

Table 7. Research in Singapore*

Citation	Design	Study Location	Study Period	Study Sample	Pollutants	Health Outcomes	Summary of Published Findings
Chew FT, Goh DY, Lee BW. 1999. Geographical comparison of the prevalence of childhood asthma and allergies in Singapore. <i>Ann Trop Paediatr</i> 19:383–390.	Cross sectional	Singapore	1994	2030 school-children 6–7 yr, 4208 school-children 12–15 yr	Ambient air pollution	Asthma, allergies	Using data from an International Study on Asthma and Allergies in Childhood (ISAAC) questionnaire, it was found that geographic differences in the prevalence of asthma and rhinitis were associated with demographic and socioeconomic factors but not with air pollution or environmental factors.
Chew FT, Goh DYT, Ooi BC, et al. 1999. Association of ambient air-pollution levels with acute asthma exacerbation among children in Singapore. <i>Allergy</i> 54:320–329.	Time series	Singapore	1990–1994	2.7 million residents of Singapore	TSP, SO ₂ , NO ₂ , O ₃	Morbidity (acute asthma, emergency-department visits)	Singapore's overall concentrations of air pollution were generally within WHO air quality guidelines. Higher concentrations of SO ₂ and TSP were associated with more frequent emergency-department visits for children 3–12 yr, but not for those 13–21 yr.
Chew FT, Ooi BC, Hui JK, et al. 1995. Singapore's haze and acute asthma in children. <i>Lancet</i> 346:1427.	Descriptive	Singapore	1994	Children (< 12 yr)	PM ₁₀ from forest-fire haze	Emergency-department visits for acute asthma	An increase in emergency-department visits for acute asthma was observed in children exposed to forest-fire haze.
Emmanuel SC. 2000. Impact to lung health of haze from forest fires: The Singapore experience. <i>Respirology</i> 5:175–182.	Time series (episode)	Singapore	1997	—	PM ₁₀ , SO ₂ , NO ₂ , CO, O ₃ , haze	Outpatient visits and mortality for respiratory disease, accidents, emergency visits	During several months of haze from forest fires, a 50- to 150-µg/m ³ increase in PM ₁₀ concentrations was significantly associated with increases in outpatient visits for upper respiratory illness (12%), asthma (19%), and rhinitis (26%). Neither hospital admissions nor mortality increased significantly.
Goh, KT, Lun KC, Chong YM, et al. 1986. Prevalence of respiratory illnesses of school children in the industrial, urban and rural areas of Singapore. <i>Trop Geogr Med</i> 38:344–350.	Cross sectional	Singapore	1983	3216 primary school children	Air pollution (industrial, urban)	Respiratory symptoms and illnesses (cough, wheezy chest, blocked or running nose, sinusitis, asthmatic attacks, bronchitis or pneumonia, lung function)	Differences in the prevalence of respiratory illnesses and in lung function tests were observed among children in three areas, but these could not be accounted for by variations in air pollution concentrations.

* Last updated September 2007. — = not provided.

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Neo KS, Goh KT, Sam CT. 2000. Blood lead levels of a population group not occupationally exposed to lead in Singapore. <i>Southeast Asian J Trop Med Public Health</i> 31:295–300.	Cross sectional	Singapore	1995–1997	269 government employees	Lead	Blood lead concentrations	Exposure to traffic, age (>50 yr), and active smoking were significantly associated with blood lead concentrations.
Ooi PL, Goh KT, Heng BH, et al. 1991. Biological monitoring of human exposure to environmental lead in Singapore. <i>Rev Environ Health</i> 9:207–213.	Cross sectional	Singapore	1990–1991	1408 children and adults (6 mo–50 yr)	Lead	Blood lead concentrations	The average blood lead concentration was 7.66 µg/dL. Multivariate analyses showed that significant variations in blood lead concentrations were related to sex, age, active and passive smoking, exposure to traffic, and exposure to recent paintwork.
See SW, Balasubramanian R, Yang TS, et al. 2006. Assessing exposure to diesel exhaust particles: A case study. <i>J Toxicol Environ Health A</i> 69:1909–1925.	Health impact	Singapore Boon Lay bus interchange	2003–2004	—	PM _{2.5} , PAHs	Lifetime cancer risk	A lifetime cancer risk of 1.64×10^{-6} to 2.70×10^{-6} was reported, based on the assumption that the amount of air inhaled was 20 m ³ /day. Taking the deposition fraction into account, the risk was still higher (1.11×10^{-6} to 1.82×10^{-6}).
Sultan ZM. 2007. Estimates of associated outdoor particulate matter health risk and costs reductions from alternative building, ventilation and filtration scenarios. <i>Sci Total Environ</i> 377:1–11.	Health impact	Singapore	2002	—	Outdoor PM	Savings from reduced health risks associated with improved building design, ventilation, and filtration	Findings suggested that nationwide adoption of improved building, ventilation, and filtration strategies would reduce the number of health cases attributable to PM pollution by approximately half, amounting to savings of U.S.\$17.7 billion. For residential buildings, closed residences and air-conditioning would be associated with fewer cases of mortality (10% and 6%, respectively) and morbidity (8% and 4%, respectively) as well as savings of U.S.\$1.5 billion and U.S.\$0.9 billion, respectively. Mechanical ventilation and filtration in schools would be associated with fewer hospital admissions for asthma and its exacerbations. Enhanced workplace filtration would reduce cases of mortality and morbidity by 14% and 13%, respectively, amounting to savings of up to U.S.\$2.4 billion.

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Tan WC, Qiu D, Liam BL, et al. 2000. The human bone marrow response to acute air pollution caused by forest fires. <i>Am J Respir Crit Care Med</i> 161:1213–1217.	Panel (episode)	Singapore	1997	30 men (19–24 yr)	PM ₁₀ , SO ₂ , NO ₂ , CO, O ₃	FEV ₁ , FVC, bone-marrow and blood-cell responses (PMNs)	During the 1997 haze from forest fires, serial white blood cell counts showed that elevated counts of band neutrophils were significantly associated with elevated PM ₁₀ and SO ₂ compared with a period after the haze had cleared.

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