



Table 3. Southeast Asia Studies*

Citation	Design	Study Location	Study Period	Study Sample	Exposure	Health Outcome	Summary of Published Findings
INDONESIA							
Aditama TY. 2000. Impact of haze from forest fire to respiratory health: Indonesian experience. <i>Respirology</i> 5:169–174.	Descriptive (episode)	8 provinces	1997–1998	General population	Haze disaster	Respiratory health	Data collected from pulmonologists, health offices, and hospitals indicated a “significant” increase in respiratory conditions that the authors attributed to air pollution haze.
Browne DR, Husni A, Risk MJ. 1999. Airborne lead and particulate levels in Semarang, Indonesia and potential health impacts. <i>Sci Total Environ</i> 227:145–154.	Health impact	Semarang	1996–1997	1.3 million adults and children	TSP, airborne lead	Mortality (total, RespD)	Increased TSP near major roads resulted in an estimated 1.6% increase in total mortality and a 7.9% increase in RespD mortality.
Duki MI, Sudarmadi S, Suzuki S, et al. 2003. Effect of air pollution on respiratory health in Indonesia and its economic cost. <i>Arch Environ Health</i> 58:135–143.	Cross section, Health impact	Jakarta, Bandar Lampung	1996–1997	16,663 pairs of junior-high-school students and their mothers	NO ₂	Prevalence rate of respiratory symptoms, savings in mean direct out-of-pocket expense per capita for treatment and reduce average work/school days lost per capita	The prevalence rate of respiratory symptoms is significantly associated with NO ₂ . The reduction of NO ₂ to a proposed level of 25 ppb could yield savings in mean direct out-of-pocket expense per capita for treatment of the respiratory symptoms of 6.8–7.9 US dollars, and reduce average work/school days lost per capita by 3.1–5.5 days.
Frankenberg E, McKee D, Thomas D. 2005. Health consequences of forest fires in Indonesia. <i>Demography</i> 42:109–129.	Cross section (episode)	Indonesia	1997	Adults (30–55 yr, ≥ 56 yr, men and women)	Haze from forest fire	Respiratory symptoms, difficulty of carrying a heavy load, general health	Between 1993–1997, individuals who exposed to haze experienced greater increases in difficulties with activities of daily living than did their counterparts in nonhaze areas. The results for respiratory and general health suggest that haze had a negative health impact.
Hong CY, Chia SE, Widjaja D, et al. 2004. Prevalence of respiratory symptoms in children and air quality by village in rural Indonesia. <i>J Occup Environ Med</i> 46:1174–1179.	Cross section	Kerinci, SP7, Pelalawan	2001	382 children	PM ₁₀ , NO ₂ , CO, HC	Prevalence of respiratory symptoms	High PM ₁₀ and hydrocarbon level was associated with higher prevalence of respiratory symptoms in two studied villages.
Kunii O, Kanagawa S, Yajima I, et al. 2002. The 1997 haze disaster in Indonesia: Its air quality and health effects. <i>Arch Environ Health</i> 57:16–22.	Cross section	Jakarta, Jambi	1997	543 adults and children	Haze disaster (PM ₁₀ , NO ₂ , CO, O ₃ , PAHs,)	Respiratory symptoms, lung function	Questionnaire interviews and lung function spirometry tests indicated respiratory symptoms in more than 90% of participants in the presence of PM ₁₀ and CO levels at very low or hazardous levels and PAH levels 6–14 times higher than an unaffected area. Gender, asthma, and wearing a mask were associated with severity of symptoms.
Ostro B. 1994. Estimating the health effects of air pollutants: A method with an application to Jakarta. Policy Research Working Paper 1301. The World Bank, Washington DC.	Health impact	Jakarta	–	–	PM, SO ₂ , NO ₂ , O ₃ , lead	Health benefits	This report proposes a method for quantifying the benefits of reduced air pollution and applies the method to data from Jakarta.

* Last updated June 2006.





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Tri-Tugaswati A, Yasuo K. 1996. Effect of air pollution on respiratory symptoms of junior high school students in Indonesia. Southeast Asian J Trop Med Public Health 27:792–800.	Cross section	Jakarta and surrounding cities	1994	16,187 junior high school students	NO ₂	Respiratory symptoms (cough, phlegm, wheeze, etc)	In a self-administered questionnaire, the prevalence of persistent cough was 7.3–10.8% and persistent phlegm was 4.5–5.0%. A significant relation was found between NO ₂ exposure and the prevalence of cough, phlegm, and wheeze.
MALAYSIA							
Mott JA, Mannino DM, Alverson CJ, et al. 2005. Cardiorespiratory hospitalizations associated with smoke exposure during the 1997, Southeast Asian forest fires. Int J Hyg Environ Health 208:75–85.	Cohort, Time series (episode)	Kuching	1995–1998	Attendants of 7 hospitals	Forest fire smoke	Hospitalization for all causes, RespD, cardiorespiratory diseases, circulatory diseases, COPD, and asthma	Significant fire-related increases were observed in respiratory hospitalizations, especially those for COPD and asthma. Survival analyses indicated that persons > 65 yr with previous hospital admissions were significantly more likely to be rehospitalized for any cause, cardiorespiratory, and respiratory diseases during the post-fire period.
Sastry N. 2002. Forest fires, air pollution, and mortality in southeast Asia. Demography 39:1–23.	Time series (episode)	Multiple cities in Malaysia	1997	All deaths	Forest fire smoke	Mortality	Smoke haze from widespread forest fires had a deleterious effect on the health of the population.
SINGAPORE							
Chew FT, Goh DY, Lee BW. 1999. Geographical comparison of the prevalence of childhood asthma and allergies in Singapore. Ann Trop Paediatr 19:383–390.	Cross section	Singapore	1994	2030 schoolchildren (6–7 yr), 4208 schoolchildren (12–15 yr)	Ambient air pollution	Asthma and allergies	In data from an International Study on Asthma and Allergies in Childhood (ISAAC) questionnaire, outcomes were associated with demographic and socioeconomic differences, 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. Allergy 54:320–329.	Time series	Singapore	1990–1994	2.7 million people	TSP, SO ₂ , NO ₂ , O ₃	Morbidity: acute asthma, emergency room visits	Although overall levels of air pollution were generally within World Health Organization quality guidelines, higher levels of SO ₂ and TSP were associated with more frequent emergency room 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. Lancet 346(8987):1427.	Descriptive	Singapore	1994	Children (< 12 yr)	PM ₁₀ from forest fire haze	Emergency room visits for acute asthma	An increase in children's emergency room visits for acute asthma was observed due to exposure to forest fire haze.

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Citation	Design	Study Location	Study Period	Study Sample	Exposure	Health Outcome	Summary of Published Findings
SINGAPORE (Continued)							
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 RespD, accident, and emergency visit	During several months of haze from forest fires, an increase of PM ₁₀ from 50 to 150 µg/m ³ 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 section	Singapore	1983	3216 primary-school children	Industrial, urban air pollution	Respiratory symptoms and illnesses for cough, wheezy chest, blocked/running nose, sinusitis, asthmatic attacks, bronchitis/pneumonia, and lung function	The differences in the prevalence of respiratory illnesses and lung function tests were observed among children in 3 areas, but this could not be accounted for by the varying air pollution levels.
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 and FVC, bone marrow and blood cell response (PMNs)	During the 1997 haze from forest fires, serial white blood cell counts showed that elevated band neutrophil counts were significantly associated with elevated PM ₁₀ and SO ₂ compared with a period after the haze had cleared.
THAILAND							
Aekplakorn W, Loomis D, Vichit-Vadakan N, et al. 2003. Acute effect of sulphur dioxide from a power plant on pulmonary function of children, Thailand. <i>Int J Epidemiol</i> 32:854–861.	Panel	Mae Moh district	1997	175 children (6–14 yr)	PM ₁₀ , SO ₂	Lung function	Declines in lung function among asthmatic children were associated with increases in particulate air pollution, rather than with increases in SO ₂ .
Aekplakorn W, Loomis D, Vichit-Vadakan N, et al. 2003. Acute effects of SO ₂ and particles from a power plant on respiratory symptoms of children, Thailand. <i>Southeast Asian J Trop Med Public Health</i> 34:906–914.	Panel	Mae Moh district	–	196 children (94 asthmatics and 98 non-asthmatics) (6–14 yr)	PM ₁₀ , PM _{10-2.5} , PM _{2.5} , SO ₂	Respiratory symptoms (upper and lower respiratory symptoms, cough)	During the study period, SO ₂ was not associated with respiratory symptoms in either asthmatics or non-asthmatics. Each 10 µg/m ³ increase in PM ₁₀ was modestly associated with an increase of lower respiratory incidence and cough in asthmatics.
Aekplakorn W, Loomis D, Vichit-Vadakan N, et al. 2004. Heterogeneity of daily pulmonary function in response to air pollution among asthmatic children. <i>Southeast Asian J Trop Med Public Health</i> 35:990–998.	Panel	Mae Moh district	1997	83 children (6–14 yr)	PM ₁₀ , SO ₂	Lung function (FVC, FEV ₁ , PEFR, and FEF ₂₅₋₇₅)	Even with the low concentration of daily SO ₂ and PM ₁₀ in study area, there was association between inter-individual variance for subject-specific changes in FVC, FEV ₁ , and PEFR and short-term exposure to SO ₂ and PM ₁₀ in children.

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THAILAND (Continued)							
Karita K, Yano E, Jinsart W, et al. 2001. Respiratory symptoms and pulmonary function among traffic police in Bangkok, Thailand. Arch Environ Health 56:467–470.	Cross section	Bangkok	1998–1999	206 policemen	Traffic emissions	Lung function, respiratory symptoms	Results of lung function spirometry and respiratory questionnaires showed no consistent decrease in pulmonary function in urban traffic police. Mean FEV ₁ and FVC were significantly lower in all urban police than in rural police. Respiratory symptoms were slightly more prevalent among urban police.
Ostro B, Chestnut L, Vichit-Vadakan N, et al. 1999. The impact of particulate matter on daily mortality in Bangkok, Thailand. J Air Waste Manage Assoc 49:PM100–PM107.	Time series	Bangkok	1992–1995	More than 6 million people	PM ₁₀	Mortality (all except accidental, homicidal, suicidal)	PM ₁₀ was significantly associated with alternative measures of daily mortality. The results suggest relative risks consistent with or greater than those reported in most US studies: A 10 µg/m ³ change in daily PM ₁₀ was associated with 1–2% increases in natural and CVD mortality and a 3–6% increase in RespD mortality.
Pisani P, Srivatanakul P, Randerson-Moor J, et al. 2006. Gstm1 and Cyp1a1 polymorphisms, tobacco, air pollution, and lung cancer: A study in rural Thailand. Cancer Epidemiol Biomarkers Prev 15:667–674.	Case control	Lampang province, Thailand	1993–1995	211 lung cancer cases, 202 controls (set 1), 211 controls (set 2)	Power plant emissions	Lung cancer	No significant association between cumulative air pollution indexes and lung cancer, even in nonsmoker subjects.
Pothikamjorn SL, Ruxrungtham K, Thampanitchawong P, et al. 2002. Impact of particulate air pollutants on allergic diseases, allergic skin reactivity and lung function. Asian Pac J Allergy Immunol 20:77–83.	Cross section	Bangkok	1999	290 high-school students	PM ₁₀	Allergic symptoms, allergic skin sensitivity, lung function	A significant increase in school absence and medical expenses was associated with high PM ₁₀ exposure.
Preutthipan A, Udomsubpayakul U, Chaisupamongkollarp T, et al. 2004. Effect of PM ₁₀ pollution in Bangkok on children with and without asthma. Pediatr Pulmonol 37:187–192.	Panel	Bangkok	1999	133 students (3rd–9th grade)	PM ₁₀ , SO ₂ , CO, O ₃	Respiratory symptoms and peak expiratory flow rate	When daily PM ₁₀ level exceeded 120 µg/m ³ , the daily reported nasal irritation of asthmatic children was significantly higher than days when PM ₁₀ levels were < 120 µg/m ³ . Peak expiratory flow rate did not change with different ambient PM ₁₀ levels in both non-asthmatic and asthmatic groups.
Tamura K, Jinsart W, Yano E, et al. 2003. Particulate air pollution and chronic respiratory symptoms among traffic policemen in Bangkok. Arch Environ Health 58:201–207.	Cross section	Bangkok	1998–1999	1603 policemen	Traffic emissions	Chronic nonspecific respiratory symptoms	Among nonsmokers, the prevalence of nonspecific respiratory disease in the heavily polluted areas was significantly higher than that in the suburban control area. For each 10 µg/m ³ increase in PM ₁₀ , the odds ratio for chronic nonspecific respiratory symptoms was 1.11.

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Thanh BD, Lefevre T. 2001. Assessing health benefits of controlling air pollution from power generation: the case of a lignite-fired power plant in Thailand. <i>Environ Manage</i> 27:303–317.	Health impact	Thailand	1992–1995	Residents	Power plant emissions (PM ₁₀ and SO ₂)	Health and monetary benefit from flue gas desulfurization of power plant	The installation of the flue gas desulfurization to control SO ₂ emission at Mae Moh significantly reduces adverse health effects not only on the population living near the power plant but also all over the country. The benefit is much higher than the investment and operation costs of equipment.
Vajanapoom N, Shy CM, Neas LM, et al. 2002. Associations of particulate matter and daily mortality in Bangkok, Thailand. <i>Southeast Asian J Trop Med Public Health</i> 33:389–399.	Time series	Bangkok	1992–1997	Residents	PM ₁₀ , visibility	Daily mortality for all causes (except for injury and poisoning), respiratory diseases, cardiovascular diseases, and other diseases	Increasing PM ₁₀ and decreasing visibility levels were independently associated with increasing daily mortality from non-external causes, cardiovascular, respiratory, and other diseases. The associations were stronger for respiratory diseases than for cardiovascular and other diseases and were stronger for persons ≥65 yr than for those in the younger age group.
Vichit-Vadakan N, Ostro BD, Chestnut LG, et al. 2001. Air pollution and respiratory symptoms: Results from three panel studies in Bangkok, Thailand. <i>Environ Health Perspect</i> 109(Suppl 3):381–387.	Panel	Bangkok	1995–1996	92 adults, 80 nurses, 79 children (8–12 yr)	PM ₁₀ , PM _{2.5}	Respiratory symptoms	Daily upper and lower respiratory symptoms were generally associated with daily PM ₁₀ and PM _{2.5} concentrations. Estimated odds ratios were consistent with or slightly higher than those reported in US studies. Time trends in data make the effect magnitude uncertain.
Wongsurakiat P, Maranetra KN, Nana A, et al. 1999. Respiratory symptoms and pulmonary function of traffic policemen in Thonburi. <i>J Med Assoc Thai</i> 82:435–443.	Cross section	Bangkok	1996–1997	629 traffic policemen, 303 controls	Traffic emissions	Respiratory symptoms, lung function	Nonsmoker traffic policemen had significantly higher prevalence of cough, phlegm, rhinitis symptoms, and abnormal air flow than nonsmoker controls. Mean FEV ₁ and FVC values were also significantly lower for the policemen. Policemen who did not wear protective masks had significantly increased prevalence of abnormal FVC compared with controls and abnormal FEV ₁ and FVC compared with mask-wearing policemen.

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