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Technical Note

Malaysian Traffic Police in Highly Populated Areas: Is it Safe Working Outdoors on a Daily Basis?

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ABSTRACT

Previous studies have reported on the increment in the concentration levels of outdoor air pollution affecting the lung functions among traffic police as they work outdoors, on an average, for 12 hours daily. This paper provides an analysis of the outdoor air pollutant trends. It is novel in considering how it can be used to understand the impact on the 1,149 Malaysian Traffic Police in the states of Kuala Lumpur (KL) and Johor Bahru (JB). The study used 165, 604 data from a nine-year database (2009–2017) of selected Malaysian air monitoring stations in KL and JB. The statistical analysis showed that the yearly trends of PM_{10} were above the Malaysian Ambient Air Quality Guideline (MAAQG) standard while the SO_2, O_3, NO_2, and CO readings were below the standard. An increasing trend was noticed in the total number of vehicles in both states from 2009 to 2017. All the pollutants were positively correlated with each other, indicating that most of the pollutants are from similar sources. There is a strong positive correlation between the total number of vehicles and CO, NO_2, and O_3. This study proves the trends and consequences of outdoor air pollutants coupled with the rise in the number of vehicles that can affect respiratory health and well-being of the traffic police personnel. As a resolution to this, an efficient risk control such as air monitoring system for traffic police is necessary. The findings of this study will facilitate its usefulness to the authorities, management, policymakers, and researchers in the years ahead.

Keywords: Traffic-related air pollutant; Air quality; Hazardous air pollutants; Respiratory health; PM_{10}.

INTRODUCTION

The primary task of traffic police personnel in Malaysia, according to the Police Act of 1967, is to monitor and regulate the traffic flow of public roads and the enforcement of the Road Transport Act 1987 (Police Act 1967). Hence, they are required to work outdoors for long periods (8–16 hours) (ILO, 2012). The Traffic Police in the Point Duty Unit mainly works on regulating the traffic flow in congested junctions all around the city centres and outskirts across the country. As the traffic flow tends to be heavy regularly, the need for traffic police to regulate traffic flow is important (Muhammad *et al.*, 2012). The details of the traffic police tasks in the Point Duty Unit and the flow of traffic are shown in Table 1. This study concentrates on traffic police in Kuala Lumpur (KL) and Johor Bahru (JB) as both states have one of the busiest city centres in Malaysia with a large population (Mohamad Jamil *et al.*, 2018).

Due to the heavy traffic load, the traffic police personnel are often exposed to outdoor air pollutants which affect their respiratory health. The health impacts of these air pollutants are, namely, Chronic Obstructive Pulmonary Disorder (COPD), wheezing, lung cancer, and heart disease (Kelly and Fussel, 2015). A study by Azhari *et al.* (2018) stated that the exposure to trace gases in the atmosphere might lead to acute and chronic effects on respiratory and even cardiovascular hospitalisation.

Despite all the studies on the air quality and its impact, the previous works have not addressed the current situation experienced by the Malaysian Traffic Police. This study was intended to discuss the critical situation in the working area (KL and JB) of Malaysian Traffic Police in Point Duty Unit.

METHODS

The states of KL and Johor are chosen as the study areas since these states have among the busiest city centres in Malaysia. The city centres are KL and JB respectively as shown in Fig. 1 according to their territory. A wide range of air

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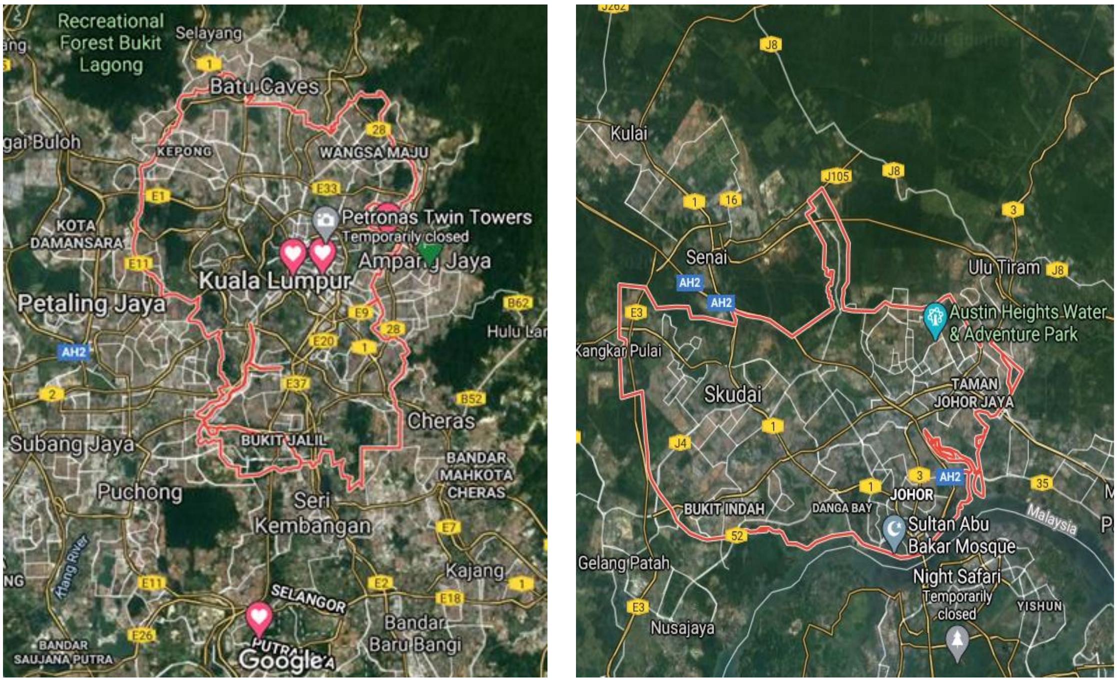
Table 1. Job description of traffic police in Point Duty Unit.

Shift	Time	Flow of Traffic[#]	Job Description
Morning	6 am	Peak hour and heavy traffic[a]	Assemble in Traffic Police station for clock-in and briefing on duty of the day
	7 am		To be ready at the designated junction
	7–10 am		Starts working to regulate traffic flow on the public roads
	10 am–2pm	Uninterrupted[b]	Report back at the station and attend a briefing on 'Summons and traffic hindrance' duty Patrolling
	2 pm	Slow [c]	End of duty
Evening	2 pm	Slow [c]	Assemble in Traffic Police station for clock-in and briefing on duty of the day
	3–4 pm	Uninterrupted[b]	Patrolling
	4–8 pm	Peak hour and heavy traffic[a]	Starts working to regulate traffic flow on the public roads
	8–10 pm		Report back at the station and attend a briefing on 'Summons and traffic hindrance' duty Patrolling
	10 pm	Uninterrupted[b]	End of duty

[a] Traffic volume is the highest at this point of time.
[b] Traffic flow is smooth.
[c] Traffic volume is increasing but still moving.
[#] Source by:
Bavani, M. (2010, August 2). *Morning peak hour ban for heavy vehicles starts today*. The Star. https://www.thestar.com.my/news/community/2010/08/02/morning-peak-hour-ban-for-heavy-vehicles-starts-today
TomTom Traffic Index (2020). *Kuala Lumpur traffic Malaysia.* https://www.tomtom.com/en_gb/traffic-index/kuala-lumpur-traffic/



(a) Study area (KL territory) (b) Study area (JB territory)

Fig. 1. Study area.

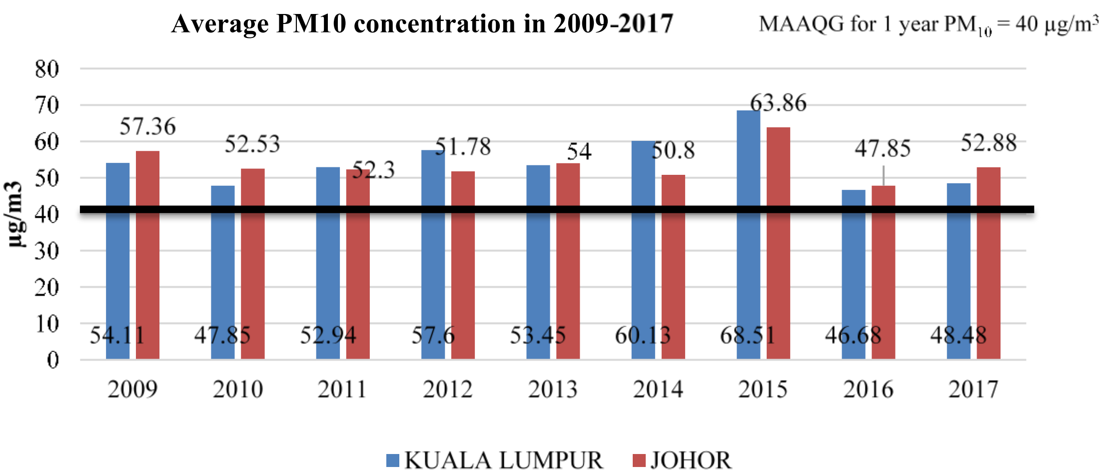
quality data is also available for these two states. The primary body responsible for collecting, analysing, and presenting the air quality data is the Department of Environment (DOE), Malaysia. The air quality data in Malaysia is managed by a private entity (Alam Sekitar Sdn Bhd (ASMA)) who has been contracted by the DOE. The air quality data are monitored daily on a 24-hour basis from an air quality monitoring station. As postulated by the World Health Organization (WHO), the monitored air pollutants are particulate matter with a size of less than 10 microns in diameter (PM_{10}), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and ground-level ozone (O_3) (DOE, 1997). A nine-year database from 2009 to 2017 was sourced from the DOE and further analysed for trends of the outdoor air pollutants. The transportation data (number of vehicles by road) from 2009 to 2017 was obtained from the Malaysian Road Transport Department and validated by Department of Statistics Malaysia (2017). All the statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 22. For all the statistical analyses, the p-value of < 0.05 as the significance level was used. The research covered the data collected from 2009 to 2017. This large range was used to ensure that all possible research done in this field was covered.

RESULTS AND DISCUSSION

Air Quality Data in KL and Johor

Fig. 2 illustrates the trends of PM_{10} (24-hour average time) in KL and Johor from 2009 to 2017. The data was compared with the Malaysian Ambient Air Quality Guideline (MAAQG) standard of 2020, as shown in Table 2. Findings show that average PM_{10} concentration was above the MAAQG standard every year from 2009 to 2017. The release of PM_{10} is primarily by the industrial sector (Salahudin *et al.*, 2013) and this explains the high concentration of PM_{10} in both states as both KL and Johor are central to many industrial and business operations (Azmi *et al.*, 2010). Meanwhile, the highest average concentration of PM_{10} recorded was in 2015 for both states. This finding is believed to occur as a result of 2015 Haze episodes in Malaysia, deemed to be the worst after 1997 Haze due to prolonged haze lasting over two months (DOE, 2015).

Coincide, the average concentrations of SO_2, O_3, NO_2 and CO recorded from 2009 to 2017 were below the revised MAAQG standard of 2020 (Figs. 3–6). As can be seen, the highest concentrations of SO_2 were recorded in 2017 for both states. SO_2 is usually the product of industrial activities and motor vehicles predominantly from diesel-engine trucks and buses (Pereira *et al.*, 2007; Azmi *et al.*, 2010). The peak could relate to an increase in the release of SO_2 by existing or newly developed power stations due to increasing demands of energy supply in the country (Salahudin *et al.*, 2013; Energy Commission Malaysia, 2019). Meanwhile, an observation of O_3, NO_2 and CO, their trends are almost similar annually and were below the MAAQG standard of 2020. These findings are also in similar with the previous work by Norela *et al.* (2004, 2010).



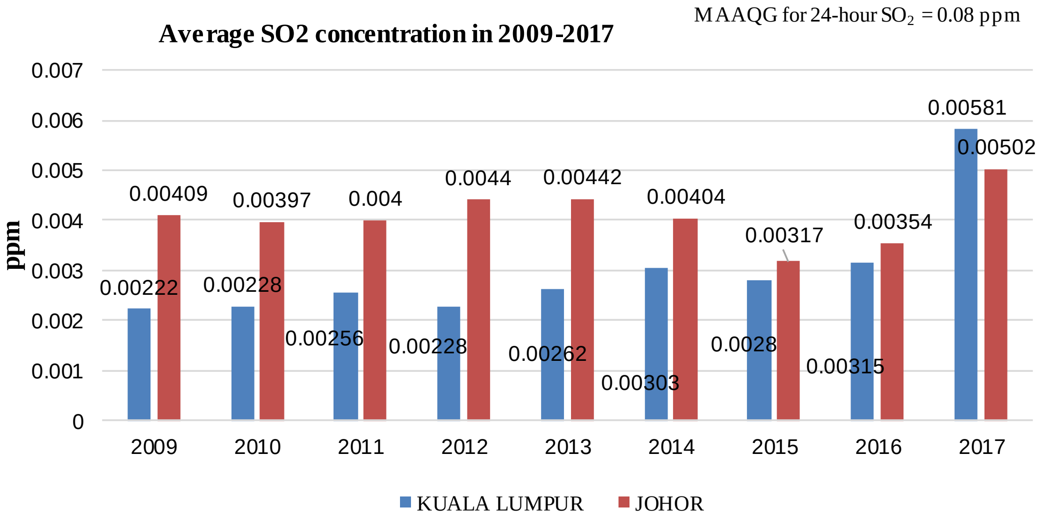
[b]Black solid line marking the cut-off point according to Malaysia standard for PM_{10} with 1 year-averaging time

Fig. 2. Average PM_{10} concentrations (2009–2017).

Table 2. New Malaysian Ambient Air Quality Guideline (MAAQG) standard (Source: DOE, 1997).

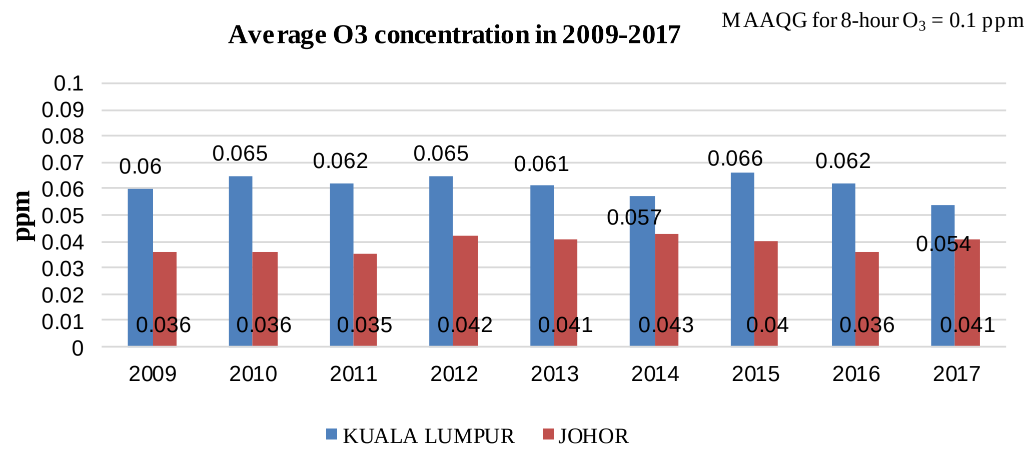
Pollutants	Averaging Time	Ambient Air Quality Standard (2020) µg m^{-3}
Particulate Matter with the size of less than 10 micron (PM_{10})	1 year	40
	24 hours	100
Sulfur Dioxide (SO_2)	1 year	250
	24 hours	80
Nitrogen Dioxide (NO_2)	1 year	280
	24 hours	70
Ground Level Ozone (O_3)	1 year	180
	8 hours	100
*Carbon Monoxide (CO)	1 year	30
	8 hours	10

* mg m^{-3}.



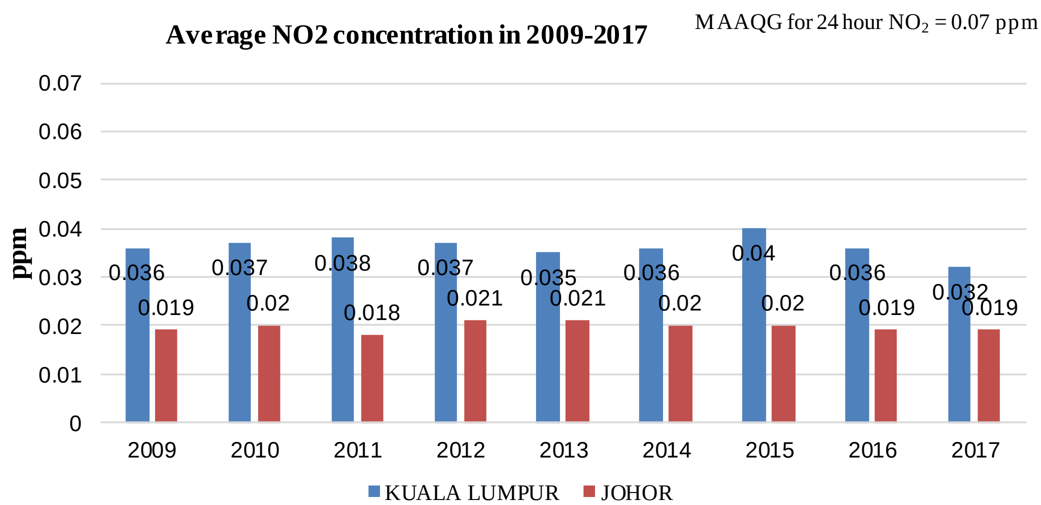
[b] *Black solid line marking the cut-off point according to Malaysia standard for SO_2 with 24 hour averaging time*

Fig. 3. Average SO_2 concentrations (2009–2017).



[b] *Black solid line marking the cut-off point according to Malaysia standard for O_3 with 24-hour averaging time*

Fig. 4. Average O_3 concentrations (2009–2017).



[b] *Black solid line marking the cut-off point according to Malaysia standard for NO_2 with 24 hour averaging time*

Fig. 5. Average NO_2 concentrations (2009–2017).

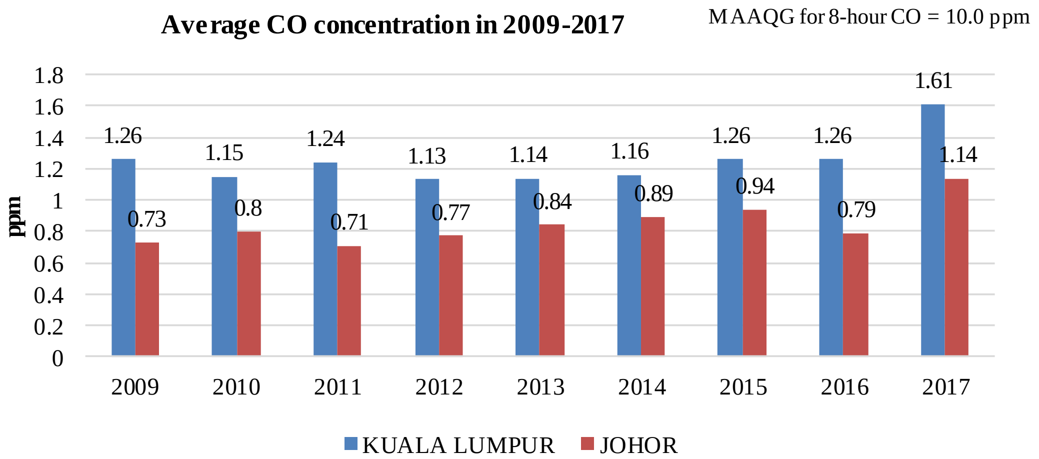


Fig. 6. Average CO concentrations (2009–2017).

O_3 is a secondary gas made up of nitrogen oxides (NO_x) and volatile organic compound (VOC) by photochemical responses involving the sunlight and heat from its precursor pollutants (Anderson *et al.*, 2010; Chelani, 2013). The combination of high temperature and pressure of fuel oxidises the nitrogen in the gas to generate NO_2 with enough oxygen (Anderson *et al.*, 2010). Apart from that, industrial processes also produce NO_2 as a by-product (Ling *et al.*, 2014). NO_2 is also emitted from open burning, domestic fuel sources, and long-range air pollutants from transportation sources (Rajab *et al.*, 2011). CO is a colourless, odourless, and toxic air pollutant, which is produced by the incomplete combustion of carbon. The largest contributors of CO in the atmosphere are vehicular gas emissions (Transportation Research Board and National Research Council, 2002). However, these major air pollutants were also affected by the surface of meteorological conditions which are unaccounted for in this study. Nonetheless, the current work can ascertain the trends of air pollutants in both KL and Johor to understand the impact towards Malaysian Traffic Police in these areas.

Total Number of Vehicles on the Road

Due to the rapid industrialisation, it can be anticipated that the number of vehicles on the road to increase annually and indirectly play a major role in the gas emissions from traffic (Chen *et al.*, 2019). This fact is supported by the latest data from the Road Transport Department of Malaysia from 2010 to 2014 (Department of Statistics Malaysia, 2015) which shows that the total number of vehicles in each state is led by KL (4.6 million in 2014) and Johor (2.3 million in 2014) with the largest number of vehicles on the road (Fig. 7). Specifically, the total number of vehicles in KL and Johor from 2009 to 2017 is shown in Fig. 8 (Road Transport Department, Malaysia, 2017). The increasing trend of the number of vehicles can be seen growing each year with the latest number in 2017 exceeding 6.4 million vehicles in KL and 3.6 million in Johor. This finding is in agreement with a similar finding reported by other researchers. Previous studies (Abdullah *et al.*, 2012; Salahudin *et al.*, 2013) showed that high levels of air pollutants are probably associated with motor vehicle emissions.

Correlation between All the Air Pollutants

Table 3 shows the correlation between all the air pollutants, where a significant positive correlation can be found in all the parameters with each other. In this present study, PM_{10} has a moderate positive correlation with CO ($r = 0.347$, $p < 0.01$) and a low positive correlation with O_3 ($r = 0.220$, $p < 0.01$), NO_2 ($r = 0.245$, $p < 0.01$) and SO_2 ($r = 0.220$, $p < 0.01$). Additionally, CO is found to have a moderate positive correlation with SO_2 ($r = 0.522$, $p < 0.01$) and a low positive correlation with O_3 ($r = 0.217$, $p < 0.01$) and NO_2 ($r = 0.236$, $p < 0.01$), while O_3 has a moderate positive correlation with NO_2 ($r = 0.427$, $p < 0.01$) and a low positive correlation with SO_2 ($r = 0.257$, $p < 0.01$). NO_2 is found to be in a moderate positive correlation with SO_2 ($r = 0.533$, $p < 0.01$). These findings are in line with several previous studies (Mansouri *et al.*, 2011; Rahman *et al.*, 2015) which found all the parameters positively correlated with each other. The significant correlations revealed that the pollutants might have similar or overlapping origins (Kumar and Joseph, 2006; Lee *et al.*, 2018). However, further work would be needed to assess this matter.

Correlation between the Number of Vehicles and All the Pollutants Concentrations

Table 4 shows the correlation between the number of vehicles and the average concentrations of all the pollutants. This study reports strong positive correlations of the total number of vehicles on the road with CO ($r = 0.876$, $p < 0.01$), O_3 ($r = 0.847$, $p < 0.01$), and NO_2 ($r = 0.868$, $p < 0.01$). As for SO_2 and PM_{10}, the correlations are found to be not significant. Certain factors can explain the non-correlation findings between SO_2 and PM_{10} with the number of vehicles. This fact might due to initiation of EURO-2M fuel usage that reduces the amount of SO_2 released into the environment since 2009 (Abdullah *et al.*, 2012; Mohamed Binyehmed *et al.*, 2016). Meanwhile, PM_{10} level of concentration in Malaysia is conformed to the burning of biomass in neighbouring countries (Sentian *et al.*, 2018) and is easily manipulated by other factors, along with weather and monsoon directions

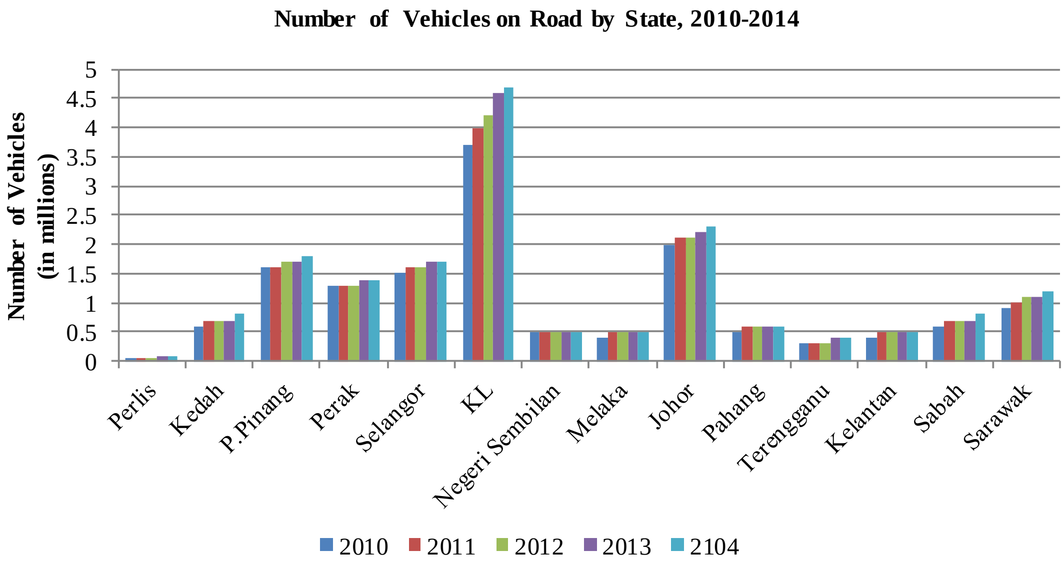


Fig. 7. Number of Vehicles on Road by state (2010–2014).

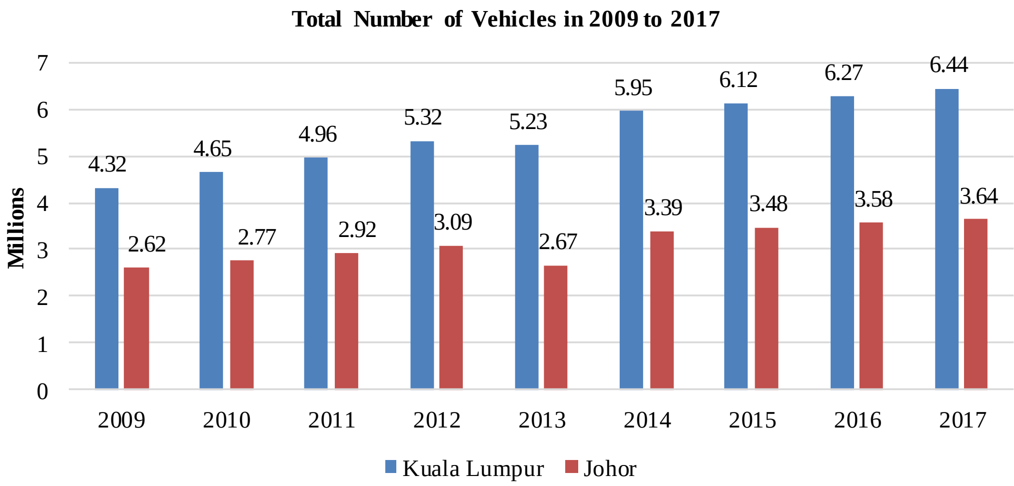


Fig. 8. Number of vehicles on road in KL and Johor (2009–2017).

Table 3. Correlation between all the air pollutants.

Pollutants	PM_{10}	CO	O_3	NO_2	SO_2
PM_{10}	1				
CO	0.347 [a]	1			
O_3	0.220 [a]	0.217 [a]	1		
NO_2	0.245 [a]	0.236 [a]	0.427 [a]	1	
SO_2	0.220 [a]	0.522 [a]	0.257 [a]	0.533 [a]	1

[a] significant at $p < 0.01$.

Table 4. Correlation between the air pollutants and number of vehicles.

Variables	Total no of vehicles	PM_{10}	CO	O_3	NO_2	SO_2
Total no of vehicles	1	0.94	0.876[a]	0.847 [a]	0.868 [a]	0.309

[a] significant at $p < 0.01$.

(Verma and Desa, 2008; Barmpadimos *et al.*, 2011; Mohamad *et al.*, 2015; Rahman *et al.*, 2015). As a whole, however, more work is required to examine the key sources of each type of pollutant in detail.

Nevertheless, the findings from present study coincide with a previous study (Zakaria *et al.*, 2019) which suggested that the concentration of the pollutants rises with the number of traffic count on the road and originates from the source where the sampling of pollutants was made. Another study in Malaysia (Tajudin *et al.*, 2019) also reported a positive correlation between the number of vehicles and air pollutants. As the air pollutants are mostly emitted from motor vehicles (Abdullah *et al.*, 2012), this proves that the number of vehicles on the road affects the concentration of pollutants. From the present study, the air pollutants namely, CO, O_3 and NO_2, increases with the total number of vehicles on the road. Hence, by working outdoor for long hours, the traffic police personnel are directly exposed to the harmful air pollutants.

Exposure Level among Traffic Police Personnel

The traffic police personnel enforce the transportation legislation, policies, and agreements for commercial and non-commercial vehicles using Malaysian roads. Exposure to dust and outdoor pollutants without any preventive measure has possibly caused the traffic police personnel to be highly susceptible to a decrease in pulmonary functions over time (Mohamad Jamil *et al.*, 2018). When travelling or standing along the roads with heavy traffic, significantly during the rush hours, the traffic police personnel are exposed directly to traffic-related air pollution, which could eventually lead to health complications.

A previous study by the same author among the traffic police in Kuala Lumpur were found to be exposed to a high $PM_{2.5}$ concentration at a personal level which is from 12.4 µg m^{-3} to 55.3 µg m^{-3} in 8 working hours with the mean level at 28.7 ± 11.1 µg m^{-3} (Mohamad Jamil, 2016). Compared to the Malaysian Ambient Air Quality Guideline (MAAQG), the mean of $PM_{2.5}$ reported does not exceed the 24-hour value of 35 µg m^{-3} (DOE, 2015). Muhammad *et al.* (2012) recorded a relatively lower mean value of $PM_{2.5}$ at 22.33 ± 8.54 µg m^{-3} in a study among traffic police in Kuala Lumpur back in 2012. A current study by Fandi *et al.* (2020) reported that extended exposure to benzene and ethylbenzene increases the risk of adverse health effects among traffic police.

As shown in Table 5, there are a few studies that have reported on the exposure to air pollutants among Malaysian traffic police in their working environment. From this, it is clear that traffic police are working in an unfavourable situation for their health. However, these police officers have no other options as they need to fulfil their duties in order to preserves the public safety. Hence, all the key stakeholders must take immediate action for this matter.

CONCLUSIONS

This work was devoted to ascertaining the air quality in the working area (KL and Johor) among Malaysian Traffic Police at their Point Duty and recognising the impacts it carries. This work also determines the total number of vehicles on the road and their relationship with air pollutants. This study revealed that the average concentrations of PM_{10} were above the MAAQG revised standard of 2020, whereas SO_2, NO_2, O_3 and CO recorded below the standard. The increasing trends in the number of vehicles can be seen every year from 2009 to 2017 in both KL and Johor. All the pollutants are found to be positively correlated with each other. The average concentrations of CO, NO_2, and O_3 increased with the total number of vehicles.

As a consequence, the outdoor air quality is decreased and directly affects outdoor workers, particularly traffic police at their point of duty. Based on the results from this study, it would be timely and prudent for the bodies and management of the Royal Malaysian Police to begin strategising and formulating an effective plan to monitor the exposure of their officers to the harmful pollutants in the outdoor air. For future work, an efficient individual monitoring system for

Table 5. Studies on exposure to air pollutants among traffic police.

Previous studies	Respondents	Pollutants	Outcome
Muhammad *et al.* (2012)	Traffic police (KL) General police	$PM_{2.5}$	Exposure to elevated concentration level to traffic related air pollutant was the risk factors in the development of respiratory diseases.
Muhammad *et al.* (2014)	Traffic police (Putrajaya) General police	PM_{10}	The traffic policemen are at risk of respiratory diseases, as reflected by an increase in the reported
Sulaiman and Anual (2015)	Traffic police (KL) General police	PM_{10}	There was increased DNA damage in lymphocytes of traffic police officers compared to indoor workers.
Mohamad Jamil (2016)	Traffic police (KL and Johor)	$PM_{2.5}$	The main factors of abnormality in lung functions are exposure to $PM_{2.5}$ and duration of services.
Fandi *et al.* (2018)	Traffic police (KL)	PM_{10}	The respiratory symptoms were significantly higher in the exposed group which they were 3.9, 4.1, and 3.5 times more likely to develop cough, wheezing, and breathlessness respectively.
Fandi *et al.* (2020)	Traffic police (Klang Valley)	Benzene, toluene, ethylbenzene, m,p-xylene, and o-xylene (BTEX)	The estimated cancer risks suggests that the prolonged benzene and ethylbenzene exposure experienced by traffic policemen placed them at higher risk to adverse health effects.

exposure to air pollution may be a better resolution in order to control and manage the adverse air exposure during work. The data from this present study will facilitate its usefulness to the related authorities, management, policymakers, and researchers in the years ahead.

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