UNIVERSITI PUTRA MALAYSIA

RISK FACTORS OF RESPIRATORY EFFECTS FROM WORK EXPOSURE AND PM2.5 AMONG POLICEMAN

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October 2016

Chairman : Karmegam Karuppiah, PhD
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Without any protections from traffic-related air pollution, traffic policeman was exposed to them on daily basis as their duties are to manage traffic congestion. This study was to determine the risk of respiratory effects from work exposure and $PM_{2.5}$ among traffic policemen. A pulmonary function test using spirometer was used to measure pulmonary function of subjects and personal air sampling pumps were used to measure personal exposure level of $PM_{2.5.}$ In order to collect background data, occupational and health history, questionnaires were given to each subject. The mean exposure level of $PM_{2.5}$ among traffic policemen was 28.69 µg/m^3. The traffic policemen were determined as having lower lung function parameters (FVC, 91% and FEV1, 94%) due to their nature of work and the environment. It was found that some of them possess respiratory symptoms (Coughing 33.6%, Phlegm 25.4%, Wheezing 14.9% and 32.1%). From the finding, $PM_{2.5}$ personal exposures level ($p<0.05$), age ($p=0.04$), rank ($p=0.04$), duration of services ($p=0.01$), and average working hours ($p<0.001$) were significantly related with pulmonary function among traffic police. Also, $PM_{2.5}$ personal exposures level was significantly associated with coughing ($p<0.05$) among traffic policemen. The outcomes also indicated that the main factors of abnormality in lung functions are exposure to $PM_{2.5}$ and duration of services. These baseline data can be used in the future studies by researcher, engineers and students. Most importantly, they serve as reference to the top management of traffic police officers in order to develop an occupational safety and health guideline for police officers as they are covered by Occupational Safety and Health Act (OSHA, Act 514 1994).

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

FAKTOR-FAKTOR RISIKO KESAN PERNAFASAN DARIPADA PENDEDAHAN KERJA DAN $PM_{2.5}$ DI KALANGAN POLIS

Oleh

PUTRI ANIS SYAHIRA BINTI MOHAMAD JAMIL

Oktober 2016

Pengerusi : Karmegam Karuppiah, PhD
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Tanpa sebarang perlindungan dari pencemaran udara yang berkaitan dengan trafik, anggota polis trafik telah terdedah kepada pencemaran ini pada setiap hari memandangkan tugas mereka adalah untuk menguruskan kesesakan lalu lintas. Kajian ini adalah untuk menentukan risiko kesan pernafasan daripada pendedahan kerja dan $PM_{2.5}$ di kalangan anggota polis trafik. Ujian fungsi paru-paru menggunakan spirometer telah digunakan untuk mengukur fungsi paru-paru responden dan pam pensampelan udara peribadi juga telah digunakan untuk mengukur tahap pendedahan peribadi $PM_{2.5}$. Dalam usaha bagi mengumpul data latar belakang, sejarah dan kesihatan pekerjaan, boring soal selidik telah diberikan kepada responden. Min tahap pendedahan $PM_{2.5}$ di kalangan anggota polis trafik ialah 28.69 µg/m3. Anggota polis trafik telah direkodkan sebagai mempunyai fungsi paru-paru yang lebih rendah (FVC, 91% dan FEV1, 94%) kerana sifat kerja mereka dan faktor persekitaran. Kajian telah mendapati bahawa sesetengah daripada mereka mempunyai gejala pernafasan (Batuk 33.6%, Kahak 25.4%, Berdehit 14.9% dan Sesak nafas 32.1%). Dari dapatan itu, tahap pendedahan peribadi $PM_{2.5}$ ($p < 0.05$), umur ($p = 0.04$), pangkat ($p = 0.04$), tempoh perkhidmatan ($p = 0.01$), dan waktu kerja purata ($p < 0.001$) adalah berkaitan dengan fungsi paru-paru di kalangan polis trafik. Juga, tahap pendedahan peribadi $PM_{2.5}$ dikaitkan dengan ketara bersama batuk ($p < 0.05$) di kalangan anggota polis trafik. Hasil dapatan kajian juga menunjukkan bahawa faktor-faktor utama dalam fungsi paru-paru adalah pendedahan kepada $PM_{2.5}$ dan tempoh perkhidmatan. Data-data ini boleh digunakan dalam kajian masa depan oleh penyelidik, jurutera dan pelajar. Yang paling penting, dapatan ini akan menjadi rujukan kepada pengurusan tertinggi pegawai polis trafik untuk meningkatkan keselamatan dan garis panduan kesihatan bagi pegawai-pegawai polis memandangkan mereka dilindungi oleh Akta Keselamatan dan Kesihatan Pekerjaan (OSHA, Akta 514 1994).

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I certify that a Thesis Examination Committee has met on 25 October 2016 to conduct the final examination of Putri Anis Syahira binti Mohamad Jamil on her thesis entitled "Risk Factors of Respiratory Effects from Work Exposure and $PM_{2.5}$ among Policeman" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

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LIST OF ABBREVIATIONS

CNS	Central Nervous Systems
COPD	Chronic Pulmonary Disorder
EPA	Environmental Protection Agency
FEV	Forced expiratory Volume
FVC	Forced vital capacity
NMAM	NIOSH Manual of Analytical Method
PDRM	Polis Diraja Malaysia
SPSS	Statistical Package for Social Science
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 Background

Each year in Unites States, an estimated of 10 million work-related injuries and 400 000 new work-related illness were reported based on statistics by Levy et al (2006). As compared to the United States, occupational injury and illness rates were higher in developing countries. Levy et al. (2006) had reported that major categories of occupational illness by organ systems were such as musculoskeletal disorders, respiratory disorders, neurologic and psychiatric disorders including hearing impairment.

In Malaysia, statistics by Department of Occupational Safety and Health (2010), the number of occupational lung disease from 2001-2009 is increasing tremeandously. In 2001, there were 14 cases, 2002 with 17 cases, 2003 and 2004, both recorded 29 cases. In 2005, the number of cases dropped to 15 cases and climbed back to 17 cases in 2006 and 25 cases in 2007. The significant increase is seen in 2008 with 49 cases. Up to 2009, there is already 54 cases of occupational lung disease reported to the department. The statistics were shown in Figure 2.1.

As one of the major categories of occupational illness, respiratory disorders were one of the main concerns in occupational health. World Health Organization (2016), stated that there were many contributing risk factors to respiratory disorders. One of them was ambient air pollution. Recently, according to the World Health Organization (2016), in the 2010 Global Burden of Disease reported that they estimated the burden of disease related to urban air pollution to 52 million DALYs (disability-adjusted life years). That is fully 2/3 of the burden worldwide. Moreover, a number of studies appear that some of the air pollutants in several large cities are increasing with time and were not always within the national ambient air quality standards for monitoring the ambient air quality (Araki, 2013).

Ambient air pollutions were derived mainly from fuel combustion. They include primary pollutants (sulfur dioxide, nitrogen oxides, and particles), secondary acidic aerosols and other particles, and oxidant pollutants (primarily ozone) that were produced by photochemical reactions involving hydrocarbons and nitrogen oxides (Katsouyanni, 2003).

In Malaysia, there were three major sources of air pollution namely mobile sources, stationary sources and mobile sources (Department of Statistics (2015). Ling et al. (2014) stated emissions from mobile sources have been the essential source of air pollution which is contributing at least 65-75% of total air

pollution for the past years. As reported by Department of Statistics (DoS, 2015), Malaysia, the highest percentages of the air emission load were by motor vehicles that are 69% as shown in Figure 2.1. Stationary sources were related to industry, power station, industrial fuel burning processes, and domestic fuel burning (Ling et al.,2014). Here, in Malaysia, large numbers of these sources reside in Selangor followed by Sarawak, Johor, Sabah, Perak, and Pahang. Rafia et al. (2003) states that other source includes open burning sources such as the burning of solid wastes and forest fires. This has occurred commonly in some poorly managed disposal sites and results in smoke and fly ash problems.

As Department of Statistics (2015) found that major air emission are from mobile vehicles, it is supported by Road Transport Department (2014) which reported increasing trends of number of vehicles on road by state from 2010-2014 as shown in Figure 2.2. In Kuala Luympur itself, it increase from 3.8 million (2010) to 4 million (2011) to 4.2 million (2012) to 4.5 million (2013) and 5.9 million in 2014. The increasing number of vehicles on road simultaneously increase the air pollution in the surrounding. This is agreed by Beijing Government (2016) which reported an increase in traffic congestion and increased environmental pollution are due to the facts that the number of cars has exceeded four million in Beijing.

In Figure 2.3, according to the Road Transport Department (JPJ, 2014), in Malaysia, Kuala Lumpur has 5.9 million vehicles which were the highest vehicle population followed by Johor (3.3 millions), Selangor (2.6 millions), Pulau Pinang (2.5 millions) and Perak (2.1 millions). These condition advance to severe traffic congestion in almost all parts of the highway network and corridors and thus, due to vehicular exhaust emissions in these areas, the environment is deteriorated.

Air pollution will leave an impression on those who were exposed to them. Those polluted air can cause respiratory irritation or breathing difficulties even for a healthy people. The actual risk depends on current health status, the pollutant type and concentration, and the length of exposure to the polluted air (Sacramento Metropolitan Air Quality Management District, 2016).

Muhammad et al (2012) stated among those affected by air pollution runoff were employees who work outside. For example, traffic police, street sweeper, and postal workers. Since they are working outside for most of the time, hence they were exposed to polluted air for a long time in high concentrations. Among them, traffic police were exposed to polluted air more frequently as their duties adjure them to control road traffic at the highly congested junctions (Muhammad et al, 2014).

Under the Police Act, 1967 Section 21 task of regulating, controlling and maintaining the flow of traffic on public roads falls to the responsibilities of the

traffic policeman. With such responsibilities, they have no choice other than to perform the given task. Their task was considered heavy duty as they had to deal with congested traffic condition and attitude of selfish drivers. Thus, if coupled with the polluted air, their health was worsening due to occupational factors.

As evidence, Jafary et. al. (2007) stated that to individuals who perform physical labor close to traffic, the traffic-related air pollution was an occupational health hazard. Another study by Thippanna and Lakhtakia (1999) in twin cities of Hyderabad and Secureabad states that traffic policeman was posted at various traffic junctions through which a maximum number of vehicles pass and they were more prone to develop health hazards of automobile exhausts on the respiratory system. Although this study is old, the findings were important as there were very limited study done among traffic police working at the junctions (Point Duty Department) and their respiratory health.

One of the common respiratory diseases were occupational lung diseases. The occupational lung diseases were most probably due to the deposition of dust in the lungs. These were determined by the sort of dust, the period of exposure, the concentration and size of airborne dust in the breathing zone which is stated by Johncy et al. (2011).

Occupational lung diseases were more widespread and more disabling than any other group of occupational disease. The lung with its wide surface area, thin alveolar epithelium, and high blood flow was an important site of contact with substance from the environment. Over periods of time, the inhalation of dust leads to proliferation and fibrotic changes in lungs as stated in a book by Ritchie (1990).

As suggested by Vyas (2000), a new era towards scientific approach in diagnosis, prognosis, and management of pulmonary disorders have been opened by the pulmonary function tests through early recognition of their alteration in industry workers due to their constant exposure to various dust pollutants and to institute protective and preventive measures to minimize the hazards of exposure to polluted environment.

However, there was very limited specific study been conducted on the respiratory symptoms and pulmonary function among the traffic policeman in Malaysia. Hence, this study measured the prevalence and associated factors of pulmonary function among traffic policeman. The results from this study serves as a reference to help administration body to improve the working environment and work procedure so that it will be convenient for their health and productivity.

1.2 Problem Statements

This present study concerns about the risk factors of respiratory symptoms and pulmonary functions of traffic policemen in heavy traffic area in Kuala Lumpur and Johor Bahru. The study locations were selected in a manner so as to recruit as many potential study participants as possible. As they have to fulfill a few criteria such as traffic police men who have worked in an environment which expose them to the traffic related air pollution.

This study was conducted in Traffic Police Station in Kuala Lumpur (Balai Trafik Jalan Tun H.S.Lee) and Johor (Balai Trafik Johor Bharu). Since KL and Johor are having similar situations regarding their characteristics based on information by Royal Malaysian Police (2009b), this research is done in these states. By looking at the air pollution index in 2014, both locations were in unhealthy status which were 170 for Kuala Lumpur and 198 for Johor Bahru. The status is overwhelming for both states whereby everyone may begin to experience health effects with members of sensitive groups may experience more serious health effects. Moreover, as reported by Royal Malaysian Police (2014c), the number of traffic police riders in KL and Johor is the largest in Malaysia. However, the traffic policemen that were included in this study were taken from Point Duty department only. This is due to their nature of work which mainly involving outdoor activities also the duty of controlling traffic on public roads. To ensure the consistency of the data, this step of involving only traffic police from this specific department is a must. Moreover, different department has different types of task and duration of outdoor work.

Policemen especially traffic police usually live under constant alarm of physical danger, working in long and irregular hours (8-16 hours), and were exposed to abhorrent sides of life which eventually results in psychological stress and even personality and family issue (International Hazard Datasheets on Occupation, 2015). They had also involved in work relate accidents such as vehicle crashes, falls during rescue, chase and similar operations. Moreover, they were exposed to a number of hazards during their working time such as particulates exposure in outdoor air and noise.

These policemen were to carry out their duties regardless of the risk they are facing such as bad motorcycles condition (use in patrolling) and even in worst weather condition. Thereupon, they were prone to develop health problems on the grounds that they were spending much time outdoors, including under the sun or in bad weather. For instance, they may have developed lung cancer, COPD, hearing problems and much more. Besides, as policemen, they were to help the public in needs regardless of situation, such as unavoidable contacts with people who have contagious diseases (Encyclopaedia of Occupational Health and Safety, 1998).

It has been reported in a few previous studies that the exposure to traffic air pollutant significantly affecting their lung function, where the lung function tests were conducted among the traffic police. A study in Thailand, by Karita et al (2001), found that the more exposed group had significantly reduced lung function than less exposed group. DeToni et al. (2005) in Italy, reported that police officers assigned to traffic control had a significantly more problems with their respiratory health compared to police in administrative departments. In India, by Satapathy et al. (2009), Pal et al. (2010), Singh et al. (2009), and Gupta et al. (2011) reported similar results with $p < 0.001$.

There were a few similar studies on traffic policemen in Malaysia. A study by Muhammad. et. al (2012) which is a comparative study among traffic police in KL and general police in Bukit Aman Headquarters. This study identifies the correlation of $PM_{2.5}$ personal exposures and lung function together with respiratory symptoms. They found that there is no correlation between $PM_{2.5}$ exposure and the lung function of the respondents. However, all the lung function parameters were significantly lower ($p<0.05$) among traffic policemen compared to general police. Anyhow, this study used a small sample size and only one study location which was in KL. Another study by Muhammad et. al (2014) also a comparative study among traffic police in Selangor and general police in Putrajaya. However, this study concerns on PM_{10} personal exposure and its relationship with lung function and respiratory symptoms. In this study, they obtain similar results with previous study where the traffic police had significant reduction ($p<0.05$) in all lung parameters compared to control group. Once more, the limitations of this previous study were having small sample size and only in one location. Above all, both of the study ceases that there was significant decrement in the lung function parameters tested which is FVC and FEV.

Since the traffic police in the Point Duty Department is working in an outdoor environment, they are directly exposed to air pollutant scattered in the air. By looking at the annual report by Department of Statistics, air pollution level in Malaysia in 2014, is on unhealthy level (KL,170 and JB, 198) which may cause everyone to have health effects whereas members of susceptible groups might develop serious health effects. This was supported by the Air Quality and Pollution Measurement by US EPA as shown in Figure 2.6 and the measurement of air quality in Table 2.1.

Hence, based on these data, we can conclude that the traffic policemen who perform labor close to traffic are working in an environment that is unfavorable for their health. They were also facing hazards which physically and psychosocially affect their health. Therefore, working in such environment has made them prone in getting respiratory health problems. In short term health effects, whereby high levels of air pollution leads to acute condition and possible long term health effects are still unknown and difficult to detect. Examples of health effects related to air pollution are asthma, bronchitis, COPD and lung cancer.

Scientists, after twenty years of epidemiological studies, have revealed that fine particle pollutants is significantly related to respiratory morbidity and mortality (Brunkreef et al., 2002). Helfand et al. (2001) and Nemery et al. (2001) reported that increment in particulate matter concentration in the air may directly lead to high morbidity and mortality rate of a population, since the last century. The average life span in European Union countries were decreased by 8.6 months by $PM_{2.5}$ itself (Orru et al., (2011). Not long before, Zanobetti et al., (2009) and Dominici et al. (2006) illustrated that respiratory diseases and hospitalization rate increased by 2.07% and 8% respectively when the daily $PM_{2.5}$ increased by 10 µg/m^3. These study also demonstrated that serious symptoms of respiratory tract diseases, reduction in lung function and raised in morbidity and mortality rate of cardiopulmonary diseases were directly associated with the increase in air particle pollutants.

Besides, a study by Muhammad et al (2012), reported that the risk factors in the development of respiratory diseases exposure was the increasing concentration level of traffic pollutant as they found higher prevalence of respiratory symptoms and reduction in lung function among traffic policemen working in Kuala Lumpur Traffic Police Station.

According to Pravati et al. (2010) statements, long term exposures to gases and fumes present in the environment near heavy traffic decreases the pulmonary functions. This eventually result in alteration of pulmonary function test parameters. Besides, occupational exposure may also cause reversible early airway obstruction by Das and Jha (2009). From the study, evidence reported that the workers' complaints on respiratory problems such as cough with sputum, dry cough, breathlessness and wheezing. Muhammad et al (2012) also reported that the services of workers in terms of working days lost, health cost increase, reduced productivity of working quality and other socio-demographic aspects of their life were affected by the consequences of impairment or reduction of lung function and respiratory health problems.

However, there were limited studies in Malaysia regarding pulmonary functions parameters in traffic policeman. Specifically, there was no systemic study has been conducted in traffic policeman in Kuala Lumpur (KL) and Johor Bahru (JB). In response to this problem, this study proposes to investigate possible respiratory symptoms and prevalence of pulmonary functions in traffic policeman who work in heavy traffic areas in KL and JB.

1.3 Study Justification

Sopan et al. (2005) concludes that as consequences of exposure to vehicular exhaust at workplace environment, the traffic policemen are highly susceptible to having respiratory impairment. In Malaysia, there were no systemic studies conducted to ascertain risk factors of the pulmonary function and respiratory symptoms among traffic policemen.

Therefore, this study was important as a baseline data for the assessments of pulmonary function among the traffic policemen. In addition, this study was going to help the policemen and community better understanding to occupational injury and illness with respect to their factors. This was also helpful to avoid difficulties in improvement to be made towards a better workplace. As this study is supported by research grant, the data obtained will eventually lead to development of guidelines with respect to exposure limits and safety work procedure by considering work specification of traffic policeman.

Also, from the result of this study, the authorities were able to identify illness and health problems of the traffic policemen specifically.

1.4 Conceptual Framework

Figure 1.1 showed the conceptual framework for this study. This was a guide on the direction of the study and clearer picture as what the study was about. This study was to resolve the associations of $PM_{2.5}$ personal exposure levels and respiratory symptoms as well as lung function among traffic police during 8 hours of work duration.

Effects of exposure to $PM_{2.5}$ can be categorized into two that were cardiopulmonary and respiratory health effects. In this study, respiratory health effects were focused on. To measure the effects, lung test was used and the abnormality was measured. The respiratory symptoms were measured by questionnaire and their relationships with some factors are measured.

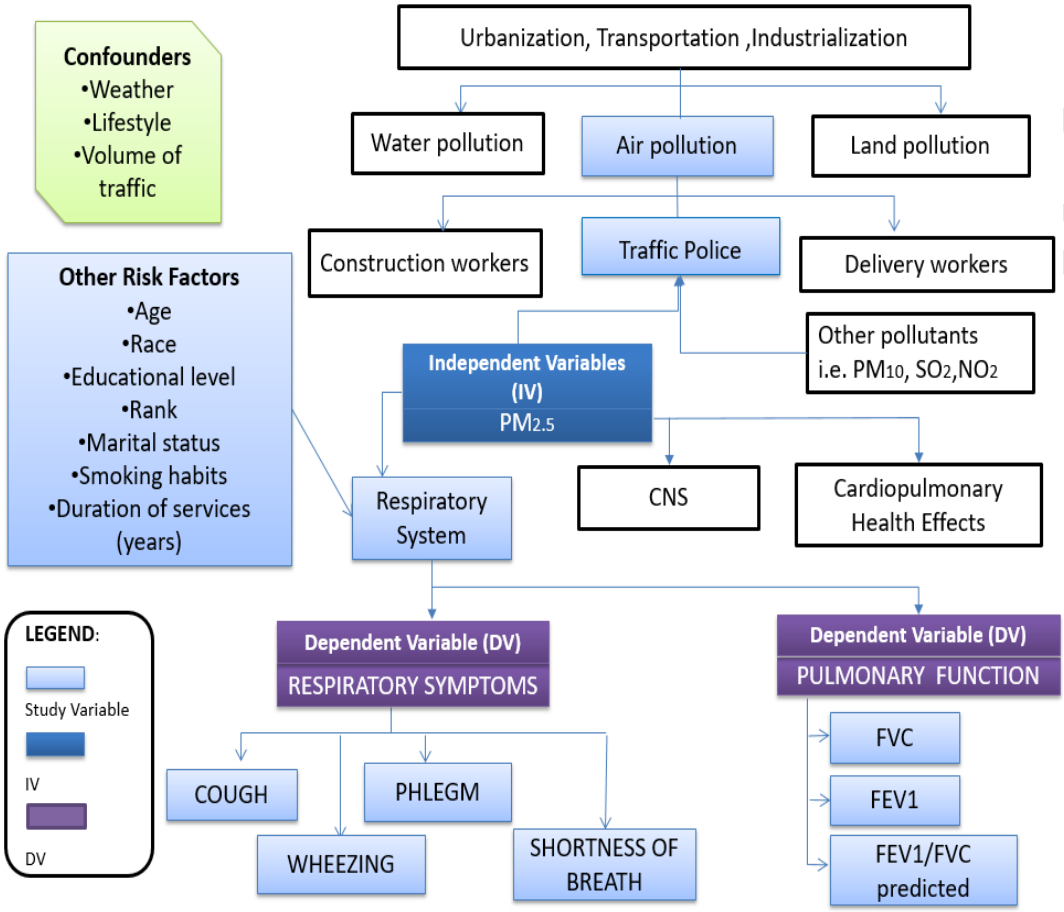

Figure 1.1: Conceptual framework of the variables related to the study

1.5 Definition

1.5.1 Pulmonary function test

1.5.1.1 Conceptual definition

Pulmonary function test was a test that was invented to indicate how great the lungs are working. It revealed how the lungs are widening and deflating also the efficiency of oxygen and dioxide exchange between the blood and the air within the lungs were measured.

1.5.1.2 Operational definition

In occupational settings, spirometry was one of the most commonly used to test for pulmonary functions. It was used to constitute a baseline before assigning a worker to job tasks that were physically demanding, which requires the use of a respirator, or that may expose the worker to respiratory hazards. In order to determine the pulmonary function of an individual, a numbers of parameters need to be measured. In this test, the parameters that were measured was:

i) forced vital capacity (FVC),
ii) forced expiratory volume in one second (FEV1), and
iii) forced expiratory ratio (FEV1/FVC %)

1.5.2 Respiratory symptoms

1.5.2.1 Conceptual definition

Respiratory symptoms were common symptoms of lung or heart conditions, emotions, or injury. Respiratory symptoms may accompany other symptoms affecting the respiratory system including: absence of breathing (apnea), cough that gets more severe over time, difficulty breathing, loose, wet cough that produces thick white or yellow phlegm, rapid breathing (tachypnea), shortness of breath and wheezing (whistling sound made with breathing).

Breathing problems may be present in conditions affecting the lungs alone or may be seen in association with more generalized conditions, such as dehydration or infections as stated in an article by Local Health (2013).

1.5.2.2 Operational definition

There were several ways to assess respiratory symptoms. In this study, respiratory symptoms were assessed by questionnaire. In the questionnaire, included the early symptoms regarding respiratory health effects such as coughing, phlegm, wheezing and shortness of breath.

1.5.3 Personal exposure levels of $PM_{2.5}$

1.5.3.1 Conceptual definition

According to USEPA, “Particulate matter”, PM, was a complicated mixture of markedly small particles and liquid droplets. Multiple components, such as acids nitrates and sulphate, organic chemicals, metals, and soil or dust particles produce these particles which were also known as particle pollution.

The size of particles determines their potential for inducing health problems. EPA was concerned about particles that almost always pass through the throat, nose and eventually the lungs which were 10 micrometres in diameter or smaller. Once inspired, the particles influenced the lungs and heart and hence, causing adverse health effects. EPA had the particle pollution grouped into two categories:

a) "Inhalable coarse particles," are larger than 2.5 micrometres and smaller than 10 micrometres in diameter, such as those found near roadways and dusty industries.

b) "Fine particles," are 2.5 micrometres in diameter and smaller, such as those found in smoke and haze. Sources such as forest fires can discharge these kinds of particles or when gases diffuse from power plants, industries and automobiles are reciprocated in the air, fine particles are form.

1.5.3.2 Operational definition

In order to measure the personal exposure level of PM2.5, there were several methods that can be used. However, a standard procedure which was the NIOSH Manual of Analytical Methods (NMAM), Fourth edition (Method 0600) was chosen as a reference. This was to ensure its validity and reliability. It was the frequently used methods and was revised from time to time.

1.6 Research Objectives

1.6.1 General Objective

To determine the risk factors of respiratory effects from work exposure and $PM_{2.5}$ among traffic policemen.

1.6.2 Specific Objectives

i. To determine the socio-demographic characteristics, lifestyle and occupational factors of the respondents.
ii. To determine the personal exposure level of $PM_{2.5}$ by socio-demographic characteristics, lifestyle and occupational factors among traffic police.
iii. To determine the distribution of pulmonary function by socio-demographic characteristics, lifestyle and occupational factors among traffic police.
iv. To determine the distribution of respiratory symptoms by socio-demographic characteristics, lifestyle and occupational factors among traffic police.
v. To determine the correlations between concentration of $PM_{2.5}$,socio demographic characteristics, lifestyle and occupational factors with lung function among traffic policemen.
vi. To determine the association between concentration of $PM_{2.5}$ and respiratory symptoms among traffic policemen.
vii. To determine the factors (socio demographic characteristics, lifestyle and occupational factors) associated with pulmonary function among traffic police using logistic regression.

1.7 Hypothesis

The alternative hypotheses are:

1. There is a significant correlations between concentration of $PM_{2.5}$,socio demographic characteristics, lifestyle and occupational factors with lung function among traffic policemen.
2. There is a association between concentration of $PM_{2.5}$ and respiratory symptoms among traffic policemen.
3. There is a significant association between the factors (socio demographic characteristics, lifestyle and occupational factors) associated with pulmonary function among traffic police.

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