub> , photochemical oxidants	17,354 deaths from intracerebral hemorrhage, 46,370 deaths from ischemic stroke	Death from intracerebral hemorrhage was associated with exposure to high concentrations of PM <sub>7</sub> (> 200 µg/m <sup>3</sup> ) two hours before death (OR, 2.4; 95% CI, 1.5–3.9), independent of the 24-hr mean concentration. Air quality standards for PM should be based not only on 24-hr mean concentrations, but also on hourly data.
Yamazaki S, Sokejima S, Nitta H, et al. 2005. Living close to automobile traffic and quality of life in Japan: A population-based survey. <i>Int J Environ Health Res</i> 15:1–9.	Cross sectional	Japan Naie	2000	4836 residents of Naie (> 20 yr)	Traffic pollution	Vitality, mental health	Traffic exposure was found to lead to lower vitality and mental health for respondents living near roadways. Health-related quality of life (HRQOL) can be used to evaluate the effects of traffic exposure on health.
Yanagisawa Y, Nishimura H, Matsuki H, et al. 1986. Personal exposure and health effect relationship for NO <sub>2</sub> with urinary hydroxyproline to creatinine ratio as indicator. <i>Arch Environ Health</i> 41:41–48.	Cross sectional	Japan Suginami Aikawa (communities in Tokyo)	1980–1981	800 mothers of primary school children	NO <sub>2</sub> (personal exposure)	Ratio of urinary hydroxyproline to creatinine (as a biomarker of NO <sub>2</sub> )	The ratio of urinary hydroxyproline to creatinine was positively correlated with personal exposure to NO <sub>2</sub> and with cigarette smoking. The effects of NO <sub>2</sub> were independent of cigarette smoking.
Yano E, Yokoyama Y, Higashi H, et al. 1990. Health effects of volcanic ash: A repeat study. <i>Arch Environ Health</i> 45:367–373.	Cross sectional	Japan Kanoya Tachiro	1985–1986	1991 women (30–59 yr)	Volcanic ash (SPM, SO <sub>2</sub> , NO <sub>2</sub> )	Chronic bronchitis, other respiratory symptoms	There was no significant difference in the prevalence of nonspecific respiratory symptoms or eye symptoms between an area exposed to volcanic ash and control areas.

\* Last updated September 2007. — = not provided.

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Yano E, Yokoyama Y, Nishii S. 1986. Chronic pulmonary effects of volcanic ash: An epidemiologic study. Arch Environ Health 41:94–99.	Cross sectional	Japan Kushira Sakurajima Oura	1980	2006 women (30–59 yr)	Volcanic ash (TSP, SO <sub>2</sub> )	Prevalence of chronic bronchitis and other respiratory symptoms	In an area highly exposed to volcanic ash, 9.9% of women experienced one or more respiratory symptoms. In areas of medium and low exposure, 6.4% and 5.4% of women, respectively, experienced symptoms. Volcanic ash might be associated with the prevalence of respiratory symptoms and disease.
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	Japan Tokyo	July–Aug. 1980–1995	Hospital emergency transports (people > 65 yr)	PM <sub>10</sub> , SO <sub>2</sub> , NO <sub>2</sub> , CO, O <sub>3</sub>	Cardiovascular disease (angina, cardiac insufficiency, hypertension, myocardial infarction), respiratory disease (asthma, acute and chronic bronchitis, pneumonia)	Concentrations of NO <sub>2</sub> or PM <sub>10</sub> were associated with daily hospital emergency transports for angina, cardiac insufficiency, myocardial 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 [Japanese Journal of Hygiene] 47:890–900.	—	—	—	—	—	Chronic bronchitis, bronchial asthma, pulmonary cancer	—
Yorifuji T, Yamamoto E, Tsuda T, et al. 2005. Health impact assessment of particulate matter in Tokyo, Japan. Arch Environ Occup Health 60:179–185.	Health impact	Japan Tokyo	2001–2003 (exposure data), 2002 (outcome data)	7.8 million residents of Tokyo (> 30 yr)	PM (SPM, assumed to be PM <sub>10</sub> )	All-cause mortality from PM exposure (excluding violent deaths and accidents)	Achieving stricter PM-exposure guidelines would increase the number of deaths prevented. If the long-term reference concentration of PM <sub>2.5</sub> were reduced to 12 µg/m <sup>3</sup> , 8% of all-cause mortality (6700 deaths) could be prevented per year.

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Citation	Design	Study Location	Study Period	Study Sample	Pollutants	Health Outcomes	Summary of Published Findings
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. <i>Br J Dermatol</i> 145:966–973.	Cross sectional	Japan Osaka	1985– 1997	4 million primary school children (7–12 yr)	SPM, SO <sub>2</sub> , NO <sub>2</sub>	Atopic dermatitis	The prevalence of atopic dermatitis increased from 15.0% in 1985 to 24.1% in 1993 but leveled off thereafter. A significant inverse correlation between the prevalence of atopic dermatitis and air pollution was observed among Japanese primary school children.
Zhang ZW, Moon CS, Watanabe T, et al. 1997. Background exposure of urban populations to lead and cadmium: Comparison between China and Japan. <i>Int Arch Occup Environ Health</i> 69:273–281.	Cross sectional	China Beijing Shanghai Nanning Tainan Japan Tokyo Kyoto Sendai	1993– 1995	202 Chinese women, 72 Japanese women	Lead, cadmium	Blood lead and cadmium concentrations	Average dietary lead intake (25.8 µg/day) and blood lead concentrations (5.67 µg/dL) in the Chinese women were significantly higher than in the Japanese women (11.6 µg/day in food, 3.21 µg/dL in blood). Background lead exposure was higher in the Chinese women.

\* Last updated September 2007. — = not provided.