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Exposure to respirable dust (pm_{10}) and respiratory health Among traffic policemen in selangor

[1]Nor Syafarizwa Muhammad, [2]Juliana Jalaludin, [3]Sharmadevan Sundrasegaran

[1]*Department of Environmental and Occupational Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, 43400, Malaysia.*
[2]*Department of Environmental and Occupational Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, 43400 Malaysia.*
[3]*Department of Environmental and Occupational Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, 43400 Malaysia.*

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ABSTRACT

Background: Exposure to traffic air pollutants has shown a significant health effect on the respiratory systems and a decrease in lung function among traffic policemen**.** **Objective:** The main objective of this study is to determine the relationships between personal exposure levels to PM_{10} and respiratory health among traffic policemen working at Traffic Police Station in Petaling Jaya, Selangor and general duty policemen attached to Police Headquarters, Putrajaya as a comparative group. **Results:** The median personal exposure level of PM_{10} among the traffic policemen was 208.33±49.02µg/m^3 compared to only 49.02±49.01µg/m^3 among the comparative group. Result from Mann Whitney U test showed that there was a significant difference ($p<0.001$) between the two study groups. There was a significant difference in FVC (litre) with $z = -5.218$, $p<0.05$, FEV_1 (litre) with $z = -4.987$, $p<0.05$, FVC% predicted with $z = -3.716$, $p<0.05$, and FEV_1% predicted with $z = -2.593$, $p<0.05$ between exposed group and comparative group**.** **Conclusion:** The result from this research showed that the traffic policemen are at risk of respiratory diseases, as reflected by an increase in the reported respiratory symptoms and reduction in lung function.

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INTRODUCTION

Air pollution is a global problem due to the process of urbanization and rapid population growth. Motor vehicle contributed, by far the largest amounts of air pollution in many big cities of developed countries [1]. This is partly because of the relatively high densities of the road networks that have been built in the cities of developing countries. Other reasons are because of the increasing population in the cities and the increase of numbers of motor vehicle ownership. These developments have resulted in rapid deteriorating air quality in many big cities.

In Malaysia, air pollution has been a major problem over the past few years due to the rapid growth of the industrial sector and the increase in traffic volume. Air pollution occurs as a consequence of natural processes as well as human activity [2]. Mobile or vehicular pollution in urban areas is predominant and significantly contributes to air quality problems [3]. The particles emitted from the vehicular exhaust of more than 10-micron size are held in the upper respiratory tract. Meanwhile, particles less than 10 micron size (PM_{10}) accumulates in the lung and produces respiratory abnormalities.

Air quality crisis in the cities is mainly due to vehicular emissions. Exposure to air pollutants is known to be harmful to health, in general, and to the lungs, in particular. In this respect, traffic policemen are at a risk, since they are continuously exposed to emissions from vehicles, due to the nature of their job. Automobile exhaust consists of oxides of nitrogen, carbon monoxide, particulate matter, and others, which cause injury to the terminal bronchioles and a decrease in the pulmonary compliance and vital capacity. Air pollution due to road traffic is a serious health hazard and thus the persons who are continuously exposed, may be at an increased risk [4].

Corresponding Author: Juliana J., Department of Environmental and Occupational Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, 43400, Malaysia
E-mail: Juliana@upm.edu.my, Phone: +60389472401

Klang Valley is the largest and the most densely populated metropolitan area in Malaysia. Petaling Jaya is considered a satellite town in Klang Valley area. Klang Valley is the region that is most prone to serious air pollution compared to other parts of the country [5]. It provides a much conducive environment for pollutants to accumulate particularly when the atmospheric conditions are stable. The unhealthy air quality in Klang Valley from February to March 2002 was due to peat swamp and forest fires in several areas of Selangor and Kuala Lumpur. This is due to the hot and dry weather with reduced rainfall.

Particles less than 10 micrometres in diameter (PM_{10}) pose a health concern because they can be inhaled and accumulated in the respiratory system [6]. Particles less than 10 micrometers in diameter (PM_{10}) are referred to as respirable particles and are believed to pose a large health risk. Sources of fine particles include all types of combustion and some industrial processes. United Stated Environment Protection Agency (USEPA) National Ambient Air Quality Standard (NAAQS) recommends that particulates 2.5 micrometres to 10 micrometres in diameter (PM_{10}) must be maintained at less than the 150 micrograms of particulates per cubic meter of air ($\mu g/m^3$). PM_{10} is associated with lower respiratory symptoms, exacerbation of asthma and chronic cough. Weaker association is observed for upper respiratory symptoms. A small but usually significant decline in lung function has also been observed [7].

This study aims to determine the association between the personal levels of traffic air pollution (PM_{10}) and respiratory health among traffic policemen working in Selangor area as well as general duty policemen who are attached to the administrative office. Traffic policemen are considered to be in the high risk group that is exposed to the high density traffic areas which is polluted with air pollutants (PM_{10}). This is because most of them do not wear any of the Personal Protective Equipment (PPE). In addition, this study is important to evaluate lung function (FVC and FEV_1) and other respiratory symptoms among traffic policemen, particularly on the effects of the exposure towards respirable particle (PM_{10}) particulate matter. Findings from study are important to assess lung function and respiratory health problems among the traffic policemen and also their personal exposure level to respirable particle (PM_{10}) particulate matter to generate scientific data.

MATERIAL AND METHODS

A cross-sectional study was conducted in which the spirometric parameters of a group of 60 traffic policemen, aged 23-55 years, working at the Traffic Police Station in Petaling Jaya Selangor were compared with those working in the administrative office, consisting of 57 respondents from Police Headquarters in Putrajaya, as a comparative group. Random sampling method was used to select the study respondents. Respondents who fulfilled the inclusion criteria were selected for personal exposure to respirable particle (PM_{10}) monitoring. The study was conducted from early February until April 2013. The respondents were interviewed for data collection purposes based on the socio-demographic information obtained from the validated questionnaire developed based on ATS [12].

Lung function test was run using Spirometer in order to determine the lung function abnormalities of the respondents. The lung abnormalities involve FVC, FEV_1 and FVC/FEV_1. The spirometer was used to measure the volume of the air in the lungs and the volume that respondents are able to breathe out in one second. A calculation to determine a normal value of FVC and FEV_1 of lung function among the respondents is based on the value for Malaysians in normal population group [8].

The concentrations of respirable particle (PM_{10}) were collected using Personal Air Sampling Pump (Gillian Air Pump). The duration of the air sampling was 8 hours. After that, the final weights were taken in order to identify the weight changes from the filter paper. Analysis of the samples involved a gravimetric method using a weight balance instrument. It involved a comparison of post (W2) and pre-sampling (W1) weight of filter paper.

Data collected in the study was analysed by using SPSS ver. 21 (Statistical Package for Social Science). Univariate testing was used to analyse the descriptive analysis variables in the statistics of socio-demographic Meanwhile, a bivariate testing was done in order to determine the association between study variables and concentration of personal exposure level of respirable particle (PM_{10}). Descriptive analysis was done to explore the characteristics of the data which includes screening and transformation of data. It was used to test the mean of age, duration of work, prevalence of respiratory symptoms and lung function tests and other related variables. Then, Kolmogorov-Smirnov statistics were used to test normality for all continuous variables and Mann Whitney U test was used to make comparison of the difference in median for all quantitative study variables. Chi-square test was used to compare the prevalence of respiratory symptoms between the traffic policemen and the comparative group. For the correlation test, Spearman Rho was performed to determine the association between personal exposure levels, duration of work to air pollutant and lung function among the respondents. Logistic regression technique was used to determine the main factor that influence the lung function level among study respondents after controlling all the confounders.

RESULTS AND DISCUSSION

As for traffic policemen, their job schedule during working days was based on 3 shifts: morning, afternoon as well as an evening shift to control the flow of the busy roads. While for the comparative group, they work as administrative workers at the Police Headquarters in Putrajaya with the same work background.

Table 1: Socio-demographic characteristic between two study groups

Variables	Study Groups		z value	p value
	Exposed Group (n=60)	Comparative Group (n=57)		
Age	36.80 ± 10.62	39.44 ± 9.69	-1.291	0.197
Height (cm)	1.690 ± 0.07	1.685 ± 0.09	-1.080	0.280
Weight (kg)	74.00 ± 12.00	75.00 ± 12.00	-0.134	0.894
BMI	25.91 ± 4.17	25.16 ± 3.64	-0.619	0.536
Income (RM)	1976 ± 1091	2300 ± 1336	-0.382	0.702
Smoking Habits Yes No	 21(35) 39(65)	 20(35) 37(65)	-0.010	0.992

N=117, Statistic Mann Whitney U test, *Significant at $p \leq 0.05$

Table 1 shows the median of age for exposed group was 36.80 ± 10.62 while, 39.44 ± 9.69 was from the comparative group. The median of height, weight and BMI for the exposed group were 1.690 ± 0.07, 74.00 ± 12.00, and 25.91 ± 4.17 respectively. Meanwhile, among comparative group, the median of height, weight and BMI were 1.685 ± 0.09, 75.00 ± 12.00, and 25.16 ± 3.64 respectively. The median of income among respondents in the study group was 1976 ± 109 while for the comparative group it was 2300 ± 1336. There were 21(35%) smokers and the remaining 39(65%) were non-smoker among traffic policemen. As for the comparative group, 20(35%) out of 57 respondents were smokers while the rest were non-smoker.

Table 2: Comparison Personal Exposure Level of Respirable particles (PM_{10}) concentration exposure between two study groups.

Variable	Study Group				z value	p value
	Exposed Group (n=60)		Comparative Group (n=57)			
	Median ± IQR	Range	Median ± IQR	Range		
Respirable particle concentration ($\mu g/m^3$)	208.33 ± 49.02	134.80-379.90	49.02 ± 49.01	12.55-98.04	-9.343	<0.001*

N = 117, Statistic Mann Whitney U test, *Significant at $p \leq 0.05$

Normality test was carried out and the results obtained showed that the data of personal exposure level to PM_{10} was not normally distributed Mann Whitney U test was conducted in order to compare the personal exposure level to PM_{10} among exposed group and comparative group. Table 2 shows that the median of respirable particle (PM_{10}) concentration for exposed group (208.33 ± 49.02$\mu g/m^3$) was higher than the comparative group (49.02 ± 49.01$\mu g/m^3$). There was a significant difference in personal exposure level to PM_{10} among study group and comparative group.

Table 3: Comparison of respiratory symptoms between two study groups

Variables	Study Group Frequency (%)		χ^2	p value	O.R (95% CI)
	Exposed Group (n=60)	Comparative Group (n=57)			
Cough Yes No	 19 (32) 41 (68)	 7(12) 50 (88)	3.683	0.055	2.47 (1.01 – 6.05)
Phlegm Yes No	 22 (37) 38 (63)	 8 (14) 49 (86)	8.711	0.003*	3.55 (1.42 – 8.84)
Chest Tightness Yes No	 10 (17) 50 (83)	 5 (9) 52 (91)	2.584	0.108	2.65 (0.78 – 8.99)
Wheezing Yes No	 5 (8) 55 (92)	 6 (11) 51(89)	1.210	0.271	2.50 (0.47– 13.44)

N = 117, Statistic Mann Whitney U test, *Significant at $p \leq 0.05$

Results of respiratory symptoms for exposed group showed that the respondents experienced cough (32%), phlegm (37%), and chest tightness (17%) and there is a higher prevalence in exposed group. This is an exception for wheezing (8%), which is lower than in the study group compared to the comparative group which registered a higher 11%. The results of respiratory symptoms among the comparative group in which cough

(12%), phlegm (14%), and chest tightness (9%) were of lower prevalence if compared to the exposed group. Phlegm was significantly higher in exposed group.

Table 4: Comparison of lung function level between two study groups

Variables	Study Groups Median ± IQR Exposed Group (n=60)	Study Groups Median ± IQR Comparative Group (n=60)	z value	p value
FVC (litre/s)	4.21± 0.39	4.46 ± 0.38	-5.754	<0.001*
FEV_1 (litre/s)	3.88 ± 0.59	4.24 ± 0.22	-5.484	<0.001*
FVC% predicted	73.65 ± 8.42	78.20 ± 9.19	-3.716	0.001*
FEV_1% predicted	76.67 ± 19.93	78.71 ± 6.63	-2.593	0.002*
FEV_1/FVC % predicted	98.91 ± 4.05	97.31 ± 4.64	-1.658	0.097

N=117, Statistic Mann Whitney U test, *Significant at $p \leq 0.05$

Table 4 shows that the results that have been obtained for the median of FVC (litre) were 4.21 ± 0.39 for exposed group while for the comparative group it was 4.46 ± 0.38. The median for FEV_1 (litre) was 3.88 ± 0.59 and 4.24 ± 0.22 for exposed group and comparative group respectively. As for FVC% predicted and FEV_1% predicted in exposed group, it was 73.65 ± 8.42 and 76.67 ± 19.93 respectively. In the comparative group, the median for FVC% predicted and FEV_1% predicted were 78.20 ± 9.19 and 78.71 ± 6.63 respectively. The median result of FEV_1/FVC % predicted was 98.91 ± 4.05 and 97.31 ± 4.64 in exposed group and comparative group respectively. There was a significant difference in FVC (litre), FEV_1 (litre), FVC% predicted, and FEV_1% predicted between two study groups. However, there was no significant difference in FEV_1/FVC % predicted between exposed and comparative group.

Table 5: Comparison of lung function status between two study groups

Variables	Status	Study Groups Frequencies (%) Exposed Group (n=60)	Study Groups Frequencies (%) Comparative Group (n=57)	x^2	p value	O.R (95% CI)
FVC% predicted	Abnormal	29(48)	17(30)	4.197	0.040*	2.20 (1.03-4.71)
	Normal	31(52)	40(70)			
FEV_1% predicted	Abnormal	50(83)	34(60)	8.097	0.004*	3.38 (1.43-8.00)
	Normal	10(17)	23(40)			
FEV_1/FVC% predicted	Abnormal	-	-	-	-	
	Normal	60(100)	57(100)			

N=117, *Significant at $p \leq 0.05$

The lung function abnormalities among all the respondents were obtained from the questionnaire. Table 5 shows that 29 (48%) and 17 (30%) of abnormal FVC% while 31 (52%) and 40 (70%) of normal FVC% predicted among exposed group and comparative group respectively. For FEV_1% predicted, 50 (83%) and 34 (60%) of abnormal while 10 (17%) and 23 (40%) of normal among the exposed and comparative group respectively. Referring to Table 6, it shows that for FVC% predicted, it was 2 times more likely for respondents among exposed group to get abnormalities in lung function status while for FEV_1% predicted, there was a 3 times more likely scenario for exposed group to get abnormalities in lung function status. Therefore, there was a significant different in FVC% predicted and FEV_1% predicted between two study groups.

Table 6: Correlation between exposures of respirable particles (PM_{10}) and the lung function parameters between two study groups

Variables	Respirable Particles concentration (μg/m^3) Exposed Group (n=60) r value	Exposed Group (n=60) p value	Comparative Group (n=57) r value	Comparative Group (n=57) p value
FVC (liter)	-0.095	0.468	0.121	0.355
FVC% predicted	0.159	0.226	0.026	0.845
FEV1 (liter)	-0.094	0.476	-0.002	0.990
FEV1% predicted	0.156	0.233	-0.024	0.857
FEV_1/FVC% predicted	-0.042	0.749	-0.149	0.257

N=117

The association between personal exposure levels to respirable particles (PM_{10}) and lung function parameters (FVC level, FEV_1 level, FVC% predicted, FEV_1% predicted and FEV_1/FVC % predicted) were determined by using Spearman Rho correlation test. Table 6 shows no significant association between respirable particles (PM_{10}) exposure and lung function tests in both exposed and comparative group.

Table 7: Correlation between working duration (years) and the lung function parameters in exposed group

Variables	Working duration (years)	
	Exposed Group (n=60)	
	r value	p value
FVC (litre)	0.112	0.396
FVC% predicted	0.156	0.234
FEV1 (litre)	0.086	0.511
FEV1% predicted	0.198	0.129
FEV_1/FVC% predicted	0.086	0.515

N=60, *Significant at $p \leq 0.05$

Statistical analysis of Spearman Rho test was performed in order to determine the association between the working duration (years) and lung function parameters (FVC level, FEV_1 level, FVC% predicted, FEV_1% predicted and FEV_1/FVC % predicted). Table 7 shows that there was no significant association between the working duration (years) and the lung function parameters among exposed group.

Table 8: Factors influencing the abnormality FVC% and FEV_1% predicted among study respondents after control all the confounders

Independent Variables	FVC%				FEV_1%			
	β	S.E	p value	OR (95% CI)	β	S.E	p value	OR (95% CI)
Constant	-0.686	0.317	-	-	0.491	0.314	-	-
Respirable Particle (PM_{10}) concentration (μg/m^3)	-0.800	0.391	0.041*	2.23 (1.03-4.79)	1.223	0.440	0.005*	3.40

N=117, 95% CI= 95% Confidence Interval, β= Regression Coefficient, S.E= Standard Error, *Significant at p<0.05

Logistic regression was conducted in order to determine the main factors that influenced the abnormality in FVC% and FEV_1% predicted among study respondents after controlling the confounders in this study. Table 8 shows that the FVC% and FEV_1% predicted had a significant regression with the concentration levels of personal exposure to respirable particles (PM_{10}) among study respondents (p<0.05).

For this research study, the criteria have been restricted to only male respondents of Malay ethnicity. Therefore, gender and race confounding factors can be controlled. Other confounding factors such as age, height, and weight were all compared among both the study group and the comparative group as shown in Table 1. Respondents' age ranged from 23-55 years old. The median age for the study group was 36.80 ± 10.62 while the median age was 39.44 ± 9.69 for the comparative group. The median of height, weight, BMI and income for the exposed group was 1.690 ± 0.07, 74.00 ± 12.00, 25.91 ± 4.17 and 1976 ± 1091 respectively. Among comparative group, the median of height, weight, BMI and income was 1.685 ± 0.09, 75.00 ± 12.00, 25.16 ± 3.64 and 2300 ± 1336 respectively. Based on Table 1, there was no significant difference in age, height, weight, BMI as well as in income between two study groups. Some factors such as race, age, gender, height and weight are important factors that can influence the prediction of lung function parameters among the respondents that have been assessed [9].

Table 2 shows that the median of respirable particle (PM_{10}) concentration for exposed group (208.33 ± 49.02μg/m^3) were higher than the comparative group (49.02 ± 49.01μg/m^3). Traffic policemen working at the Traffic Police Station in Petaling Jaya, Selangor were exposed to more than 4 times the mean concentration levels of PM_{10} (206.29 ± 52.49μg/m^3) compared to only (48.85 ± 25.92μg/m^3) among the comparative group. Results that were obtained from statistical analysis showed that there was a significant difference in the personal exposure to concentration levels of PM_{10} between two study groups. Respiratory system has defence mechanisms to help prevent airborne particles from getting into the lungs and causing harm. When you inhale, the air is drawn in through the nose or mouth into the upper respiratory system, which consists of the nasal passages, trachea, and conducting airways [10]. The air becomes moist and makes numerous twists and turns through the nasal passages and branching airways. Traffic produces road dust and air turbulence that can stir up road dust.

Kanae *et al.*, [11] found that the traffic policemen who work next to busy roads were exposed continually to high amount of respirable dust (PM_{10}) than Thailand's National Air Quality Standard of 120μg/m^3. The mean PM_{10} concentration for study group shows the result of 206.29±52.49μg/m^3 which is 1.38 times higher than the mean concentration according to National Ambient Air Quality Standard which is 150μg/m^3. It is also 1.72 times higher than Thailand's National Air Quality Standard of 120μg/m^3. Kisku [12] in Lucknow City shows that among vendors, drivers and traffic policemen, the mean value of PM_{10} concentration is 1.04 times higher than the usual level.

All respondents completed the validated questionnaires based on American Thoracic Society [13]. The health part of the questionnaire involved chronic adverse respiratory symptoms. According to respiratory symptoms for the exposed and comparative group in Table 3, it shows that phlegm symptoms were significantly higher in exposed group. Respondents in the exposed group were also three times more likely to be infected with phlegm compared to the comparative group. This may be due to the exposure to the traffic air pollutants during working hours that causes them to have phlegm filled with mucus. Besides, cough is also considered as another parameter. This indicates an occurrence of a higher number of respondents from the exposed group, the prevalence of cough is strongly associated with the cigarette smoking [14].

PM can alter the body's defence systems against foreign materials, damage lung tissues, and aggravate existing respiratory and cardiovascular disease. In some cases, PM exposure can even lead to premature death. However, the effectiveness of defence mechanism in different individuals may vary and therefore a threshold for adverse effects may be very low at the population level in sensitive subgroups range of threshold may exist and it may depend on type of the effect and susceptibility of individuals and the specific population groups [10]. PM also can include a substantial amount of constituents (indirect abrasion products, suspended particles, and secondary PM) derived from other sources [15]. Adverse health effects have been associated with exposures to PM over both short periods such as a day and longer periods such as a year or more [10]. The human immune system developed in a time and environment where dust was made of large particles. Humans have developed a means of protecting themselves against these large particles. Particles larger than 10 microns generally get caught in the nose and throat, never making it as far as the lungs.

Table 3 reported symptom which is phlegm is significantly higher in exposed group compared to the comparative group. It can also be seen in the results section of a study that there is a significantly higher prevalence of respiratory symptoms and chronic respiratory disorders in the exposed group (comprising bus drivers, conductors, and taxi drivers) compared to the unexposed group [16]. There was a possibility that some of the respondents, who experienced adverse respiratory symptoms, were avoiding any unfavourable effects on the employment prospect which ensures that the respiratory symptoms did not have any significant relationship between the exposed group and comparative group. Thus, the study hypothesis was rejected.

All the respondents did the lung function test using Spirometer Spirolab II Model based on the standard from American Thoracic Society [17]. After the calculation of the percentage value (FVC% predicted and FEV_1% predicted) based on the value of FVC and FEV_1, the results shown in Table 4 revealed that all the parameters except for FEV_1/FVC % predicted had shown a significant reduction among exposed group when compared to the comparative group. This significant reduction was because the exposed group were involved directly to traffic air pollutants and was exposed to respirable particle (PM_{10}) from the roadsides. Higher value of FVC% and FEV_1% predicted were recorded among the comparative group who had less exposure to the polluted working environment compared to traffic policemen who deal with vehicles on an everyday basis. Therefore, there was a significant difference in FVC level, FEV_1 level, FVC% predicted, FEV_1% predicted among the two study groups. However, there was no significant difference in FEV_1/FVC % predicted between two study groups.

According to Table 5, there was a significant difference in FVC% predicted and FEV_1% predicted between study groups. For FEV_1/FVC % predicted, there were no abnormalities obtained among exposed and comparative group. The statistical analysis showed that the abnormality of FVC% predicted was significantly higher and respondents in the exposed group were two times more likely to get the lung function abnormalities. From the abnormality of study group in FEV_1% predicted, it was significantly higher and respondents from the exposed group were three times more likely to get lung function abnormalities.

Results from the study are also consistent with the study conducted by Kanae *et al.*, [11]. The results of the spirometry test stated that the pulmonary function of Bangkok police tend to be lower than the comparative group. The FEV_1 was significantly lower for those who were exposed to a more polluted working area compared to those who worked in less polluted areas. Therefore, for overall study results, it showed that the lung function among respondents in exposed group was significantly lower than comparative group. There was also a study among urban population of Hyderabad city in India that stated that the FEV_1% predicted was significantly lower among the subjects from the commercial areas. The FVC and FEV_1 also were significantly higher among the subjects in commercial areas compared to residential areas [18].

Based on the results in Table 6, there was no significant association between respirable particulate (PM_{10}) exposure and lung function parameters among exposed group as well as in the comparative group. Furthermore, there were only 60 traffic policemen who participated in this study. There was no significant association between personal exposure level to respirable particles (PM_{10}) and lung function parameters perhaps because of the small number of subjects that participated in this research study. This is also because this study is a cross sectional comparative study which means the time to conduct this research study is limited. There was also no significant relationship between exposure level to PM_{10} and lung function among total respondents in both groups, exposed group as well as in the comparative group [19]. However, in another study, the lung function status showed that the FVC and FEV_1/FVC % had a significant difference between the exposed group (roadside vendor) and comparative group (university personnel) [20]. Therefore, based on this study, the result of correlation that was obtained between respirable particles (PM_{10}) and lung function in this study was not consistent with some of the previous study that has been conducted because of the insignificant relationship between the variables due to the sample size which is too small to detect the significant association.

A Spearman's Rho Test was performed to determine the association between the duration of work and lung function for the traffic policemen. Based on Table 7, the results showed there was no significant association between working duration (years) and lung function parameters among exposed group as well as for the comparative group. For the traffic policemen, 30 out of 60 respondents have had more than 10 years working experience as traffic policemen. In another study between the two group of traffic policemen, there was 66% of those who have had more than 10 years (>10) working duration and show a higher prevalence in respiratory diseases compared to those who have had working experience of less than 10 years (<10) which is 33% [3]. The insignificant of the results may be because there were only 60 traffic policemen who participated in this study. The human biological variation which was different depends on individuals which may cause the difference in susceptibility among the subjects.

The effects of air pollutants on health vary depending on several factors. These include the level of exposure, susceptibility and the subjects' characteristic such as age, gender, underlying disease, smoking, physiological and social status, genetic and nutritional deficiencies [1]. Thus, there was no significant association between working duration and lung function perhaps because of the small number of subjects that participated in this research study. It can also be because this study was a cross sectional comparative study which was conducted in very limited time. Therefore, based on this study, the result of correlation that has obtained between working duration and lung function parameters in this study was not consistent with the previous study. This is because of the insignificant relationship between the variables due to sample size which is too small to detect the significant association.

Based on the results that have obtained from Table 8, it show that there was a significant regression between FVC% predicted and FEV_1% predicted with the concentration levels of personal exposure to respirable particles (PM_{10}) after the logistic regression was conducted. This showed that the concentration levels of respirable particles (PM_{10}) was the main factor that influenced the abnormalities of FVC% predicted and FEV_1% predicted among study respondents. It must be noted that abnormalities were obtained after confounders such as smoking and concentration levels of personal exposure to respirable particles (PM_{10}) were controlled. Thus the hypothesis was rejected.

Conclusions:

The results from this research showed that the traffic policemen were determined as lower lung function parameters due to their working environment. The effect of pollution by vehicular exhausts may be responsible for these pulmonary function impairments. Traffic policemen that were exposed to higher concentration levels of PM_{10} have shown a significant reduction in FVC and FEV_1 compared to the comparative group. As a conclusion, this study showed that working as traffic policemen can lower the lung function parameters and it has the potential to expose to the respirable particles (PM_{10}) which is indicated by an increase in number of reported respiratory problem among traffic policemen.

As for recommendations, the administration can implement certain actions in order to increase the awareness and knowledge towards the working risk of traffic policemen. The management can change their job schedule. For example, traffic policemen who work at more polluted roadsides can have their job rotated with the other colleagues so that they will experience lesser exposure to traffic air pollutants than before. Other actions like limiting their working duration at the busy roadsides every week such as only twice a week and replace them with the other traffic policemen should also be carried out. In short, it is important for them to understand the health effects of exposure from vehicular pollution.

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