

ORIGINAL ARTICLE

Respiratory Effects of Exposure to High Levels of Particulate Among Malaysian Traffic Police

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ABSTRACT

Introduction: Malaysian traffic police are always working on the public roads to alleviate traffic congestion and therefore exposed them to the polluted air every day. In particular, polluted air containing $PM_{2.5}$ is dangerous to their respiratory health as they can penetrate deep into the lungs, leading to bronchitis, lung cancer and many more. Hence, this research examined the relationship of personal exposure level to $PM_{2.5}$ with respiratory symptoms among traffic policemen in Kuala Lumpur and Johor Bahru. **Methods:** 134 participants among traffic policemen were agreed to participate in this study. They were requested to complete a questionnaire regarding the sociodemographic background and respiratory health information. The questionnaire was adopted from International Union Against Tuberculosis Lung Diseases (1986). Personal exposure level of $PM_{2.5}$ was measured using an air pump with 5.0 μ m pore size PVC filter. **Results:** The mean exposure level of $PM_{2.5}$ among traffic policemen was 28.69 μ g/m³. It was found that some of them possess respiratory symptoms (Coughing 33.6%, Phlegm 25.4%, Wheezing 14.9% and Shortness of breath 32.1%). There was significant association detected at p-value < 0.05 in coughing. Despite, there was no significant association in other symptoms such as phlegm, wheezing and shortness of breath. **Conclusions:** Traffic police were exposed to a relatively high level of $PM_{2.5}$ (12.4 μ g/m³ to 55.3 μ g/m³) and showed symptoms of respiratory effects. Therefore, recognition of the risks connected with occupational lung disease and exposure monitoring must be a high priority. This baseline data can serve as a reference to the top management of traffic police officers in order to develop an occupational safety and health guideline for police officers as required by Occupational Safety and Health Act (OSHA, Act 514 1994).

Keywords: $PM_{2.5}$, Respiratory Health, Traffic Policemen, Ambient Air Pollution

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INTRODUCTION

Since the traffic police work in outdoor settings, they are directly subjected to air-scattered pollutants (1). Working in a setting complete of bad air has therefore made them susceptible to issues with respiratory health. Supported by the latest data on 17 September 2019 by Malaysian Department of Environment (2019) (2), the air quality index showed 158 for Kuala Lumpur and 152 in Johor Bahru achieved during the current haze episode. Exposure to these levels of air quality equates to the unhealthy level which may cause everyone to have health effects especially among members of susceptible groups such as older adults, children and asthmatic individuals (3,4).

Thousands of pollutants present in air pollution may

include mixture of solid and liquid particles (particulate matter (PM)) suspended in the air, and various gases such as volatile organic compounds (VOCs), nitrogen oxides (NO_2 or NO_x), ozone (O_3) and carbon monoxide (CO) (5). The most significant processes resulting in air pollution are the combustion of fossil fuels used in vehicles, vessels or other engines, household heating systems, in industries, or power plants (6). Emissions produced by transport-related operations, especially the use of vehicles and trucks, are the significant cause of air pollutions and will affect the people in the same vicinity. Traditionally, air pollution health effects studies have evaluated some air pollution markers (7), for instance, size-specific PM fractions, particularly, particles with an aerodynamic diameter of less than 10 μ m (PM_{10}) or less than 2.5 μ m ($PM_{2.5}$), or NO_2 respectively. Previous study also stated that among the common indirect air pollution markers used is traffic density at the closest roads or residential distance from busy roads (7).

Scientists have found that fine particle pollutants are substantially linked to respiratory morbidity and

mortality since 20 years of epidemiological studies (8). Helfand (9) and Nemery (10) reported that increment in particulate matter concentrations in the air especially particulate matter size less than 2.5 microns in diameter ($PM_{2.5}$) might immediately lead to elevated morbidity and mortality rates. The average life span of human population in the European Union (11) countries was decreased by 8.6 months by $PM_{2.5}$ itself. Not long before, Zanobetti (12) and Dominici (13) illustrated that respiratory diseases and hospitalization rate increased by 2.07% and 8% respectively when the daily $PM_{2.5}$ rose by $10 \mu\text{g}/\text{m}^3$. These studies have also shown that serious signs of illnesses of respiratory tract diseases, decreased lung function, and increased morbidity and mortality rates of cardiopulmonary illnesses were directly linked with increased air particle pollutants (8).

Besides, occupational exposure may also trigger early reversible airway obstruction as described by Das and Jha (14) in their research where employees have reported complaining about respiratory issues such as sputum cough, dry cough, breathlessness and wheezing. Muhammad (1) also reported that the services of workers in term of working days lost, increased in health cost, reduced in the productivity of working quality and other socio-demographic aspects of their lives were affected by the impacts of lung function deficiency and respiratory health issues.

Although the level of air quality in Malaysia was previously reported to be unhealthy, coupled with the nature of the work of the traffic police, which is mainly outdoors at congested junctions, there is limited literature to link air pollutant exposure with respiratory symptoms among Malaysian traffic police. In response to this problem, this research intended to find the association between $PM_{2.5}$ exposure and respiratory symptoms among traffic policemen who work in heavy traffic areas in KL and JB.

MATERIALS AND METHODS

This was a cross-sectional study involving a total of 134 traffic police in the age group of 20-56 years who worked for more than 1 year. This study was conducted in Traffic Police Station in Kuala Lumpur (Balai Trafik Jalan Tun H.S. Lee) and Johor (Balai Trafik Johor Bahru). Since KL and Johor Bahru had similar situations regarding their traffic volume, the research was done in these states. The participants were recruited using simple random sampling where they were subsequently chosen based on the inclusion criteria on the healthy traffic policemen in the age group of 20-56 years who are working in traffic junctions for more than 1 year.

$PM_{2.5}$ was measured using an air pump (Personal Air Sampling Pump- GilAir-5 and GilAir-3) which used PVC filter with $5.0\mu\text{m}$ pore size. During the measurement, the cassette was placed at the subjects breathing zone

for the entire working hours while the pump is attached to the body of respondents. In this study, the respondents wore the pump for 8 hours working from 0600 hours to 1400 hours. Preparation before sampling is done by weighing the filters in an environmentally controlled area. The filter is assembled in the filter cassettes using forceps and close firmly with plug-in each opening so there is no leakage around the filter. Before attaching the cassette to the cyclone, the interior of the cyclone is inspected and cleaned to prevent contamination. The sampler is then checked for any leakage before calibration to the appropriate flow rate with the pump. The flow rate used is $2.5 \text{ L}/\text{min} \pm 5\%$ for the AI cyclone with flexible connecting tubing (15). The average of pre and post flow rate were used to calculate the air volume which later was used to determine the concentration of $PM_{2.5}$ in air by dividing the mass of contaminant with the air volume obtained. The calibration was done before and after every sampling. For quality assurance on the sampling procedure, the samples were replicated for each batch of field samples. The post sampling weight is recorded for further calculation on respirable particulate. The formula (15) is as followed:

$$C = \frac{(W_2 - W_1) - (B_2 - B_1)}{V} \times 10^3, \text{ mg}/\text{m}^3,$$

where: W_1 = tare weight of filter before sampling (mg),
 W_2 = post-sampling weight of sample-containing filter (mg),

B_1 = mean tare weight of blank filters (mg),

B_2 = mean post-sampling weight of blank filters (mg),

V = volume as sampled at the nominal flow rate (i.e., 1.7 L/min or 2.2 L/min).

Air sampling collection method of $PM_{2.5}$ was based on the Fourth Edition of the NIOSH Manual of Analytical Methods (NMAM), (Method 0600) (15).

Besides, a questionnaire was used to determine respiratory symptoms such as chronic cough, phlegm, chest tightness and wheezing experienced by the respondents. The questionnaire was adopted from the International Union Against Tuberculosis Lung Diseases: Bronchial Symptoms Questionnaire (1989) (16).

RESULTS

The total respondents involved in this study were 83% response rate due to the hectic work and mobile as traffic police and also their work nature that makes it difficult to achieve 100% of respondents. Majority of the participants were Malay (76.1%), followed by Others (21.6%), Chinese (1.5%) and Indian (0.7%) with age ranged from 20-59 years old. Most of the respondents completed at least Secondary education (86.6%). In addition, 81.3% were smokers and despite their hectic life in working as traffic police, 82.8% of them were involved in any physical activities which they did during their ample time. According to rank, majority of them were Corporal (24.3% and 59.4%), Constable (52.9%

and 7.8%), Lance Corporal (15.7% and 21.9%) and the least were Sergeant (7.1% and 10.9%). In this study, the mean duration of services in traffic department was 6.5 years whereby in total, 53.7% of the respondents have worked for less than 6 years and 47.3% have worked for more than 6 years in this department. They also have average working hours of 9.5 hours per day. From the questionnaire, none of them wore any personal protective equipment such as mask. Table I revealed the personal concentrations of PM_{2.5} obtained from this study which were ranged from 12.4 to 55.3 µg/m³ in 8-hours of a shift work. Based on the study location, the mean of PM_{2.5} concentration reported by respondents in KL and JB police station were 27.2 µg/m³ and 30.4 µg/m³ respectively. By looking at Table II, participants in this study who reported symptoms: coughing were 33.6%, phlegm (25.4%), wheezing (14.9%) and shortness of breath (32.1%). A Chi-square test was used to determine the association of exposure to PM_{2.5} with reported respiratory symptoms among traffic policemen. Based on the data in Table II, a significant association was detected at p-value < 0.05 for coughing when exposed to high level of PM_{2.5}. Participants reported coughing symptoms as they were exposed to high concentration of PM_{2.5}. Despite, none of the remaining symptoms (phlegm, wheezing and shortness of breath) was significant.

Table I: PM_{2.5} concentration exposure

Variables	KL		JB		Total	
	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range
PM _{2.5}	27.2 ± 11.9	12.4 – 55.3	30.4 ± 9.9	14.0 – 50.8	28.7 ± 11.1	12.4 – 55.3

Table II: Association between concentration of PM_{2.5} and respiratory symptoms among traffic policemen (N=134)

Variables	Concentration of PM _{2.5} Frequency (%)		Total Frequency (%) N=134	χ ²	p-value
	Low (<35 µg/m ³)	High (≥35 µg/m ³)			
Coughing					
Yes	25 (26)	20(53)	45(33.6)	8.630	.003**
No	71(74)	18(47)	89(66.4)		
Phlegm					
Yes	21(22)	13(34)	34(25.4)	2.188	.139
No	75(78)	25(74)	100(74.6)		
Wheezing					
Yes	14(15)	6(16)	20(14.9)	.031	.860
No	82(85)	32(84)	114(85.1)		
Shortness of breath					
Yes	28(29)	15(39)	43(32.1)	1.327	.249
No	68(71)	23(61)	91(67.9)		

DISCUSSION

Through this present study, it was found that the traffic police were exposed to PM_{2.5} with a mean concentration of 28.7± 11.1 µg/m³. However, the concentration level of fine particle (PM_{2.5}) cannot be compared with

OSHA or other work standards for Time Weighted Average (TWA) for exposure level because there was no particular standard for PM_{2.5}. Compared to the New Malaysia Ambient Air Quality Guideline Standard (NAAQGS) which is, the average value of PM_{2.5} reported did not exceed the 24-hour value of 35 µg/m³ (17). The concentration level of PM_{2.5} in this present study found to be higher than the previous study conducted among traffic police and administrative police in Kuala Lumpur by Muhammad (1) which recorded mean value of 22.33±8.54 µg/m³. When compared to other studies with respect to working in outdoor environment, Amaran (18) found the mean value of 31.05±1.62 µg/m³ among roadside hawkers in Serdang which is higher mean value, compared to present study. Previous study on the concentration level of PM_{2.5} also reported a greater mean value by Fairuz in 2010 for roadside hawkers in Kelantan (19), at 31.39±14.81 µg/m³ and Mukram (20) for postmen in KL at 32.29±5.70 µg/m³.

In line with the hypothesis of this study where the participants have complaints on respiratory symptoms due to their work. As PM_{2.5} is less than 2.5 micron in size, so a possibility that inhalation of PM_{2.5} would cause respiratory symptoms could not be denied (21). PM_{2.5} is a stronger risk factor than the coarse part of PM₁₀ (particles in the 2.5–10 µm range) to cause adverse health effects on long-term exposure (22). Long-term exposure to PM_{2.5} is associated with an increase in the long-term risk of cardiopulmonary mortality by 6–13% per 10 µg/m³ (23). These results build on existing evidence of exposure to particle pollution is linked to a range of respiratory health effects (24). As indicated by the U.S. EPA, while the respiratory system has excellent resilience to air pollution through its mechanism of protection and repair, reduced in respiratory function will be the consequences of continuous exposure to increased particle pollution, even among healthy people (25).

The present study tested the hypothesis that traffic police who were exposed to a high concentration of PM_{2.5} would likely to report more coughing symptoms. This result was expected as a relatively high-level study on concentrations of particulate matter and respiratory symptoms found to be associated (26,27,28). Coughing was a typical symptom of respiratory illness as it will be the first body response to inhalation of foreign substances and small particles (29). American Lung Association stated that a cough may occur with symptoms of certain diseases of the lung, heart, stomach and nervous system. Some of the symptoms that commonly occur with a cough include sore throat, runny nose, heartburn and night sweats (30). However, this study used a self-reported questionnaire to detect respiratory symptoms hence, the clinical examination by a health practitioner is to be considered in future research. The generalizability of the results was limited by only considering traffic police from Point Duty Unit

in Kuala Lumpur and Johor Bahru only due to the lack of time and budget. Nevertheless, the results can be used as baseline data for traffic police since both KL and JB are the main city centre in Malaysia.

CONCLUSION

Traffic policemen were mainly exposed to physical hazards which emitted from vehicles such as fine particle. For this type of occupation, preventing them from being exposed to traffic pollutant is impossible; hence minimizing and monitoring the exposure is the only way out. Recognition of the risks connected with occupational lung disease and exposure monitoring must, therefore, be a high priority. A suggestion for the authorities is to have an indicator system which can effectively monitor the exposure to traffic air pollutants. By this, the authorities can take immediate action in order to protect the traffic police in the affected working area. It is under the duty of an employer under OSH Act1994 Section 15 (General Duties of Employer) to provide a safe working environment for the workers to do their job.

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