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THE ASSOCIATION BETWEEN VEHICULAR AIR POLLUTION ($PM_{2.5}$) EXPOSURE LEVEL AND THE PREVALENCE OF JOB STRAIN WITH RESPIRATORY HEALTH AMONG MUNICIPAL WORKERS IN KUALA LUMPUR

PUTERI NATASHA ARINA BINTI TALIB

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ABSTRACT

THE ASSOCIATION BETWEEN VEHICULAR AIR POLLUTION ($PM_{2.5}$) EXPOSURE LEVEL AND THE PREVALENCE OF JOB STRAIN WITH RESPIRATORY HEALTH AMONG MUNICIPAL WORKERS IN KUALA LUMPUR

PUTERI NATASHA ARINA BINTI TALIB

Introduction: The increment of motor vehicles has cause the deterioration of air quality in Kuala Lumpur. Its emissions also been revealed to cause deleterious impacts on health such as the development of respiratory symptoms and the reduction of pulmonary function of traffic wardens who extensively work outdoor. **Objectives:** To determine the association between vehicular air pollution ($PM_{2.5}$) exposure level and the prevalence of job strain with respiratory health among municipal workers in Kuala Lumpur. **Methodology:** A cross-sectional comparative study was conducted among 75 traffic wardens (exposed) and 75 administration staffs (non-exposed) in DBKL who were randomly selected. A self-administered questionnaire was distributed in order to gain socio-demographic information and working characteristics. A standardized Job Content Questionnaire (JCQ) and International Union against Tuberculosis and Lung Diseases (IUATLD) was added in the questionnaire to assess job strain and psychosocial factors and to determine the respiratory symptoms exists among respondents. Chestgraph HI-101 Spirometer was used to assess pulmonary function. The SidePak™ Personal Aerosol Monitor was used to measure vehicular air pollution ($PM_{2.5}$) level concentration in ambient air. **Result:** The mean exposure to vehicular air pollution ($PM_{2.5}$) among exposed group was 65.30 ± 7.76 $\mu g/m^3$ compared to 24.60 ± 7.91 $\mu g/m^3$ of non-exposed group. The vehicular air pollution exposure level ($PM_{2.5}$) was significantly different between those who had cough ($t= 2.329$, $p= 0.021$) and phlegm ($t= 3.043$, $p= 0.003$). There were significant difference in several pulmonary parameters; measured FEV_1 ($p= 0.049$), percentage of FEV_1/FVC ($p<0.001$), predicted FVC ($p=0.001$) and predicted FEV_1 ($p= 0.002$) between exposed and non-exposed group. Significant correlation between vehicular air pollution ($PM_{2.5}$), age, body mass index (BMI), employment period and working hour with pulmonary function parameters were also shown among respondents. There was a significant association between BMI with shortness of breath ($\chi^2= 8.487$, $p= 0.037$). An association was detected between co-worker support and phlegm ($\chi^2= 4.106$, $p= 0.043$) but no association showed between other psychosocial factors with all respiratory symptoms and pulmonary function parameters. **Conclusion:** The findings of this study showed that both exposure to vehicular air pollution ($PM_{2.5}$) and psychosocial factors elevate the risk of the development of respiratory symptoms and reduced pulmonary function.

Keywords: Vehicular Air Pollution, Job Strain, Respiratory Health

ABSTRAK

HUBUNGKAIT ANTARA TAHAP PENDEDAHAN PENCEMARAN UDARA KENDERAAN ($PM_{2.5}$) DAN PREVALEN KETEGANGAN KERJA DENGAN KESIHATAN RESPIRATORI DALAM KALANGAN PEKERJA PERBANDARAN DI KUALA LUMPUR

PUTERI NATASHA ARINA BINTI TALIB

Pengenalan: Peningkatan kenderaan bermotor telah menyebabkan kemerosotan kualiti udara di Kuala Lumpur. Pelepasannya juga didedahkan untuk menyebabkan kesan buruk terhadap kesihatan seperti perkembangan gejala pernafasan dan pengurangan fungsi paru-paru warden trafik yang secara meluas bekerja di luar. **Objektif:** Untuk menentukan perkaitan antara tahap pendedahan pencemaran udara ($PM_{2.5}$) dan kelaziman ketegangan kerja dengan kesihatan pernafasan di kalangan pekerja perbandaran di Kuala Lumpur. **Metodologi:** Kajian perbandingan keratan rentas dilakukan di antara 75 warden trafik (terdedah) dan 75 kakitangan pentadbiran (tidak terdedah) di DBKL yang dipilih secara rawak. Borang soal selidik diedarkan untuk mendapatkan maklumat sosio-demografi dan ciri-ciri kerja responden. Soalan 'Job Content Questionnaire' (JCQ) dan 'International Union against Tuberculosis and Lung Diseases' (IUATLD) telah ditambah dalam soal selidik untuk menilai faktor ketegangan kerja dan faktor psikososial serta untuk menentukan gejala pernafasan yang wujud di kalangan responden. 'Chestgraph HI-101 Spirometer' digunakan untuk menilai fungsi paru-paru dan 'SidePak™ Personal Aerosol Monitor' digunakan untuk mengukur tahap pencemaran udara ($PM_{2.5}$) pada udara ambien. **Keputusan:** Pendedahan purata kepada pencemaran udara kenderaan ($PM_{2.5}$) di kalangan kumpulan terdedah ialah 65.30 ± 7.76 $\mu g/m^3$ berbanding dengan 24.60 ± 7.91 $\mu g/m^3$ kumpulan tidak terdedah. Tahap pendedahan pencemaran udara ($PM_{2.5}$) adalah ketara di antara mereka yang mengalami batuk ($t= 2.329$, $p= 0.021$) dan kahak ($t= 3.043$, $p= 0.003$). Terdapat perbezaan yang signifikan dalam beberapa parameter paru-paru; ukuran FEV_1 ($p= 0.049$), ukuran peratusan FEV_1/FVC ($p <0.001$), ramalan FVC ($p= 0.001$) dan ramalan FEV_1 ($p= 0.002$) antara kumpulan terdedah dan tidak terdedah. Hubungan antara pencemaran udara kenderaan ($PM_{2.5}$), umur, indeks jisim badan (BMI), tempoh pekerjaan dan jam kerja dengan parameter fungsi paru-paru juga ditunjukkan di kalangan responden. Terdapat kaitan yang signifikan antara BMI dengan sesak nafas ($\chi^2= 8.487$, $p= 0.037$) dikesan antara sokongan rakan sekerja dan kahak ($\chi^2= 4.106$, $p= 0.043$) tetapi tiada kaitan ditunjukkan antara faktor psikososial yang lain dengan semua gejala pernafasan dan parameter fungsi paru-paru. **Kesimpulan:** Penemuan kajian ini menunjukkan bahawa kedua-dua pendedahan kepada pencemaran udara kenderaan ($PM_{2.5}$) dan faktor psikososial menaikkan risiko perkembangan gejala pernafasan dan mengurangkan fungsi paru-paru.

Kata kunci: Pencemaran Udara Kenderaan, Ketegangan Kerja, Kesihatan Pernafasan

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LIST OF ABBREVIATIONS

%	Percentage
DBKL	Dewan Bandaraya Kuala Lumpur
FEV_1	Forced Expiratory Volume in 1 second
FEV_1/FVC	Forced Expiratory Ratio
FVC	Forced Vital Capacity
GAS	General Adaptation Syndrome
IUATLD	International Union against Tuberculosis and Lung Diseases
JCQ	Job Content Questionnaire
JDC	Job Demand Control
PM	Particulate Matter

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CHAPTER 1

INTRODUCTION

1.1 Background

According to the WHO (2017), the reported number of lung diseases in Malaysia reached 5,037 or 3.64% from total deaths which ranked 79th highest in the world. In Great Britain, 1.3 million people who worked in year 2015/2016 were estimated to suffer from an illness arise from their work which estimated to contribute around 13,000 deaths per year caused by previous exposures at work, primarily to dusts and chemicals. The occupational lung disease was estimated to cause 12,000 deaths each year linked to the past exposure at work and 18,000 estimated annual new cases of self-reported work-related breathing or lung problems (HSE, 2016; HSE 2017). Similarly in the United States, approximately there were 2.9 million non-fatal workplace injuries and illnesses reported by private industries in 2015 (BLS, 2015).

Not limited to occupational settings, exposure to respiratory hazards in environment such as dust and other pollutants suspended in air henceforth reducing the

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quality of air. Preceding over urbanization in developing cities including Malaysia, transportation systems play an important role as to expedite mobility of human population in everyday life. There are various areas of transportations comprised of motor vehicles, water transportation, air transportation and railroad. The major concerns to human population is on the motor vehicles increment due to population enlargement, traffic congestion, employment opportunity and widespread road networks especially its effect on health. In general, a vehicle can emit multiple pollutants such as particulate matter ($PM_{2.5}$,PM_{10}), nitrogen oxides (NO_x), volatile organic compounds (VOC) and sulphur dioxide (SO_2) .

Uchiyama (2013) explained that road dust produced by traffic and air turbulence that will exacerbate road dust. The content of dust which mainly particulate matters with diameter less than 10 micrometre inhaled by human and can affect the respiratory system. There were strong evidence found in previous studies on a correlation between fine particulates matter ($PM_{2.5}$) with increasing mortality in lung cancer and cardiopulmonary disease. Therefore, an air quality standard for exposure to $PM_{2.5}$ was establish in 2009. In Japan, yearly average level of $PM_{2.5}$ is set at not more than 15 $\mu g/m^3$ and not more than 35 $\mu g/m^3$ for daily average. For instance, WHO (2005) guideline limits exposure to $PM_{2.5}$ for 10 $\mu g/m^3$ annual mean and 25 $\mu g/m^3$ in 24-hours meanwhile for PM_{10} 20 $\mu g/m^3$ annual mean and 50 $\mu g/m^3$ 24-hours mean. In 2012, WHO estimated 14% of deaths were due to lung cancer, while 14% were due to acute lower respiratory infections or chronic obstructive pulmonary disease and 72% of ambient air pollution-related premature deaths were due to ischaemic heart disease and strokes.

Particulates matter cause a significant burden of disease and reduce life expectancy on average by almost 9 months in Europe (WHO, 2013). Mariammal et al. (2012) suggested that spirometry is a standout amongst the most critical indicative apparatuses which plays a noteworthy part in the diagnosis and prognosis of these respiratory diseases, depicts the impact of restriction or obstruction on the lung function. Sancini et al. (2010) supported that the exposure to urban air pollution can alter respiratory functions. The authors proved an inverse relationship between the flow expiratory volume (FEV_1) with working near high traffic density and the quantity of motor vehicles.

Siti , Emilia & Irniza (2016) conducted a study among roadside hawkers and a comparative group on traffic-related exposure with respiratory health symptoms and lung function. The findings showed that the roadside hawkers exposed to higher amount of $PM_{2.5}$ of 31.05 $\mu g/m^3$ compared to 19.41 $\mu g/m^3$ exposure to comparative group. The respiratory symptoms reported (cough, phlegm, chest tightness and wheezing) were significantly associated with exposure to $PM_{2.5}$ ($p<0.05$). The average lung function parameters of exposed group was significantly lower than comparative group. Another similar study was conducted at Bangkok, Thailand by Kongtip et al. (2008) which reported that roadside street vendors had a greater amount of exposure to $PM_{2.5}$ higher than residential street vendors as motor vehicle emissions constituted the main source of fine and ultra-fine particles. There were significant difference of symptoms developed by roadside street vendors on upper (nose congestion, sore throat, cold) and lower (cough, phlegm) respiratory as well as other health symptoms including headache, fever, and eye irritation compared to comparative group.

Not only traffic wardens and roadside hawkers, pedestrian and cyclist also exposed to $PM_{2.5}$. Greaves, Issarayangyun & Liu (2008) explained the pedestrian exposure to fine particulates ($PM_{2.5}$) along a busy road in Sydney, Australia. A higher traffic volumes were associated with increased $PM_{2.5}$ concentrations. Walking with the traffic (clockwise) resulted in significantly higher (p-value <0.001) average concentrations than walking against the traffic. Moreover, they suggest that the distance of pedestrians with traffic is crucial with even a few metres making a difference. In addition, there was an association between $PM_{2.5}$ and wind speed which windy environment lower the $PM_{2.5}$ concentration.

Moreover, findings of previous studies showed that respiratory health can also be affected by psychosocial factors. ILO/WHO (1984) defined psychosocial factors at work as the associations between and among workplace, work content, organisational/hierarchical conditions and labourers' abilities, needs, culture, individual additional employment contemplations that may, through perception and experience, impact wellbeing, work execution and job fulfilment. Bongers et al. (1993) explained that occupational related psychosocial factors arising from job content, organizational aspect and relationship which can be characterized by symptoms or impaired functioning and unfit wellbeing. Psychosocial can be measured by using standardized questionnaires used worldwide developed by Karasek et al. (1979).

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CCOHS (2017) listed thirteen psychosocial risk factors at workplace consist of psychological support, organizational culture, clear leadership & expectations, civility & respect, psychological competencies & requirements, growth & development, recognition & reward, involvement & influence, workload management, engagement, balance, psychological protection and protection of physical safety. Smith and Nicholson (2001) stated that psychological stress affect susceptibility to induced upper respiratory tract illnesses. Furthermore, they believed the life stressors also can intensify the susceptibility towards infectious diseases. A result from Cobb & Steptoe (1996) study recommended that under naturalistic conditions, the psychosocial resources influenced the stressful experience on risk of infectious illness.

Thus, this study was conducted to determine the association between both job strain and vehicular air pollution ($PM_{2.5}$) exposure level with respiratory health among municipal workers in Kuala Lumpur.

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1.2 Problem Statement

This study covered about job strain, exposure to vehicular pollutants ($PM_{2.5}$) and respiratory symptoms among municipal workers who characterized by specific criteria of work types; traffic wardens as exposed group and non-exposed group of administration staffs in Kuala Lumpur. The study participants are selected in manner so as to fulfil inclusive criteria specified such traffic wardens who have worked exposed to environment and vehicular air pollution for more than 1 year and administration staffs who have worked only in building for hours of working period. Generally, traffic wardens carry out their duties in long hours at highly polluted environment which mainly caused by vehicular emissions, heat and and noise. The traffic wardens are exposed to $PM_{2.5}$ highly generated by congested vehicles especially during peak hour predominantly in the early morning, lunch hour and late in the evening. The traffic wardens are responsible to manage and control traffic, issuing summon to traffic offenders and patrolling during the working hours.

Bigazzi and Figliozzi (2014) elaborated the long-term health effects studies which showed increased risk for development of asthma, lung function reduction, elevated blood pressure, and cardiac and pulmonary mortality. There were some evidences reported that the effects on mortality and cardiovascular/pulmonary hospital admissions exist for short-term exposure to traffic-related air pollution particularly PM and Ultrafine Particle (UFP). Previous study on exposure of vehicular air pollutants ($PM_{2.5}$) from heavy traffic among exposed traffic personnel in Kathmandu, Nepal by Shrestha et al., (2015) showed

significant results of developing respiratory diseases symptoms includes pain and chest tightness, shortness of breath and irritation in respiratory tract. Nihfir et al. (2015) also conducted another study on the effect of vehicular exhaust in pulmonary function among traffic police officers at Batticaloa, Sri Lanka. The results showed high occurrence of shortness of breath and a significant reduction in pulmonary parameter FEV_1 ($p<0.05$) has been noticed among exposed group compared to control.

Outcomes from epidemiological studies have shown higher risks for lung cancer in relationship with various measures of air pollution. The association between incidence of lung cancer and long-term exposure to air pollution was analysed by cohort study by Nielsen et al. (2013). He stated that there were associations between residential exposure to particulate matter air pollution at enrolment and the risk for lung cancer. Most results from previous cohort studies of ambient particulate matter air pollution and lung cancer incidence or mortality in general populations showed associations that were statistically significant (Nielson, 2011; Katanoda, 2011).

Urbanization in Kuala Lumpur alludes all of the expanding amount of people that live in urban areas and it predominantly brings about the physical developments. Malaysia recently standout amongst those urbanized countries for Southeast Asia. The urban population in Malaysia has increased from around 66% in 2004 to 74% in 2014. Department of Statistics (2018) estimated the population of Malaysia at 32.3 millions in fourth quarter of 2017 with 1.3% growth rate. The direct results from urbanization in Malaysia has caused population enlargement especially in the heart of Malaysia, Kuala

Lumpur. Due to population hike, there are more increment in vehicles ownerships as well as road network to ease mobility.

Ling et al., (2010) has analysed the air quality trend in Kuala Lumpur from 1999 to 2007. There was a drop in good day numbers of air quality from year 2000 to 2003 reported but the situation improved back since 2004. As for 2004 onwards, the trends of air quality recorded high good day. The improvement of trends may due to the relocation of air quality monitoring station from the city centre to Bandar Sri Permaisuri which the data are less suitable to reflect the real situation at the city centre. However, the number of unhealthy/hazardous day showed increasing pattern from 2006 (API=5) to 2007 (API=19).

According to Road Transport Department (2015), the top most of total number of motor vehicles by state in Malaysia are Kuala Lumpur (6,117,938 millions) followed by Johor (3,478,959 millions), Selangor (2,779,732 millions) and Pulau Pinang (2,556,735 millions). Thus, the vehicular emission in these area has threatened the environmental air quality in Kuala Lumpur.

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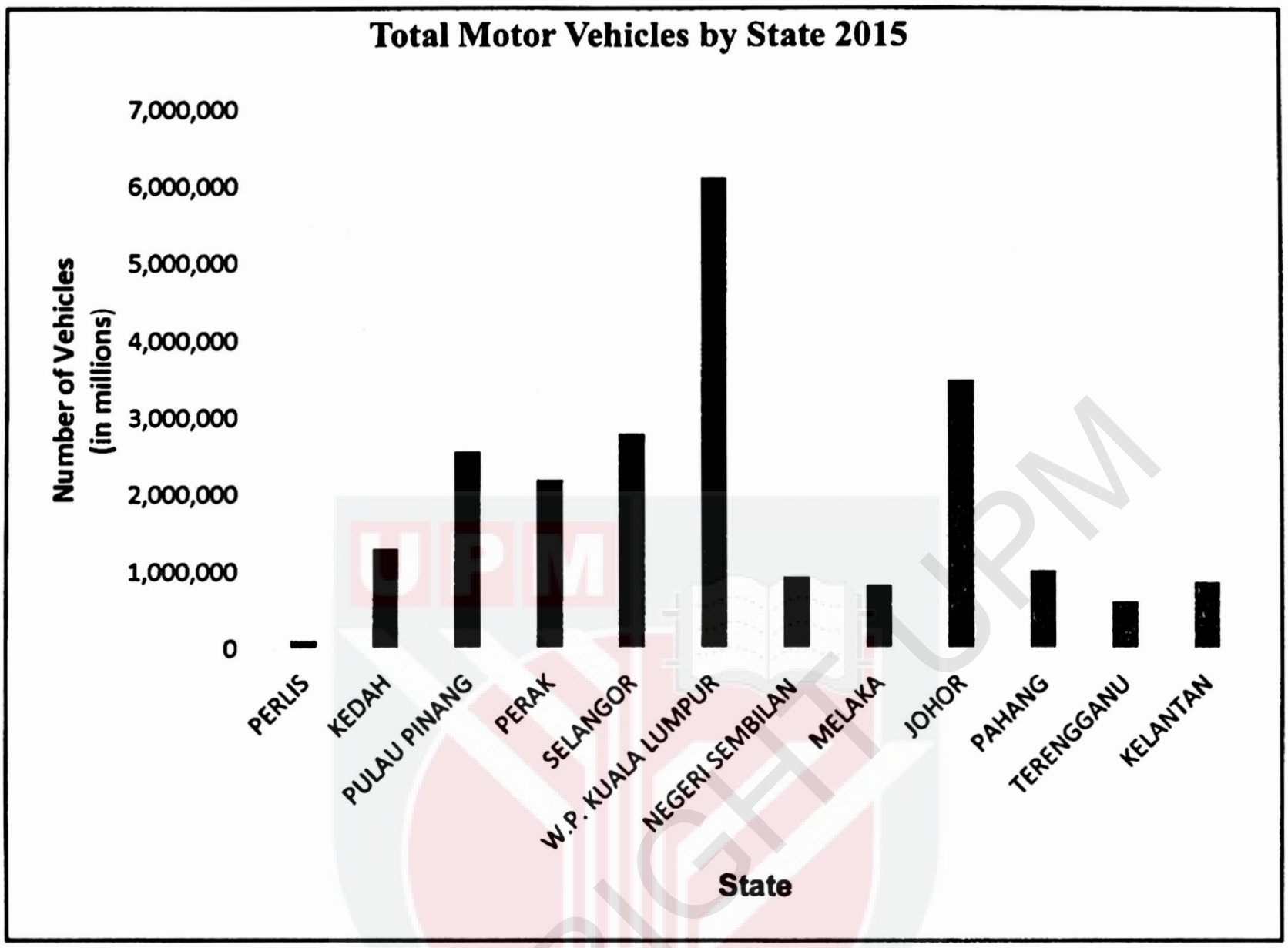


Figure 1.2.1: Total Motor Vehicles by State in 2015

(Source: Road Transport Department)

Department of Statistics (2015) analysed the main sources of pollutants to the atmosphere are from mobile vehicles (70%) followed by power plant (24.3%), industrial (2.8%) and other (2.9%). Thus, this shown that high numbers of motor vehicles in Kuala Lumpur act as the major factor which promote to the deterioration of air quality.

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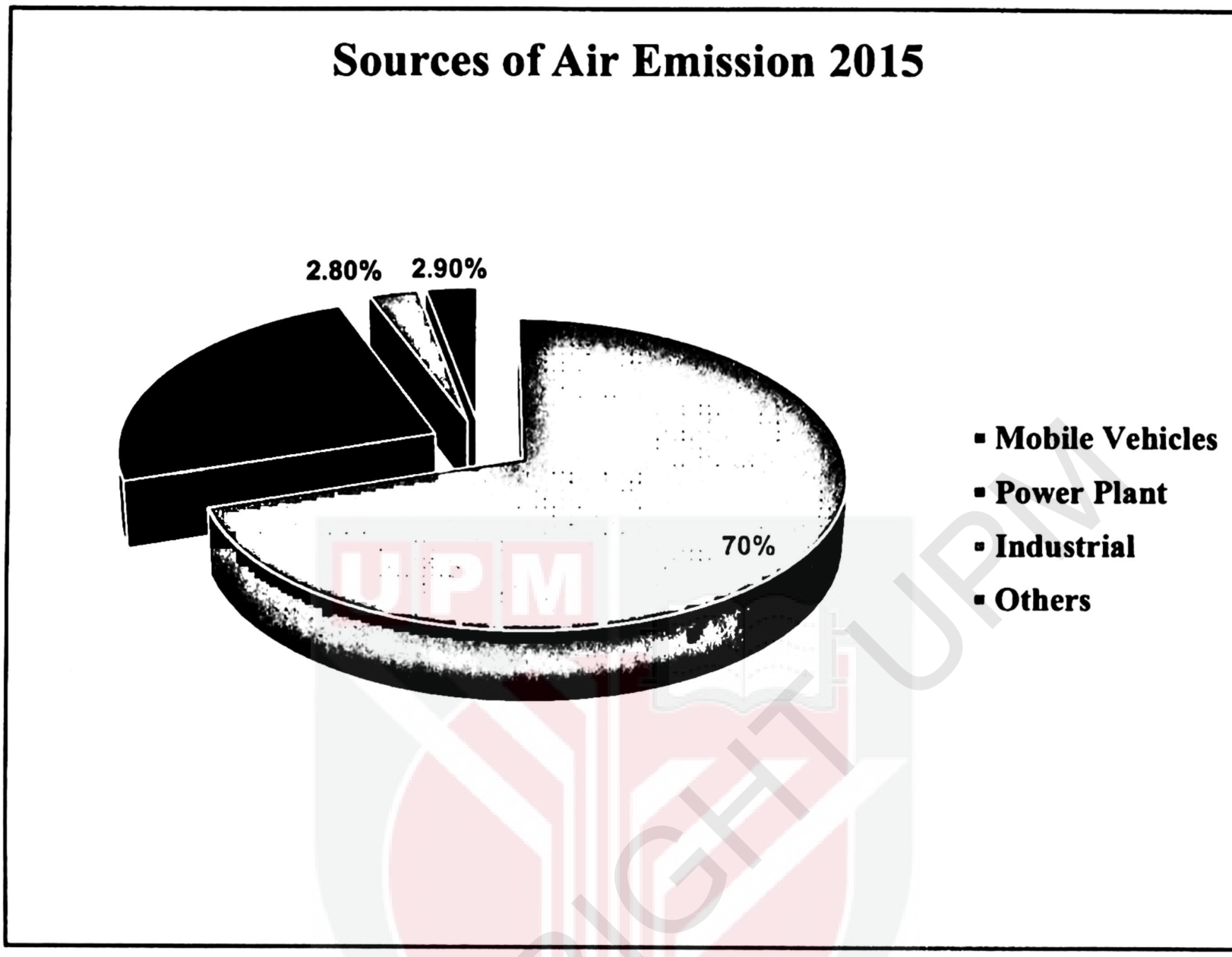


Figure 1.2.2: Emission of Pollutants to the Atmosphere by Source in Malaysia (Source: Department of Statistics, 2015)

Union of Concerned Scientist (2014) stated that emissions from motor vehicles such cars and trucks comprise of particulates matter, hydrocarbons, nitrogen oxides, carbon monoxide and sulphur dioxide. Santoso et al. (2011) supported that high levels of ambient air pollution have been associated with anthropogenic sources such as industry, rubbish burning, and traffic.

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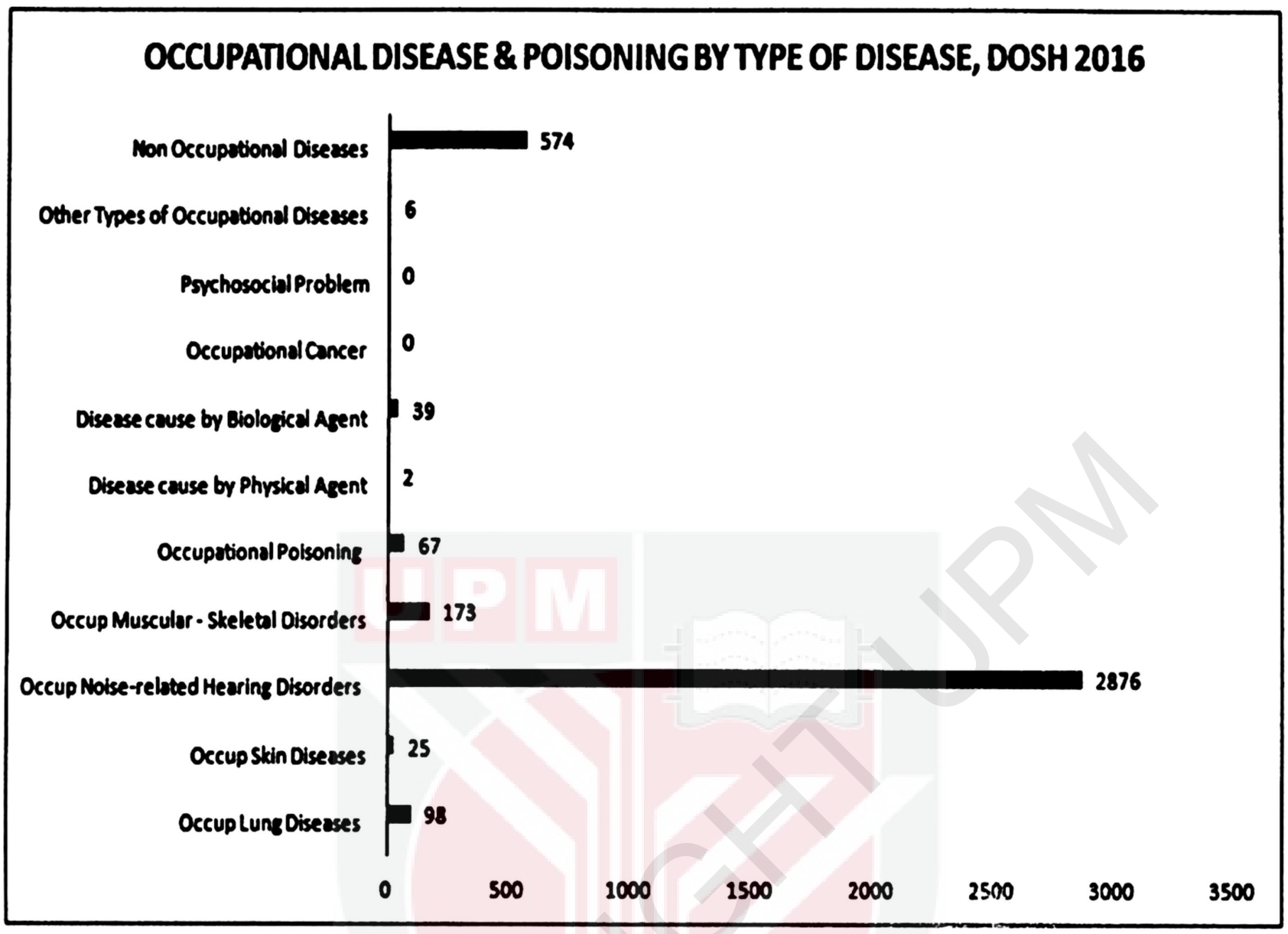


Figure 1.2.3: Occupational Disease & Poisoning by Type of Disease

(Source: Department of Safety and Health, 2016)

Department of Safety and Health (2016) showed that the top four number of reported occupational disease and poisoning leading in Malaysia is occupational noise-related hearing disorders (2876 cases), non-occupational diseases (574 cases), occupational muscular – skeletal disorders (173 cases) and occupational lung diseases (98 cases). Since occupational lung diseases are included in the top four of the statistics, there is a likelihood for lung impairment, reduced function and lung problems of traffic wardens prior to exposure to vehicle air pollution during performing everyday tasks. A study by Patel et. al, (2010) revealed that the positive associations between ambient air pollutants

and respiratory symptoms. According to Shenoy et al., (2017) who conducted study among traffic policemen in Kottayam, acute impacts of vehicular emissions incorporate irritation of eyes and nose, alter in lung capacities, migraine, nausea and sickness. Cumulative exposure is related with hack, sputum generation and pulmonary function decrements.

The inability of persons or workers to cope with psychosocial factors that may arise during work may lead to stress. Back in 1936, Hans Selye developed a theory of the General Adaptation Syndrome (GAS) known as a stress model which describes the body's response towards stress (Healthline, 2017). According to the model, stress induced the cortisol or hydro cortisol hormones. Prolonged release of these hormone will depressed the immune system and thus making an individual be more susceptible to infectious diseases. Moreover, prolonged release of these hormone also promote chronic inflammation on the body which can exacerbate the damage on the organs including the lungs. Psychosocial factors among traffic wardens in workplace need to be addressed because its effect may cause increasing absenteeism, withdrawal practices, job strain, turnover, expanded extra expenses on restorative treatment and greater risk of developing any unwanted condition.

However, there is no study specifically for municipal workers (traffic wardens) who are mostly affected by the emission from vehicles in Kuala Lumpur. Since the emission may contain hazardous contaminants to health such as particulate matter ($PM_{2.5}$), the level of their exposure need to be assessed as most of their task involved traffic. In

addition, there are some complaints arise due to respiratory symptoms among them reported previously. So, this study purposes to determine the association between job strain and vehicular air pollution ($PM_{2.5}$) exposure with respiratory health among municipal workers in Kuala Lumpur.

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1.3 Study Justification

In general, this study will generate broad range of knowledge on factors and hazards arises during performing work task which may lead to job strain, exposure to vehicular pollutants ($PM_{2.5}$) and respiratory health. The traffic wardens could be unaware of their level of exposure to particulate matter ($PM_{2.5}$). By conducting this study, traffic wardens maybe able to know their exposure during working hours. Sufficient studies were made among Royal Malaysia Police Officer (policemen), roadside hawkers and children exposure to $PM_{2.5}$ but none for municipal council workers who the traffic wardens are directly/indirectly may expose to high level of air pollutants such as emission from vehicles and ambient air during controlling traffic congestion at peak hours.

Mariammal et al., (2012) stated that occupational related respiratory symptoms among sanitary workers who worked more than 15 years showed higher symptoms such as dyspnoea (15%), sinusitis (40%), sneezing (30%), running nose (10%) and asthma (5%) compared to construction and control groups. Moreover, both sanitary and construction workers posed high incident of sinusitis, sneezing and dyspnoea due to dust flow at their work site. Lung function parameters of sanitary and construction were reduced significantly compared to control when the year of experience above 15 years. Dominici (2006) explained there were increasing number of mortality and morbidity related to respiratory and cardiovascular diseases prior exposure to air pollutants. The authors added that the workers who work in dusty environment pose a significant tendency to inhale all pollutants into deposited into the lung and lead to adverse respiratory effects such as lung irritation and lung function impairment.

This study will add new knowledge on the ability of psychosocial factors to exacerbate the respiratory health of workers who are exposed to air pollution level. Pressman & Cohen (2005) reported that the interruption of a disease-causing agent into the body is not an ample cause for disease. The incapability of immune system to recognize the foreign material triggered disease to occurs. Herbert & Cohen (1993) signified that psychological stress could modify immune response in humans. The inhaled foreign materials into the lungs were supported to be the cause of respiratory illness/disease (Oberdordter, 2000; Nel, 2005). In this study, the traffic wardens are likely to expose to high level of air pollutants ($PM_{2.5}$) during performing their task through inhalation. Due to job demands and unfavourable polluted environment, they are at risk in developing respiratory illness over time.

Centre for Disease Control and Prevention (2017) stated that 68% of deaths worldwide were due to non-communicable disease (cancer, chronic respiratory disease, and cardiovascular disease) and 75% of deaths reported from low and middle income countries. For instance, Malaysia government also emphasize in reducing non-communicable diseases prevalence especially for asthma and chronic obstructive pulmonary disease (COPD) and its related risk factors in Ninth Malaysia Plan (RMK-9). This study will provide new information from findings which can be used for decision-makers such as government or private sectors, study participants and also public.

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1.4 Conceptual Framework

Figure 1.4.1 showed the conceptual framework for this study. The study will be conducted to explore the association between psychosocial factors and vehicular air pollution ($PM_{2.5}$) with respiratory symptoms among municipal workers which categorized into two groups; exposed for traffic warden and non-exposed for administration staffs. The main route for the pollutant to invade exposed and non-exposed group by inhalation. The independent variables are socio-demographic factors, working characteristics and psychosocial factors and respiratory symptoms acts as the dependent variable. This symptoms will be assess by using questionnaire. Pulmonary function test will be used to measure the effect from exposure.

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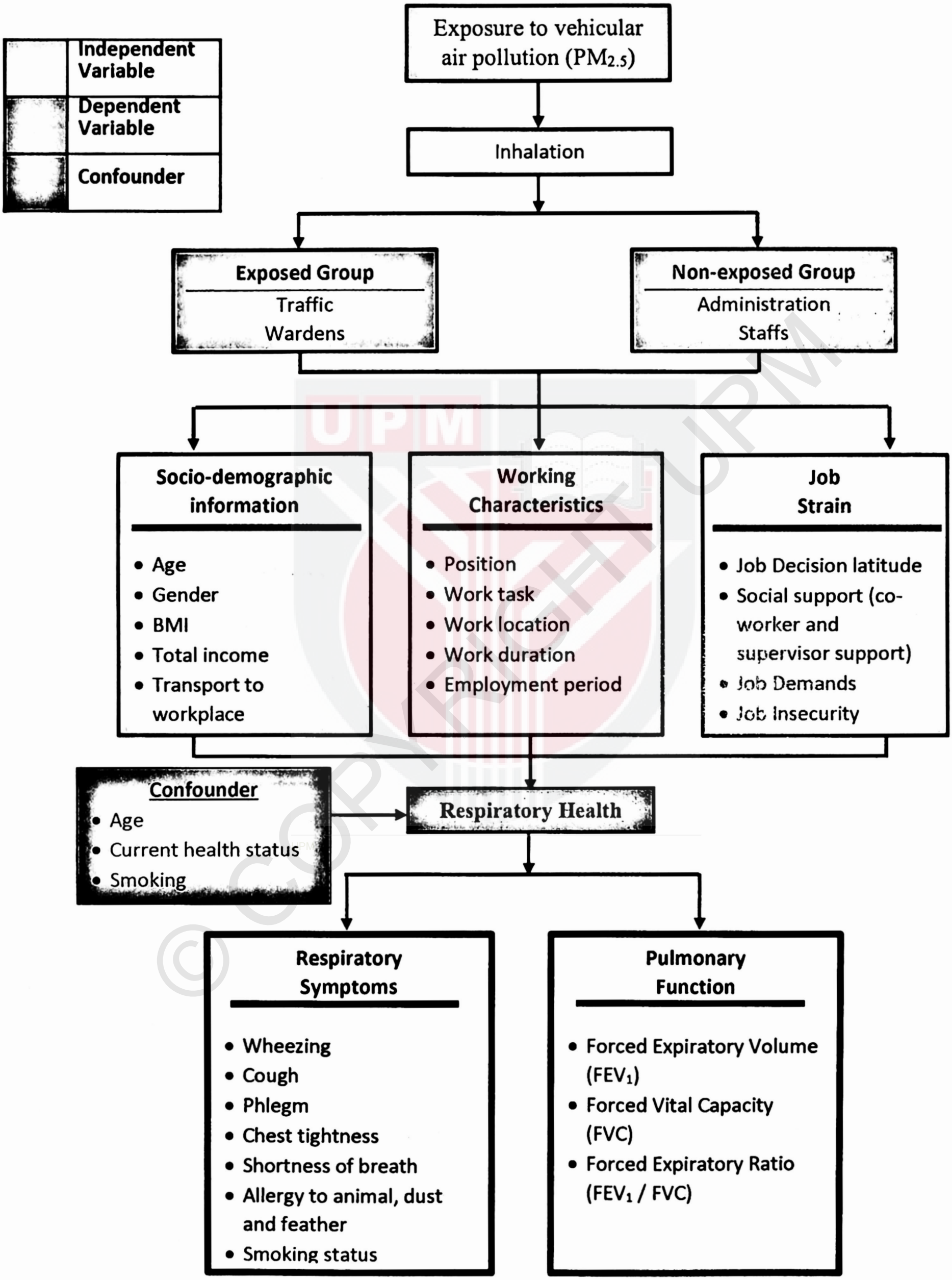


Figure 1.4.1: Conceptual framework

1.5 Study Variables

1..1.1 Independent Variables

The level of exposure to vehicular air pollution ($PM_{2.5}$), socio-demographic factors, working characteristics and psychosocial factors.

1..2.1 Dependent Variable

The respiratory symptoms and pulmonary function.

1.6 Research Objectives

General Objective

To determine the association between vehicular air pollution ($PM_{2.5}$) exposure level and the prevalence of job strain with respiratory health among municipal workers in Kuala Lumpur.

Specific Objectives

i. To determine the socio-demographic information among exposed (traffic wardens) and non-exposed group (administration staffs).

ii. To determine the working characteristics among exposed and non-exposed group.

iii. To measure the level of vehicular air pollution ($PM_{2.5}$) exposure level among exposed and non-exposed group.

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iv. To identify the job strain and psychosocial factors among exposed and non-exposed group.

v. To identify the respiratory symptoms among exposed and non-exposed group.

vi. To assess the pulmonary function among exposed and non-exposed group.

vii. To determine the association between (i) socio-demographic factors (ii) working characteristics (iii) vehicular air pollution ($PM_{2.5}$) (iv) job strain and psychosocial factors with pulmonary function and respiratory symptoms among exposed and non-exposed group.

1.7 Hypothesis

i. There are significant associations between (i) socio-demographic factors (ii) working characteristics (iii) vehicular air pollution ($PM_{2.5}$) (iv) psychosocial factors with pulmonary function and respiratory symptoms among respondents

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1.8 Definition of Terms

1.8.1 Conceptual Definition

Vehicular air pollution

The principal air-quality pollutant emissions from petrol, diesel, and alternative-fuel engines are carbon monoxide, oxides of nitrogen, un-burnt hydrocarbons and particulate matter. It include nitrogen oxides (NOx), particulate matter (PM), hydrocarbon (HC) and Carbon monoxide (CO) (Vehicle Certification Agency, 2017).

Job strain

Job strain refers to the physical and psychological hardships that go along with a job when a worker has inadequate power to respond to the demands and expectations imposed. Karasek (1979) states that the combination of high job demands and low job decision latitude which is classified as strain job will lead to negative physical health outcomes.

Respiratory Health

Respiratory symptoms are common symptoms of lung or heart conditions, emotions, or injury. The medical terms for respiratory symptoms include hypopnea (shallow breathing) hyperpnea (deep breathing), dyspnea (difficulty breathing), tachypnea (rapid breathing), and apnea (absence of breathing) (Healthgrade, 2017). Pulmonary function is a set of tests that measure breathing and how well the lungs functioning (MedlinePlus, 2017).

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Municipal workers

The municipal workers are the individual who work for a local authority - a town, city or county council (Working Class Movement Library, 2017).

1.8.2 Operational Definition

Vehicular air pollution

The level of vehicular air pollution ($PM_{2.5}$) is measured using personal aerosol monitor (SidePak™) by photometric method. The data logging is on along the working hour.

Job strain

The job strain is assessed by using 27 items of psychosocial factors listed in Job Content Questionnaire (JCQ) based on Job Demand Control (JDC) model (Karasek & Theorell, 1990).

Respiratory Health

Respiratory health comprises of respiratory symptoms and pulmonary function. Respiratory symptoms are measured by using a questionnaire adapted from International Union against Tuberculosis and Lung Disease (IUALTD). Symptoms measured include wheeze and tightness in the chest, shortness of breath, cough and phlegm from chest. For assessing pulmonary function, spirometry is the most common used method to test the pulmonary function. Parameters measured;

i. Forced vital capacity (FVC)

ii. Forced expiratory volume in one second (FEV_1)

iii. Forced expiratory ratio (%FEV_1/FVC)

Municipal workers

The individuals who were employed by Dewan Bandaraya Kuala Lumpur (DBKL).

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CHAPTER 2

LITERATURE REVIEW

2.1 Respiratory Health

Lungs are the most important organ in respiratory system. The body cells demand a constant supply of oxygen for the metabolic procedures that are vital to sustain life. The respiratory framework works with the circulatory system to distribute oxygen to whole body and to expel the end-waste of metabolism processes. It additionally controls pH of the blood. External respiration is a trade of gasses between the lungs and the blood and internal respiration transports oxygen to and from the tissue cells (National Cancer Institute, 2017).

There are several factors may contribute to the variation of total lung capacity of individual such as age, sex, weight and weight. In nature, females incline to have lower total lung capacity when compared to males (Calabrese, 2001). The range of lung volumes among normal adult is 4 to 6 litres (Moses, 2001).

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The respiratory system and its parts are shown in figure below. The system can be divided into two parts; upper airway passages (includes nose, mouth, sinuses, throat and larynx) and lower airway passage (includes trachea, bronchial tube and alveoli).

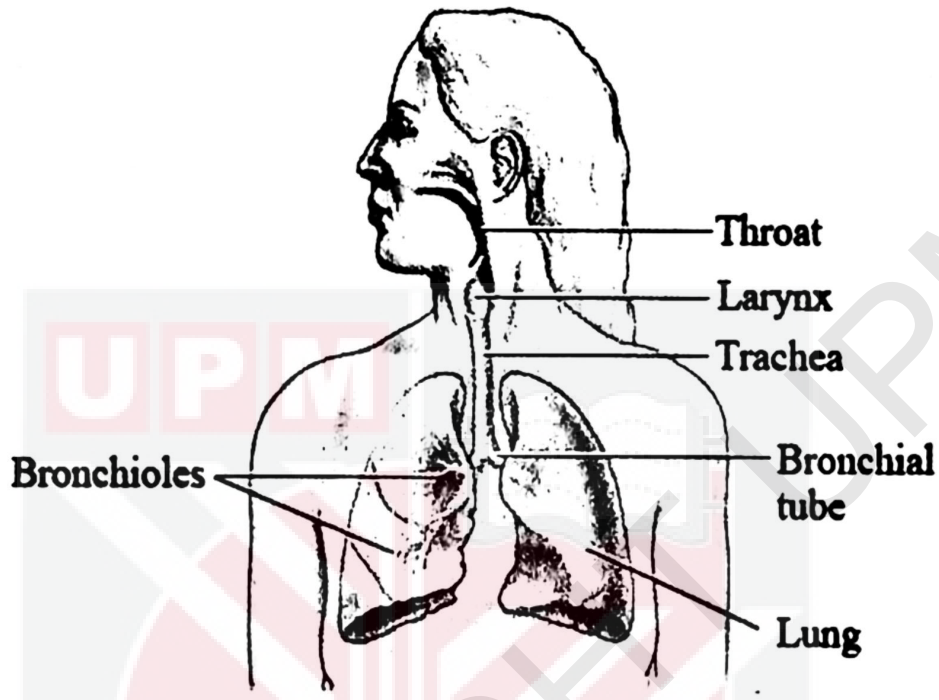


Figure 2.1.1: Respiratory System

Source: WebMD.com (2017)

Inhalation is the fastest and easiest route of exposure of anything at workplace and environment. The chance of inhaling toxic or hazardous particles in the air are very high. The absorption are depending on its concentration, period of exposure, shape, size and respiration rate. Higher respiration rate may poses high chance to inhale more air particles into the respiratory tract. CCOHS (2017) described that respiratory system has its defence mechanism to remove out any foreign substances that have enter the respiratory tract. The foreign substances will stuck on the layer of mucus propel by cilia which prevent from go further into lungs. All of substances trapped on the mucus layer are coughed out or swallowed.

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2.1.1 Respiratory Symptoms

Estévez-García, Rojas-Roa, & Rodríguez-Pulido, (2013) evaluated higher prevalence of respiratory symptoms such cough, expectoration and rhinosinusitis in the traffic-police group in Bogotta. Medical examination of traffic-police group revealed a higher nasal irritation prevalence when compared to office work group. Neghab & Choobineh, (2007) investigated that the exposed group in cement industry who highly exposed to dust during cement processing had higher prevalence of phlegm, cough, shortness of breath and wheezing. Thus, this proved that respiratory symptoms are associated with the occupational exposure to cement dust.

Table 2.1.1.1: Dust and health effect

Dusts	Effects
Fibrous dusts	Pneumoconiosis
Toxic dusts	Poisoning
Radioactive dusts	Cell damage, mutation, cancer
Allergies dusts	Allergies, asthma
Carcinogenic dusts	Cancer
Irritant dusts	Bronchitis

Source: (Lukacova, Liptai, & Lazarova, 2014)

Based on Table 2.1.1.1, Lukacova, Liptai, & Lazarova, (2014) explained various type of dust may affect health in different way. The range of harmful effect of dust ranging from skin irritation to lung cancer which depend on the type and degree of exposure. Table 3 shown the examples of dusts and its effect to health. Finding of Proietti et al., (2005)

led a study of prevalence of respiratory symptoms due to exposure to urban pollution among Catania police officers which divided the study population into three groups; truly exposed group (exposed to air pollution), truly non-exposed group (administrative office) and another one group to any police officer who do not fall into mentioned group. The research showed a significant difference in mean age between the exposed group and the non-exposed group ($p < 0.01$). A greater prevalence of symptoms of cough, wheeze and dyspnoea detected in truly exposed group and positive reaction to skin allergy tests compared with the truly non-exposed group. The highest prevalence of cough, dyspnoea and wheezing was seen in smokers of study population when compared to non-smokers and to ex-smokers of each group.

The prevalence of non-specific respiratory disease in polluted, moderately polluted, and suburban areas in Hong Kong was 13.0%, 10.9%, and 9.4%, respectively, indicating an association between prevalence of respiratory symptoms developed by traffic police and traffic related air pollution (Tamura et al., 2003). In Bangkok, Thailand, traffic policemen had higher prevalence of frequent phlegm (30.95%), wheezing (27.7%), frequent coughing (18.3%) and breathlessness (4.3%) than their wives as non-exposed group (Karita et al., 2004). Another parallel study in Jalgoan City, India proved that traffic policemen reported higher frequency of coughing (40%) and shortness of breath (10%). He added that traffic police posed high rate of respiratory, skin problems and eye irritation with notable number of having lung disorders (Ingle et al., 2010).

2.1.2 Pulmonary Function

Based on article in Healthline (2017), pulmonary function test is a tool used to assess the lungs work. It includes how well the lung to take in and withdraw air as well as the effectiveness of lungs to move oxygen to whole body parts. From this test, healthcare provider can diagnose the possibilities of individual certain lung disorders. Parameters measured are Forced Vital Capacity (FVC) Forced Expiratory Volume (FEV_1) and Forced Expiratory ratio FEV_1/FVC. FVC is total amount of exhaled air during the FEV_1 test. FEV_1 measures the volume of a person can exhaled during forced breath. Obstructive lung diseases incorporate conditions that make it difficult to breathe out all the air in the lungs while individuals with restrictive lung disease experience issues to expand their lungs with air.

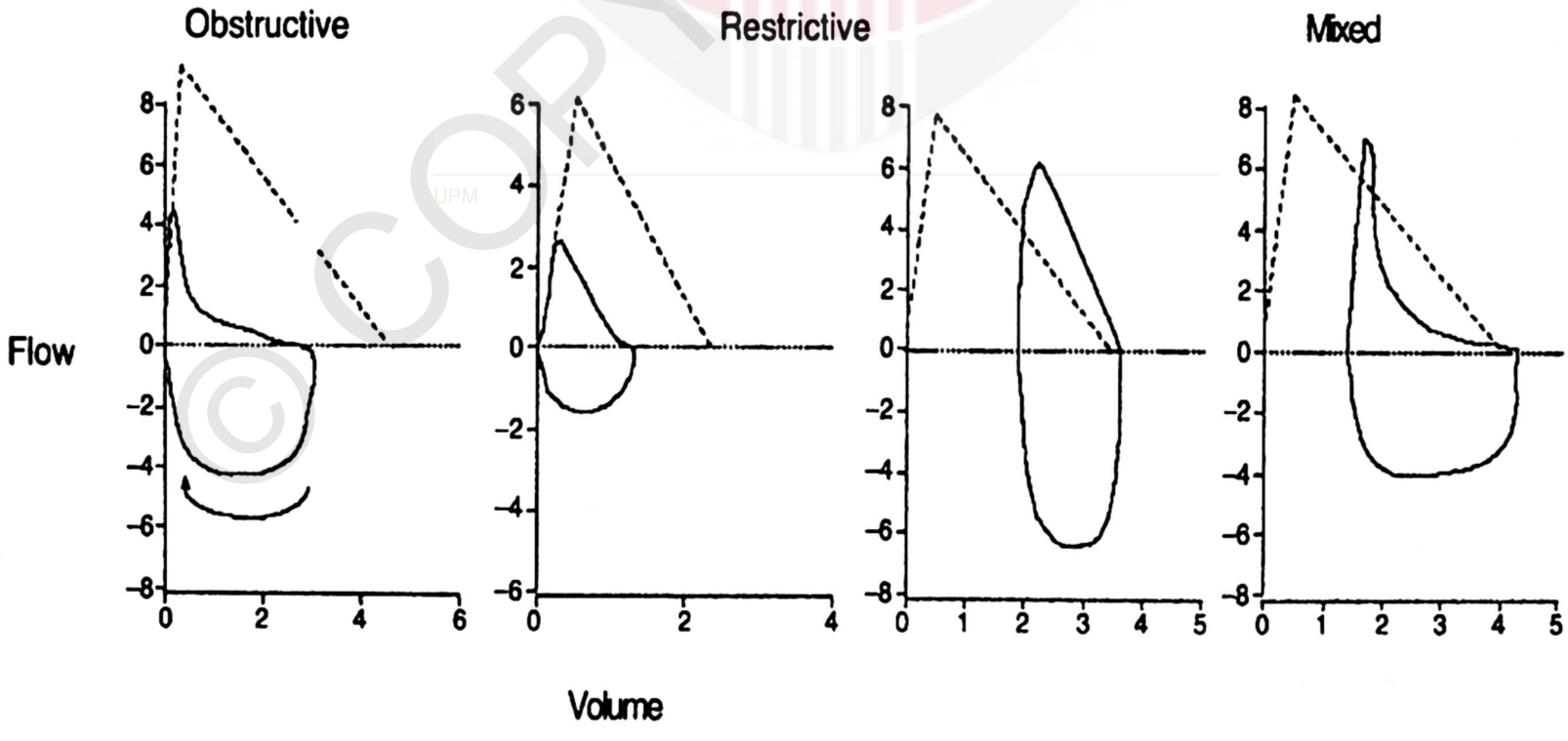


Figure 2.1.2.1: Spirometry results

Das and Jha, (2009) conducted a study among jute mill workers in Sunsari Nepal due to exposure to industrial dust. The results shown that all pulmonary function parameters except FEV_1/FVC were significantly reduced when compared to the values of control subjects.

Karavus et al., (2002) stated that their means of spirometric measurements were compared between the two groups of villagers (exposed: live around plant, control: far from plant). The results of lung function found to be statistically significant higher in the individuals of the Control Villages compared to the individuals of the Villages around Power Plant. This shown that Villages around Power Plant has reduced lung function.

Rodrigues et al., (2014) demonstrated that traffic policemen were among the subjects maximally exposed to traffic-related pollution. The study showed significant pulmonary function reductions in the traffic policemen due to exposure to vehicular pollution in comparison to that of the non-traffic policemen of the control group. In addition, the prevalence of lung disorders for obstructive and restrictive, in exposed traffic policemen group was higher when compared to the non-traffic policemen of the control group. Another study in India by Gupta et al. (2011), traffic policemen as the exposed group showed significant reduction in pulmonary function parameters such as forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) compared to control group.

Sayyad et al.., (2013) was performed a research of the pulmonary functions test on 50 non-smokers traffic policemen as exposed group while 50 non-smokers adult male as control group at Tirupati, India and the study has corroborated that automobile pollution can cause adverse health impacts to human especially to the people who extensively exposed to it. The results from the study observed a significant reduction in spirometric parameters of FVC and FEV_1among traffic policemen in contrast with control group. This pulmonary changes were estimated prior restriction and obstruction during expiration due to the alteration of tissue in lungs preceding chronic irritation by pollutants exposure.

A study of traffic policemen in Shanghai, China also represented a high risk group suffering from the respiratory injury. The outcomes from the study indicated that high level of exposure to PM2.5 was associated with the decrease in pulmonary functions FEV1, FEV_1/FVC and lymphocyte count among traffic policemen compared to common population. The exposed group exhibited a high risk of developing pulmonary diseases and suffered from more severe lung dysfunction than common population. (Zhoa et al., 2015).

The augmentation number of vehicles in Dhaka, the largest city in Bangladesh were leading to air pollution over the time. The study subjects of two groups; study group (male traffic policemen) and control group (healthy adult male) were similar in respect of age and BMI. The results indicated that the lung functions parameter of FVC, FEV_1 and FEV_1/FVC were significantly ($p< 0.001$) lower in the traffic policemen than the control

group. The study suggested that traffic policemen have decreased lung function and some of them may have asymptomatic obstructive lung disease (Ahmed et al., 2016).

Analogously, a study in Gujarat, India among traffic police personnel as the exposed group and controls as unexposed group proved statistically significant of less FVC ($p<0.0032$), MVV ($p<0.0001$) and more FEV_1/FVC ($p<0.0001$) results in case group as compared to controls. Evidence from the study has conveyed the reduction of FEV_1 is more than that of FVC with FEV_1/FVC ratio being more than normal which connotes restrictive pattern of lung diseases in exposed study subjects. However, age-associated changes also contribute to the divergence of real and estimation value of pulmonary function among subjects. The traffic police personnel who exposed more than 4 years statistically significant reduction ($p<0.05$) in all pulmonary function parameters FVC, FEV_1 and FEV_1/FVC (Makwana et al., 2015).

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2.2 Exposure to Vehicular Air Pollution ($PM_{2.5}$)

Particulate matter is mixture of solid particles and liquid droplets which scattered in the air. It can be dirt, soot, smoke and dust. In general, particulates matter are classified into two groups according to their size. Inhalable particles deposited in nasopharyngeal region (upper respiratory passage) are those with aerodynamic diameter of 10 micrometers and smaller whereas fine inhalable particles deposited as deep as alveolar region are those with aerodynamic diameter of 2.5 micrometers and smaller. Most of these particles formed in the environment as an upshot of complex reaction of variety chemicals (USEPA, 2007).

Natural sources of particulate matter are dust storms, volcanic eruptions, living vegetation, sea spray, forest and grassland fires. The man-made or anthropogenic sources of particulates matter are from various industrial processes, domestic heating, traffic and power plants (Praznikar & Praznikar, 2011). According to Muhammad et al. (2012), developed countries with increasing of road networks and motor vehicles ownership as well as population growth grant rapid deteriorating of air quality in big cities. In support of increasing number of vehicle ownership, traffic congestion is seen as leading factor to abundance of negative impacts ranging from tailpipe emissions to time and fuel wastage (Levy, Buonocore & Stackelberg, 2010).

Vehicles are one of the anthropogenic sources contributing the existence of particulate matter in environment of urban areas and its emission has been revealed to

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cause deleterious impacts on human health (Rissler et al., 2012). Pant & Harrison, (2013) classified vehicular emissions into two categories; exhaust emission and non-exhaust emission. The exhaust particulate matter comprises of emissions occurred through vehicle's tailpipe as it depends on the engine type, fuel, lubricating oil, and its maintenance. The non-exhaust particulate matter emissions are initiated by several mechanisms such as through abrasion, corrosion and re-suspension from tyre, clutch, brake and road surface.

Table 2.2.1: New Malaysia Ambient Air Quality Standard

Pollutants	Averaging Time	Concentration
PM_{10} ($\mu g/m^3$)	1 Year	50
	24 Hours	150
$PM_{2.5}$ ($\mu g/m^3$)	1 Year	35
	24 Hours	75
SO_2 ($\mu g/m^3$)	1 Hour	350
	24 Hours	105
NO_2 ($\mu g/m^3$)	1 Hour	320
	24 Hours	75
O_3 ($\mu g/m^3$)	1 Hour	200
	8 Hours	120
CO (mg/m^3)	1 Hour	35
	8 Hours	10

Table 2.2.1 showed the latest Malaysia Ambient Air Quality Standard which was built up to keep in mind the end goal to supplant the more established Malaysia Ambient Air Quality Guideline that has been utilized since 1989. The latest standard has include one new parameter, $PM_{2.5}$ as previously only five parameters included which are PM_{10}, SO_2, NO_2, O_3 and CO. In Malaysia, 1 hour and 24 hours concentration limit for $PM_{2.5}$ are 35 and 75 $\mu g/m^3$ respectively.

Table 2.2.2: USEPA National Ambient Air Quality Standards

Pollutant (unit)	Primary / Secondary	Averaging Time	Level
CO (ppm)	Primary	1 hour	35
		8 hours	9
Pb ($\mu g/m^3$)	Primary and Secondary	3 months	0.15
NO_2 (ppb)	Primary	1 hour	100
	Primary and Secondary	1 year	53
PM_{10} ($\mu g/m^3$)	Primary and Secondary	24 hours	150
$PM_{2.5}$ ($\mu g/m^3$)	Primary and Secondary	24 hours	35
	Primary	1 year	12
	Secondary	1 year	15
O_3 (ppm)	Primary and Secondary	8 hours	0.070
SO_2 (ppb)	Primary	1 hour	75
	Secondary	3 hours	0.5

***Primary**: for public health protection, including protecting the health of immune-compromised populations (elderly,asthmatic patient, children)

***Secondary**: for public welfare protection, including protection against reducing field of vision and damage to crops, animal, vegetation, and buildings.

Table 2.2.2 shown the US Environmental Protection Agency (EPA) National Ambient Air Quality Standards of its 7 criteria pollutants. The limit average concentration for primary and secondary protection in 24 hours exposure of $PM_{2.5}$ are 35 $\mu g/m^3$.

There are numerous studies conducted worldwide regarding exposure to particulate matter in order to grasp its nature and effects on human population. Diesel fumes particulate constitutes a huge extent of the PM in surrounding air. Specifically, diesel debilitate exhaust cause bronchoconstriction, neutrophilic aggravation and dysfunction of alveolar phagocytosis together with histamine discharge from mast cell in healthy people (Binawara et al., 2010).

2.3 Job Strain and psychosocial factors

Psychosocial factors are components that can affect individual mental reaction at workplace due to work and work conditions, conceivably causing psychological health issues. Psychosocial factors incorporate the way work is done and the setting in which work happens. This include collaboration with social environment such as colleagues, customers and client.

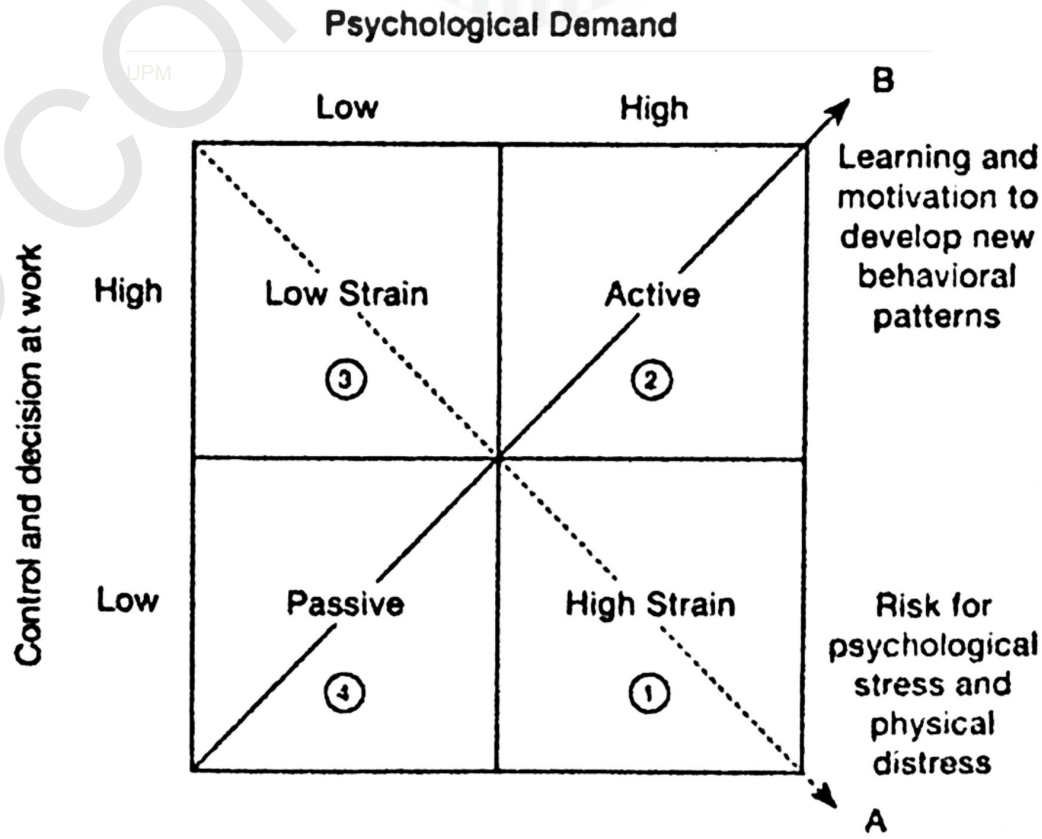


Figure 2.3.1: Job Demand-Control (JDC) model (Karasek, 1979; Karasek & Theorell, 1990)

With reference to a theoretical model of psychosocial, Job Demand-Control (JDC) model was a developed model of mental and well-being based on three (3) variables;

i. Demands: A situation where work environment provide pressure to an individual include workload, long working hours and tight deadline.
ii. Control: The ability of individual to cope with pressure comprises of experience, responsibility, skills and autonomy.
iii. Support: Involving social environment to the individual which include management style, team working and organizational culture.

Based on figure 2.3.1, JDC model explained "high strain" classifies as high job demand and low control and decision at work. This condition may lead high stress to the individual who cannot adapt. A "low strain" was defined as high control and decision at work with low job demand. This situation may lead to little stress. Then, "active" was categorized as high job demand, high job control and high decision latitude. An individual who is active can be flexible to attain new skills and somehow can manage the stress. "Passive" was characterized as low job demand, low control and low decision latitude. This condition may lead to boredom and no development of new skills.

Garbarino et al., (2011) carried out a study to differentiate the stress levels perceived by members among Italian special force (policemen) using JDC model. This study expounded that special police force routine work is favourably stressful when compared to special events. The study population are subject to high physical workload

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(expressed by the 'demand' variable of the JDC model) and in order to sustain stability in the situation, these policemen require a high level of control over their own work (control).

Similar to Hansson et al., (2017) who used JDC model to investigate the relationship of psychosocial job strain and work related social support among police officers in Sweden. The outcomes illustrated that active men with high-strain jobs showed job decision latitude of male officers were higher with high levels of work-related social support ($p<0.001$) and similar results for female officers ($P<0.01$). Furthermore, more psychological disruption when subjects with high work-related social support reported compared to those with low work-related social support ($p<0.01$). Gyamfi (2014) propounded that role overload and co-worker support should be deem as a direction to improve job satisfaction among the police officers.

General Adaptation Syndrome (GAS) explained by Hans Selye on hypothalamic-pituitary-adrenal axis (HPA axis) system which helps the body to cope with stress. GAS promotes three steps of coping which comprised of alarm state, resistance state and exhaustion state of body reactions. For the alarm state, body responds with "fight-or-flight" reaction upon confrontment to a stressor and sympathetic nervous system is triggered. Hormones, for example, cortisol and adrenalin discharged into the blood circulation system to meet the risk or threat. The body's assets now activated. Next, for resistance state, parasympathetic nervous system restores many physiological functions to normal levels while body concentrates resources against the induced stressor. During this

stage, hormones continue to circulate at high levels as well as the levels of blood glucose, heart rate and blood pressure. The body persists on red alert. For final stage of GAS is exhaustion state. This state describe if the stressor proceeds past body's ability to handle, the organism vulnerable to disease and death due to depletion of resources produced.

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CHAPTER 3

METHODOLOGY

3.1 Study Design

This research is a cross-sectional comparative study designed to determine the association between vehicular air pollution ($PM_{2.5}$) exposure level and the prevalence of job strain with respiratory health among municipal workers in Kuala Lumpur.

3.2 Study Location

This study was conducted at Kuala Lumpur. The sampling location were at the area of Loke Yew Road, Sultan Ismail Road and city centre area according to traffic wardens working schedule. Kuala Lumpur was chosen due to its location as the city centre with high traffic congestion, greater in motor vehicles volume estimated at 6,117,938 millions (Road Transport Department, 2015) and high population estimated at 30.2 millions in Malaysia, specifically 1.79 millions in Kuala Lumpur (Department of statistics, 2017).

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3.3 Sampling

3.3.1 Sampling unit

The sampling unit involved in this study met inclusion criteria which the traffic wardens and administration staffs who have been working or employed by Dewan Bandaraya Kuala Lumpur for more than 1 year.

3.3.2 Sampling method

The study samples were randomly selected. A list name of exposed group (traffic wardens) and non-exposed group (administration staffs) was obtained from DBKL. A software (Stat Trek) was used to select respondents based on numbering from the list. Figure 10 illustrated the flow of this research prior approval from DBKL. At the end of data collection, results was analysed by using Statistical Package for Social Science Software (SPSS) Version 22.

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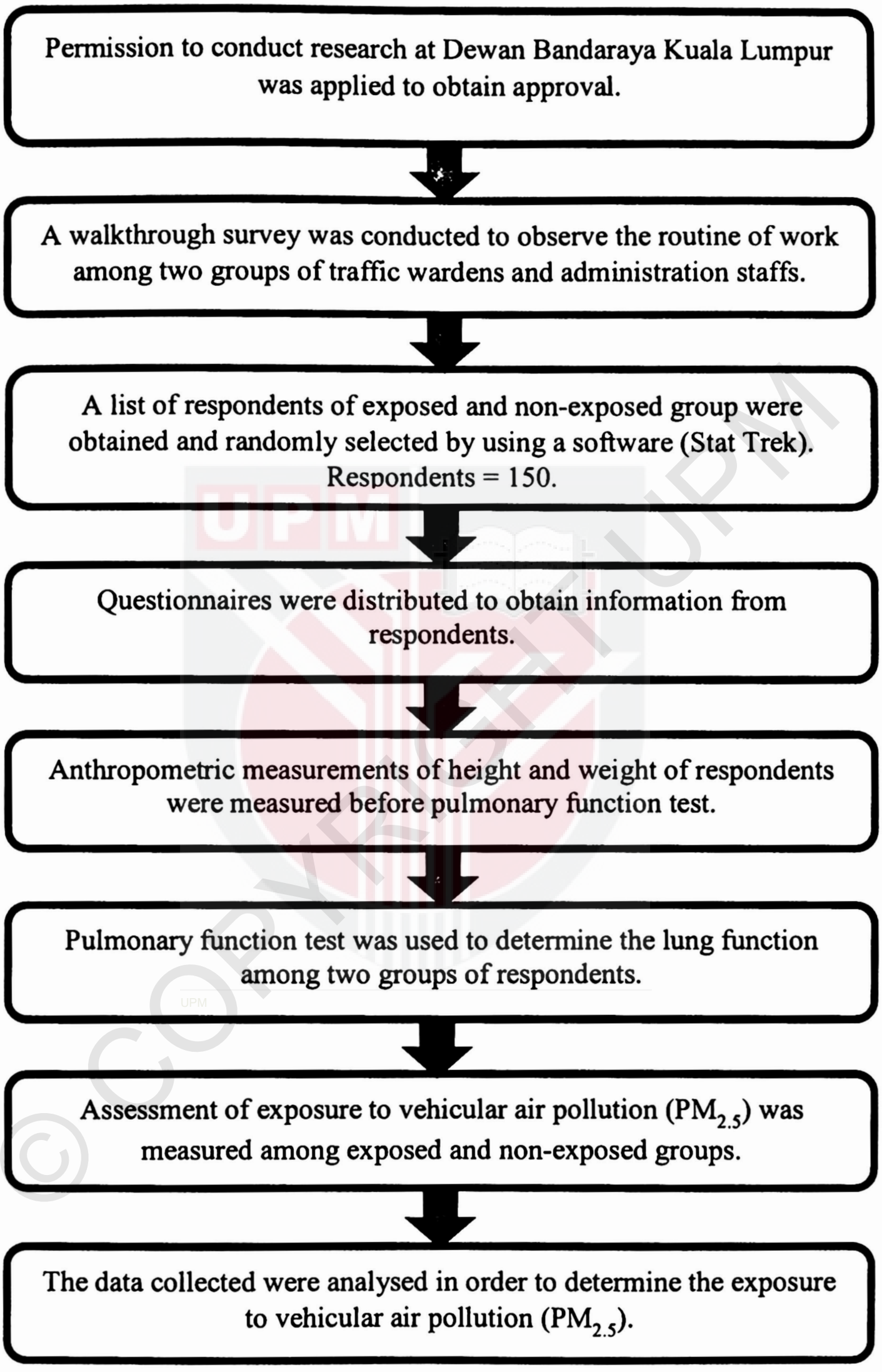


Figure 3.3.2.1: Procedure of research flow chart

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3.3.3 Sampling size

The sample size calculation was based on Ingle et al. (2005) findings on exposure to vehicular pollution ($PM_{2.5}$) and lung function among traffic policemen in Jalgaon City, India. There were significant reduction in all parameters of lung function ($p<0.001$) based on the study. The value of standard deviation of findings was used as reference. Lemeshaw et al., (1990) formula for two groups comparison is used as shown below:

$$n = \frac{z^2_{1-\frac{\alpha}{2}}[2\sigma^2]}{d^2}$$

$$n = \frac{1.96^2[2(2.8^2)]}{1^2}$$

n = 60.2 ≈ 60 in each group (exposed and non-exposed)

n = 60 exposed + 60 non-exposed

n = 120 respondents

Where:

σ = Standard deviation in FVC estimated at 2.8 (assumed both groups to be the same)

Therefore, the number of total respondents are 120.

3.3.4 Exclusion criteria

The exclusion criteria was male traffic wardens or/and administration staffs who already diagnosed with respiratory diseases such as asthma and other related diseases prior to their current occupation. This exclusion criteria was chosen to remove non-occupational factors of respiratory problems including genetics and childhood factors.

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3.4 Instrumentation

3.4.1 Side Pak

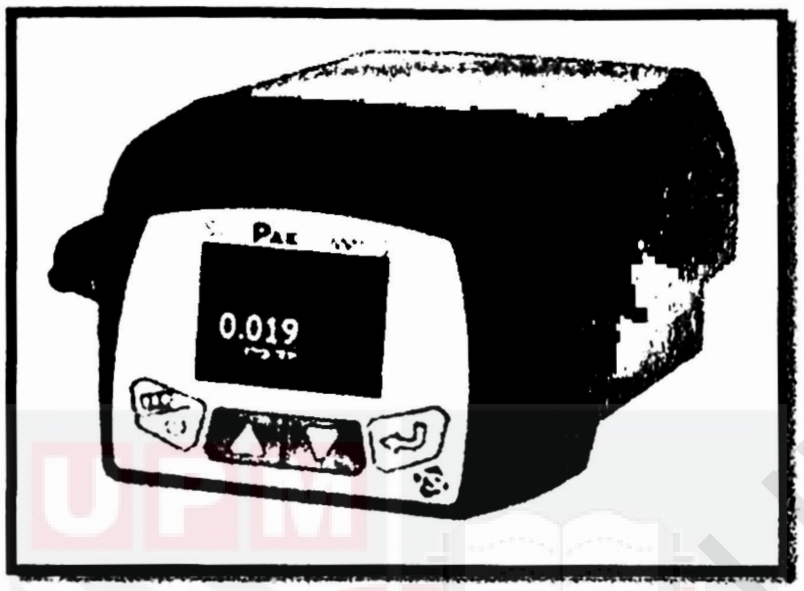


Figure 3.4.1.1: TSI SidePak™ AM520

(Source: http://www.tsi.com/sidepak-personal-aerosol-monitor-am520/)

The TSI SidePak™ AM520 is an equipment used as personal aerosol monitor. It is portable, battery-operated, data logging and light scattering laser photometer. The equipment able to measure particulate matter (PM) with variety in size such as PM_1, $PM_{2.5}$, PM_4, PM_5 and PM_{10} by changing the impactor. In addition, the equipment is suitable to be used as to get real-time measurement.

3.4.2 Questionnaire

The questionnaires were distributed among respondents. The questionnaire consist of four sections:

Section A: Socio-demographic information

A section comprises on background information of respondents such as age, gender, height, weight and transport to workplace.

Section B: Working characteristics

A section to assess respondent's occupation details such as job position, work task, work location, employment period and duration of exposure.

Section C: Psychosocial factors

Section C was adopted from Job Content Questionnaire (JCQ) by Job Demand Control (JDC) Model for assessing job strain among respondents. This was a section to appraise the content of work duties by workers (Karasek et al., 1998). The JCQ contain 27 questions which divided into 4 domains;

i. Job decision latitude (sub-domain: skill discretion and decision authority)
ii. Job demand (sub-domain: physical and psychological demand)
iii. Social support (sub-domain: co-worker support and supervisor support)
iv. Job insecurity.

The evaluation was based on Job Content Instrument Scale Construction in JCQ user guide. A likert scale was used for measuring all items from 1 (strongly disagree) to 4 (strongly agree). The reported Cronbach's alpha value is 0.78 for Malay version.

Table 3.4.2.1: JCQ 27 items

Domain	Sub-domain	Items
Job decision latitude	Skill discretion	Q1, Q2, Q3, Q5, Q7, Q9
	decision making authority	Q4, Q6, Q8
Job demand	Physical and physiological demand	Q10, Q11, Q12, Q13, Q14, Q15
Social support	Co-worker support	Q17, Q18, Q19, Q20
	supervisor support	Q21, Q22, Q23, Q24
Job insecurity		Q16, Q25, Q26, C27

Table 3.4.2.2: JCQ Formula

JCQ domains and subdomains	Formula
Job Skill Discretion	[Q1 + Q3 + Q5 + Q7 + Q9 + 5 - Q2] X 2
Job Decision Making Authority	[2 X (Q4 + Q6 + Q8)] X 2
Job Demands	3 X (Q10 + Q11) + 2 X (15 – Q13 – Q14 – Q15)
Job Decision Latitude	Job Skill Discretion + Job Decision Making Authority
Job Strain	(Job Demands X 2) / Job Decision Latitude
Co-worker Support	Q17 + Q18 + Q19 + Q20
Supervisor Support	Q21 + Q22 + Q23 + Q24
Job Insecurity	Q25 + Q27 + 5 - Q16

Section D: Respiratory symptoms

This section was adopted from International Union against Tuberculosis and Lung Disease (IUATLD). It was intended to determine respiratory symptoms includes wheezing, shortness of breath, cough, phlegm, asthma and smoking behaviour of respondents. The respondents only required to answer a set of categorical data which comprised of "Yes" and "No" whether they did experience the symptoms or having smoking behaviour in previous 1 year time or not.

3.4.3 SECA Body meter and SECA Body Weighting

Anthropometric data such as weight and height were taken by using SECA products for obtaining accurate and precise measurements. For SECA 206 Body Meter and SECA 761 Mechanical Personal Scale unit of measurement taken are in centimetre (cm) with 1 millimetre (mm) sensitivity and kilogram (kg) with 1 kg sensitivity respectively.

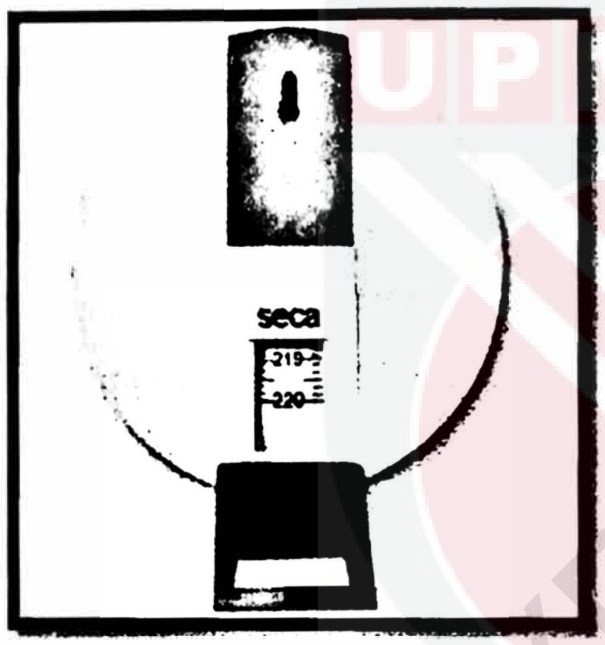


Figure 3.4.3.1: SECA 206 Body Meter

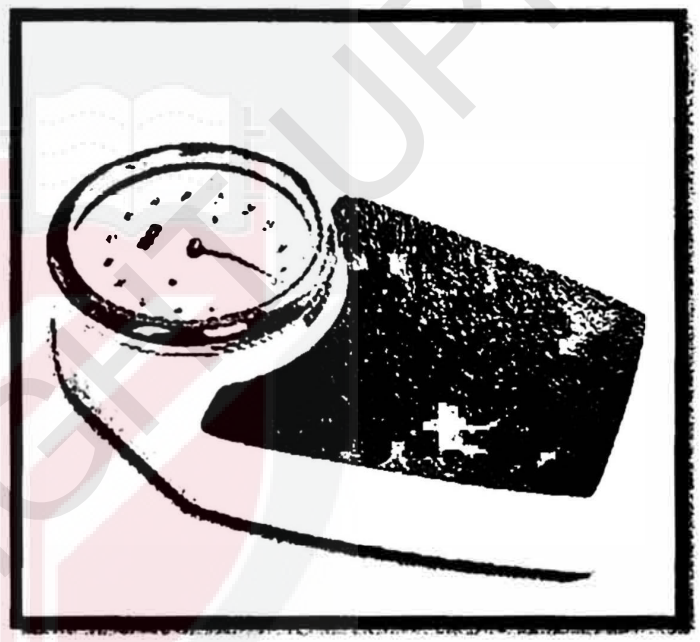


Figure 3.4.3.2: SECA 761 Mechanical Personal Scale

(Source: Seca.com, 2017)

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3.4.4 Spirometer

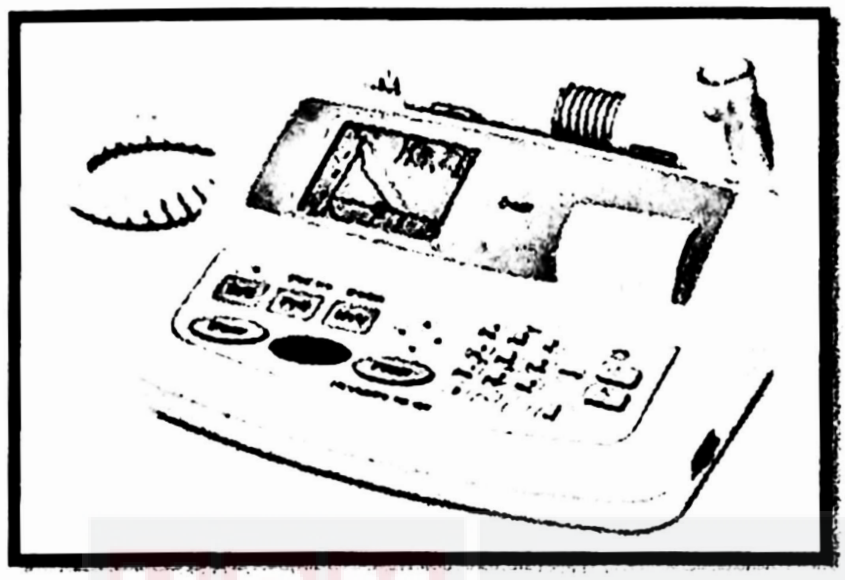


Figure 3.4.4.1: Chestgraph HI-101 Spirometer

(Source: Acc Medical Solution.com, 2017)

Spirometer was used in order to assess pulmonary function of both exposed and non-exposed group. This instrument was the most commonly used to evaluate lung function effectiveness in order to measure the volume of air come into the lungs and the volume that are able to be breathe out in one second. The parameters measured by spirometer were forced vital capacity (FVC), forced expiratory volume in one second (FEV_1) and forced expiratory ratio (FEV_1/FVC). A reduced in FVC and FEV_1 with a normal FEV_1/FVC ratio indicate restrictive lung disease while a reduced in FEV_1/FVC ratio demonstrate obstructive lung disease.

For analysing spirometry results, reference equation from Singh et al., (1993) will be used. This is due to the existing of difference in lung function among different racial and ethnicity due genes and environment of particular region (Duong et al., 2013).

The reference equations for Malaysian were:

- For male: Age (20 – 69 years old)

$$\mathbf{FVC} = 0.0407(\text{Height}) - 0.0296(\text{Age}) - 2.343$$

$$\mathbf{FEV_1} = 0.0353(\text{Height}) - 0.0315(\text{Age}) - 1.784$$

- For female: Age (20 – 69 years old)

$$\mathbf{FVC} = 0.0312(\text{Height}) - 0.022(\text{Age}) - 1.640$$

$$\mathbf{FEV_1} = 0.0294(\text{Height}) - 0.0238(\text{Age}) - 1.609$$

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3.5 Quality Control

3.5.1 Questionnaire Pre-test

A pre-test was conducted to 10% of the total sample size population among UPM police officers (exposed group) and administration staffs (non-exposed group). The questionnaires were in bilingual which in Malay and English version. The respondents were tested on the content of questionnaires to evaluate the level of understanding on each question constructed. The Cronbach's alpha value for Job Content Questionnaire (JCQ) was 0.85 while for International Union against Lung and Tuberculosis Disease (IUALTD) was 0.75.

3.5.2 Repeated measurement for weight and height

The measurements of height and body weight were taken for three (3) times and average value was used in order to get accurate and precise readings.

3.5.3 Calibration

The spirometer and TSI SidePak™ were calibrated before used to ensure the consistency, accuracy and the reliability of readings from the instruments.

3.6 Procedure of Data Collection

3.6.1 Walkthrough Survey

A walkthrough survey was conducted at Dewan Bandaraya Kuala Lumpur as to gather information on the numbers of total staffs, total number of traffic wardens, assess working schedule and discussion for further information of traffic warden job task.

3.6.2 Questionnaire Distribution

The questionnaires were distributed to 75 traffic wardens (exposed group) and 75 administration staffs (non-exposed group) of DBKL prior the exclusion criteria. Any respondent who already diagnosed with respiratory diseases such as asthma and other related diseases was excluded from this research. A briefing was conducted on how to answer the questionnaire together with consent form. Respondents were given several minutes to answer the questionnaire. Next, respondents will perform a pulmonary function test by using spirometer with 3 times test.

The pulmonary function test results were compiled to the questionnaire according to ID number which only used in this study as to ensure the confidentiality of respondent. Upon completion of questionnaire and pulmonary function test, a token of appreciation was given to each of respondents as to convey gratitude to them for their participation. All questionnaires collected were kept in a secure files and place.

3.6.3 Air Sampling

The traffic wardens were divided into several work task which were tidal control flow as Task 1 and point duty (morning and evening) as Task 2. The tidal flow control was defined as task of traffic control starting at Loke Yew Road area which involved the opening of contra flow to overcome the heavy traffic followed by issuance of compound at city area. The point duty can be described as duty of traffic control at road junctions in Kuala Lumpur during peak hours and followed by issuance of compound at the area.

The air sampling were conducted in 3 different places at the area of Loke Yew Road, Sultan Ismail Road and city centre area according to traffic wardens working schedule. Three traffic wardens were selected to represent both Task 1 and 2 while one administration staff was selected to represent exposure among all administration staffs who worked indoor.

The SidePak™ with tygon tube to mimic normal human breathing was used in order to measure vehicular air pollution ($PM_{2.5}$) level with sampling duration between 6 to 8 hours on each work task. The equipment was calibrated by using zero calibration filter and the data was logged in 5 minutes interval. As for administration staffs, several measurements were taken at the office for 8 hours with 5 minutes interval data logging to get the mean value who whole day exposure.

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3.7 Statistical Analysis

All data were analysed by using Statistical Package for Social Science (SPSS) Version 22.0 and descriptive data was expressed as mean, median, frequency and percentage. Significant level is set at $p<0.05$ for all statistical analysis. Kolmogorov-Smirnov test was used to test the normality of data and if $p>0.05$, the normality of data is assumed. In addition, kurtosis and skewness values also considered to determine normality as if its value is in between ±2, the data is normal distributed.

Table 3.7.1: Statistical Analysis

No.	Objectives	Parametric Test	Non-Parametric Test
1	To determine the socio-demographic information among exposed (traffic wardens) and non-exposed group (administration staffs).	Descriptive analysis	
2	To determine the working characteristics among exposed and non-exposed group.	Descriptive analysis	
3	To measure the level of vehicular air pollution ($PM_{2.5}$) exposure level among exposed and non-exposed group.	Descriptive analysis	
4	To identify the job strain and psychosocial factors among exposed and non-exposed group.	Descriptive analysis	

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5	To identify the respiratory symptoms among exposed and non-exposed group.	Descriptive analysis	
6	To assess the pulmonary function among exposed and non-exposed group.	Descriptive analysis	
7	To determine the associations between (i) socio-demographic factors (ii) working characteristics (iii) vehicular air pollution ($PM_{2.5}$) (iv) psychosocial factors with pulmonary function and respiratory symptoms among exposed and non-exposed group.	Independent T-test, Pearson's Correlation and chi square	Spearman Rho Correlation and chi square

3.8 Ethical Issues

The ethical approval and consent were obtained from Universiti Putra Malaysia (UPM) Ethical Committee for research involving human subject before data collection started. The respondents were informed about the purpose of the study through information sheet and verbally by the researcher. All information given by respondents was kept private and confidential which only used for research and scientific publication.

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CHAPTER 4

RESULTS

The purpose of this study was to determine the association between vehicular air pollution ($PM_{2.5}$) exposure level and the prevalence of job strain with respiratory health among municipal workers in Kuala Lumpur. A total of 150 male subjects were selected which consists of 75 traffic wardens and 75 administration staffs from Dewan Bandaraya Kuala Lumpur (DBKL) thus contributed to 100% of response rate.

4.1 The Socio-demographic Information

Table 4.1.1 showed the socio-demographic information of respondents in this study as to achieve specific objective 1 in order to determine the socio-demographic factors among exposed (traffic wardens) and non-exposed group (administration staffs). The information included in this study were age, race, body mass index (BMI), education level, total income, number of dependence and transport to workplace. For exposed and non-exposed group, the average age group was between 31-40 years old with 41.3% and 50.7% respectively. As for race, majority of both exposed and non-exposed group were

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Malay, 93.3% and 100% respectively. The marital status for exposed group shows greater percentage of married (78.7%) compared to single (21.3%) similar to non-exposed group which shows 77.3% of them were married and 22.7% of single respondents. Most of the respondents from exposed group show normal body mass index (BMI) of 48.0% while 42.7% and 9.3% of them were overweight and obese respectively. According to non-exposed group, 2.7% of the population show underweight BMI, 44.0% of the population show normal BMI, 40% of the population show overweight BMI and 13.3% of theme were obese. The educational level of exposed group predominantly 65.3% of finished school and 34.7% of diploma/degree holder while for the non-exposed group, most of them were 73.3% of finished school and 26.7% of diploma/degree holder. Both exposed (90.7%) and non-exposed (76.0%) group respondents used motorcycle as transport to workplace.

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Table 4.1.1: Socio demographic information of respondents

Variables	Exposed (N=75)		Non-Exposed (N=75)	
	f (%)	Mean[a]±SD Median[b]	*f* (%)	Mean[a]±SD Median[b]
Age		34.1[a] ± 9.75		35.51[a] ± 8.51
20-30 years old	29 (38.7)		24 (32.0)	
31-40 years old	31 (41.3)		38 (50.7)	
41-50 years old	6 (8.0)		6 (8.0)	
≥ 51 years old	9 (12.0)		7 (9.3)	
Race				
Malay	70 (93.3)		75 (100)	
Non-Malay	5 (6.7)		0(0)	
Marital Status				
Single	16 (21.3)	2.00[b]	17 (22.7)	2.00[b]
Married	59 (78.7)		58 (77.3)	
BMI		25.6[a] ± 3.64		25.8[a] ± 3.65
Underweight	0(0)		2 (2.7)	
Normal	36 (48.0)		33 (44.0)	
Overweight	32 (42.7)		30 (40.0)	
Obese	7 (9.3)		10 (13.3)	
Educational Level				
Primary	0 (0)	3.00[b]	1 (1.3)	3.00[b]
Secondary	49 (65.3)		54 (72.0)	
Diploma/Degree	26 (34.7)		20 (26.7)	
Total Income				
≥ RM 4,001	3 (4.0)	3.00[b]	6 (8.0)	3.00[b]
RM 3,001 – RM 4,000	14 (18.7)		20 (26.7)	
RM 2,001 – RM3,000	51 (68.0)		34 (45.3)	
≤ RM 2,000	7 (9.3)		15 (20.0)	
Number of Dependence				
≤ 1 person	21 (28.0)	2.00[b]	18 (24.0)	2.00[b]
2 – 4 persons	43 (57.3)		45 (60.0)	
≥ 5 persons	11 (14.7)		12 (16.0)	

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Transport to Workplace		
Public Transport	0(0)	7 (9.3)
Motorcycle	68 (90.7)	57 (76.0)
Car	7 (9.3)	11 (14.7)

N= 150. Descriptive Analysis.

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4.2 The working characteristics of respondents

Table 4.2.1 showed the working characteristics of respondents in this study as to achieve specific objective 2 in order to determine the working characteristics among exposed and non-exposed group. The information included in this study were work location, employment period, working hour, overtime work and frequency of overtime. As for work location, 100% of exposed group were actively conducting their task outdoor while 100% of non-exposed group indoor. The majority them have been working for 1 – 10 years (65.3%, 50.7%), followed by 11 – 20 years (20%, 36.0%), 21 – 30 years (9.3%, 9.3%) and more than 31 years (5.3%, 4.0%) respectively.

The working hour of exposed group (10 hours) was relatively longer than non-exposed group (8 hours). All exposed respondents work in shift mode and all non-exposed respondents work in normal mode. The reported overtime work preceded by exposed respondents (98.7%) and followed by non-exposed respondents (60.0%). For overtime frequency, majority of the exposed group worked overtime 4 – 6 times per month (61.3%), less than 3 times a month (25.3%), more than 6 times per month (12.0%) while the non-exposed group reported that majority of frequency of overtime were 4 – 6 times per month (26.7%), more than 6 times per month (17.3%), less than 3 times per month (16.0%)

Table 4.2.1: Working characteristics of respondents

Variables	Exposed (N=75)		Non-Exposed (N=75)	
	f (%)	Mean[a]±SD Median[b]	*f* (%)	Mean[a]±SD Median[b]
Work Location				
Indoor	0 (0)		75 (100)	
Outdoor	75 (100)		0 (0)	
Employment Period		10.32[a] ± 9.50		11.71[a] ± 8.44
1 – 10 years	49 (65.3)		38 (50.7)	
11 – 20 years	15 (20.0)		27 (36.0)	
21 – 30 years	7 (9.3)		7 (9.3)	
≥ 31 years	4 (5.3)		3 (4.0)	
Working Hour		10.00[a] ± 0.00		8.29[a] ± 0.65
8 hours	(0)		66 (88.0)	
10 hours	75 (100)		9 (12.0)	
Work Shift				
Normal	0 (0)		75 (100)	
Shift	75 (100)		0 (0)	
Overtime Work				
Yes	74 (98.7)		45 (60.0)	
No	1 (1.3)		30 (40.0)	
Overtime Frequency				
< 3 times per month	19 (25.3)	2.00[b]	12 (16.0)	3.00[b]
4 - 6 times per month	46 (61.3)		20 (26.7)	
> 6 times per month	9 (12.0)		13 (17.3)	
Never	1 (1.3)		30 (40.0)	

N= 150. Descriptive Analysis.

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4.3 The vehicular air pollution ($PM_{2.5}$) exposure level between groups

Table 4.3.1 showed the mean of vehicular air pollution ($PM_{2.5}$) of respondents in this study as to achieve specific objective 3 in order to measure the level of particulate matter ($PM_{2.5}$) exposure among exposed and non-exposed group. Based on the results, this study revealed that exposed group had higher concentration of exposure to vehicular air pollution ($PM_{2.5}$) of 65.3 ± 7.76 $\mu g/m^3$ which ranging from 52.2 $\mu g/m^3$ – 70.9 $\mu g/m^3$ compared to 24.60 ± 7.91 $\mu g/m^3$ of non-exposed group exposure which ranging from 16.2 $\mu g/m^3$ to 35.0 $\mu g/m^3$.

Table 4.3.2 showed the mean of vehicular air pollution ($PM_{2.5}$) for exposed group accordingly to their work task. The mean concentration for tidal flow control, morning shift point duty and evening shift point duty were 68.4 ± 25.3 $\mu g/m^3$, 70.9 ± 26.8 $\mu g/m^3$ and 52.2 ± 17.5 $\mu g/m^3$ respectively.

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Table 4.3.1: Vehicular air pollution ($PM_{2.5}$) level

Variables	Exposed (N=75)		Non-Exposed (N=75)	
	Mean±SD	Range	Mean±SD	Range
Vehicular Air Pollution ($PM_{2.5}$), $\mu g/m^3$	65.30 ± 7.76	52.2 – 70.9	24.60 ± 7.91	16.2 – 35.0

N= 150. Descriptive Analysis.

Table 4.3.2: Vehicular air pollution ($PM_{2.5}$) level of exposed group

Variables	Vehicular Air Pollution ($PM_{2.5}$) (N=3)	
	Mean±SD	Range
Task 1: Tidal Flow Control	68.4 ± 25.3	25 – 135
Task 2: Point Duty Control		
Morning Shift	70.9 ± 26.8	32 – 119
Afternoon Shift	52.2 ± 17.5	28 – 107

N= 3. Descriptive Analysis.

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4.4 The prevalence of job strain and psychosocial factors among respondents

Table 4.4.1 described the job strain and psychosocial factors (job demands, job decision latitude, co-worker support, supervisor support and job insecurity) among respondents in this study as to achieve specific objective 4 in order to identify the job strain among exposed and non-exposed group The job strain is derived by using formula:

$$Job\ Strain = \frac{Job\ Demands\ \times 2}{Job\ Decision\ Latitude}$$

The job strain score more than 1 revealed high job strain. There were 69 (46.0 %) of total respondents had high job strain.

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Table 4.4.1: Distribution of psychosocial factors and job strain among respondents

Psychosocial Factors	N=150			
	f (%)	Mean ± SD	Median	Range (Min-Max)
Job Demands		32.68 ± 3.61	32	18 - 42
Job Decision Latitude		67.21 ± 7.96	68	38 - 90
Co-worker Support		12.74 ± 1.61	12	5 – 16
Supervisor Support		12.05 ± 2.03	12	4 - 16
Job Insecurity		4.77 ± 1.18	5	3 – 9
Job Strain		0.99 ± 0.18	0.97	0.60 – 1.89
Yes	69 (46.0)			
No	81 (54.0)			

N= 150. Descriptive Analysis.

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4.4.1 The distribution of job strain and psychosocial factors between groups

Table 4.4.1.1 showed the distribution of job strain and psychosocial factors for 2 groups of exposed and non-exposed. Each domain was classified into high and low according to median cut-off of total respondent as stated in Table 10.

The exposed and non-exposed group had high job demands of 54.7% and 52.0% respectively. Job decision latitude and co-worker support were reported high among exposed group (57.3% and 92.0%) compared to non-exposed group (54.7% and 90.7%). As for supervisor support, non-exposed group (88.0%) was observed to be high compared to exposed group (72.0%). All respondents (100%) in exposed group showed low job insecurity compared to high job insecurity in majority of non-exposed respondents (57.3%). The job strain indicated by groups showed that non-exposed group (49.3%) had high job strain than exposed group (42.7%).

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Table 4.4.1.1: Psychosocial factors and job strain between groups

JCQ Domain	Exposed (N=75)			Non-Exposed (N=75)		
	f (%)	Mean ± SD	Range	*f* (%)	Mean ± SD	Range
Job Demands		32.48 ± 3.87	24 - 42		32.88 ± 3.33	24 - 42
High	41 (54.7)			39 (52.0)		
Low	34 (45.3)			36 (48.0)		
Job Decision Latitude		67.21 ± 7.95	38 - 90		67.07 ± 9.73	38 - 90
High	43 (57.3)			41 (54.7)		
Low	32 (42.7)			34 (45.3)		
Co-worker Support		12.75 ± 1.61	5 - 16		12.80 ± 1.84	5 - 16
High	69 (92.0)			68 (90.7)		
Low	6 (8.0)			7 (9.3)		
Supervisor Support		12.05 ± 2.03	4 - 16		12.55 ± 2.16	4 - 12
High	54 (72.0)			66 (88.0)		
Low	21 (28.0)			9 (12.0)		

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Job Insecurity		4.77 ± 1.18	3 - 9		4.95 ± 1.39	3 – 9
High	0 (0)			43 (57.3)		
Low	75 (100.0)			32 (42.7)		
Job strain		0.99 ± 0.86	0.9 – 1.9		1.00 ± 0.20	0.6 – 1.3
Yes	32 (42.7)			37 (49.3)		
No	43 (57.3)			38 (50.7)		

N= 150. Descriptive Analysis.

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4.5 The respiratory symptoms among respondents

Table 4.5.1 described the respiratory symptoms among respondents in this study as to achieve specific objective 5 in order to identify the respiratory symptoms among exposed and non-exposed group In this study, the respiratory symptoms measured were wheezing, chest tightness, shortness of breath, cough, phlegm, animal, dust and feathers also smoking status. Based on the results, only 14.7% and 10.7% had wheezing in exposed and non-exposed group. It was reported that 13.3% of exposed group had chest tightness compared to 6.7% of non-exposed group. Only 53.3% and 54.7% of exposed group had cough and phlegm compared to 34.7% and 30.7% in non-exposed group respectively. 13.3% of exposed group were having allergies to animal, dust and feathers while only 8.0% in non-exposed group. The distribution of smoking status was observed to be high number of smokers among exposed group (56.0%) than non-exposed group (49.3%).

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Table 4.5.1: Respiratory symptoms and smoking status among groups

Symptom	Exposed N=75 *f* (%)	Non-Exposed N=75 *f* (%)
Wheezing		
Yes	11 (14.7)	8 (10.7)
No	64 (85.3)	67 (89.3)
Chest Tightness		
Yes	10 (13.3)	5 (6.7)
No	65 (86.7)	70 (93.3)
Shortness of breath		
Yes	12 (16)	17 (22.7)
No	63 (84)	58 (77.3)
Cough		
Yes	40 (53.3)	26 (34.7)
No	35 (46.7)	49 (65.3)
Phlegm		
Yes	41 (54.7)	23 (30.7)
No	34 (45.3)	52 (69.3)
Alergy to animal, dust and feathers		
Yes	10 (13.3)	6 (8.0)
No	65 (86.7)	69 (92.0)
Smoking		
Yes	42 (56.0)	37 (49.3)
No	33 (44.0)	38 (50.7)

N= 150. Descriptive Analysis.

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4.6 The pulmonary function among respondents

Table 4.6.1 showed the pulmonary function among respondents in this study as to achieve specific objective 6 in order to assess the pulmonary function among exposed and non-exposed group. The mean of measured FVC in exposed and non-exposed group were 3.20 litres and 3.23 litres whereas the measured FEV_1 in exposed and non-exposed group were 2.87 litres and 3.08 litres respectively. The mean of percentage of FEV_1/FVC were 89.78% in exposed group and 95.30% in non-exposed group. The value of predicted FVC and FEV_1 were calculated based on reference equation for Malaysian by Singh et al. (1993) which suitable to be used for age ranging from 20 to 69 years old. The predicted FVC of exposed and non-exposed group were 3.66 litres and 3.45 litres while the predicted FEV_1 were 3.23 litres and 3.03 litres respectively. The predicted percentage of FEV_1/ FVC were 87.95% in exposed group and 87.81% in non-exposed group.

Table 4.6.2 showed the mean difference of pulmonary function among exposed and non-exposed groups. There were significant difference of measured FEV_1 (t= -1.988, p= 0.049), percentage of FEV_1/FVC (t= -3.648, p<0.001), predicted FVC (t= 3.419, p= 0.001) and predicted FEV_1 (t= 3.162, p= 0.002).

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Table 4.6.1: Pulmonary function test among respondents

Variables[a]	Exposed (N=75)		Non-Exposed (N=75)	
	Mean ± SD	Range	Mean ± SD	Range
Measured FVC (L)	3.21 ± 0.65	1.99 – 4.97	3.23 ± 0.63	2.17 – 5.34
Measured FEV_1 (L)	2.87 ± 0.66	0.99 – 4.56	3.08 ± 0.59	2.06 – 4.81
Measured % FEV_1/FVC	89.8 ± 11.41	41.1 – 100.00	95.3 ± 6.41	68.5 – 100.00
Predicted FVC (L)	3.66 ± 0.39	2.74 – 4.39	3.45 ± 0.39	2.47 – 4.35
Predicted FEV_1 (L)	3.23 ± 0.39	2.31 – 3.92	3.03 ± 0.38	2.06 – 3.86
Predicted % FEV_1/FVC	87.95 ± 1.58	83.82 – 88.47	87.81 ± 1.53	83.09 – 89.89

*N= 150. Descriptive Analysis.

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Table 4.6.2: Mean difference of pulmonary function test between groups

Variables[a]	Exposed (N=75) Mean±SD	Non-Exposed (N= 75) Mean±SD	Mean difference (95% CI)	t-value	*p*-value
Measured FVC (L)	3.21 ± 0.65	3.23 ± 0.63	-0.025 (-0.23, 0.18)	-0.241	0.810
Measured FEV_1 (L)	2.87 ± 0.66	3.08 ± 0.59	-0.202 (-0.40,-0.001)	-1.988	0.049*
Measured % FEV_1/FVC	89.8 ± 11.41	95.3 ± 6.41	-5.514 (0.92, 0.34)	-3.648	<0.001**
Predicted FVC (L)	3.66 ± 0.39	3.45 ± 0.39	0.218 (0.09, 0.34)	3.419	0.001*
Predicted FEV_1 (L)	3.23 ± 0.39	3.03 ± 0.38	0.197 (0.07, 0.32)	3.162	0.002*
Predicted % FEV_1/FVC	87.95 ± 1.58	87.81 ± 1.53	0.146 (-0.36, 0.65)	0.575	0.566

[a]*Independent T-test*
**p-value is significant at 0.05 level*
***p-value is significant at 0.001 level*

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4.7 The association of socio-demographic information with pulmonary function and respiratory symptoms

This section was to achieve specific objective 7 (i) in order to determine the association between socio-demographic information (age, race, BMI, educational level, total income, number of dependence and transport to workplace) with pulmonary function and respiratory symptoms between groups.

4.7.1 Mean difference of socio-demographic information between groups

Based on Table 4.7.1.1, there was no significant difference of age among exposed and non-exposed group (Z= -1.742, p=0.081). Based on Table 4.7.1.2, there was no significant difference of BMI between groups.

Table 4.7.1.1: Mean difference of age among respondents

Variable	Median (IQR)		Z	p-value
	Exposed (N=75)	Non-Exposed (N=75)		
Age[a]	32 (26, 38)	34 (29, 39)	− 1.742	0.081

[a]*Mann-Whitney U-Test*
**p-value significant at 0.05 level*
***p-value is significant at 0.001 level*

Table 4.7.1.2: Mean difference of other socio-demographic information (BMI) between groups

Variables	Mean ± SD		Mean difference (95% CI)	t-value	*p*-value
	Exposed (N=75)	Non-exposed (N=75)			
Body Mass Index (BMI)	25.58 ± 3.64	25.78 ± 0.66	-0.20 (-1.37, 0.98)	-0.329	0.743

[a] *Independent T-test*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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4.7.2 Correlation between socio-demographic information with pulmonary function

Table 4.7.2.1 showed the correlation between age and BMI with pulmonary function. There were significant correlation between age with measured FVC (r= -0.280, p= 0.001), measured FEV_1 (r= -0.267, p= 0.001), predicted FVC (r= -0.760, p<0.001), predicted FEV_1 (r= -0.809, p<0.001) and predicted percentage of FEV_1/FVC (r= -0.988, p<0.001) while no significant correlation between age with measured percentage of FEV_1/FVC.

For BMI, there were significant correlation between BMI with predicted FEV_1 (r= -0.161, p= 0.050) and predicted percentage of FEV_1/FVC (r= -0.187, p= 0.022). However, no significant correlation between BMI with other pulmonary function parameters (measured FVC, measured FEV_1, measured percentage of FEV_1/FVC and predicted FVC,).

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Table 4.7.2.1: Correlation between age and body mass index (BMI) with pulmonary function among respondents

Variables	Measured FVC (L)		Measured FEV_1 (L)		% FEV_1/FVC		Predicted FVC (L)		Predicted FEV_1 (L)		Predicted % FEV_1/FVC	
	r	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value
Age[a]	-0.280	0.001*	-0.267	0.001*	0.048	0.556	-0.760	<0.001**	-0.809	<0.001**	-0.988	<0.001**
Body Mass Index (BMI)[b]	-0.088	0.283	-0.147	0.073	-0.103	0.208	-0.148	0.070	-0.161	0.050*	-0.187	0.022*

[a]Spearman Rho Correlation
[b]Pearson Correlation Coefficient r-test
**p-value is significant at 0.05 level*
***p-value is significant at 0.001 level*

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4.7.3 Association between socio-demographic information with respiratory symptoms

The chi-square test was conducted to determine the association between socio-demographic information with all respiratory symptoms such as wheezing, chest tightness, shortness of breath, cough, phlegm, animal, dust and feathers also smoking. Based on Table 4.7.3.1, there was no significant association between all socio-demographic information (age, race, marital status, BMI, educational level, total income, number of dependence and transport to workplace) with wheezing.

Table 4.7.3.1: Association between socio-demographic information and wheezing among respondents

Socio demographic[a]	Wheezing (N=150)			
	Yes	No	χ^2	*p*-value
Age				
20-30 years old	6	46	0.523	0.914
31-40 years old	10	60		
41-50 years old	1	12		
≥ 51 years old	2	13		
Race				
Malay	18	127	0.251	0.497
Non-Malay	1	4		
Marital Status				
Single	3	30	0.489	0.767
Married	16	101		
BMI				
Underweight	1	1	3.241	0.356
Normal	10	59		
Overweight	6	56		
Obese	2	15		

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Educational Level				
Primary	0	1	0.359	0.836
Secondary	14	89		
Diploma/Degree	5	41		
Total Income				
≥ RM 4,001	1	8	0.461	0.927
RM 3,001 – RM 4,000	4	30		
RM 2,001 – RM3,000	12	73		
≤ RM 2,000	2	20		
Number of Dependence				
≤ 1 person	3	36	0.141	0.707
2 – 4 persons	16	72		
≥ 5 persons	0	23		
Transport to workplace				
Public Transport	0	7	1.278	0.528
Motorcycle	16	109		
Car	3	15		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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Based on Table 4.7.3.2, no significant association between all socio-demographic information (age, race, marital status, BMI, educational level, total income, number of dependence and transport to workplace) with chest tightness .

Table 4.7.3.2: Association between socio-demographic information and chest tightness among respondents

Socio demographic[a]	Chest Tightness (N=150)			
	Yes	No	χ^2	*p*-value
Age				
20-30 years old	7	46	2.181	0.536
31-40 years old	6	63		
41-50 years old	0	12		
≥ 51 years old	2	14		
Race				
Malay	14	131	0.575	0.414
Non-Malay	1	4		
Marital Status				
Single	4	29	0.212	0.743
Married	11	106		
BMI				
Underweight	1	1	6.160	0.104
Normal	9	60		
Overweight	3	59		
Obese	2	17		
Educational Level				
Primary	0	1	0.767	0.682
Secondary	9	94		
Diploma/Degree	6	40		
Total Income				
≥ RM 4,001	0	9	1.171	0.760
RM 3,001 – RM 4,000	4	30		
RM 2,001 – RM3,000	9	76		
< RM 2,000	2	20		

Number of Dependence				
≤ 1 person	2	37	3.138	0.208
2 – 4 persons	12	76		
≥ 5 persons	1	22		
Transport to workplace				
Public Transport	0	7	3.965	0.138
Motorcycle	11	114		
Car	4	14		

[a]Chi-square
**p-value is significant at 0.05 level*
***p-value is significant at 0.001 level*

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Based on Table 4.7.3.3, there was a significant association between BMI with shortness of breath (χ^2= 8.487, p= 0.037) but no significant association between other socio-demographic information (age, race, marital status, educational level, total income, number of dependence and transport to workplace) with shortness of breath. According to Phi and Cramer's V value, BMI was moderately associated with shortness of breath.

Table 4.7.3.3: Association between socio-demographic information and shortness of breath among respondents

Socio demographic[a]	Shortness of breath (N=150)			
	Yes	No	χ^2	*p*-value
Age				
20-30 years old	7	46	4.228	0.238
31-40 years old	18	51		
41-50 years old	1	11		
≥ 51 years old	3	13		
Race				
Malay	29	116	1.240	0.584
Non-Malay	0	5		
Marital Status				
Single	6	27	0.036	0.850
Married	23	94		
Divorced				
BMI* **				
Underweight	2	0	8.487	0.037*
Normal	13	56		
Overweight	11	51		
Obese	3	14		
	***Phi and Cramer's V Value = 0.238			
Educational Level				
Primary	0	1	1.086	0.581
Secondary	18	85		
Diploma/Degree	11	35		

Total Income				
≥ RM 4,001	0	9	3.300	0.348
RM 3,001 – RM 4,000	9	25		
RM 2,001 – RM3,000	16	69		
≤ RM 2,000	4	18		
Number of Dependence				
≤ 1 person	6	33	1.063	0.588
2 – 4 persons	17	71		
≥ 5 persons	6	17		
Transport to workplace				
Public Transport	1	6	2.617	0.270
Motorcycle	22	103		
Car	6	12		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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Based on Table 4.7.3.4, no significant association between all socio-demographic information (age, race, marital status, BMI, educational level, total income, number of dependence and transport to workplace) with cough.

Table 4.7.3.4: Association between socio-demographic information and cough among respondents

Socio demographic[a]	Cough (N=150)			
	Yes	No	χ^2	*p*-value
Age				
20-30 years old	17	36	7.046	0.070
31-40 years old	38	31		
41-50 years old	4	8		
≥ 51 years old	7	9		
Race				
Malay	65	80	1.209	0.272
Non-Malay	1	4		
Marital Status				
Single	10	23	3.221	0.073
Married	56	61		
Divorced				
BMI				
Underweight	2	0	2.971	0.396
Normal	28	41		
Overweight	28	34		
Obese	8	9		
Educational Level				
Primary	0	1	3.235	0.198
Secondary	50	53		
Diploma/Degree	16	30		
Total Income				
≥ RM 4,001	4	5	0.668	0.881
RM 3,001 – RM 4,000	16	18		
RM 2,001 – RM3,000	38	47		
≤ RM 2,000	8	14		

Number of Dependence				
≤ 1 person	15	24	0.698	0.705
2 – 4 persons	40	48		
≥ 5 persons	11	12		
Transport to workplace				
Public Transport	6	1	5.807	0.055
Motorcycle	54	71		
Car	6	12		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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Based on Table 4.7.3.5, there were no significant association between all socio-demographic information (age, race, marital status, BMI, educational level, total income, number of dependence and transport to workplace) with phlegm.

Table 4.7.3.5: Association between socio-demographic information and phlegm among respondents

Socio demographic[a]	Phlegm (N=150)			
	Yes	No	χ^2	p-value
Age				
20-30 years old	24	29	3.616	0.306
31-40 years old	31	38		
41-50 years old	2	10		
≥ 51 years old	7	9		
Race				
Malay	62	83	0.015	0.902
Non-Malay	2	3		
Marital Status				
Single	10	23	2.644	0.104
Married	54	63		
BMI				
Underweight	2	0	3.829	0.280
Normal	29	40		
Overweight	24	38		
Obese	9	8		
Educational Level				
Primary	0	1	0.757	0.685
Secondary	44	59		
Diploma/Degree	20	26		
Total Income				
≥ RM 4,001	2	7	3.829	0.280
RM 3,001 – RM 4,000	14	20		
RM 2,001 – RM3,000	40	45		
≤ RM 2,000	8	14		

Number of Dependence				
≤ 1 person	16	23	3.549	0.170
2 – 4 persons	42	46		
≥ 5 persons	6	17		
Transport to workplace				
Public Transport	1	6	2.419	0.298
Motorcycle	56	70		
Car	8	10		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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Based on Table 4.7.3.6, there were no significant association between all socio-demographic information (age, race, marital status, BMI, educational level, total income, number of dependence and transport to workplace) with allergic to animal, dust and feathers.

Table 4.7.3.6: Association between socio-demographic information with allergy to animal, dust and feathers among respondents

Socio demographic[a]	Allergy to animal, dust and feathers (N=150)			
	Yes	No	χ^2	p-value
Age				
20-30 years old	6	47	0.169	0.983
31-40 years old	7	62		
41-50 years old	1	11		
≥ 51 years old	2	14		
Race				
Malay	16	129	0.618	0.432
Non-Malay	0	5		
Marital Status				
Single	4	29	0.094	0.754
Married	12	105		
BMI				
Underweight	0	2	2.673	0.445
Normal	9	60		
Overweight	4	58		
Obese	3	14		
Educational Level				
Primary	0	1	1.521	0.467
Secondary	9	94		
Diploma/Degree	7	39		
Total Income				
≥ RM 4,001	1	8	0.288	0.962
RM 3,001 – RM 4,000	3	31		
RM 2,001 – RM3,000	10	75		
≤ RM 2,000	2	20		

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Number of Dependence				
≤ 1 person	2	37	4.232	0.120
2 – 4 persons	9	79		
≥ 5 persons	5	18		
Transport to workplace				
Public Transport	1	6	0.109	0.947
Motorcycle	13	112		
Car	2	16		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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Based on Table 4.7.3.7, there was a significant association between race with smoking status (χ^2= 0.016, p= 0.022) but no significant association between other socio-demographic information (age, marital status, BMI, educational level, total income, number of dependence and transport to workplace) with smoking status. According to Phi and Cramers V value, race was weakly associated with smoking.

Table 4.7.3.7: Association between socio-demographic information and smoking status among respondents

Socio demographic[a]	Smoking status (N=150)			
	Yes	No	χ^2	*p*-value
Age				
20-30 years old	27	26	1.103	0.776
31-40 years old	39	30		
41-50 years old	5	7		
≥ 51 years old	8	8		
Race* **				
Malay	79	66	0.016	0.022*
Non-Malay	0	5		
			***Phi and Cramer's V Value = 0.196	
Marital Status				
Single	15	18	0.883	0.347
Married	64	53		
BMI				
Underweight	1	1	1.269	0.736
Normal	33	36		
Overweight	35	27		
Obese	10	7		
Educational Level				
Primary	1	0	1.011	0.603
Secondary	53	50		
Diploma/Degree	25	21		

Total Income				
≥ RM 4,001	4	5	0.279	0.964
RM 3,001 – RM 4,000	18	16		
RM 2,001 – RM3,000	45	40		
≤ RM 2,000	12	10		
Number of Dependence				
≤ 1 person	20	19	1.130	0.568
2 – 4 persons	49	39		
≥ 5 persons	10	13		
Transport to workplace				
Public Transport	2	5	2.146	0.342
Motorcycle	66	59		
Car	11	7		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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4.8 The association of working characteristics with pulmonary function and respiratory symptoms

This section was to achieve specific objective 7 (ii) in order to determine the association of working characteristics (work location, working hour, work shift, overtime work, overtime frequency) with respiratory symptoms and pulmonary function between groups.

4.8.1 Mean difference of working characteristics between groups

Based on Table 4.8.1.1, there were significant difference of working hour (t= 23.30, p<0.001), overtime work (t= -6.611, p<0.001) and overtime frequency (t= -6.093, p<0.001) between exposed and non-exposed groups but no significant difference of employment period among them.

Table 4.8.1.1: Mean difference of working characteristics between groups

Variables	Mean ± SD		Mean difference (95% CI)	t-value	*p*-value
	Exposed (N=75)	Non-exposed (N=75)			
Employment Period	10.32 9.50	11.71 8.44	-1.387 (-4.29, 1.51)	-0.945	0.345
Working Hour	10.00 0.00	8.24 0.65	1.760 (1.61, 1.91)	23.30	<0.001**
Overtime Work	1.01 0.12	1.40 0.49	-0.387 (-0.50, 0.27)	-6.611	<0.001**
Frequency Overtime	1.89 0.65	2.81 1.14	-0.920 (-1.22, -0.62)	-6.093	<0.001**

[a] *Independent T-test*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

4.8.2 Correlation between working characteristics with pulmonary function among respondents

Table 4.8.2.2 showed the correlation between employment period and working hour with pulmonary function. There were significant correlation between employment period with measured FVC (r= -0.030, p<0.001), measured FEV_1 (r= -0.315, p<0.001), predicted FVC (r= -0.729, p<0.001), predicted FEV_1 (r= -0.777, p<0.001) and predicted percentage of FEV_1/FVC (r= -0.938, p<0.001) while no significant correlation between working characteristics with measured percentage of FEV_1/FVC.

There were significant correlation between working hour with measured percentage of FEV_1/FVC (r= -0.236, p= 0.004), predicted FVC (r= 0.231, p= 0.004), predicted FEV1 (r= 0.213, p= 0.004) found in this study. However, no significant correlation between working hour with measured FVC, measured FEV_1 and predicted percentage of FEV_1/FVC.

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Variables[a]	Measured FVC (L)		Measured FEV_1 (L)		% FEV_1/FVC		Predicted FVC (L)		Predicted FEV_1 (L)		Predicted % FEV_1/FVC	
	r	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value
Employment Period (Year)[a]	-0.030	<0.001**	-0.315	<0.001**	-0.040	0.627	-0.729	<0.001**	-0.777	<0.001**	-0.938	<0.001**
Working Hour[a]	-0.017	0.833	-0.133	0.105	-0.236	0.004*	0.231	0.004*	0.213	0.004*	0.019	0.815

[a] Pearson Correlation Coefficient r-test
**p-value is significant at 0.05 level*
***p-value is significant at 0.001 level*

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4.8.3 Association between working characteristics with respiratory symptoms among respondents

The chi-square test was conducted to determine the association between working characteristics with all respiratory symptoms such as wheezing, chest tightness, shortness of breath, cough, phlegm, animal,dust and feathers also smoking.

Based on Table 4.8.3.1, there were no significant association between all working characteristics (work location, employment period, working hour, work shift, overtime work, and overtime frequency) with wheezing.

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Table 4.8.3.1: Association between working characteristics and wheezing among respondents

Working Characteristics[a]	Wheezing (N=150)			
	Yes (%)	No (%)	χ^2	*p*-value
Work Location				
Indoor	8	67	0.542	0.461
Outdoor	11	64		
Employment Period				
1 - 10 years	16	71	6.996	0.072
11 - 20 years	1	41		
21 - 30 years	1	13		
≥ 31 years	1	6		
Working Hour				
8 hours	7	59	0.452	0.501
10 hours	12	72		
Work Shift				
Normal Shift	8 11	67 64	0.542	0.461
Overtime Work				
Yes	15	104	0.002	0.965
No	4	27		
Overtime Frequency				
< 3 times per month	3	28	2.518	0.472
4-6 times per month	11	55		
> 6 times per month	1	21		
Never	4	27		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

Based on Table 4.8.3.2, there were no significant association between all working characteristics (work location, employment period, working hour, work shift, overtime work, and overtime frequency) with chest tightness.

Table 4.8.3.2: Association between working characteristics and chest tightness among respondents

Working Characteristics[a]	Chest Tightness (N=150)			
	Yes (%)	No (%)	χ^2	*p*-value
Work Location				
Indoor	5	70	1.852	0.174
Outdoor	10	65		
Employment Period				
1 - 10 years	12	75	4.370	0.224
11 - 20 years	1	14		
21 - 30 years	1	13		
≥ 31 years	1	6		
Working Hour				
8 hours	5	61	0.770	0.380
10 hours	10	74		
Work Shift				
Normal	5	70	1.852	0.174
Shift	10	65		
Overtime Work				
Yes	12	107	0.005	0.946
No	3	28		
Overtime Frequency				
< 3 times per month	3	28	0.054	0.997
4-6 times per month	7	59		
> 6 times per month	2	20		
Never	3	28		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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Based on Table 4.8.3.3, there were no significant association between all working characteristics (work location, employment period, working hour, work shift, overtime work, and overtime frequency) with shortness of breath.

Table 4.8.3.3: Association between working characteristics and shortness of breath among respondents

Working Characteristics[a]	Shortness of breath (N=150)			
	Yes (%)	No (%)	χ^2	*p*-value
Work Location				
Indoor	17	58	1.069	0.301
Outdoor	12	63		
Employment Period				
1 - 10 years	17	70	1.838	0.607
11 - 20 years	9	33		
21 - 30 years	1	13		
≥ 31 years	2	5		
Working Hour				
8 hours	16	50	1.821	0.177
10 hours	13	71		
Work Shift				
Normal	17	58	1.069	0.301
Shift	12	63		
Overtime Work				
Yes	21	98	1.050	0.306
No	8	23		
Overtime Frequency				
< 3 times per month	6	25	1.153	0.764
4-6 times per month	11	55		
> 6 times per month	4	18		
Never	8	23		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

Based on Table 4.8.3.4, there were significant association between work location (χ^2= 5.303, p= 0.021) and work shift (χ^2= 5.303, p= 0.021) with cough. However, no significant association between other working characteristics (employment period, working hour, overtime work, overtime frequency) with cough. According to Phi and Cramer's V value, the work location and work mode were weakly associated with cough. However, it was minimally acceptable.

Table 4.8.3.4: Association between working characteristics and cough among respondents

Working Characteristics[a]	Cough (N=150)			
	Yes (%)	No (%)	χ^2	*p*-value
Work Location				
Indoor	26	49	5.303	0.021*
Outdoor	40	35		
	***Phi and Cramer's V Value = 0.188			
Employment Period				
1 - 10 years	38	49	0.621	0.892
11 - 20 years	20	22		
21 - 30 years	5	9		
≥ 31 years	3	4		
Working Hour				
8 hours	24	42	2.789	0.095
10 hours	42	42		
Work Shift				
Normal	26	49	5.303	0.021*
Shift	40	35		
	***Phi and Cramer's V Value = 0.188			
Overtime Work				
Yes	53	66	0.068	0.795
No	13	18		

Overtime Frequency				
< 3 times per month	12	19	1.030	0.794
4-6 times per month	32	34		
> 6 times per month	9	13		
Never	13	18		

[a]Chi-square

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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Based on Table 4.8.3.5, there were significant association between work location (χ^2= 8.830, p= 0.003), working hour (χ^2= 4.197, p= 0.040) and work shift (χ^2= 8.830, p= 0.003) with phlegm. However, no significant association between other working characteristics (employment period, overtime work, overtime frequency) with phlegm. According to Phi and Cramer's V value, the work location and work mode were moderately associated with phlegm while working hour was weakly associated with phlegm but it was minimally acceptable.

Table 4.8.3.5: Association between working characteristics and phlegm among respondents

Working Characteristics[a]	Phlegm (N=150)			
	Yes (%)	No (%)	χ^2	*p*-value
Work Location				
Indoor	23	52	8.830	0.003*
Outdoor	41	34		
		***Phi and Cramer's V Value = 0.243		
Employment Period				
1 - 10 years	41	46	2.106	0.551
11 - 20 years	15	27		
21 - 30 years	6	8		
≥ 31 years	2	5		
Working Hour				
8 hours	22	44	4.197	0.040*
10 hours	42	42		
		***Phi and Cramer's V Value = 0.167		
Work Shift				
Normal	23	52	8.830	0.003*
Shift	41	34		
		***Phi and Cramer's V Value = 0.243		
Overtime Work				
Yes	51	68	0.009	0.926
No	13	18		

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Overtime Frequency				
< 3 times per month	13	18	0.085	0.994
4-6 times per month	29	37		
> 6 times per month	9	13		
Never	13	18		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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Based on Table 4.8.3.6, there were no significant association between all working characteristics (work location, employment period, working hour, work shift, overtime work, and overtime frequency) with allergy to animal, dust and feathers.

Table 4.8.3.6: Association between working characteristics with allergy to animal, dust and feathers among respondents

Working Characteristics[a]	Allergy to animal, dust and feathers (N= 150)			
	Yes (%)	No (%)	χ^2	*p*-value
Work Location				
Indoor	6	69	1.119	0.290
Outdoor	10	65		
Employment Period				
1 - 10 years	12	75	6.456	0.091
11 - 20 years	2	40		
21 - 30 years	0	14		
≥ 31 years	2	5		
Working Hour				
8 hours	5	61	1.182	0.277
10 hours	11	73		
Work Shift				
Normal	6	69	1.119	0.290
Shift	10	65		
Overtime Work				
Yes	14	105	0.729	0.393
No	2	29		
Overtime Frequency				
< 3 times per month	4	27	0.945	0.815
4-6 times per month	7	59		
> 6 times per month	3	19		
Never	2	29		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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Based on Table 4.8.3.7, there were no significant association between all working characteristics (work location, employment period, working hour, work shift, overtime work, and overtime frequency) with smoking status.

Table 4.8.3.7: Association between working characteristics and smoking status among respondents

Working Characteristics[a]	Smoking status (N=150)			
	Yes (%)	No (%)	χ^2	*p*-value
Work Location				
Indoor	37	38	0.669	0.414
Outdoor	42	33		
Employment Period				
1 - 10 years	45	42	1.061	0.787
11 - 20 years	22	20		
21 - 30 years	7	7		
≥ 31 years	5	2		
Working Hour				
8 hours	32	34	0.827	0.363
10 hours	47	37		
Work Shift				
Normal	37	38	0.669	0.414
Shift	42	33		
Overtime Work				
Yes	64	55	0.287	0.592
No	15	16		
Overtime Frequency				
< 3 times per month	14	17	3.056	0.383
4-6 times per month	40	26		
> 6 times per month	10	12		
Never	15	16		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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4.9 The association of vehicular air pollution ($PM_{2.5}$) exposure level with pulmonary function and respiratory symptoms

This section was to achieve specific objective 7 (iii) in order to determine the association of vehicular air pollution ($PM_{2.5}$) with respiratory symptoms and pulmonary function between groups.

4.9.1 Mean difference of vehicular air pollution ($PM_{2.5}$) exposure level between groups

Based on Table 4.9.1.1, there was a significant difference between vehicular air pollution ($PM_{2.5}$) exposure among exposed and non-exposed group (t= 31.808, p<0.001).

Table 4.9.1.1: Mean difference of vehicular air pollution ($PM_{2.5}$) exposure level between groups

Variables[a]	Mean ± SD		Mean difference (95% CI)	t-value	*p*-value
	Exposed (N=75)	Non-exposed (N=75)			
Vehicular Air Pollution, $PM_{2.5}$ ($\mu g/m^3$)	65.30 ± 7.76	24.60 ± 7.91	40.70 (38.17, 43.22)	31.808	<0.001**

[a] *Independent T-test*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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4.9.2 Correlation between vehicular air pollution ($PM_{2.5}$) exposure level with pulmonary function test

Table 4.9.2.1 showed the correlation between vehicular air pollution ($PM_{2.5}$) with pulmonary function. There were significant positive correlation between vehicular air pollution ($PM_{2.5}$) with predicted FEV_1 (p= 0.001) and predicted FEV_1 (p= 0.002) while significant negative correlation between vehicular air pollution ($PM_{2.5}$) with measured FEV_1 ($p<0.05$) and measured percentage of FEV_1/FVC (p= 0.001). However, no significant correlation between vehicular air pollution ($PM_{2.5}$) with measured FVC and predicted percentage of FEV_1/FVC.

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Table 4.9.2.1: Correlation between vehicular air pollution ($PM_{2.5}$) exposure level with pulmonary function (N = 150)

Variables[a]	Measured FVC (L)		Measured FEV_1 (L)		% FEV_1/FVC		Predicted FVC (L)		Predicted FEV_1 (L)		Predicted % FEV_1/FVC	
	r	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value
Vehicular Air Pollution ($PM_{2.5}$), $\mu g/m^3$	-0.020	0.810	-0.161	0.049*	-0.287	<0.001**	0.271	0.001*	0.252	0.002*	0.047	0.566

[a] *Pearson Correlation Coefficient r-test*
**p-value is significant at 0.05 level*
***p-value is significant at 0.001 level*

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4.9.3 Association between vehicular air pollution ($PM_{2.5}$) exposure level with respiratory symptoms

Table 4.9.3.1 showed the association between vehicular air pollution ($PM_{2.5}$) with respiratory symptoms. Regarding the results, there were significant difference between vehicular air pollution ($PM_{2.5}$) with cough (t= 2.329, *p*= 0.021) and phlegm (t= 3.043, *p*= 0.003) but no significant difference with other respiratory symptoms such as wheezing, chest tightness, shortness of breath, allergy to animal dust and feathers also smoking status. According to Phi and Cramer's V value, the phlegm were moderately associated with vehicular air pollution ($PM_{2.5}$) while cough was weakly associated with vehicular air pollution ($PM_{2.5}$) but it was minimally acceptable.

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Table 4.9.3.1: Mean difference of vehicular air pollution ($PM_{2.5}$) exposure level between respiratory symptoms among respondents

Variables[a]	Vehicular Air Pollution ($PM_{2.5}$), $\mu g/m^3$ Mean ± SD	Mean difference (95% CI)	t-value	*p*-value
Wheezing				
Yes	49.02 ± 20.80	4.66 (-5.95, 15.28)	0.868	0.387
No	44.36 ± 22.02			
Chest Tightness				
Yes	53.51 ± 21.98	9.51 (-2.18, 21.20)	1.607	0.110
No	43.99 ± 21.72			
Shortness of Breath				
Yes	41.37 ± 21.70	-4.44 (-13.37, 4.50)	-0.982	0.328
No	45.81 ± 21.90			
Cough* **				
Yes	48.43 ± 19.28	7.41 (1.12, 13.71)	2.329	0.021*
No	41.01 ± 19.42			
		***Phi and Cramer's V Value = 0.188		
Phlegm* **				
Yes	49.78 ± 18.93	9.60 (3.37, 15.83)	3.043	0.003*
No	40.18 ± 19.25			
		***Phi and Cramer's V Value = 0.243		
Allergy to animal, dust and feathers				
Yes	49.83 ± 20.82	5.78 (-5.96, 16.90)	0.945	0.346
No	44.37 ± 21.98			
Smoking				
Yes	45.95 ± 21.54	2.12 (-4.96, 9.20)	0.591	0.555
No	43.83 ± 22.31			

[a] *Independent T-test*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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4.10 The association of job strain and psychosocial factors with pulmonary function and respiratory symptoms

This section was to achieve specific objective 7 (iv) in order to determine the job strain and psychosocial factors with respiratory symptoms and pulmonary function between groups.

4.10.1 Mean difference of job strain and psychosocial factors scores between groups

Based on Table 4.10.1.1, there was a significant difference between supervisor support scores between group (t= -3.060, *p*= 0.003). However, no significant difference between other psychosocial factors such as job demands, job decision latitude, co-worker support, job insecurity and job strain between groups.

Table 4.10.1.1: Mean difference of scores on job strain and psychosocial factors between groups

Variables[a]	Mean ± SD		Mean difference (95% CI)	t-value	*p*-value
	Exposed	Non-exposed			
Job Demands	32.48 ± 3.87	32.88 ± 3.33	- 0.040 (- 1.57, 0.77)	- 0.678	0.499
Job Decision Latitude	67.36 ± 5.72	67.07 ± 9.73	0.293 (- 2.29, 2.87)	0.225	0.822
Co-worker Support	12.69 ± 1.35	12.80 ± 1.84	- 0.107 (- 0.63, 0.41)	- 0.406	0.686
Supervisor Support	11.56 ± 1.77	12.55 ± 2.15	- 0.987 (- 1.62, - 0.35)	- 3.060	0.003*
Job Insecurity	4.59 ± 0.90	4.94 ± 1.39	- 0.36 (- 0.74, 0.02)	-1.878	0.063
Job Strain	0.97 ± 0.15	1.00 ± 0.20	- 0.032 (- 0.09, 0.03)	-1.083	0.281

[a] *Independent T-test*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

4.10.2 Correlation between scores on job strain and psychosocial factors with pulmonary function

Based on Table 4.10.2.1, there were no significant correlation between job strain and psychosocial factors (job demands, job decision latitude, co-worker support, supervisor support, job insecurity) with all pulmonary function parameters (measured FVC, measured FEV_1, measured $\%FEV_1/FVC$, predicted FVC, predicted FEV_1 and predicted $\%FEV_1/FVC$) among respondents.

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Table 4.10.2.1: Correlation between scores on job strain and psychosocial factors with pulmonary function

Variables[a]	Job Demands		Job Decision Latitude		Co-worker Support		Supervisor Support		Job Insecurity		Job Strain	
	r	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value	*r*	*p*-value
Measured FVC (L)	0.105	0.199	-0.053	0.518	0.065	0.429	-0.064	0.435	0.030	0.712	0.111	0.175
Measured FEV_1 (L)	0.086	0.294	0.048	0.560	0.060	0.464	0.000	0.998	0.019	0.820	0.107	0.192
Measured FEV_1/FVC	-0.013	0.335	0.015	0.852	0.011	0.890	0.119	0.146	-0.007	0.931	0.004	0.964
Predicted FVC (L)	0.079	0.270	0.092	0.265	0.100	0.222	-0.016	0.843	-0.091	0.267	-0.007	0.928
Predicted FEV_1 (L)	0.091	0.270	0.093	0.257	0.099	0.230	-0.014	0.886	-0.081	0.326	0.000	0.955
Predicted % FEV_1/FVC	0.133	0.105	0.069	0.404	0.034	0.677	<0.001	0.997	0.022	0.792	0.049	0.555

[a] Pearson Correlation Coefficient r-test

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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symptoms

The chi-square test was conducted to determine the association between psychosocial factors with all respiratory symptoms such as wheezing, chest tightness, shortness of breath, cough, phlegm, animal, dust and feathers also smoking. Based on Table 4.10.3.1, there was no significant association between all psychosocial factors (job demands, job decision latitude, co-worker support, supervisor support, job insecurity and job strain) with wheezing.

Table 4.10.3.1: Association between job strain and psychosocial factors with wheezing

Variables[a]	Wheezing (N=150)			
	Yes	No	χ^2	p- value
Job Demands				
High	8	83	1.205	0.076
Low	11	48		
Job Decision Latitude				
High	9	68	0.137	0.711
Low	10	63		
Co-worker Support				
High	17	120	0.095	0.671
Low	2	8		
Supervisor Support				
High	18	102	2.953	0.124
Low	1	29		
Job Insecurity				
High	9	72	0.385	0.535
Low	10	59		
Job Strain				
Yes	8	11	0.133	0.715
No	61	70		

[a]*Chi-square*

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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Based on Table 4.10.3.2, there was no significant association between all psychosocial factors (job demands, job decision latitude, co-worker support, supervisor support, job insecurity and job strain) with chest tightness.

Table 4.10.3.2: Association between job strain and psychosocial factors with chest tightness

Variables[a]	Chest Tightness (N=150)			
	Yes	No	χ^2	*p*-value
Job Demands				
High	7	84	1.369	0.242
Low	8	51		
Job Decision Latitude				
High	9	68	0.501	0.479
Low	6	67		
Co-worker Support				
High	13	124	0.459	0.621
Low	2	11		
Supervisor Support				
High	15	105	4.167	0.041
Low	0	30		
Job Insecurity				
High	7	74	0.361	0.548
Low	8	61		
Job Strain				
Yes	5	10	1.077	0.299
No	64	71		

[a]Chi-square

**p-value is significant at 0.05 level*

***p-value is significant at 0.001 level*

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Based on Table 4.10.3.3, there was a significant association between supervisor support with shortness of breath (χ^2 = 6.156, p= 0.013) but no significant association between other psychosocial factors (job demands, job decision latitude, co-worker support, job insecurity and job strain) with shortness of breath. According to Phi and Cramer's V value, the supervisor support were weakly associated with shortness of breath. However, it was minimally acceptable.

Table 4.10.3.3: Association between job strain and psychosocial factors with shortness of breath

Variables[a]	Shortness of breath (N=150)			
	Yes	No	χ^2	*p*-value
Job Demands				
High	15	76	1.205	0.272
Low	14	45		
Job Decision Latitude				
High	14	63	0,135	0.714
Low	15	58		
Co-worker Support				
High	28	109	1.237	0.464
Low	1	12		
Supervisor Support* **				
High	28	92	6.156	0.013*
Low	1	29		
			***Phi and Cramer's V Value = 0.203	
Job Insecurity				
High	15	66	0.075	0.784
Low	14	55		
Job Strain				
Yes	13	16	0.020	0.888
No	56	65		

[a]*Chi-square*
**p-value is significant at 0.05 level*
***p-value is significant at 0.001 level*

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Based on Table 4.10.3.4, there was no significant association between all psychosocial factors (job demands, job decision latitude, co-worker support, supervisor support, job insecurity and job strain) with cough.

Table 4.10.3.4: Association between job strain and psychosocial factors with cough

Variables[a]	Cough (N=150)			
	Yes	No	χ^2	*p*-value
Job Demands				
High	42	49	0.003	0.953
Low	24	35		
Job Decision Latitude				
High	35	42	0.136	0.712
Low	31	42		
Co-worker Support				
High	60	77	0.027	0.870
Low	6	7		
Supervisor Support				
High	51	69	0.548	0.459
Low	15	15		
Job Insecurity				
High	35	46	0.045	0.833
Low	31	38		
Job Strain				
Yes	31	35	0.045	0.833
No	38	46		

[a]Chi-square
**p-value is significant at 0.05 level*
***p-value is significant at 0.001 level*

Based on Table 4.10.3.5, there was a significant association between co-worker support and phlegm (χ^2= 4.106, p= 0.043) but no association between in other psychosocial factors (job demands, job decision latitude, supervisor support, job insecurity and job strain) with phlegm. According to Phi and Cramer's V value, the co-worker support was weakly associated with phlegm. However, it was minimally acceptable.

Table 4.10.3.5: Association between job strain and psychosocial factors with phlegm

Variables[a]	Phlegm (N=150)			
	Yes	No	χ^2	p-value
Job Demands				
High	39	52	0.003	0.953
Low	25	34		
Job Decision Latitude				
High	30	47	0.888	0.346
Low	34	39		
Co-worker Support* **				
High	55	82	4.106	0.043*
Low	9	4		
			***Phi and Cramer's V Value = 0.165	
Supervisor Support				
High	50	70	0.245	0.630
Low	14	16		
Job Insecurity				
High	37	44	0.653	0.419
Low	27	42		
Job Strain				
Yes	34	30	2.281	0.131
No	35	51		

[a]*Chi-square*
**p-value is significant at 0.05 level*
***p-value is significant at 0.001 level*

Based on Table 4.10.3.6, there was no significant association between all psychosocial factors (job demands, job decision latitude, co-worker support, supervisor support, job insecurity and job strain) with allergy to animal, dust and feathers.

Table 4.10.3.6: Association between job strain and psychosocial factors with allergy to animal, dust and feathers

Variables[a]	Allergy to animal, dust and feathers (N=150)			
	Yes	No	χ^2	*p*-value
Job Demands				
High	11	80	0.490	0.484
Low	5	54		
Job Decision Latitude				
High	10	67	0.849	0.344
Low	6	67		
Co-worker Support				
High	16	121	1.700	0.362
Low	0	13		
Supervisor Support				
High	14	106	0.630	0.740
Low	2	28		
Job Insecurity				
High	8	73	0.115	0.734
Low	8	61		
Job Strain				
Yes	7	9	0.037	0.848
No	62	72		

[a]Chi-square
**p-value is significant at 0.05 level*
***p-value is significant at 0.001 level*

Based on Table 4.10.3.7, there was no significant association between all psychosocial factors (job demands, job decision latitude, co-worker support, supervisor support, job insecurity and job strain) with smoking status.

Table 4.10.3.7: Association between job strain and psychosocial factors with smoking status

Variables[a]	Smoking status (N=150)			
	Yes	No	χ^2	*p*-value
Job Demands				
High	50	41	0.482	0.488
Low	29	30		
Job Decision Latitude				
High	45	32	2.117	0.146
Low	43	39		
Co-worker Support				
High	74	63	1.152	0.283
Low	5	8		
Supervisor Support				
High	64	56	0.107	0.744
Low	15	15		
Job Insecurity				
High	39	42	1.442	0.230
Low	40	29		
Job Strain				
Yes	34	45	0.590	0.443
No	35	36		

[a]Chi-square
**p-value is significant at 0.05 level*
***p-value is significant at 0.001 level*

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CHAPTER 5

DISCUSSION

This chapter reviews and discuses about the contributing factors of independent variables of socio-demographic information, working characteristics, vehicular air pollution ($PM_{2.5}$), job strain and psychosocial factors on dependent variables of pulmonary function and respiratory symptoms among respondents. The data collections were conducted from January 2018 to April 2018 among Dewan Bandaraya Kuala Lumpur (DBKL) staffs which consists of 75 traffic wardens and 75 administration staffs. All data collected were analysed by using SPSS (Statistical Package for Social Science) Version 22.

5.1 The respondents background

The respondents recruited in this study was in balance proportion in order to minimize variability between two groups. The traffic wardens conducted traffic control task as a collaborative effort with Royal Malaysian Police in accordance to manage heavy traffic in the city centre of Kuala Lumpur especially at peak hours (morning, lunch hour, evening). The inclusion criteria were male traffic wardens and administration staffs must have been working or employed by DBKL for more than 1 year while the exclusion

criteria were male traffic wardens and administration staffs who already diagnosed with respiratory diseases such as asthma and other related diseases prior to their current occupation.

Majority of the respondents were Malay followed by Indian with age ranged from 23-59 years old. The mean body mass index (BMI) of exposed group was 25.6 ± 3.64 while 25.8 ± 3.65 which classified both groups into overweight class. According to CDC (2015), people who weight more than ideal weight are at risk for many chronic and serious diseases and health conditions which eventually can cause death. Examples of chronic diseases includes hypertension, breathing problems and lowering the quality of life. The majority income of respondents were between RM 2,000 – RM 3,000 with 2-4 numbers of dependence. Regarding to Central Bank of Malaysia Annual Report (2017), the estimated provisional living wage in Kuala Lumpur for year 2016 were RM 2,700 for single adult, RM 4,500 a couple without children and RM6,500 with two children. For working characteristics, the exposed group worked in shift mode outdoor while most of the non-exposed group worked in normal mode indoor. More respondents in exposed group reported overtime work compared to non-exposed group.

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5.2 The prevalence of job strain, respiratory symptoms and vehicular air pollution ($PM_{2.5}$) exposure level

The prevalence of job strain among exposed (traffic wardens) and non-exposed (administration staffs) group were 42.7% and 49.3% respectively. These figure was lower than those found by Marsilamani et al. (2013) who reported that the prevalence of job strain among Malaysian police personnel in Kuala Lumpur was 38.8%. When com-pared to this study, exposed group (traffic warden) posed higher prevalence than the previous findings. This inconsistence may due to the long hours of working (10 hours) among traffic warden compared to the traffic personnel. The present findings also showed that the non-exposed group had high job strain compared to the exposed group. This result can be explained due to static movement in the office, high workloads in the office, documentation dateline and prolonged sitting at workspace area in extended hours. However, the exposed group was more prevalent to report respiratory symptoms which were cough (53.3%) and phlegm (54.7%) compared to non-exposed group due to high exposure to vehicular air pollution ($PM_{2.5}$) during working period.

In addition, the vehicular air pollution ($PM_{2.5}$) exposure level for exposed group ($65.30 \pm 7.76 \mu g/m^3$) were corresponding with the long hours working shift in outdoor environment and relatively higher compared to non-exposed group ($24.60 \pm 7.91\ \mu g/m^3$). This reading was not exceeded the latest Malaysia Ambient Air Quality Standard by Department of Environment which was 75 $\mu g/m^3$. However, the exposure reading of exposed group exceeded the National Ambient Air Quality Standard (NAAQS) by US Environmental Protection Agency which was 35 $\mu g/m^3$ for 24 hours.

5.3 The association between socio-demographic information with pulmonary function and respiratory health

This study found significant correlation between age and body mass index (BMI) with pulmonary function parameters among respondents. Fragoso & Gill (2011) mentioned that in adult life span, there will be a reduction in physio-logical capacity which includes respiratory muscle strength, ventilatory control (control of breathing), gas exchange (ventilation-perfusion rate) and respiratory mechanics (air flow limitation). Lowery et al. (2013) also stated that there are many age-related changes in respiratory system. The changes include the volume reduction of thoracic cavity, decreased lung volumes, and modification of respiratory muscles which aid breathing process. The function on a cellular level of respiratory system in the aging population is less efficient compared to young population.

As body mass index (BMI) was correlated with pulmonary function, Littleton (2011) supported that overweight and obesity has been significantly associated with respiratory function. The study suggested that weight loss may lead to the reversal from abnormal to normal respiratory function. The result of this study was similar to Chlif (2009) who conducted a study of pulmonary function among obese population with comparative group. The results showed that the spirometric value of predicted FEV_1 and predicted FVC were significantly lowers in obese population compared to other group ($p<0.001$).

Besides pulmonary function, the Body Mass Index (BMI) also showed a significant association with one of respiratory symptoms which was shortness of breath. Currow et al. (2017) stated that the key factors leading to individual sensation of shortness of breath includes respiratory, cardiovascular and neuromascular disorders. The latent cause to respiratory disorder was found due to smoking. However, in this study it is revealed that there was no association between BMI and smoking status. The study also added that to improve breathlessness, lung volumes, and muscle strength, there was a need to lose weight. Thus, this verify the relationship of obesity/overweight with breathlessness. The authors further explained that obesity can cause various adverse effect to respiratory system and eventually can cause decrease in total lung capacity, reduction of lung compliance and increase probability of sleep disorder breathing.

There was a significant association between races with smoking found in this study. This can be explained due to most of the respondents in this study were Malay and 79 out of 150 total respondents reported that they were smoking which eventually supported that the relationship become significant.

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The association between working characteristics with pulmonary function and respiratory symptoms

Based on analysis of mean difference, it showed that there were significant difference of working hour (t= 23.30, p<0.001), overtime work (t= -6.661, p<0.001) and overtime frequency (t= -6.093, p<0.001) between exposed and non-exposed groups but no significant difference of employment period among them. This is due to the independent samples were selected which comprised of traffic wardens and administration staffs. They have different working hour and the needs of overtime in their task.

As for working characteristics, employment period and working hour with pulmonary function were discovered to be correlated in this study. The longer the employment period and working hour, the higher the level of air pollution that can be inhaled by the exposed group. The result of the present study is supported by Nie et al. (2015) who demonstrated that long working hours have detrimental effect on self-reported health. In addition, Gotshi et al. (2008) also stated that long term exposure to air pollution particularly to exposure to susceptible population and the comparisons of the findings with those of other studies they referred to, confirmed that chronic exposure to air pollution have been associated with respiratory health problem. Lung function was the one of interest objective to measure of respiratory health and act as early predictor of pulmonary morbidity and mortality.

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The present study also discovered significant association between working characteristics (work location, working hour and working shift) and respiratory symptoms (cough and phlegm) among respondents. These results were parallel to those reported by Ingle et al. (2005) who conducted a study on vehicular pollution exposure among traffic policemen in Jalgaon City, India. They also stated that functional impairment of lung to have undeviating association with pollutants concentration and duration of exposure which chronic exposure to air pollutants can cause respiratory problem. Their study concluded that traffic police with working period more than 10 years showed higher prevalence of respiratory symptoms and reduction of lung function compared to traffic police who worked less than 10 years while 40% of traffic policemen reported suffering from frequent coughing. Another study in India by Gupta et al. (2011), traffic policemen as the exposed group who worked more than 8 years showed significant reduction in pulmonary function parameters such as forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) compared to traffic policemen who worked less than 8 years. . This results indicated that the increase in the duration of exposure will increase the likelihood of the occurrence of respiratory symptoms.

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5.5 The association between vehicular air pollution (PM2.5) exposure with pulmonary function and respiratory symptoms

A significant difference between vehicular air pollution level ($PM_{2.5}$) exposure was found among exposed and non-exposed group at $p<0.001$. The result for vehicular air pollution level ($PM_{2.5}$) among exposed group showed varied concentration level prior to the work task. For clarification, the exposed group were worked in shift mode and divided into several duties which were tidal flow control and point duty control. For tidal flow control, the team started their task as early as 6.00 am and start controlling heavy traffic at Loke Yew area at 6.45 am. After 9.00 am, they started their task at city centre such as issuing compound to the traffic offenders until the end of their shift.

Due to very mobile task, high concentration of vehicular air pollution 68.4 $\mu g/m^3$ was recorded for tidal flow control team. Similar to the point duty control, the team conduct their task at the junction of city centre and started their task as early as 8.00 am for morning shift while 3.00 pm for afternoon shift. The work tasks were almost similar to tidal flow control which started with traffic controlling and issuing traffic compound to offenders. Based on the results, the readings were observed to be high concentration at 70.9 $\mu g/m^3$ for morning shift whereas 52.2 $\mu g/m^3$ for afternoon shift.

The high concentration of vehicular air pollution level ($PM_{2.5}$) was parallel with the report from Department of Statistics (2017) which stated that population of Malaysia is increasing that lead to the increment in vehicles ownerships as well as road network to

ease mobility. According to Road Transport Department (2015), the top most of total number of motor vehicles by state in Malaysia were highest in Kuala Lumpur (6,117,938 millions) followed by Johor (3,478,959 millions), Selangor (2,779,732 millions) and Pulau Pinang (2,556,735 millions). Department of Statistics, Malaysia (2015) also analysed the main sources of pollutants to the atmosphere in Malaysia were majority from mobile vehicles (70%) followed by power plant (24.3%), industrial (2.8%) and other (2.9%). Thus, this shown that high numbers of motor vehicles in Kuala Lumpur acted as the major factor which promote to the deterioration of air quality.

The measured vehicular air pollution ($PM_{2.5}$) in this study was found to be higher compared to a study conducted to a comparison study among traffic policemen and general police in Kuala Lumpur by Muhammad et al. (2012) which only recorded 22.33 ± 5.70 $\mu g/m^3$. Putri et al. (2016) also conducted a study among traffic policemen of Point Duty Department in Malaysia specifically in Kuala Lumpur and Johor Bahru. The result of the study shown that traffic policemen in Kuala Lumpur exposed to 27.20 ± 11.90 $\mu g/m^3$ whereas in Johor Bahru exposed to 30.40 ± 9.90 $\mu g/m^3$. Another occupations that also exposed to vehicular air pollution ($PM_{2.5}$) were roadside hawkers and postmen. A study of roadside hawkers and its comparative group of hawkers nearby housing area by Siti , Emilia & Irniza (2016) found that the roadside hawkers were exposed to high amount of $PM_{2.5}$ with 31.05 $\mu g/m^3$ concentration compared to 19.41 $\mu g/m^3$ exposure to comparative group.

The present study discovered that the vehicular air pollution level ($PM_{2.5}$) was correlated with pulmonary function. This findings were consistent with a study by Sayyad et al. (2013) which carried out a comparative study between 50 traffic police as exposed group and 50 adult male as control in India. The results showed that there were significant decrease of pulmonary function parameters FVC, FEV_1 and FEV_1/FVC in the exposed group. The mean values of FEV_1 of the traffic policemen were significantly lower than the control group was 3.29 ± 0.5 L whereas 3.43 ± 0.5 L for control group at $p<0.01$.

This study discovered the relationship between exposure to vehicular air pollution ($PM_{2.5}$) with the occurrence of respiratory symptoms (cough and phlegm). Muhammad et al. (2012) found the consistent findings as the most reported respiratory symptoms among traffic policemen who exposed to air pollution in Kuala Lumpur was phlegm. Another evidence by Karita et al. (2014) on the exposure of air pollution to traffic policemen and their wives as non-exposed group which found undeviating result as present study which showed the vehicular air pollution ($PM_{2.5}$) was associated with the development of respiratory symptoms. The traffic policemen reported higher prevalence of frequent phlegm (30.95%) and frequent coughing (18.3%) than non-exposed group. A comparative study among roadside hawkers and comparative group to traffic related air pollution by Siti , Emilia & Irniza (2016) also reported that respiratory symptoms (cough, phlegm, chest tightness and wheezing) were significantly associated with exposure to $PM_{2.5}$ ($p<0.05$).

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5.6 The association between job strain and psychosocial factors with pulmonary function and respiratory symptoms

The present study found that there were no significant correlation between psychosocial factors (job demands, job decision latitude, co-worker support, supervisor support, job insecurity and job strain) with all pulmonary function parameters (FVC, FEV1, %FEV_1/FVC, predicted FVC, predicted FEV_1 and predicted %FEV_1/FVC) among respondents. The relationship between psychosocial and pulmonary function were inconclusive due to limited literature review among the topics. However, Suglia (2011) observed notable association between psychosocial stressor and lung function among childhood. But, these findings cannot be extrapolated to adult population due to physical and physiological variability between adult and children.

This study delineated association between psychosocial factors and respiratory symptoms as there was a significant association between supervisor support with shortness of breath and no significant association between other psychosocial factors (job demands, job decision latitude, co-worker support, job insecurity and job strain) with shortness of breath. Runeson-Broberg and Norback (2014) outlined in order to understand the association between stress and respiratory diseases, there is the need to take into consideration of individual socio-demographic factors, psychosocial factors, behaviour and personality factors that can contribute to the vulnerability and severity of respiratory infection. His study described that person who have low support and control, low skills discretion, low decision making authority and low supervisor support were associated with frequent respiratory infections. Men with low work control, low social support and low

supervisor support were associated with frequent respiratory infection. Garbarino (2014) also stated that personality factors such as low emotional stability may alleviate or escalate the strain induced by environmental stressors.

Work is seen as a source of psychosocial stress which can be measured through demand-control-support model (DCS). The DCS were incorporated of high demands, low control and low social sup-port make up the occurrence of psychosocial stress. Their study described that person who have low support and control, low skills discretion, low decision making authority and low supervisor support were associated with frequent respiratory infections. They added that men with low work control, low social support and low supervisor support were associated with frequent respiratory infection.

Sloan (2011) mentioned that communication with others at workplace can affect employees' well-being. The relationship between co-workers interaction and support improved individual job performance, satisfaction and well-being. Bakker (2014) state that Job Demands-Resources studies depicted that the best job performance of employees were seen in demanding and resourceful work environment, since that work environment triggered their work engagement. Nielson et al (2008) recommended that management level can affect employees' job demands and resources which obliquely influence their performance. Kalidass and Bahron (2015) expressed that a good employee-supervisor relationship has the power to minimize the job insecurity among employee in order to achieve the principal organizational goals.

Pressman and Cohen (2005) also reported that the interruption of a disease-causing agent into the body is not an ample cause for disease. The incapability of immune system to recognize the foreign material triggered disease to occur. Herbert & Cohen (1993) signified that psychological stress could modify immune response in humans which lead to the development of respiratory symptoms.

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CHAPTER 6

CONCLUSION, LIMITATION AND RECOMMENDATION

6.1 Conclusion

In general, road traffic is one of the major source of the air pollution in Malaysia. Traffic congestion accelerates vehicular air pollution ($PM_{2.5}$) level and reduced air quality. The results from this study showed that the exposed group (traffic warden) were exposed to high level of vehicular air pollution ($PM_{2.5}$) which reported more prevalent of respiratory symptoms and reduction of pulmonary function compared to non-exposed group (administration staffs). This study revealed socio-demographic information (age and BMI), working characteristics (employment period and working hour) and vehicular air pollution ($PM_{2.5}$) were associated in the reduction of pulmonary function and the report on respiratory symptoms of respondents consistent with previous study. However, no association found between psychosocial factors with the reduction of pulmonary function. For psychosocial factors, only supervisor support and co-worker support were associated with respiratory symptoms.

6.2 Limitation

This study is a cross-sectional study design which conducted in short period of time and only allow the data collection of exposure and health effect at the same time. Thus, this study design is not really suitable especially to assess causal relationship between factors and its outcome as most outcome takes some period of time to develop. This study only assesses on respiratory symptoms, pulmonary function and personal exposure level to vehicular air pollution ($PM_{2.5}$) among population. The determination of real personal exposure level to vehicular air pollution ($PM_{2.5}$) is difficult due to shift work and mobile nature of duty. The measurement of personal exposure level to vehicular air pollution ($PM_{2.5}$) is limited due to time and equipment constraints which do not cover overall area of working locations between exposed group.

The weather condition is the major limitation for vehicular air pollution ($PM_{2.5}$) sampling as the results are more likely to be a bit low after raining compared to the results for sunny day. This study is lacking of control to respondent bias which can affect the participants' responses either away from the actual or truthful response. In order to overcome, it is good to conduct simple interview session to ensure the accuracy of responses. Other than that, recall bias among respondents especially during answering respiratory symptoms in questionnaire provided.

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6.3 Recommendation

For future study, a longitudinal study design more likely to be suitable to oversee cause-and-effect relationship as most of respiratory symptoms and disorders takes time to develop in human. The increment of study respondents also can help to increase the power of study. It is recommended to broaden the area of sampling location by comparing between two different municipal area such as Johor Bahru and Kuala Lumpur to gain more accurate and representative data. The use of air sampling pumps and filter cassette are encouraged to be use in future study as the method of air collection by using gravimetric method to track the difference between these two equipment whereas this study only used photometric method.

Besides pulmonary function test and reporting of respiratory symptoms, there are several method to determine respiratory illness which includes;

- Pulse oximetry – a direct reading and non-invasive method to monitor amount of oxygen in blood equipment. It is possible to detect abnormalities of ventilation in respiratory function.
- Blood test – detection of specific organism that can cause respiratory problems and doctors can use blood cultures to test for bacteria present in blood.

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As for recommendation to the management, the administration can use several ways in order to increase awareness and knowledge of traffic wardens regarding the exposure to vehicular air pollution ($PM_{2.5}$) during working hour. For example, the first step is to conduct periodical medical check-up for all of traffic wardens and observed thee trend of any results obtained from the medical check-up session for further action. Next, administration officer who arranged the job schedule should first identify the condition of duty location. The arrangement of duty location should be classified into heavy traffic (more polluted), moderate traffic (moderately polluted) or less traffic (less polluted). The locations were encouraged to be rotated from more polluted area to less polluted area or vice versa as to reduce the frequency of exposure towards the high vehicular air pollution ($PM_{2.5}$) level.

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APPENDIX 1:
ETHICAL APPROVAL

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APPENDIX 2:
APPROVAL LETTER

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APPENDIX 3:
CONSENT FORM

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BORANG 2.4: PENERANGAN DAN PERSETUJUAN RESPONDEN

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1.TAJUK KAJIAN

Hubungan antara Tahap Pendedahan Pencemaran Asap Kenderaan (PM2.5) dan Prevalen Tekanan Kerja dengan Kesihatan Pernafasan dalam Kalangan Pekerja Perbandaran di Kuala Lumpur

2. PENGENALAN

Perbandaran dan pemodenan di Kuala Lumpur telah menyebabkan pertambahan peluang pekerjaan bagi rakyat Malaysia. Pertambahan bilangan kenderaan bermotor juga dilihat menyumbang kepada pencemaran udara setempat. Warden trafik merupakan antara individu yang berpotensi untuk terdorong kepada gejala pernafasan kerana kebanyakan aktiviti pekerjaan mereka adalah di luar bangunan. Selain itu, terdapat juga pelbagai faktor psikososial di tempat kerja yang boleh memberikan kesan kepada tahap kesejahteraan individu. Kajian ini bertujuan untuk menentukan faktor psikososial dan pendedahan pencemaran udara kendaraan ($pm_{2.5}$) dengan gejala pernafasan antara pekerja perbandaran di kuala lumpur.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Anda perlu menjawab soalan kaji selidik yang terdiri daaripada empat (4) bahagian yang berkaitan maklumat sosio-demografi, kriteria pekerjaan, faktor psikososial dan gejala pernafasan.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Warden trafik dan bukan warden trafik yang mempunyai masalah atau penyakit berkaitan pernafasan seperti lelah.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Faedah yang boleh diperolehi oleh peserta dalam kajian ini adalah peserta dapat membantu untuk membuktikan pekerjaan mereka mempunyai risiko yang tinggi terhadap pendedahan pencemaran udara kenderaan ($PM_{2.5}$). Selain itu, peserta juga akan membantu untuk memperbaiki persekitaran pekerjaan ke arah yang lebih selamat.

b) KEPADA PENYELIDIK?

Data-data yang dikumpul daripada kajian ini akan digunakan sebagai data asas untuk kajian di masa hadapan. Di samping itu, pengetahuan baru akan diperoleh mengenai faktor psikososial dan pendedahan pencemaran udara kendaraan ($PM_{2.5}$) dengan gejala pernafasan antara pekerja perbandaran yang terdiri daripada warden trafik di kuala lumpur.

6. ADAKAH IA BERISIKO?

Proses kajian ini tidak berisiko bahaya kepada pekerja. Pekerja hanya dinilai melalui soalan kaji selidik dan ujian fungsi paru-paru. Pendedahan terhadap pencemaran udara akan menggunakan alat pemantauan kualiti udara.

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Ya kerana semua maklumat akan kekal sebagai sulit. Keputusan serta dapatan kajian yang terperinci jugak tidak akan didedahkan kecuali peserta itu sendiri.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN INI?

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Nota: Peserta boleh menarik diri daripada penyertaan pada bila-bila masa tanpa sebarang penalti daripadan pihak penyelidik. Kajian ini merupakan kajian secara sukarelawan daripada peserta.

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini

_____

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9. PERSETUJUAN

Saya..... No Kad Pengenalan. .....
beralamat.....
.....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan saya.

Saya setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan ..... Tandatangan .....
(*Responden*) (*Saksi*)

Tarikh :..... Nama :.....

No. K/P: .....

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh ..... Tandatangan .....
(*Penyelidik*)

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APPENDIX 4:
QUESTIONNAIRE

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Department of Environmental and Occupational Health

Faculty of Medicine and Health Sciences

Universiti Putra Malaysia

Title

The Association between Vehicular Air Pollution ($PM_{2.5}$) Exposure Level and The Prevalence of Job Strain with Respiratory Health among Municipal Workers in Kuala Lumpur

Questionnaire Instruction

This questionnaire contains five sections;

1. **Section A**: Sociodemographic information
2. **Section B**: Working Characteristics
3. **Section C**: Psychosocial factors
4. **Section D**: Respiratory symptoms

Respondent required to answer all questions in this book and please mark your answer on the boxes provided. Answers will be private and confidential, only for study purpose.

Please return this questionnaire booklet to researcher upon completion (Puteri Natasha Arina – 012 6292237).

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Section A: Socio-demographic information

1	Age *Umur*		Years old/*tahun*
2	Gender *Jantina*		Male/*lelaki*
			Female/*perempuan*
3	Marital status *Status perkahwinan*		Single/*belum berkahwin*
			Married/*berkahwin*
			Divorced/*bercerai*
4	Height/Weight *Tinggi/Berat*		cm
			kg
5	BMI *BMI*		Underweight/*kurang berat*
			Normal/*normal*
			Overweight/*berat berlebihan*
			Obese/*obes*
6	Ethnic background *Kaum*		Malay/*melayu*
			Indian/*india*
			Chinese/*cina*
			Others/*lain-lain*:_____
7	Educational level *Tahap pendidikan*		Not attending school/*tidak bersekolah*
			Primary/*Sekolah rendah*
			Secondary/*menengah*
			Diploma/Degree /*Diploma/ijazah*
8	Total income *Jumlah pendapatan*		More than RM 4,001 / *lebih dari RM 4,001*
			RM 3,001 – RM 4,000 / *RM 3,001 – RM 4,000*
			RM 2,001 – RM 3,000 / *RM 2,001 – RM 3,000*
			Less than RM 2,000 / kurang dari RM 2,001

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9	Number of dependence *Bilangan tanggungan*		≤ 1 person / ≤ 1 orang
			In between 2-4 persons / antara 2-4 orang
			5 persons or more / 5 orang dan lebih

9	Transport to workplace *Pengangkutan*		Public transport/*kenderaan awam*
			Motorcycle/*motorsikal*
			Car/*kereta*

Section B: Working characteristics

1	Position *Jawatan*				
2	Work Task Description *Huraian tugas*				
3	Work Location *Tempat Kerja*		Indoor (dalam)		Hours (jam)
			Outdoor (luar)		Hours (jam)

4	Employment period *Tempoh pekerjaan*		Years/*tahun*
5	Days work per week *Jumlah hari bekerja seminggu*		Days/*hari*
6	Working hour per day *Jumlah jam bekerja sehari*		hours(jam)
7	Work Shift *Giliran kerja*		Normal
			Shift

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8 **Overtime Work**

Kerja lebih masa

	Yes
	No

If yes, how frequent you did overtime?

Jika ya, berapa kerap anda kerja lebih masa?

	< 3 times per month/ *< 3 setiap bulan*
	4 to 6 times per month/ *4 hingga 6 kali sebulan*
	> 6 times per month/ *> 6 kali sebulan*

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Section C: Psychosocial factors

Please choose the most suitable answer accordingly to your job.

strongly disagree/ *Sangat tidak setuju*	disagree/*tidak setuju*	Agree/ *setuju*	strongly agree/ *sangat setuju*
1	2	3	4

1	My job requires that I learn new things *Pekerjaan saya memerlukan saya mempelajari perkara baru.*	1	2	3	4
2	My job involves a lot of repetitive work *Pekerjaan saya melibatkan kerja yang berulang-ulang.*	1	2	3	4
3	My job requires me to be creative *Pekerjaan saya memerlukan kreativiti.*	1	2	3	4
4	My job allows me to make a lot of decisions on my own *Pekerjaan saya membenarkan saya membuat keputusan sendiri.*	1	2	3	4
5	My job requires a high level of skill *Pekerjaan saya memerlukan kemahiran yang tinggi.*	1	2	3	4
6	On my job, I am given a lot of freedom to decide how I do my work *Semasa bekerja, kebebasan saya membuat keputusan sendiri adalan amat terbatas.*	1	2	3	4
7	I get to do a variety of things on my job *Semasa bekerja, saya berupaya melakukan berbagai perkara yang berbeza-beza.*	1	2	3	4
8	I have a lot to say about what happens on my job *Saya mempunyai hak untuk menentukan pekerjaan saya*	1	2	3	4
9	I have an opportunity to develop my own special abilities *Saya berpeluang untuk mengembangkan kebolehan saya.*	1	2	3	4
10	My job requires working very fast *Pekerjaan saya memerlukan saya bekerja dengan sangat pantas.*	1	2	3	4
11	My job requires working very hard *Pekerjaan saya memerlukan saya bekerja bersungguh-sungguh.*	1	2	3	4
12	My job requires lots of physical effort	1	2	3	4

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	Pekerjaan saya memerlukan kekuatan fizikal yang banyak.				
13	I am not asked to do an excessive amount of work *Saya tidak diminta/disuruh untuk melakukan kerja-kerja secara berlebihan.*	1	2	3	4
14	I have enough time to get the job done *Saya mempunyai masa yang cukup untuk menyudahkan kerja saya.*	1	2	3	4
15	I am free from conflicting demands others make *Saya bebas daripada tekanan-tekanan yang dibuat oleh orang lain.*	1	2	3	4
16	My job security is good Harapan saya untuk dinaikkan pangkat dan *mempertingkatkan kerjaya saya adalah cerah.*	1	2	3	4
17	People I work with are competent in doing their jobs *Rakan-rakan sekerja saya berkemampuan dalam melakukan kerja mereka.*	1	2	3	4
18	People I work with take a personal interest in me *Rakan-rakan sekerja mengambil berat tentang saya.*	1	2	3	4
19	People I work with are friendly *Rakan-rakan sekerja saya adalah peramah.*	1	2	3	4
20	People I work with are helpful in getting the job done *Rakan-rakan sekerja saya membantu bagi memastikan kerja-kerja disiapkan.*	1	2	3	4
21	My supervisor is concerned about the welfare of those under him *Majikan saya mengambil berat mengenai kebajikan orang bawahannya*	1	2	3	4
22	My supervisor pays attention to what you are saying *Majikan saya memberikan perhatian terhadap apa yang saya katakan*	1	2	3	4
23	My supervisor is helpful in getting the job done *Majikan saya memberi bantuan dalam memastikan kerja-kerja dapat disiapkan.*	1	2	3	4
24	My supervisor is successful in getting people to work together *Majikan saya berjaya mengajak orang lain bekerja bersama-sama.*	1	2	3	4

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Regular and steady / *tetap*	Seasonal / *Sementara*	Frequently layoffs / *kerap berhenti*	Both seasonal and frequent layoffs / *sementara dan kerap berhenti*	Other / *lain-lain*
1	4	4	4	9

25	How steady is your work? *Berapa stabilkah kerja anda?*	1	4	4	4	9

Never / Tidak *pernah*	Face possibility once / *pernah sekali*	Face possibility more than once / *pernah lebih sekali*	Actually constant / *sentiasa*	Laid off / *tidak bekerja*
1	2	3	4	5

26	During the past year, how often were you in a situation where you faced job loss or layoff? Pada tahun lepas, berapa kerapkah anda berada dalam keadaan situasi dimana anda menghadapi kehilangan pekerjaan atau tidak bekerja?	1	2	3	4	5

Not at all likely / sangat tidak setuju	Not too likely / tidak setuju	Somewhat likely / setuju	Very likely / sangat setuju
1	2	3	4

27	Sometimes people permanently lose jobs they want to keep. How likely is it that during the next couple of years you will lose your present job with your employer? *Kadangkala seseorang itu hilang pekerjaan tetap mereka. Adakah kemungkinan anda akan kehilangan pekerjaan anda sekarang dalam beberapa tahun lagi?*	1	2	3	4

Section D: Respiratory Symptoms/Gejala Pernafasan

Please tick (√) for your answer in the space provided.

Wheezing / *Dada berbunyi*		**Yes**	**No**
1	Have you had wheezing or whistling in your chest, at any time in the last 12 months? *Adakah anda terasa dada anda berbunyi pada bila-bila masa dalam jangka masa setahun lepas?*		
2	If yes, for how long this condition occurred? *Jika ya, sudah berapa lama keadaan ini berlaku?*		Bulan (month) / tahun (years)
Chest tightness / Sesak dada		**Yes**	**No**
3	Have you woken up with a feeling of tightness in your chest first thing in the morning, at any time in the last 12 months? *Adakah anda terasa dada anda sesak setelah bangun pagi pada bila-bila masa dalam jangka masa setahun lepas?*		
4	If yes, for how long this condition occurred? *Jika ya, sudah berapa lama keadaan ini berlaku?*		Bulan (month) / tahun (years)
Shortness of breath / Kesukaran bernafas		**Yes**	**No**
5	Have you, at any time in the last 12 months, had an attack of shortness of breath that came on during the day when you were not doing anything strenuous? *Adakah anda pernah diserang kesukaran bernafas semasa hari yang anda tidak berbuat apa-apa?*		
6	Have you had an attack of shortness of breath that came on after you stopped exercising, at any time in the last 12 months? *Adakah anda pernah diserang kesukaran bernafas selepas berhenti melakukan senaman pada bila-bila masa dalam jangka masa 12 bulan lepas?*		
7	Have you, at any time in the last 12 months, been woken at night by an attack of shortness of breath? *Dalam jangka masa 12 bulan lepas, adakah anda pernah terjaga malam kerana diserang kesukaran bernafas?*		

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Cough / Batuk		**Yes**	**No**
8	Have you, at any time in the last 12 months, been woken at night by an attack of coughing? *Dalam jangka masa 12 bulan lepas, adakah anda pernah terjaga malam kerana diserang batuks?*		
9	Do you usually cough first thing in the morning? *Adakah anda kerap batuk di permulaan pagi anda?*		
Phlegm / Kahak		**Yes**	**No**
10	Have you frequently had phlegm? *Adakah anda kerap mempunyai kahak?*		
11	Do you usually bring up phlegm from your chest first thing in the morning? *Adakah anda selalunya mengeluarkan kahak di permulaan pagi anda?*		
Allergy to animals, dust and feathers		**Yes**	**No**
12	When you are in a dusty part of the house or with animals (for instance, dogs, cats or horses) or near feathers (including pillows, quilts and eiderdowns) do you ever: *Apabila anda berada dalam keadaan berhabuk di rumah atau bersama haiwan (seperti anjing, kucing atau kuda) atau berdekatan dengan bebulu (termasuk bantal, selimut, tilam), adakah anda pernah:*		
	(a) Get a feeling of tightness in your chest? *Berasa sesak/ketat pada bahagian dada*		
	(b) Start to feel short of breath? *Mula berasa pendek nafas*		
Smoking Status		**Yes**	**No**
13	Have you ever smoked for as long as a year? *Adakah anda pernah merokok sepanjang setahun ini?*		
14	Do you now smoke: *Anda masih merokok:*		
	Not at all (Proceed to question 16) / *Tidak sama sekali*		
	Occasionally / *kadang-kadang*		
	Daily / *Setiap hari*		
15	What do (did) you usually smoke? *Apakah yang biasanya anda merokok?*		
	Commercial / Ready-made cigarettes: _____(brand) *Rokok komersial / siap sedia*		
	Hand rolled cigarettes / *rokok yang dibuat sendiri*		
	Pipe / *Paip*		
	Vape / *Vape*		

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16	**If you have given up smoking altogether, how long is it since you last gave up smoking?** ***Adakah anda telah berhenti merokok, bila kali terakhir anda merokok?***	
	Less than a month ago / ***Kurang sebulan lepas***	
	More than a month ago / ***Lebih sebulan lepas***	

THANK YOU ☺

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