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To cite this article: Mohd Fairus Awang *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **228** 012015

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Exposure to PM_{2.5} in urban area and respiratory health symptoms among urban workers in Klang Valley

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Abstract. Urban workers are susceptible to traffic-related air pollution (TRAP) exposure that can increase the prevalence of respiratory health symptoms among them. PM_{2.5} was the main pollutants emitted from vehicle emission during fossil fuel combustion. This will influence TRAP level in an urban environment. This study was a cross-sectional comparative study that conducted among traffic policemen (n = 160) and office workers (n = 149) in Klang Valley. The respondents' information and respiratory health symptoms were gathered using a set of questionnaire that adapted from American Thoracic Society (ATS). The air samples for personal exposure and workplace exposure were collected during working hours. The average PM_{2.5} levels for traffic policemen was 87µg/m³ (personal) and 86µg/m³ (workplace). The average PM_{2.5} levels for office workers was 28µg/m³ (personal) and 26µg/m³ (workplace). The statistical results of PM_{2.5} levels between both groups are significant difference for personal exposure (z = -15.685, p < 0.001) and workplace exposure (z = -14.519, p < 0.001). The Chi-Square test result indicates that there is a significant difference in cough episode between both groups. This study concludes that exposure to high levels of PM_{2.5} from TRAP would increase the prevalence of respiratory health symptoms among urban workers.

1. Introduction

Human activities such as transportation activity, burning solid fuel, and open burning contribute pollutants to urban air [1]. Traffic-related air pollutant (TRAP) was a major contributor to air pollution in urban areas [2] whereas vehicle emissions are the main source of TRAP [3]. According to the International Agency for Research on Cancer (IARC), outdoor air pollution was classified as a group 1 carcinogen to human. Furthermore, Fanizza et al., (2018) have found that vehicular exhaust was the main source of PM with aerodynamic diameter 2.5 µm (PM_{2.5}) based on the physicochemical [4]. In addition, the PM from TRAP consists of multiple chemical compounds, such as polycyclic aromatic hydrocarbon (PAH) [3, 5, 6]. The study finding by Silva et al. (2015) found that PAH can cause DNA damage and acts as an endpoint impact of air pollution [7].



TRAP not just deteriorates air quality in an urban environment, but also influences health risk among urban dwellers. Patton et al., (2014) suggested that residents that live near a busy road were likely to have asthma, cardiovascular and respiratory diseases, and a decreased lung function [8]. A report from Abidin et al., (2014) study on exposure of TRAP among schoolchildren in Selangor at age 10 to 11 years old found that exposure to TRAP was significantly associated with asthma symptoms among schoolchildren [9]. Meanwhile, according to Bowatte et al., (2018), TRAP exposure also has a strong association with both the incidence and persistence of asthma in middle age adults [10].

Klang Valley that is located at the center of Selangor also is a fast-growing and highly populated area in Malaysia and well known for the development of industries and community activities. The Road Transport Department Malaysia (JPJ) reported about four percent increment of vehicles on the road in Malaysia (based on reports 2012 to 2014). Therefore, this will promote the anthropogenic generation of air pollution and increase health risk in the community especially those who work outdoors. Urban workers such as traffic policemen are susceptible exposure to high levels of TRAP. Therefore, they are at the highest risk of health effect compared to those who work indoor [11]. The aim of this study is to compare the PM_{2.5} level between outdoor and indoor workers. In addition, the present study also compares the prevalence of respiratory health symptoms among respondents in Klang Valley.

2. Materials and methods

The cross-sectional comparative study was conducted between 160 traffic policemen (exposed group) and 149 office workers (comparative group) in Klang Valley. The respondents were selected based on gender, employment year and health exposure. They were male of between 20 to 60 years old, more than one-year employment, and never had radiotherapy, chemotherapy, therapeutic drug use or exposure to X-ray diagnosis in the past six months. This study was also approved by the Ethical Committee of Universiti Putra Malaysia (JKEUPM-2017-247). To gather the information on socio-demographic information and respiratory health status a set of questionnaire adapted from American Thoracic Society (ATS) was distributed among respondents. The air samples were collected during the working period for both personal and workplace exposure. PM_{2.5} was measured by using Sidepak AM520 Personal Aerosol Monitor (TSI) for personal exposure and Dusttrak Aerosol Monitor 8534 (TSI) for workplace exposure. The data was analyzed using Statistical Package for Science Version 23 (SPSS Ver. 23) for statistical analysis. The comparison of PM_{2.5} between traffic policemen and office workers was analyzed using the Mann-Whitney U test. Meanwhile, Chi-Square test was conducted for the comparison of respiratory health symptoms between both groups.

3. Results and discussions

3.1. Comparison of PM_{2.5} exposure between exposed and comparative group

195 respondents were selected for personal air sampling. Figure 1 shows the average concentrations of PM_{2.5} between traffic policemen and office workers at the workplace and personal exposure. The average personal exposure of PM_{2.5} was 87µg/m³ for traffic policemen and 28µg/m³ for office workers. The average of the PM_{2.5} level at the workplace for traffic policemen was 86µg/m³ and for office workers was 26µg/m³. Mann - Whitney U test was conducted to compare pollutants exposure among both groups. Table 1 shows the comparison of PM_{2.5} exposure between both groups. There is a significant difference of PM_{2.5} exposure between traffic policemen and office workers for personal exposure ($z = -15.685$, $p < 0.001$) and workplace exposure ($z = -14.519$, $p < 0.001$). The present study indicates that the traffic policemen experience PM_{2.5} level above the guideline limits according to WHO and Malaysia standard for 24 hours exposure.

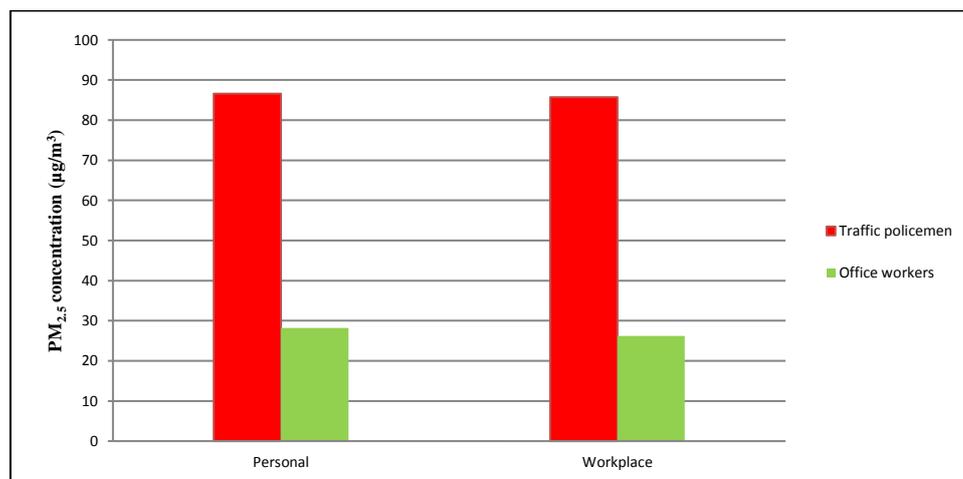


Figure 1: PM_{2.5} exposure among respondents in Klang Valley

In Malaysia environment, the concentrations of air pollutants in the urban area are higher at peak hour during weekdays [12]. According to Jalaludin et al. (2014) concentration of PM_{2.5} in the ambient was higher at morning and afternoon caused by traffic congestion of school bus in the school area. In the meantime, the nature of working hour for traffic policemen is also during peak hour [13]. As a result, this condition causes traffic policemen to be exposed to high level of air pollutants. A previous study by Muhammad et al, (2014) in Malaysia found that traffic policemen experience four times higher concentration of PM compare to the comparative group [14]. However the present study the traffic policemen were exposed to three times higher of PM_{2.5} compared to office workers. According to Shamshad et al. (2015), exposure to air pollutants from the urban area could increase the oxidative stress that can risk respiratory health [15]. Furthermore, study finding by Li et al. (2014) found that exposure to high level traffic-related PM_{2.5} has a positive relationship to DNA damage as an indication early stage of cancer [16]. Hence, the urban workers who working outdoor are expected exposure to high level of TRAP and increase the prevalence of respiratory health symptoms and health risk like cancer.

Table 1. Comparison of PM_{2.5} Exposure among Traffic Policemen and Office Workers

Variables	Group	Median (µg/m ³)	IQR (µg/m ³)	Z	p
PM _{2.5} (Personal)	Exposed	89.00	41.00	-15.685	>0.001*
	Comparative	30.00	9.00		
PM _{2.5} (Workplace)	Roadside	84.95	35.00	-14.519	>0.001*
	Office	24.30	11.30		

*Significant at $p < 0.05$, $N = 195$; exposed = 105; comparative = 90

3.2. Comparison of respiratory health symptoms among respondents

The comparison of respiratory health symptoms between traffic policemen and office workers is presented in Table 2. There were no significant difference for phlegm ($\chi^2 = 0.047$, $p = 0.828$), wheezing ($\chi^2 = 0.113$, $p = 0.737$) and chest tightness ($\chi^2 = 0.649$, $p = 0.421$) symptoms between both groups. Meanwhile, there is a significant difference in cough symptom ($\chi^2 = 5.465$, $p = 0.018$) between traffic policemen and office workers. This study finding was different from the previous study done by Muhammad et al. (2014) [14]. In their study, only phlegm shows a significant difference between the exposed group and comparative group ($\chi^2 = 8.711$, $p = 0.003$). The prevalence ratio (PR) of traffic policemen that had a cough is two times more compared to office

workers. A TRAP exposure not only affects an adult's respiratory health but also give a negative impact on children's respiratory health. Sofiah and Jalaludin (2013) reported that children that livings near the busy road, who are expected exposure to high level of PM_{2.5} were had lower lung function compared to those who live far from the busy road [17].

Table 2. Comparison of respiratory health symptoms among respondents

Variables	Exposed	Comparative	χ^2	p-value	PR	95% CI
	(160)	(149)				
Total (%)						
Cough						
Yes	61(38.1)	38(25.5)	5.465	0.018*	1.800	1.106 – 2.930**
No	99(61.9)	111(74.5)				
Phlegm						
Yes	36(22.5)	32(21.5)	0.047	0.828	1.061	0.619 – 1.820
No	124(77.5)	117(78.5)				
Wheezing						
Yes	18(11.3)	15(10.1)	0.113	0.737	1.132	0.549 – 2.337
No	142(88.7)	134(89.9)				
Chest tightness						
Yes	22(13.8)	16(10.7)	0.649	0.421	1.325	0.667 – 2.633
No	138(86.2)	133(89.3)				

N=309, *significant at p<0.05, significant PR at 95% CI > 1

4. Conclusion

This study suggested that exposure to high level of PM_{2.5} from TRAP would increase the prevalence of a cough among urban workers in Klang Valley. The traffic policemen were exposed to PM_{2.5} at three times higher than the comparative group. In addition, the prevalence of cough episode among traffic policemen was two times higher compared to office workers

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Acknowledgment

The authors would like to thank the Ministry of Higher Education, Malaysia for supporting the study with a grant under Fundamental Research Grant Scheme (Project Code: 04-01-16-1808FR). We also wish to extend our gratitude to The Royal Malaysia Police of Bukit Aman for the permission and cooperation of conducting this research among traffic policemen in Klang Valley. The authors also declare that there is no conflict of interests.