Traffic-related air pollutants (TRAP) in relation to respiratory symptoms among security guards

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Abstract. Traffic-related air pollutants (TRAP) comprises emissions from moving vehicles and secondary pollutants formed in the atmosphere. Security guards are among the outdoor workers exposed to TRAP pollutants, mainly particulate matter 2.5 (PM2.5), which can lead to chronic respiratory diseases. Occupational lung disease is a significant health concern in Malaysia, which, relatively little research on respiratory issues among Malaysian security personnel. The objective of this study is to evaluate the exposure level of TRAP PM2.5 and respiratory symptoms among security guards. The study utilized environmental monitoring to assess the concentration of TRAP PM2.5 and a questionnaire adopted from the American Thoracic Society Division of Lung Diseases questionnaire (ATS-DLD-78A) was administered to eligible respondents to observe symptoms of cough, phlegm, wheezing, and shortness of breath. Approximately 45% of the respondents reported experiencing cough as a respiratory symptom when exposed to high levels of TRAP PM2.5. Factors of smoking status and the number of cigarettes smoked per day have been identified as potential risk factors correlated with respiratory symptoms. Given this, implementing job rotations for security guards could minimize their exposure to pollutants over the long term, rather than solely focusing on raising awareness about the proper use of personal protective equipment.

1 Introduction

Security personnel protect individuals and property from crime and violence. They face physical risks, including exposure to high levels of air pollution such as particulate matter, ozone, and nitrogen dioxide. Their irregular working hours and outdoor exposure increase the risk of respiratory illnesses. PM2.5 refers to small airborne particles with a diameter of 2.5 microns or less. It can directly reach the lungs and poses a significant threat to human health.

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In a comparative study in the Klang Valley, PM2.5 concentrations at workplaces was 86 $\mu g/m^3$ for traffic police officers and 26 $\mu g/m^3$ for office workers [1].

As per the recent study by Mohd Fairus Awang *et al*, it was found that traffic police officers are exposed to PM2.5 levels exceeding both the WHO and Malaysian Ambient Air Quality Standards (MAAQS) over a 24-hour period [1]. This heightened exposure to air pollutants poses a significant health risk to traffic police officers, as they were found to be exposed to three times the amount of PM2.5 compared to office workers. This alarming level of exposure raises concerns about potential health issues, including an increased risk of respiratory problems and cancer [1]. This indicate that outdoor workers are more affected by air pollutants such as PM2.5 compared to indoor workers, leading to respiratory health problems. Therefore, outdoor workers are exposed to air pollutants related to traffic, which can potentially cause premature death with long-term exposure. A study reflecting the impact of particle exposure on labor productivity revealed a significant inverse correlation between worker productivity and PM2.5 exposures [2]. PM2.5 has a notable impact on the well-being and productivity of outdoor workers. To ensure a safe and healthy working environment for employees, it is essential to investigate the susceptibility to air contaminants related to traffic and respiratory symptoms in accordance with the Occupational Safety and Health Act (1994).

PM2.5 has been identified as the primary air pollutant affecting security guards, primarily due to traffic-related pollutants. PM2.5, is predominantly generated by the combustion of fossil fuels and vehicle exhaust [2]. As a large number of vehicles pass by the security guard house, PM2.5 from vehicle exhaust emerges as a major pollutant source. These minuscule PM2.5 particles can effortlessly infiltrate the respiratory and circulatory systems due to their diminutive size. Individuals participating in outdoor activities are particularly susceptible, as physical exertion leads to heightened inhalation of particulate matter [2]. The minuteness of PM2.5 enables them to infiltrate the respiratory system and reach the lungs, resulting in short-term health effects such as coughing, throat irritation, and breathing difficulties [2]. Limited comprehensive studies have been conducted to study relationship of the levels of traffic related air pollutant with respiratory symptoms among outdoor workers. Therefore, this study aims to determine the levels of TRAP PM2.5 and its correlation with respiratory symptoms among security guards.

2 Methodology

The research focuses on twenty healthy security guards from a private education sector working 8-hour shifts who were exposed to TRAP PM2.5. The DT-9881 Particle counter was utilized to measure the concentration of TRAP PM 2.5 during peak hours (morning: 8 a.m. – 9 a.m.; and evening: 5 p.m. – 6 p.m.) at two security guard houses with heavy traffic (South Gate and East Gate) with five replications of measurements. A green area without vehicular traffic access was used as a control for the comparison purposes. The questionnaire used in this study was adapted from the American Thoracic Society Division of Lung Disease questionnaire (ATS-DLD-78A). It encompasses sections for sociodemographic information, occupational details, lifestyle factors, and respiratory symptoms including cough, phlegm, wheezing, and shortness of breath.

3 Results and discussion

3.1 Socio-demographic, lifestyle and occupational factors

Majority of respondents (50%) fell into the 30-39 age range, followed by 25% in the 20-29 age range, 15% in the 40-49 age range, and 10% in the 50-59 age range (Table 1). All the respondents in this study were male security guards.

Table 1. Distribution of individual risk factors of the security guards (n = 20).

Socio-demographic and lifestyle factors		Percentage (%)
Age	20-29 years old	25
	30-39 years old	50
	40-49 years old	15
	50-59 years old	10
Gender	Male	100
Educational Level	Primary School	15
	Secondary School	55
	Diploma	5
	None	25
Smoking status	Smoker	70
	Non- smoker	30
Number of cigarettes per day	1-5	45
	6-10	20
	11-15	5

As for education, 55% of the respondents studied until secondary school, 15% until primary school, 5% until diploma, while 25% did not have any educational background. In terms of smoking habits, 70% of the respondents were smokers and 30% were non-smokers. Additionally, 45% of the smokers consumed 1-5 cigarettes per day, 20% smoked 6-10 cigarettes per day, and 5% smoked 11-15 cigarettes per day. Based on the data presented in Table 2, 80% of the respondents have previous work experience.

Most of the respondents have worked in the manufacturing industry (45%), 10% have worked as security guards, and the rest have worked in supermarkets, as police assistants, in hospitals, and as chefs. 50% of the respondents have worked for 1-5 years in their previous job. Currently, 100% of the respondents are working as security guards, with 90% working in this role for 1-5 years. Most of the respondents work 12 hours per day (100%) and 6 days per week (100%). Additionally, 45% of the respondents work overtime.

3.2 Concentration of TRAP PM 2.5

In Figure 1, a comparison is presented between the concentrations of TRAP PM2.5 in the morning and evening sections at two heavy traffic locations (south and east gates) and the control. The TRAP PM2.5 concentrations in the morning section were 554μg/m^3 for the South Gate and 509μg/m^3 for the East Gate. The differences in concentration between the heavy traffic security guard houses and the control fell within the range of 140 - 185 μg/m^3. It was found that both the south gate and the east gate were exposed to high concentrations of TRAP PM2.5. The trend of TRAP PM2.5 exposures are slightly high for the South Gate, possibly due to the higher number of vehicles preferring access through the South Gate rather than the East Gate.

Table 2. Distribution of occupational factor of the Security guards.

Occupational factor		Percentage (%)
Have you work anywhere before this	Yes	80
	No	20
Previous employment	Security guard	10
	Manufacturing company	45
	Supermarket	10
	Police	5
	Hospital	5
	Chef	5
Duration of previous work	1-5 years	50
	6-10 years	25
	11-15 years	5
Duration of current work	1-5 years	90
	6-10 years	5
	11-15 years	5
Working hours in a day	12 hours	100
Working days in a week	6 days	100
Overtime	Yes	45
	No	25

In the evening section, distinct variations were observed, as both security guard houses (South and East Gates) were exposed to equivalent concentrations of TRAP PM2.5 (273μg/m³). The concentration levels remained notably higher than the control (112μg/m³). This can be directly attributed to the substantial influx of vehicles passing by the security guard houses during peak morning and evening hours. This finding aligns with a comprehensive study conducted to analyse the relationship between vehicle numbers and PM2.5 pollutions in Amman, Jordan, which robustly established a significant correlation between heightened TRAP PM2.5 levels and many vehicles [3]. The emission of TRAP PM2.5 by engines poses a significant risk to the health of security guards and deteriorates air quality. This is primarily due to the minuscule size and respirable nature of TRAP PM2.5 particles, enabling them to deeply penetrate the lungs and potentially enter the bloodstream. Exposure to traffic-related air pollution (TRAP) PM2.5 has been conclusively linked to asthma, impaired lung function, allergies and etc. The particles' ability to penetrate the respiratory tract and reach the circulatory system makes them significantly more toxic than coarse particles. [4].

3.3 Respiratory symptoms among security guards

The respondents reported respiratory symptoms including cough (45%), phlegm (36%), shortness of breath (14%), and wheezing (5%) (Figure 2). Cough was the most commonly reported respiratory symptom, while wheezing was the least common. Fine airborne particles -TRAP PM2.5, are small, which allows them to easily enter the respiratory system and reach the lungs. This can lead to short-term health impacts such as flu, coughing, sneezing, as well as irritation of the eyes, nose, and throat, and shortness of breath. The findings indicate that the security guard experienced respiratory symptoms (cough, phlegm, wheezing, and shortness of breath) when exposed to TRAP PM2.5. It's important to remember that previous studies have shown a significant correlation between traffic density

and respiratory symptoms like coughing and wheezing in asthmatic children. [4]. Investigation on respiratory outcomes among adult demonstrate the exposure to the TRAP PM2.5 caused of chronic obstructive pulmonary disease and acute lower respiratory infections but still low due to the small number of qualifying studies. Therefore, susceptible groups from the security guard tendency to have coughing and wheezing as respiratory symptoms due to increased exposure to heavy traffic [5]. Despite being classified as susceptible groups, it was not feasible for them to wear air masks and use built-in air filters in the guard house. Their responsibilities, which include working under sun exposure and rotating duties to observe traffic access and exit, posed challenges for implementing these measures.

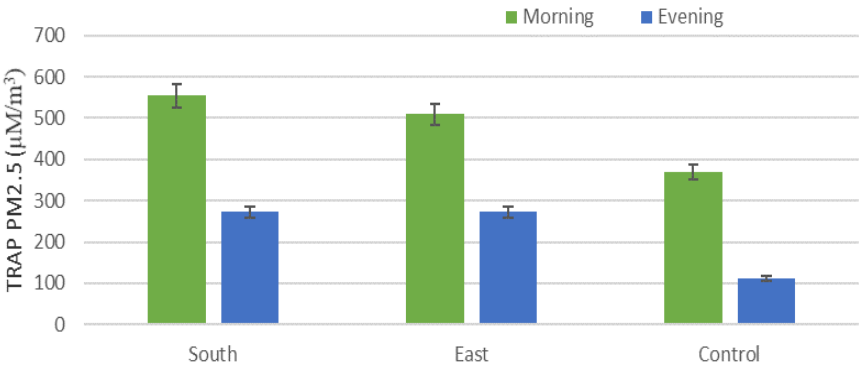

Fig. 1. Concentration of TRAP PM2.5 for morning and evening sections.

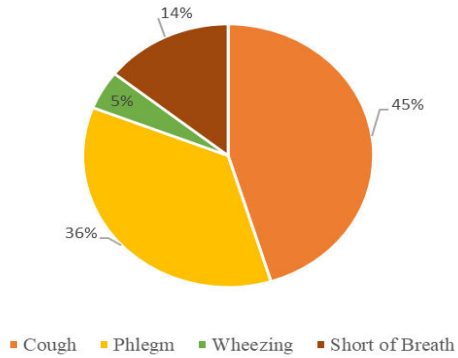

Fig. 2. Respiratory symptoms among security guard.

3.4 Correlation of exposure of TRAP PM2.5 with respiratory symptoms

In Table 3, the correlation between the concentration of TRAP PM2.5 and respiratory symptoms among security guards is presented. A significant correlation found at a p-value of 0.013 for coughing when exposed to high concentration of TRAP PM2.5 (554µm/m^3). Specifically, 85% of the respondents reported having cough symptoms when exposed to high concentrations of TRAP PM2.5 for both section morning and evening. However, none of the remaining respiratory symptoms (phlegm, wheezing, shortness of breath) have correlation with the concentration of TRAP PM 2.5. This study highlights that cough is the

respiratory symptom most closely correlate with TRAP PM2.5 exposures among security guards. Another study focusing on the exposure of PM2.5 and respiratory health symptoms among urban workers in Klang Valley found that among cough, phlegm, wheezing, and chest tightness, only cough showed a significant difference with a p-value of 0.018 in relation to PM2.5 exposures [1]. Therefore, cough is a primary respiratory symptom faced by many security guards, as the majority of them (45%) were exposed to high concentrations of TRAP PM2.5, resulting in cough as a prominent symptom.

Table 3. Correlation concentration of TRAP PM2.5 with respiratory symptoms.

Respiratory Symptom	Percentage (%)	p-value
Cough	95	0.013**
Phlegm	75	0.077
Wheezing	10	0.556
Shortness of Breath	30	0.241

3.5 Correlation of potential risk factors with respiratory symptoms

Table 4 displays the correlation of potential risk factors from socio-demographic and lifestyle of the respondents with respiratory symptoms. The factors of age, smoking status, and the number of cigarettes smoked per day were tested for their relationship with cough, phlegm, wheezing, and shortness of breath. The analysis revealed that age does not have a significant correlation with cough (p=0.789), phlegm (p=0.209), wheezing (p=0.459), or shortness of breath (p=0.389). However, the findings contradict with others whereas age as part of the contribution factors when exposure to TRAP PM 2.5 [6]. Smoking, on the other hand, exhibited a significant association with phlegm (p=0.005) but not with cough (p=0.502), wheezing (p=0.329), or shortness of breath (p=0.831). Moreover, the number of cigarettes smoked per day showed a significant association with phlegm (p=0.031) and wheezing (p=0.031) but not with cough (p=0.240) or shortness of breath (p=0.907). It is important to note that most respondents in the study (70%) were daily smokers, with 45% smoking 1-5 cigarettes per day.

The study found that over 40% of daily smokers and 27% of infrequent smokers reported persistent phlegm production among them. This suggests a significant association between smoking status and phlegm production, possibly due to the thickening of mucus in the airways caused by smoking. Additionally, the number of cigarettes smoked was linked to a dose-dependent increase in the prevalence of the wheezing syndrome, with a higher quantity of cigarettes smoked correlating with a higher likelihood of experiencing wheezing. In addition, all the respondents were working for 12 hours per day for 6 working days and 45% of them frequently overtimes for earn extra income. Overall, this study provides evidence of the detrimental effects of smoking on respiratory health, including the potential for reduced lung function due to inflammatory conditions and an excess of mucus in the pulmonary passages.

Table 4. Correlation of Potential risk factors with respiratory symptoms.

Risk Factor	Respiratory symptoms (p-value)			
	Cough	Phlegm	Wheezing	Shortness of breath
Age	0.789	0.209	0.459	0.389
Smoking	0.502	0.005*	0.329	0.831
No.of cigarettes / day	0.240	0.031*	0.031*	0.907

*significance ($p<0.05$)

4 Conclusion

Ultra-fine particles of TRAP PM2.5 can be easily detected in heavy traffic areas, and they can penetrate deeply into the lungs, causing various respiratory symptoms and leading to respiratory diseases if there is long-term exposure. Therefore, it is crucial to protect susceptible groups, such as security guards who work outdoors most of the time. High concentrations of TRAP PM 2.5 were detected in the morning at the south gates, with a level of 554 $\mu g/m^3$. A prevalence of respiratory symptoms was observed among the security guards, with 45% of the respondents reporting cough symptoms. There was a significant correlation between the concentration of TRAP PM2.5 and respiratory symptoms among the security guards. Smoking status and the number of cigarettes smoked per day have been identified as potential risk factors correlated with respiratory symptoms. Smoking shows a correlation with respiratory symptoms of phlegm. Moreover, the number of cigarettes smoked in a day significantly contributes to the symptoms of phlegm and wheezing when exposed to TRAP PM 2.5.

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