ORIGINAL ARTICLE

Work Exposure to Traffic Air Pollutants (PM_{10}, Benzene, Toluene, and Xylene) and Respiratory Health Implications among Urban Traffic Policemen in Klang Valley, Malaysia

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ABSTRACT

Introduction: This study aimed to identify the exposure levels of traffic air pollutants specifically PM_{10}, benzene, toluene, and xylene (BTX) among traffic policemen and the risks to their respiratory health. A cross-sectional comparative study was conducted among 42 traffic policemen and 42 desk-bound policemen as the exposed and comparative groups respectively. **Methods:** The questionnaire adapted from the American Thoracic Society for Adult Respiratory Health Disease (ATS-DLD) to obtain socio-demographic and respiratory symptoms data. A spirometer (Chestgraph Hi-105) was used to perform lung function test. A personal air sampling pump was used to measure the personal exposure level to PM_{10}. A Ppbrae 3000 was used to measure the outdoor and indoor concentration of BTX during morning and afternoon peak hours respectively. **Results:** The mean personal exposure level of PM_{10} among the traffic policemen was 150.14 ± 130.66 μg/m^3 compared to only 84.14 ± 94.11 μg/m^3 in the comparative group. The short exposures to BTX at the roadsides were found to be slightly higher in the afternoons than in the mornings. Indoor offices air concentrations were only detectable for benzene while the mornings and afternoons values for toluene and xylene were below the detection limits. A median concentration of benzene documented significantly higher at the selected of sampling roadsides areas (median=0.157 ppm) than indoor office areas (median=0.071 ppm). **Conclusion:** The respiratory symptoms were significantly higher in the exposed group compared to the comparative group which they were 3.9, 4.1, and 3.5 times more likely to develop cough, wheezing, and breathlessness respectively.

Keywords: PM_{10}; Benzene; Toluene; Xylene; Respiratory health

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INTRODUCTION

Rapid growth in industrialization, urbanization and transportation has caused the ambient air quality of the Klang Valley to deteriorate, sometimes to unhealthy levels. In 2009, worsening air pollution in the Klang Valley was attributed to the increased rate of respiratory diseases, which have been identified as one of the 10 principal causes of death in Malaysia (1). Anthropogenic sources primarily from automobile exhausts comprised of carcinogenic and mutagenic compounds that could lead to possible health risks among the population. Vehicular emissions consist mainly of very fine particulate matter, hydrocarbons (unburnt), nitrogen oxides, and carbon monoxide. A study in India noted that these emissions not only affected the health of the people, but also resulted in a huge loss to the economy (2). A study in Thailand revealed that gasoline in two and four-stroke engines of motorcycles emitted high levels of BTX, up to ppm levels (3).

In Malaysia, the concentration of benzene in motor fuel is in the range of 3-7% by volume, whereas USA, China, Australia and some European countries have reduced the volume to less than 2% (4). Benzene, which is carcinogenic, can be found in the air of all cities and urban areas as it is mainly released from the exhausts of petrol-driven vehicles (5). Exposure to benzene was the highest recorded (104.6 ± 99.0 μg/m^3) among traffic police personnel compared to toluene and xylene (6). The major health impact of benzene is known to be leukemia. Benzene poses its own biomarkers and could be detected via biomarkers of exposure, effects, and susceptibility in determining its adverse health effects to human (7). However, several earlier studies have also shown that workers who were exposed to BTX also experienced a decrease in lung function (6, 8). Apart from BTX, airborne particulate matter (PM_{10}) is another air pollutant that is associated with mortality and other long-term effects. If exposed to low concentrations for a long period, it can lead to an increased rate of inflammation in lung's bronchi and its function as well (9). A review of air pollution in Malaysia reported that the concentration of the total suspended particulate matter in several areas in the Klang Valley often exceeded the Recommended Malaysian Ambient Air Quality Guidelines (10). According to Solanki et al., (2015), the pulmonary function impairments are caused by the pollutants emitted from the vehicular exhausts (11). Therefore, this study's aim to discover the exposure levels of traffic air pollutants (PM_{10} and BTX) and respiratory health implications in traffic policemen of the Klang Valley.

MATERIALS AND METHODS

Study design and location

This was a comparative cross-sectional study, conducted among a total of 84 traffic and desk-bound policemen from selected traffic branches in the Klang Valley namely; Kuala Lumpur, Petaling Jaya, Subang Jaya, Serdang, Klang Selatan, Klang Utara, Sepang, Kajang, and Shah Alam. The exposed group comprised of traffic policemen involved in controlling the flow of traffic on the roads, while the comparative group involved in administrative work only. The simple random sampling technique was used in recruiting the subjects by obtaining the list of traffic and desk-bound policemen in selected areas from human resources of the Traffic Branch of Headquarters in Klang Valley. Next, the subjects were screened and those fulfilled inclusion criteria were appointed. The inclusion criteria were Malay males with ages between 20 and 50 years old, had no chronic respiratory diseases and did not perform any x-ray scan in the last 6 months.

Instruments and procedures

A questionnaire from the American Thoracic Society for Adult Respiratory Health Disease (ATS-DLD, 1978) was adapted to obtain the prevalence of respiratory symptoms (12). A questionnaire developed comprised of demographic information, occupational information, residential information, outdoor & indoor residential surroundings, environmental tobacco smoke (ETS), hobbies/activities, eating habits, allergies, medical/ health status, self-perceived symptoms and history of respiratory health similar to those used in earlier studies (13-15). A Chestgraph HI-105 Spirometer was used to perform the lung function test to determine the lung function abnormalities through different breathing measurements namely; FVC, FEV_1, and FEV_1/FVC. This device was calibrated before the test was carried out and the test run was based on the ATS Standardization of Spirometry, 2005 (16). The value obtained was compared with a standard value (17) and the predicted value was calculated. The weight and height of each respondent were also taken. The personal monitoring of PM_{10} among the respondents was conducted by using a Gillian GilAir-3 personal air sampling pump. A cyclone and filter membrane cassette with a Poly Vinyl Chloride (PVC) filter paper was installed inside the personal air sampling pump. The Poly Vinyl Chloride (PVC) filter paper was designed to trap particulate matter with an aerodynamic size of 10 microns or below. The equipment was attached to all the respondents, within the breathing zone, for 8 working hours. The procedures followed the NIOSH Manual of Analytical Methods 0500 (1994) (18). The outdoor ambient (roadside) and indoor (office) monitoring of BTX were measured in the mornings and afternoons using a Ppbrae 3000 for 15-minutes measurement for each time at eight selected sampling areas (Kuala Lumpur, Petaling Jaya, Subang Jaya, Klang Selatan, Klang Utara, Sepang, Kajang, and Shah Alam). It is essentially a Photoionization Detector (PID) with the range of 1 ppb to 10,000 ppm. This device was zero-calibrated before each measurement was taken using a zeroing tube. The Ppbrae 3000 was placed near to the roadside at least 1.5 metres above the ground and on a table in the office, to ensure that the exposure measured was at the breathing zone of the respondents. The reading values of BTX were manually multiplied by the correction factor (CF) to obtain the concentration of BTX being measured.

Statistical analyses

The Statistical Package for Social Science Version 23 was used to analyze the collected data. The socio-demographic and traffic air pollutants concentration distribution were analyzed using descriptive analyses. The association and differences in traffic air pollutants concentration and lung function level among the respondents were determined by using a t-test, Mann-Whitney U test, and Chi-square test. The Logistic Regression analysis was performed to determine the main variable that influenced the lung function among the study groups by controlling the age and smoking status.

RESULTS

Background and selection of respondents

This study was conducted among a total of 84 respondents of traffic policemen and the comparative group, office policemen in Klang Valley with all the respondents were male. The male was chosen as they predominantly employed as traffic policemen in the majority of Klang Valley areas rather than female representatives and to controls homogeneity among the study respondents. The mean and standard deviation of the respondents' age in the exposed group were 35 years old and 10 respectively. The mean age and standard deviation of the comparative group were 39 years old and 11 respectively. The youngest respondent was at age of 22 and the oldest was 50 years old. In the exposed group, 25 respondents (59.5%) were the smoker, 8 respondents (19.0%) had stopped smoking and 9 respondents (21.4%) had never smoked. Whereas, in the comparative group, 23 respondents (54.8%) were the smoker, 3 respondents (7.1%) had stopped smoking and 16 respondents (38.1%) had never smoked. The mean of years of employment of the respondents in the exposed group was 7.4 years and the standard deviation was 5.1.

The mean of years of employment of the respondents in the comparative group was 5.3 years with the standard deviation of 4.5. The minimum year of employment was a year and the maximum year of employment was 23 years. In the exposed group, 37 respondents (88.1%) studied until SPM/STPM level and 5 respondents (11.9%) had a Diploma. Whereas, in the comparative group, 35 respondents (83.3%) studied until SPM/STPM level, 5 respondents (11.9%) had Diploma and 2 respondents (4.8%) had Bachelor's Degree. The independent t-test reported there was no significance difference in mean of age (t=-1.755, p=0.083), education level (t=-1.005, p=0.318), and smoking status (t<0.01, p=1.000).

Concentrations of traffic air pollutants (PM_{10}, benzene, toluene, and xylene)

A parametric test (Independent t-test) was performed to determine the differences between the personal air concentration of PM_{10} among traffic policemen as the exposed group and office policemen as the comparative group respectively. Table I showed the mean of the individual concentration of PM_{10} among the traffic policemen was 150.14 ± 130.66 µg/m³ compared to only 84.14 ± 94.11 µg/m³ among the comparative group. The findings revealed the concentration of PM_{10} in exposed group was higher than the comparative group with statistical test showed that comparison PM_{10} concentration between the two study groups were significantly differences with p<0.05.

Table I: PM_{10} exposure level among the respondents

Variables	Exposed Group n = 42		Comparative Group n = 42		t	p value
	Mean	Standard Deviation	Mean	Standard Deviation		
PM_{10} Concentrations (µg/m³)	150.14	130.66	84.14	94.11	2.656	0.009*

Independent t-test
*Significant at p<0.05

A normality test showed that the distribution of ambient concentrations of BTX was not normally distributed. The comparison of the ambient BTX concentrations in the mornings and afternoons peak hours for each group was performed using the Mann-Whitney U test. The statistical test showed that the comparison of ambient concentrations of BTX at the roadside areas (represent exposure to the exposed group) between morning and afternoon peak hours were not significantly differences. The similar finding also observed at the eight selected indoor office areas (represent exposure to the comparative group). However, the trend of BTX level at the roadside areas was found slightly higher in the afternoon compared in the morning with median concentration was 0.178 ppm, 1.140 ppm, and 0.165 ppm respectively (shown in Table II). Meanwhile, the morning median concentration at the roadsides for BTX was 0.083 ppm, 0.045 ppm, and 0.016 ppm respectively. The morning and afternoon median concentration indoors offices for benzene was 0.066 ppm and 0.071 ppm respectively with toluene and xylene level were below the detection limits. Seems the level of benzene and toluene were slightly higher than xylene for both peak hours' time at the roadsides sampling sites (Figure 1). The Mann-Whitney U test documented benzene concentration at the roadsides where the traffic policemen controlled the traffic flows was significantly higher than indoor office areas where the desk-bound workers performed their duty with p value < 0.05 but not significant for toluene and xylene level for both morning and afternoon peak hours respectively.

Table II: Comparison of concentrations of benzene, toluene, and xylene at eight sampling roadsides and indoor office areas during morning and afternoon peak hours

Variables	Morning		Afternoon		z	p value
	Median	IQR	Median	IQR		
roadsides areas (n-=8)						
Benzene (ppm)	0.083	0.124	0.178	0.074	-1.157	0.247
Toluene (ppm)	0.045	0.047	1.140	1.142	-1.350	0.177
Xylene (ppm)	0.016	0.016	0.165	0.189	-1.695	0.090
indoor offices areas (n=8)						
Benzene (ppm)	0.066	0.101	0.071	0.257	-0.789	0.430
Toluene (ppm)	Below DL	1.818	Below DL	0.374	-0.276	0.783
Xylene (ppm)	Below DL	1.600	Below DL	0.901	-0.128	0.898

Mann-Whitney U test
DL: Detection Limit

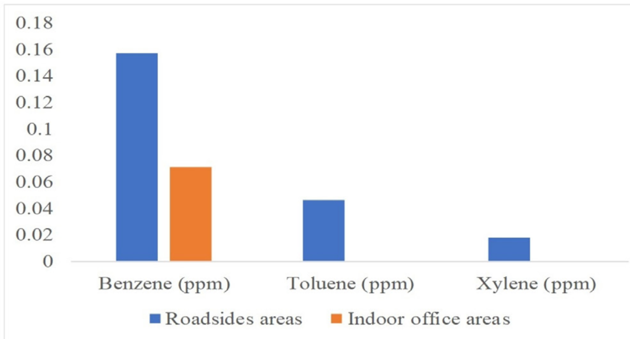

Figure 1: The median of roadsides and indoor office areas' concentrations of BTX at both morning and afternoon peak hours (median of toluene and xylene level were below detection limit for indoor offices areas and median of benzene level was significantly higher at the roadsides than indoor offices areas)

Comparison of lung function test

The determination of FEV_1% predicted and FVC% predicted was based on the normal value of predicted equation. The pulmonary function of the subjects was evaluated by three parameters namely; Forced Vital Capacity per cent (FVC%) predicted, Forced Expiratory Volume in 1 second per cent (FEV_1%) predicted and Forced Vital Capacity over Forced Expiratory Volume in 1 second per cent (FEV_1/FVC%) predicted. All respondents had performed the lung function test with standardized steps (16) and the value for FVC% predicted,

FEV_1% predicted and FEV_1/FVC% predicted had been calculated using the prediction equation formula for the Malaysian population. Table III showed the mean of FVC (litre) and FEV_1 (litre) reported in the exposed group was 3.03 ± 0.37 and 2.77 ± 0.32 respectively. Whereas, the mean of FVC (litre) and FEV_1 (litre) in the comparative group was 3.10 ± 0.59 and 2.80 ± 0.53 respectively. The mean of FVC% predicted was 81.33 ± 10.28 and 84.76 ± 11.23 for the exposed and comparative group respectively. Meanwhile, the mean of FEV_1% predicted for the exposed and comparative group were 86.75 ± 9.38 and 86.82 ± 11.67 respectively. The mean of FEV_1/FVC% predicted for the exposed group documented was 103.35 ± 4.22 and 106.72 ± 5.95 for the comparative group respectively. The statistical analysis results in Table III showed that there was a significant difference in FEV_1/FVC% predicted between the two study groups with $p<0.05$. American Thoracic Society (ATS) stated that the normal value for FVC% predicted and FEV1% predicted were ≥ 80% whilst FEV_1/FVC% predicted was >70% (16). The result of the prevalence of lung function abnormalities was based on FVC% predicted, FEV_1 predicted and FEV_1/FVC% predicted.

In Table IV, the results showed that 25 (59.4%) abnormal status for FVC% predicted and 15 (35.7%) abnormal status for FEV1 predicted among exposed group while in the comparative group, 14 (33.3%) abnormal status for FVC% predicted and 9 (21.4%) abnormal status for FEV1% predicted were recorded. A significant difference documented in FVC% predicted between the two study groups with $p<0.05$.

Association of respiratory health symptoms between the exposed and comparative groups

The respiratory symptoms include in this study were a cough, phlegm, wheezing, and breathlessness. A significant difference reported in a cough, wheezing and breathlessness between the two study groups with $p<0.05$ (Table V). The Chi-Square analysis showed the significant association between both groups for the cough, wheezing, and breathlessness symptoms but not for phlegm symptom. The statistical value reported for cough (PR=3.86, 95% CI = 1.44-10.34), wheezing (PR=4.08, 95% CI = 1.50-11.10) and breathlessness (PR=3.48 95% CI = 1.10-11.01) after adjusted for age and smoking.

Correlation between exposure level of PM_{10}, age and years of employment with lung function parameters among respondents

Pearson Correlation Test was used to determine the relationship between the individual concentration of PM_{10}, age and years of employment with the parameters of FVC% predicted, FEV_1% predicted and FEV_1/FVC% predicted among the respondents. Statistical analysis showed no significant relationship between personal exposure level of PM_{10} with lung function parameters

Table III: Comparison of lung function status among the respondents

Variables	Exposed Group n = 42		Comparative Group n = 42		t	p value
	Mean	Standard Deviation	Mean	Standard Deviation		
FVC (Litre)	3.03	0.37	3.10	0.59	-0.622	0.535
FEV_1 (Litre)	2.77	0.32	2.80	0.53	-0.283	0.778
FVC% Predicted	81.33	10.28	84.76	11.23	-1.457	0.149
FEV_1% Predicted	86.75	9.38	86.82	11.67	-0.028	0.325
FEV_1/ FVC% Predicted	103.35	4.22	106.72	5.95	-2.990	0.004*

Independent t-test
*Significant at p<0.05

Table IV: Comparison of lung function status among the respondents

Variables	Status	Study Group Frequency (%) Exposed Group n = 42	Comparative Group n = 42	χ^2	p value
FVC% predicted	Abnormal Normal	25 (59.4) 17 (40.5)	14 (33.3) 28 (66.7)	5.791	0.016*
FEV_1% predicted	Abnormal Normal	15 (35.7) 27 (64.3)	9 (21.4) 33 (78.6)	2.100	0.147
FEV_1/ FVC% predicted	Abnormal Normal	- 42 (100.0)	- 42 (100.0)	-	-

Chi-square test
*Significant at p<0.05

Table V: Association of respiratory health symptoms among the respondents

Variables	Study Group Frequency (%) Exposed Group n = 42	Comparative Group n = 42	χ^2	p value	PR (95% CI)	PR*** (95% CI)
Cough					3.52**	3.86
Yes	32 (76.19)	20 (47.62)	7.269	0.007*	(1.38-8.96)	(1.44-10.34)
No	10 (23.81)	22 (52.38)				
Phlegm					1.67	
Yes	18 (42.86)	13 (30.95)	1.278	0.258	(0.68-4.10)	-
No	24 (57.14)	29 (69.05)				
Wheezing					3.86**	4.08
Yes	20 (47.62)	8 (19.05)	7.714	0.005*	(1.45-10.29)	(1.50-11.10)
No	22 (52.38)	34 (80.95)				
Breathlessness					3.32**	3.48
Yes	13 (30.95)	5 (11.90)	4.525	0.033*	(1.06-10.37)	(1.10-11.01)
No	29 (69.05)	37 (88.10)				

Logistic regression
*Significant at p<0.05
**Significant PR > 1, 95% CI
***Adjusted PR for age and smoking

Table VI: Pearson correlation between personal exposure of PM_{10} concentration, age and years of employment with lung function parameters among the respondents

Variables	Exposed Group n = 42		Comparative Group n = 42		All respondents n=84	
	r value	p value	r value	p value	r value	p value
PM_{10} Concentrations (µg/m_3)						
FVC% predicted	0.127	0.421	-0.322	0.037*	-0.192	0.080
FEV_1% predicted	0.112	0.480	-0.319	0.039*	-0.138	0.211
FEV_1/FVC% predicted	0.023	0.885	-0.314	0.043*	-0.287	0.008**
Age						
FVC% predicted	-0.753	0.000**	-0.307	0.048*	-0.352	0.001**
FEV_1% predicted	-0.822	0.000**	-0.538	0.000**	-0.596	0.000**
FEV_1/FVC% predicted	-0.961	0.000**	-0.035	0.828	0.066	0.550
Years of Employment (Year)						
FVC% predicted	-0.529	0.000**	0.012	0.941	-0.225	0.039*
FEV_1% predicted	-0.584	0.000**	-0.163	0.302	-0.365	0.001**
FEV_1/FVC% predicted	-0.700	0.000**	0.227	0.148	0.027	0.804

Pearson Correlation Test
* Correlation is significant at p < 0.05 level
** Correlation is significant at p < 0.01 level

in the exposed group (Table VI), but significant correlation reported for all the lung function parameters in the comparative group [FVC% predicted (r=-0.322, p=0.037), FEV_1% predicted (r=-0.319, p=0.039), and FEV_1/FVC% predicted (r=-0.314, p=0.043)]. The personal exposure to PM_{10} was significantly correlated with FEV_1/FVC% predicted at p<0.01 in all respondents. All lung function parameters found significantly correlated with age in the exposed group at p<0.01. The FVC% predicted and FEV_1% predicted were correlated with age in the comparative and all respondents studied at p<0.05 and p<0.01 respectively. The years of employment was reported to be correlated with all the lung function parameters in the exposed group (at p< 0.01) and with FVC% predicted (at p<0.05) and FEV_1% predicted (at p<0.01) in all respondents, unlike in the comparative group found to be not correlated.

DISCUSSION

Background and selection of respondents

The traffic and offices policemen are predominantly Malay males and were chosen to ensure homogeneity among the study groups. The confounding factors of age, height, weight, education level, and smoking status were well-controlled as these factors including race, gender and body size would affect the reading of lung function test (19).

Concentrations of traffic air pollutants (PM_{10}, benzene, toluene, and xylene)

Results showed that the mean value of PM_{10} concentrations personally exposed among the traffic policemen was significantly higher than in the comparative group. The mean value of PM_{10} concentrations recorded among the traffic policemen was, however, lower than the mean value of 208.33 ± 49.02 µg/m^3 recorded in an earlier study by Muhammad *et al* (2014) among traffic policemen in Petaling Jaya (20). The mean value of PM_{10} concentrations with 7.99 mean working hours among the traffic policemen (i.e. 150.14 ± 130.66 µg/m^3) was exceeded the Malaysian Ambient Air Quality Guidelines (MAAQG) of 120 µg/m^3 (for 24-hour exposure) (21).

The measurements level of BTX was taken for comparison during the morning and afternoon peak hours. For the exposed group, the point of measurement was at the roadsides and for the comparative group, the point of measurement was in the offices where the respondents were working on. The Table II showed that the median concentration of benzene and toluene in the atmosphere slightly higher than xylene. This scenario could be explained by the longer stability of benzene and toluene's atmospheric lifetimes (lifetimes of 12.5 and 2.0 d, respectively) rather than only 7.8 h lifetime of xylene in the atmosphere (22). The indoor offices were only detectable for benzene compound (median at 0.066 ppm and 0.071 ppm in the mornings and afternoons respectively) whilst toluene and xylene were below detection limit. This finding tends to suggest the presence of benzene in the indoor environment being emitted from building materials, activities inside the offices and might be due to the age of building (23-24). The other factors taken into consideration for the presence of BTEX were smoking, building renovation in the last months, number of occupy, the paint remover and fragrance utilization (25). Moreover, the detectable of benzene inside the offices could be affected by the traffic emission (26) due to some of them located adjacent to the outdoor sources. The level of benzene found to be significantly higher at the roadsides than indoor offices areas for both morning and afternoon peak hours respectively. This would seem to suggest that the benzene emitted primarily from the automobile exhausts with facts of Klang Valley was a heavy traffic density urban area. Therefore, emission from exhaust mobile becomes a primary source of air pollutants (27) which estimated almost 70 percent (28) contributed to the total emission. This strengthened by a strong positive correlation discovered between high benzene concentrations with heavy traffic flow in the studied areas in Malaysia (29). Though, the median concentration for benzene, toluene, and xylene were not exceeded the short-term exposure limit, STEL (15-minute measurement) set by the occupational bodies, American Conference of Governmental Industrial Hygienists, ACGIH (maximum limit at 2.5 ppm and 150 ppm for benzene and xylene respectively) (30) and United State National Institute of Occupational Safety and Health, NIOSH (150 ppm for toluene) (31), still considered unacceptable for the ambient air guidance. The World Health Organization (WHO) reported that there is no safe exposure level can be recommended for benzene, 30-minutes of 1000 $\mu g/m^3$ for toluene exposure and 24-h of 4800 $\mu g/m^3$ of xylene exposure in ambient (9). Overall, the findings documented the traffic policemen facing at daily risk due to their exposure to those potential carcinogenic and mutagenic pollutants particularly benzene.

Comparison of lung function test

A significant difference was reported in FEV_1/FVC% predicted between the two study groups. There was no significant difference found in FVC ($t=-0.622$; $p>0.05$) and FEV_1 ($t=-0.283$; $p>0.05$) between the two study groups. The FVC% predicted ($t=-1.457$; $p>0.05$) and FEV1% predicted ($t=-0.028$; $p>0.05$) also showed no significant differences between the exposed and comparative groups. A significant difference was obtained in FEV_1/FVC% predicted between the two study groups with $p<0.05$. The lung function abnormalities of the two study groups were compared based on the Degree of Severity for FVC% predicted, FEV_1% predicted and FEV_1/FVC% predicted by ATS. The results of the prevalence of lung function abnormalities were based on the lung function parameters.

The abnormal FVC obeserved was due to the fact that the air was restricted from filling the lung to its normal capacity. As such, the traffic policemen experienced a greater lung function reduction compared to the comparative group. This observation was supported by several earlier studies (32-34) which showed a significant decline in lung parameters, particularly FEV_1/FVC%, and abnormalities in FVC among traffic policemen. Therefore, it can be summarized that the traffic policemen who were actively involved in controlling traffic flow had a poorer lung function status than the desk-bound policemen.

Association of respiratory health symptoms between the exposed and comparative groups

The respiratory symptoms included in this study were cough, phlegm, wheezing, and breathlessness. These results illustrate that the traffic policemen who were exposed to higher concentrations of air pollutants, especially PM_{10}, were 3.9, 4.1, and 3.5 times more likely to develop cough, wheezing, and breathlessness respectively. These findings were in agreement with those observed in other studies (6, 20, 35) in which exposure to BTX and PM_{10} resulted in adverse health effects to the respiratory system.

Correlation between exposure level of PM10, age and years of employment with lung function parameters among respondents

A direct and weak relationship with no significant correlation found between PM_{10} exposure concentrations with lung function parameters in the exposed group. This finding could be explained by the effects of air pollutants on a person's health vary depending on several factors, which include the level of exposure, susceptibility, and characteristics such as age, underlying disease, smoking, physiological and social status, genetic and nutritional deficiencies (9, 36). A significant correlation between personal PM_{10} level and all the lung function parameters indicating that the lung function decreased as the exposure levels increased among the comparative group but in the indirect and poor relationship. Only FEV_1/FVC% predicted correlated with PM_{10} level in all respondent such similar significant differences observed between exposed and comparative groups (as shown in Table VI). Nevertheless, the significant higher personal exposure of PM_{10} and ambient benzene particularly signaled us they are in continuous exposure. Age has correlated well with all the lung function parameters except FEV_1/FVC% predicted parameter in comparative and all respondents studied. The result tells us lung function was declined as age was increased. Age can influence the reading of FVC and FEV_1 particularly as they began to decrement in coming-of-age after stability stage at age of 30-35 years or above (19). An indirect and poor significant correlation observed between years of employment and lung function parameter in exposed at $p<0.01$. In contrast, no significant correlation was reported in the comparative group. This relationship could be described by the main task of traffic policemen was controlling the traffic flows for many years placed them at daily risk for continuous exposure to the traffic air pollutants. Notwithstanding, all respondents showed FVC% predicted and FEV_1% predicted were correlated with years of employment at $p<0.05$ and $p<0.01$ respectively.

CONCLUSION

The study has indicated that traffic policemen were regularly exposed to the traffic air pollutants, specifically BTX and PM_{10} were at a higher risk of developing the respiratory disorder, as exhibited by the lung function reduction and increased prevalence of respiratory symptoms. Their prolonged exposure to the air pollutants, especially in heavily trafficked areas, would likely cause a deterioration of the lung function. There are several shortcomings in this study. The Ppbrae 3000 used for the BTX measurements was not able to differentiate the pollutants measured even though it was sensitive and accurate. Furthermore, as the study was carried out over a short period of time (15-minutes), the measurements obtained might not truly reflect the actual exposure levels of the traffic policemen to the air pollutants. The challenge using the portable handheld Ppbrae 3000 instrument was inappropriate to measure the personal exposure due to its size and weight which then limit the duration of sampling time. Moreover, the sample size of the respondents in the study was quite small. Further studies, involving a longer period of time and a larger sample size, are recommended for a more accurate assessment of the exposure of traffic policemen to air pollutants and the resulting health implications.

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