



## A case-crossover analysis of forest fire haze events and mortality in Malaysia



Mazrura Sahani <sup>a,\*</sup>, Nurul Ashikin Zainon <sup>a</sup>, Wan Rozita Wan Mahiyuddin <sup>b</sup>,  
Mohd Talib Latif <sup>c,e</sup>, Rozita Hod <sup>d</sup>, Md Firoz Khan <sup>e</sup>, Norhayati Mohd Tahir <sup>f,g</sup>,  
Chang-Chuan Chan <sup>h</sup>

<sup>a</sup> Environmental Health and Industrial Safety Program, School of Diagnostic Science and Applied Health, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur, Malaysia

<sup>b</sup> Institute for Medical Research, Ministry of Health, Jalan Pahang, 50588 Kuala Lumpur, Malaysia

<sup>c</sup> School of Environmental and Natural Resource Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

<sup>d</sup> Department of Community Health, Faculty of Medicine, Universiti Kebangsaan Malaysia, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Cheras, Kuala Lumpur, Malaysia

<sup>e</sup> Centre for Tropical Climate Change System (IKLIM), Institute for Climate Change, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

<sup>f</sup> School of Marine Science and Environment, University of Malaysia Terengganu, 21030 Kuala Terengganu, Terengganu, Malaysia

<sup>g</sup> Institute of Oceanography and Environment (INOS), University of Malaysia Terengganu, 21030 Kuala Terengganu, Terengganu, Malaysia

<sup>h</sup> Institute of Occupational Medicine and Industrial Hygiene, Global Health Center, College of Public Health, National Taiwan University, Room 722, No. 17, Xuzhou Road, Taipei City 100, Taiwan

### HIGHLIGHTS

- We modelled association of haze events and daily mortality using a case-crossover study design.
- Days with daily PM<sub>10</sub> > 100 µg/m<sup>3</sup> were defined as haze events.
- Haze events were significantly associated with natural and respiratory mortality at various lags.
- Immediate effects of haze were particularly seen among males.
- Children and adult females mortalities were associated with delayed effects.

### ARTICLE INFO

#### Article history:

Received 25 March 2014

Received in revised form

23 July 2014

Accepted 26 July 2014

Available online 29 July 2014

#### Keywords:

Air pollution

Haze

PM<sub>10</sub>

Case-crossover

Mortality

Malaysia

### ABSTRACT

The Southeast Asian (SEA) haze events due to forest fires are recurrent and affect Malaysia, particularly the Klang Valley region. The aim of this study is to examine the risk of haze days due to biomass burning in Southeast Asia on daily mortality in the Klang Valley region between 2000 and 2007. We used a case-crossover study design to model the effect of haze based on PM<sub>10</sub> concentration to the daily mortality. The time-stratified control sampling approach was used, adjusted for particulate matter (PM<sub>10</sub>) concentrations, time trends and meteorological influences. Based on time series analysis of PM<sub>10</sub> and backward trajectory analysis, haze days were defined when daily PM<sub>10</sub> concentration exceeded 100 µg/m<sup>3</sup>. The results showed a total of 88 haze days were identified in the Klang Valley region during the study period. A total of 126,822 cases of death were recorded for natural mortality where respiratory mortality represented 8.56% ( $N = 10,854$ ). Haze events were found to be significantly associated with natural and respiratory mortality at various lags. For natural mortality, haze events at lagged 2 showed significant association with children less than 14 years old (Odd Ratio (OR) = 1.41; 95% Confidence Interval (CI) = 1.01–1.99). Respiratory mortality was significantly associated with haze events for all ages at lagged 0 (OR = 1.19; 95% CI = 1.02–1.40). Age-and-gender-specific analysis showed an incremental risk of respiratory mortality among all males and elderly males above 60 years old at lagged 0 (OR = 1.34; 95% CI = 1.09–1.64 and OR = 1.41; 95% CI = 1.09–1.84 respectively). Adult females aged 15–59 years old were

\* Corresponding author.

E-mail addresses: [mazrura@gmail.com](mailto:mazrura@gmail.com), [mazrura@fsk.ukm.my](mailto:mazrura@fsk.ukm.my) (M. Sahani).