UNIVERSITI PUTRA MALAYSIA

ASSOCIATION BETWEEN THE EXPOSURE TO AIR POLLUTANTS WITH RESPIRATORY HEALTH SYMPTOMS AMONG COMMERCIAL BUS DRIVERS IN KELANTAN

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SERDANG, SELANGOR

2020/ 2021

ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful,

First and foremost, my profound gratitude goes to the Almighty Allah for granting His blessing, good health, plentiful time, and great vitality in completing my Bachelor's Degree journey. His grace was sufficient for me. I would like to shows my gratitude to many people who had been there with me through ups and downs during the process of completing this research.

My sincere appreciation goes to my honourable supervisor, Prof. Dr. Juliana Jalaludin for the advice, guidance, encouragement, and being patient with me. Thank you for sharing your knowledge and expertise in the field and I appreciate it.

My special thanks to Mrs. Nur Faseeha Suhaimi for helping and guiding me in my research and also sharing her useful knowledge in completing my study. I would like to give my profound gratitude to all the respondent for their time and willingness in completing the questionnaire.

Furthermore, for all my friends who have been kept supporting each other through thick and thin, helping me in data collection, and motivate me every time. I cannot thank you enough for your time and advice. May Allah reward you abundantly.

Lastly, not to forget my beloved family members who were my pillar of support, praying to God for my success, and motivating me to complete my degree; my dad Ayub Bin Mohamed Jaafar, my mom Zainuna Binti Omar and also my dearest brother and sister. Also, thank you to everyone who helped me with my research, whether directly or indirectly. May Allah bless you with endless happiness and success.

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BY

ZHAFIR ADAM BIN AYUB

Introduction: Air pollution is no longer an odd issue for us to listen up, raising up or fighting up. Without having a deep sense of concern and having high hypocrisy, we are facing two huge problems, which are environmental health and our health as human being. It is typically divided into two categories which are indoor pollution and outdoor pollution. Apparently, most people are aware enough of man-made outdoor air pollution such as emission of contaminated substances into the air from industries and vehicles or traffic air pollution (TRAP). However, TRAP also can be dangerous by penetrating into the vehicle cabin affects indoor air quality. **Objective:** To study the association between working history and respiratory health symptoms among the bus drivers in Kota Bharu. **Methodology:** Focusing on the respiratory effects towards the exposure of air pollutants, 51 bus drivers and 51 administrative staffs (comparative group) aged 20 to 56 years old who operate the public bus in Kota Bharu area will be selected. Purposive sampling method will be used to fulfil the inclusive criteria for both groups. The respondents will be given a questionnaire based on American Thoracic Society (ATS-DLD-78-A). After that, measuring of air pollutants inside the bus cabin will be conducted based on main parameter ($PM_{2.5}$, CO_2 and NO_2). All the data collected from questionnaires were analysed by using Statistical Package for Social Sciences Software (SPSS). **Results:** There was a significant difference in age and educational level for both groups. Besides, there was a significant difference in duration years of working between these two groups. Next, there was a significant difference in respiratory health symptoms of cough, phlegm and chronic phlegm between the study groups. Furthermore, there was a significant difference in level of pollutant ($PM_{2.5}$, CO_2 and NO_2) between morning and afternoon in five days of sampling. Lastly, cough, phlegm and chronic phlegm had an association with the working history of the respondents (years).

Keywords: respiratory symptoms, indoor air pollutant, bus cabin, working history (years)

HUBUNGAN ANTARA PENDEDAHAN PENCEMARAN UDARA DENGAN SIMPTOM KESIHATAN PERNAFASAN DI KALANGAN PEMANDU BAS KOMERSIAL DI KELANTAN

OLEH

ZHAFIR ADAM BIN AYUB

Latarbelakang: Pencemaran udara bukan lagi satu isu yang asing untuk didebatkan. Malah kesihatan persekitaran dan juga kesihatan kita sebagai seorang manusia adalah dua masalah utama yang berpunca daripada tiadanya sifat keprihatinan dalam diri masing-masing. Ia biasanya terbahagi kepada dua kategori iaitu pencemaran dalaman dan pencemaran luar. Kebiasaannya, kebanyakan orang cukup memahami pencemaran udara luar buatan manusia seperti pelepasan bahan tercemar ke udara dari industri dan pencemaran udara lalu lintas (TRAP). Walau bagaimanapun, TRAP juga boleh membahayakan dengan cara menembusi ke dalam kabin kenderaan di mana ianya boleh mempengaruhi kualiti udara dalaman. **Objektif:** Untuk mengkaji hubungan antara sejarah kerja dan gejala kesihatan pernafasan di kalangan pemandu bas di Kota Bharu. **Metodologi:** Dengan memberi tumpuan kepada kesan pernafasan terhadap pendedahan pencemaran udara, 51 pemandu bas dan 51 kakitangan pentadbiran (kumpulan perbandingan) berumur 20 hingga 56 tahun yang mengendalikan bas awam di kawasan Kota Bharu akan dipilih. Kaedah persampelan bertujuan akan digunakan untuk memenuhi kriteria inklusif untuk kedua-dua kumpulan. Responden akan diberi borang soal selidik berdasarkan American Thoracic Society (ATS-DLD-78-A). Setelah itu, pengukuran pencemaran udara di dalam kabin bas akan dilakukan berdasarkan parameter utama ($PM_{2.5}$, CO_2 dan NO_2). Semua data yang dikumpulkan dari soal selidik dianalisis dengan menggunakan Statistical Package for Social Science Software (SPSS). **Hasil:** Terdapat perbezaan yang signifikan dalam usia dan tahap pendidikan bagi kedua-dua kumpulan. Selain itu, terdapat perbezaan yang signifikan dalam jangka masa kerja antara kedua-dua kumpulan ini. Seterusnya, terdapat perbezaan yang signifikan dalam gejala kesihatan pernafasan batuk, kahak dan kahak kronik antara kumpulan kajian. Selanjutnya, terdapat perbezaan yang signifikan tahap pencemaran ($PM_{2.5}$, CO_2 dan NO_2) antara pagi dan petang dalam pengambilan sampel selama lima hari. Akhir sekali, batuk, kahak dan kahak kronik mempunyai kaitan dengan sejarah kerja responden (tahun).

Kata kunci: gejala pernafasan, pencemaran udara dalaman, kabin bas, sejarah kerja (tahun)

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ABBREVIATIONS

<	Less Than
>	More Than
$\mu g/m^3$	Microgram Per Meter Cube
TRAP	Traffic-Related Air Pollution
AER	Air Exchange Rate
ATS	American Thoracic Society
CI	Confidence Interval
CO_2	Carbon Dioxide
COPD	Chronic Obstructive Pulmonary Disease
DOE	Department of Environment
IQR	Interquartile Range
NO_2	Nitrogen Dioxide
O_3	Ground Level Ozone
OR	Odd Ratio
PM_{10}	Particulate Matter with Aerodynamic Diameter up to 10 Micrometers
$PM_{2.5}$	Particulate Matter with Aerodynamic Diameter up to 2.5 Micrometers
SPSS Ver. 26	Statistical Package Social Science IBM Version 26
USEPA	United States Environmental Protection Agency
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Study Background

Air pollution is no longer an odd issue for us to listen up, raising up or fighting up. Without having a deep sense of concern and having high hypocrisy, we are facing two huge problems, which are environmental health and our health as a human being. A huge assemblage of scientific proof has accumulated throughout the last decade, indicating that significant health impact happens from exposure to ambient particulate matter (PM) concentrations near or below current federal standards that were presumably set to protect public health and the environment (Colburn & Johnson, 2003). The most significant human health resulted from exposure to human health is a respiratory disease. There is expanding acknowledgement of the connections between air contamination and human health. Specifically, a developing assortment of scientific writing links exposure to fine particles below PM_{10} and $PM_{2.5}$ with increased morbidity and mortality from cardiorespiratory causes (Elliot, Cole, Krueger, Vooberg & Wakefield, 1999).

Air pollution is defined as the mixture of polluted substances that can be produced by human or naturally occurred. It is typically divided into two categories which are indoor pollution and outdoor pollution. Apparently, most people are aware enough of man-made outdoor air pollution such as emission of contaminated substances into the air from industries and vehicles or traffic air pollution (TRAP). However, there is one the most dangerous air pollution that includes both categories, outdoor and indoor. Apart from industries emission, traffic air pollution also can be linked to indoor air quality, which involving the vehicles user. At the point when the public stages bus stops, outdoor air, carbon monoxide (CO), could penetrate inside the cabin and get trapped inside (Firdaus & Juliana, 2014). Hence, it already clearly stated in past research showing that TRAP can be together dominate with indoor air pollution adversely affects human. There are few vulnerable groups which easily affected compare to others by this air pollutant problem and could even interfere with their daily task, such as people with lung and cardiovascular disease, infant and young children and adult over 65 years old. Air pollution can aggravate heart disease and stroke, lung diseases such as chronic obstructive pulmonary disease and asthma, and diabetes (Airnow, 2017).

Generally, TRAP involving road users such as the drivers, riders, bikers, pedestrian and those who indirectly are on the road. However, the most susceptible group of people towards the exposure of TRAP is those who are work in transportation industry that exposed to harmful contaminated air almost every day, for instance bus driver, taxi driver, train operator and even a mail postman. To be related to indoor air quality, bus driver is among the risk group exposed to highly polluted air consisting of a mixture of air pollutant for about eight hours without any personal protective equipment (Kavitha, Juliana & Abdah, 2011). Declination in respiratory function may be happened due to the effects of a large number of contaminants from road transport such as fine particles (PM_{10} & $PM_{2.5}$) and carbon monoxide (CO), which can cause oxidative stress in the pulmonary tracts (Sylla, Faye, Diaw, Fall & Tal-Dia, 2018).

1.2 Problem Statement

Recently, a lot of past studies have demonstrated that air contamination profoundly influenced the human respiratory system. Nevertheless, there is still a lack of studies in our country regarding exposure of particulate matter in cabin of public transport. As was mention in 1.1 Study Background, bus drivers are the most susceptible group that was estimated to exposed to contaminated air, for instance particulate matter (PM), carbon monoxide (CO) and carbon dioxide (CO_2). Besides, occupation such as administrative work in office space also contributes to health symptoms due to indoor air pollution. However, the level of exposure could be different compared to bus driver due to several factors such as the TRAP factor. During inhalation, PM is brought deeply from nasal passages into the lungs and kept deposited in the alveolar sacs. There are evidences of the effects of short-term exposure to PM_{10} on respiratory health, but for mortality, and especially because of long-term exposure, $PM_{2.5}$ is possessed a greater risk factor than the PM_{10} (WHO, 2013). Moreover, the past studies regarding personal exposure to PM between the bus drivers and administrative groups found that there was a significant difference between both of them where the exposure level of PM among bus drivers was higher than the comparative groups (Kavitha, Juliana & Abdah, 2011).

The next concern is exposure to carbon monoxide (CO), a colourless, odourless and toxic gas that can adversely affect human health to death. CO is an emission source from incomplete combustion. Most fatal unintentional CO poisonings associated with motor vehicles resulted from various mechanisms of exposure such as a failure exhaust system and having an inadequately ventilated passenger compartment. When CO is starting to have a high concentration and accumulate in the air, the oxygen in the red blood cells will be replaced by CO. This can lead to serious tissue damage or even death. On 17th September, 2020 in Seberang Jaya, 3 deaths are reported due to carbon monoxide poisoning exposed in a car. Moreover, about 600 accidental deaths due to carbon monoxide poisoning are reported every year in the United States (Ernst & Zibrak, 1998).

Besides, throughout the journey, most public buses were run by limiting the air exchange of passenger of the bus by closing windows to be able to recirculate cabin air and reduce the emission of roadway contamination and reduces in-vehicle particulate concentrations. However, under these conditions, carbon dioxide (CO_2) exhaled by occupants will accumulate to reach elevated concentrations. Moreover, the possibility to have an influx of roadway pollutants is high that will adversely contribute to inhalation of passengers. The past studies found that with typical driving speed, the air exchange rate is high for pollutant loss rate compared to influx rate. The particulate pollutant in a vehicle to roadway ratios (I/O) was generally 1.0 for open windows resulting in a little reduction in exposure to roadway concentrations with typical driving speed (Hudda & Fruin, 2013). But the stages buses frequently stop resulting to exposure to more vehicles and traffic on city roads where outdoor pollutant could penetrate inside the bus get trapped indoors.

Consequently, the respiratory system becomes a primary target of the adverse effects of air pollution. Specifically, when speaking about chronic disease such as chronic respiratory diseases, it refers to the disease that develops in human over the time resulted from air pollution contaminants. Studies have shown that chronic exposure to air pollutants is associated with the development and aggravation of chronic respiratory diseases, particularly asthma and Chronic Obstructive Pulmonary Disease (COPD). Chronic respiratory diseases are affecting more and more people in the world. The WHO has estimated 235 million people with asthma and 64 million people with COPD worldwide. Many studies have shown that some people are more exposed than others to air pollution due to their professional activity such as bus drivers are exposed to large quantities of ambient air pollutants when they drive on busy roads or when they find themselves in congestion, bus stops or industrial areas (Sylla, Faye, Diaw, Fall & Tal-Dia, 2018).

1.3 Study Justification

This study is to determine the relationship between the exposures to air pollutants in bus cabin, especially in condensed traffic area in which people tend to use public bus and the respiratory symptoms faced by bus drivers. This study is significant as the level of indoor air pollutants such as $PM_{2.5}$, NO_2 and CO_2 in bus cabin is increasing significantly as the number of passengers increases, the frequency of bus stops and the state of traffic. Hence more attention is required to address this matter and to educate, especially bus drivers themselves, regarding the risk of acquiring and developing chronic respiratory symptoms caused by exposure to indoor air pollutants.

Like the previous, the mean concentration of PM_{10} inside the long-distance express buses (220.00±120.0μg/m^3) had exceeded the 24-hours annual mean (15μg/m^3) recommended by United States Environmental Protection Agency (USEPA) (Firdaus & Juliana, 2014). This study also concludes that the long-distance express buses have a lower concentration of PM_{10} compared to stages bus which idle frequently to fetch and drop the passengers resulting in the build-up of PM_{10} within the bus cabin. This concept also applied to CO and CO_2, which depends on the air exchange rate (AER). The in-vehicle to roadway ratios, I/O for these pollutants were primarily determined by vehicle air exchange rate (AER), with AER being mostly a function of ventilation setting such as recirculation or outside air, vehicle characteristics, for instance, age and interior volume and driving speed (Hudda & Fruin, 2013).

Apart from that, this study also is conducted to determine the preliminary data of personal exposure level of air pollutants ($PM_{2.5}$, NO_2 and CO_2) among bus drivers within the working hours (8 hours). Through the measurement and collection data of these air pollutants, the preliminary data could be used to predict added risk attributed to the bus driver with a comparison group. Hence a proper prevention or mitigation plan by the company could be implemented into the industry to protect the workers.

1.4 Research Questions

1. What is the level of personal exposure of air pollutants ($PM_{2.5}$, CO_2 & NO_2) face by the bus drivers in the morning and afternoon?
2. Is there any significant difference in duration years of working between the bus drivers and office staffs?
3. What is the prevalence of respiratory symptom among bus drivers and office staffs?
4. Is there any association between the working history and the respiratory health of the respondents?

1.5 Research Objectives

1.5.1 General Objectives: -

1. To study the association of working history with respiratory health effects among commercial bus drivers in Kota Bharu, Kelantan.

1.5.2 Specific Objectives: -

1. To determine the socio-demographic among the respondents.
2. To compare the level of personal exposure of air pollutants ($PM_{2.5}$, CO_2 & NO_2) face by the bus drivers in the morning and afternoon.
3. To compare the working history (years) between the bus drivers and office staffs
4. To compare the prevalence of respiratory symptoms between both groups (bus drivers and office staffs).

1.6 Research Hypothesis

1. There is a significant difference in pollutants between morning (peak hour) and afternoon (off-peak hour).
2. There is a significant difference in working history (years) between the exposed and comparative group.
3. There is a significant difference between the reported respiratory symptoms among the respondents in the exposed and comparative group.
4. There is an association between the reported respiratory symptoms among the respondents who are in long and short working history.

1.7 Conceptional Framework

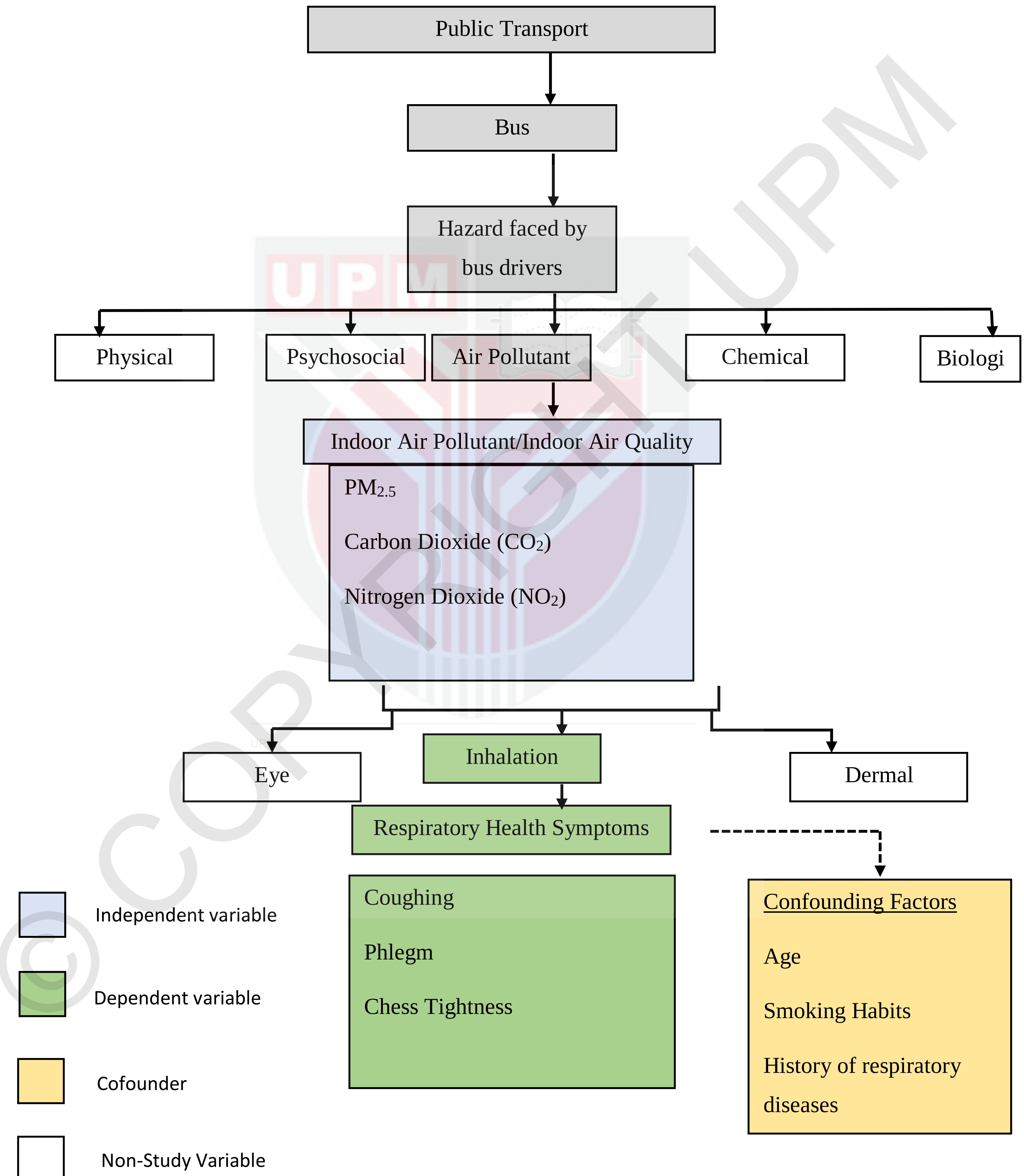

Figure 1: Conceptual Framework

1.8 Conceptual Definition

1. **Indoor Air Quality**

   Indoor air quality (IAQ) refers to the air quality of buildings and structures inside and around them, especially as it relates to the health and comfort of occupants of buildings (United States Environmental Protection Agency (USEPA)).

2. **Particulate Matter $PM_{2.5}$**

   Particles with an aerodynamic diameter which less than 2.5 micrometers $PM_{2.5}$ are referred to as fine particles and are believed to post the largest health risk. Because of their small size, fine particles can lodge deeply into the lungs (EPA, 1997).

3. **Nitrogen Dioxide (NO_2)**

   Nitrogen dioxide is an extremely reactive gas and primarily released in the air from the burning of fuels and emission from cars, lorries, buses, power plants and off-road equipment.

4. **Carbon Dioxide (CO_2)**

   Carbon dioxide is the result of complete combustion. Most of the carbon dioxide emission comes from natural sources, like the oceans, animal, including human and plant respiration and decomposing organic matter. Excess carbon dioxide uses up space in the air instead of oxygen, creating an environment for asphyxiation.

5. **Chronic Cough**

Basically, cough is a reflex that keeps the throat and airways clear. Chronic cough is when having cough at least 4 times for at least 4 days in one week for at least 3 consecutive months during the year (ATS, 2003). A chronic cough can interrupt by feeling exhausted. Severe cases of chronic cough can cause vomiting, lightheadedness and even rib fractures.

6. **Chronic Phlegm**

Phlegm is a different form of mucus made by the lower airway in response to inflammation. Chronic phlegm is when having phlegm for at least 4 days in one week for at least 3 consecutive months during years (ATS, 2003).

7. **Chest Tightness**

Chess tightness is a sensation where the chest will feel sharp, dull and stabbing as persistent tightness, pressure, fullness, or numbness resulted from the development of respiratory symptoms. A combination of cough or phlegm or increase of cough or phlegm in cases where the respondent coughs or having phlegm continuously (ATS, 2003).

1.9 Operational Definition

1. **$PM_{2.5}$**

Particulate Matter $PM_{2.5}$ personal exposure will be measured using DustTrak™ II Aerosol Monitor 8532. This personal aerosol monitor works based on a real-time light scattering principle that measured airborne particles mass concentration in the unit of milligram per cubic meter (mg/m^3).

2. **Carbon Dioxide (CO_2)**

   TSI Q-Trak will be used for measuring the level of carbon dioxide. The TSI Q-Trak is an instrument that provides real-time measurements of IAQ parameters, and the unit can be used for both spot sampling and long-term unattended monitoring. The unit for gase is parts per million (ppm) or milligram per litre (mg/L).

3. **Nitrogen Dioxide (NO_2)**

   NO_2 was measured using Aeroqual Series 500. The Series 500 air quality sensor allows it possible to track the outdoor air contaminants in real-time, all in an ultra-portable handheld device with a unit of (mg/m^3).

4. **Socio-demographic data**

   Socio-demographic data among respondent obtained from the study questionnaire modified from the American Thoracic Society (ATS-DLD-78-A).

5. **Chronic Cough**

   Symptom of chronic coughing is identified through the study questionnaire modified from American Thoracic Society ATS (ATS-DLD-78-A) as followed the information based on ATS (2003), which is having cough for at least 4 times for at least 4 days in one week for at least 3 consecutive months during the year.

6. **Chronic Phlegm**

Symptom of phlegm is identified through the study questionnaire modified from American Thoracic Society ATS (ATS-DLD-78-A) as followed the information based on ATS (2003), which is having phlegm for at least 4 days in one week for at least 3 consecutive months during years

7. **Chest Tightness**

Symptom of chest tightness is identified through the study questionnaire modified from American Thoracic Society ATS (ATS-DLD-78-A) as followed the information based on ATS (2003), which is when having a combination of cough of phlegm or increase of cough or phlegm in cases where the respondent coughs or having phlegm continuously.

CHAPTER 2

LITERATURE REVIEW

2.1 Indoor Air Pollution

As we can see, many efforts have been focusing on outdoor air without concern that the concentration also can elevate inside some private and buildings. Concern regarding potential public health issues related to indoor air pollution is based on evidence that urban residents usually spend more than 90 percent of their time indoors, some contaminant concentrations are higher than outdoors, and personal exposure is not sufficiently defined by outdoor measurements for some pollutants (Spengler & Sexton, 1983). Furthermore, people are used to thinking that indoor air quality is far better than the outside since it is enclosed, clean and much comfier than staying outside. Certain studies have indicated the concentrations of some pollutants are often 2 to 5 times higher than typical outdoor concentrations (US Environmental Protection Agency, 1987). Most common type of air pollutants that have been encountered indoors without we realising it is PM, gases such as ozone (O_3), NO_2, CO, and sulfur dioxide (SO_2); microbial and chemical volatile organic compounds (VOCs); and passive smoke (Bernstein et al., 2008).

Xu, Chen and Xiong (2016) stated that people spend most of their time in indoor environments, including vehicle cabins. Vehicle cabin is an important microenvironment that leads to passengers and drivers' exposure to elevated levels of air pollutants, such as VOCs, CO, CO_2 and PM (Hsu & Huang, 2009). Furthermore, it has been identified that the level of polluted air inside the vehicles, especially in commercial vehicles are ten times higher compared to outside vehicles (Marla, 1999). Results of one study showed that both driver zones and passenger zones of the tour buses achieved maximum CO_2 concentrations of more than 3000 ppm, and maximum daily average concentrations of 2510.6 and 2646.9 ppm, respectively, which exceeded the indoor air quality standard of Taiwan Environmental Protection Administration (8 hr-CO_2: 1000 ppm) and the air quality guideline of Hong Kong Environmental Protection Department (1 hr-CO_2: 2500 ppm for Level 1 for buses) (Chiu, Cheng, Chang, 2015). The same goes for local studies that reveal the mean concentration of indoor PM_{10} inside the long-distance express buses (220.00±120.0μg/m^3) had exceeded the 24-hours annual mean (15μg/m^3) recommended by USEPA (Firdaus & Juliana, 2014). Clearly from the studies, the authorities of public transportation have to pay great attention to various factors, specifically to the quality of service such as the ventilation and air exchange rate that need to be set up appropriately with the distance of journey that can benefits both occupier, drivers and passengers in order to enhance the quality of the journey.

2.2 Traffic-Related Air Pollution (TRAP)

As for now, the emission rate trend for TRAP showing no sign of slowing down; instead, it is rising in line along with the ever-expanding development of economic and industry growth. Over the past 20 years, there is a significant increase in traffic on roads in the United States and other places (Schrank & Lomax, 2007). The major source of air pollutants in many areas is exhaust emissions from vehicles such as PM, NOx, CO, CO_2 and VOCs or hydrocarbons (HCs) (National Research Council, 2002). These are the example of air pollutant that is threatening public health. Short term traffic-related air pollution (TRAP) has shown substantial proofs that the exposure is known to exacerbate existing respiratory diseases.

The real exposure impacts of high concentration of air pollutants are a function of both indoor and outdoor air quality and the time spent in the multiple microenvironments, but proof suggests that almost 29% of indoor air concentrations are related to outdoor resources, such as traffic emission. Several studies have shown that biomarker-based molecular epidemiology studies may assist in comprehending relative factor of ambient air pollution as a risk factor of cancer and improve health risk assessment especially under conditions of moderate or low air pollution (Kyrtopoulos et al. 2001; Hrelia et al. 2004).

2.3 Particulate Matter, Carbon Monoxide (CO), Carbon Dioxide (CO_2) and Nitrogen Dioxide (NO_2)

Particulate matter is a widespread air pollutant, consisting of a mixture of solid and liquid particles suspended in the air (World Health Organization, 2013). Based on the United States Environmental Protection Agency (USEPA), PM is mainly divided into two size categories based on their predicted penetration capacity into the lung which is PM_{10} and $PM_{2.5}$ with the aerodynamic diameter of 10µm and 2.5µm respectively. Aerodynamic diameter is one of the main criteria to describe the transport ability of PM in the atmosphere and inhaling ability through a respiratory organism (Esworthy, 2013). Particulate matter emitted from the exhaust gases of diesel engines is a complex mixture of organic molecules, insufficiently oxidised carbon, metal oxides, with the content of sulfate and nitrate groups (Armas, Gomez, Mata & Ramos, 2013). Studies have shown that particulate matter from internal combustion engines exhaust can affect human health (B.S. Sosa, et al., 2017). They can cause various respiratory and cardiovascular diseases, changes in the human immune system, damage to lung tissue, and carcinogenesis. The

World Health Organization (WHO, 2012) reported that chronic effects of air pollutants, including particulate matter (PM), lead to the premature death of 7 million people annually, while air pollution is reported to be the most important environmental health risk in the world.

CO is a colourless and odourless gas that is emitted primarily from incomplete combustion. Usually, it is created through the incomplete combustion of coal, natural gas, and oil. Excess intake of CO, which are colourless, odourless and tasteless compound inhibits the oxygen-carrying capability of haemoglobin. Exposure to CO inside vehicles has become a cause for rising concern over the past decade (Gómez-Perales et al., 2007). At the same time, CO_2 is the result of complete combustion. Most of the carbon dioxide emission comes from natural sources, like the oceans, animal including human and plant respiration and decomposing organic matter. Excess CO_2 uses up space in the air instead of oxygen, creating an environment for asphyxiation. Symptoms of mild carbon dioxide poisoning include headaches and dizziness at concentrations less than 30,000 ppm. At 80,000 ppm, CO_2 can be life-threatening. As a reference, OSHA (Occupational Safety and Health Administration) has set a CO_2 permissible exposure limit (PEL) of 5,000 ppm over an eight-hour period and 30,000 ppm over a 10-minute period.

Finally, NO_2 is one of the traffic-related air pollutants (TRAP). NO_2 is part of extremely reactive gasses called oxide of nitrogen or nitrogen oxides (NOx). NO_2 is used as a marker for the larger nitrogen oxide group. NO_2 usually comes into the air from the burning of fuels and emission from cars, lorries, buses, power plants and off-road equipment. To be clearly, NO_2 is generated from vehicles-fuel combustion, off-road vehicles, and power plant (USEPA, 2016). For indoor concern, NO_2 can be built up indoors through the cooking process (Ackermann, 2019). One of time-series studies in Malaysia reveals that within 1st January 2005 to the 31st December 2015 (Hourly long-term datasets over a period of 11 years), NO_2 is the highest levels recorded, ranging between 23 and 40 ppb generally affected by both vehicle and industrial emissions (Anis et al.,2018). In the human respiratory system, inhaling air high level of NO_2 can irritate airways. These short-term exposures can intensify respiratory diseases, especially asthma, contributing to respiratory symptoms such as breathing difficulties and coughing. Long-term exposures to high levels of NO_2 can lead to asthma progression and potentially increase vulnerability to respiratory infections.

2.4 Health Effect on Indoor Air Pollution

People used to think that indoor air quality is far better than the outside due to the fact that it is enclosed, clean and much comfier than staying at the outside. Moreover, they are used to think that reducing the mixing of outdoor and indoor air can limit penetration of outdoor pollutants into the indoors. Unfortunately, it will worsen the situation which can lead to higher concentrations of pollutants generate indoors since their dilution by outdoor air is decrease. The research has found that particulate matter may give adverse health effects through the generation of reactive oxygen species, activation of cell signalling pathways, and alterations of respiratory tract barrier function and antioxidant defences, all of which may lead to airway inflammation and changes in pulmonary function (Mulenga & Siziya, 2019). A variety of studies have shown that long-term exposure to $PM_{2.5}$ pollution is highly associated with premature death of cardiovascular, respiratory, and cerebrovascular diseases (Yang, Fang & Cheng, 2019).

The gaseous such as CO also have a high potential to poison human who are exposed to it. Tissue hypoxia is the most well-recognised pathophysiological effect of carbon monoxide because of its ability to bind with haemoglobin to form carboxyhaemoglobin against oxygen that supposedly form oxyhaemoglobin. Controlled exposure studies have shown that carbon monoxide exacerbates myocardial ischaemia, particularly in individuals with pre-existing coronary artery disease (Lee, Spath, Miller, Mills & Shah, 2020). Next, human exhale carbon dioxide in the process of breathing which can displace oxygen in an indoor environment such as a vehicle cabin, creating oxygen keep deficient in the environment. Elevated CO_2 levels in a microenvironment can lead to fatigue, weariness, drowsiness, sleepiness and limit the productivity to work (Chen et al., 2020). Furthermore, one of the studies has stated that early symptoms usually starting from having dyspnea or air hunger, increased respiration and headaches followed by severe symptoms such as heart palpitations, confusion, severe dyspnea, vomiting, disorientation and hypertension (Constantin et al., 2016).

2.5 Air Pollution in Kota Bharu, Kelantan

There has been industrialised urban development across the globe at different times (Power et al., 2018). The population in Kota Bharu in 2016 was predicted about 1.45 million people, which increased by 12% from 2010 that has been encouraged by urban development (Amal et al., 2020). The effects of complex urban surface geometry, the shape and orientation of high-rise buildings and structures, the peculiar thermal and hydrological features of city planning have contributed to a profound environmental transformation in the urban city (Fauzi, N., & Awaluddin, N. I., 2017). Consequently, during the urbanisation period, urban green space has been under the strain, and this negatively affects the ecosystem services, cultural associations, psychological well-being and the health of urban residents (Nor & Abdullah, 2019). For instance, the average concentration of PM_{10} recorded at Kota Bharu (urban) was higher than Jeli (rural) with 52.57μg/m^3 (ranging from 24.86 - 99.55μg/m^3) and 39.21μg/m^3 (ranging from 18.01 - 86.05μg/m^3), respectively (Norrimi et al., 2017)

CHAPTER 3

LITERATURE REVIEW

3.1 Study Design

The study design in this research was a cross-sectional comparative study. This study included two groups which were the bus drivers and office staffs, as a comparative group. This study focused on the respiratory effects towards the exposure of air pollutants, which was $PM_{2.5}$, CO_2 and NO_2. The office staffs were selected as comparative group due to their working nature is almost same as the bus drivers, for instance, working hour and indoor space area. Hence, finding prevalence without having comparative group will not give a complete picture of added risk due to driving occupation. This study tried to find out the predicted added risk attributed to the bus driver with a comparison group.

3.2 Study Location

Kota Bharu was selected as the location for this study. This study was conducted among public bus (Cityliner) operated in the Kota Bharu area as it is a big city in Kelantan. It is known as a fast-growing area where it has a high population, the number of vehicles is increasing yearly and traffic density. Meanwhile, for the comparative group (office staffs) was selected those who worked in the office at the main bus station in Kota Bharu.

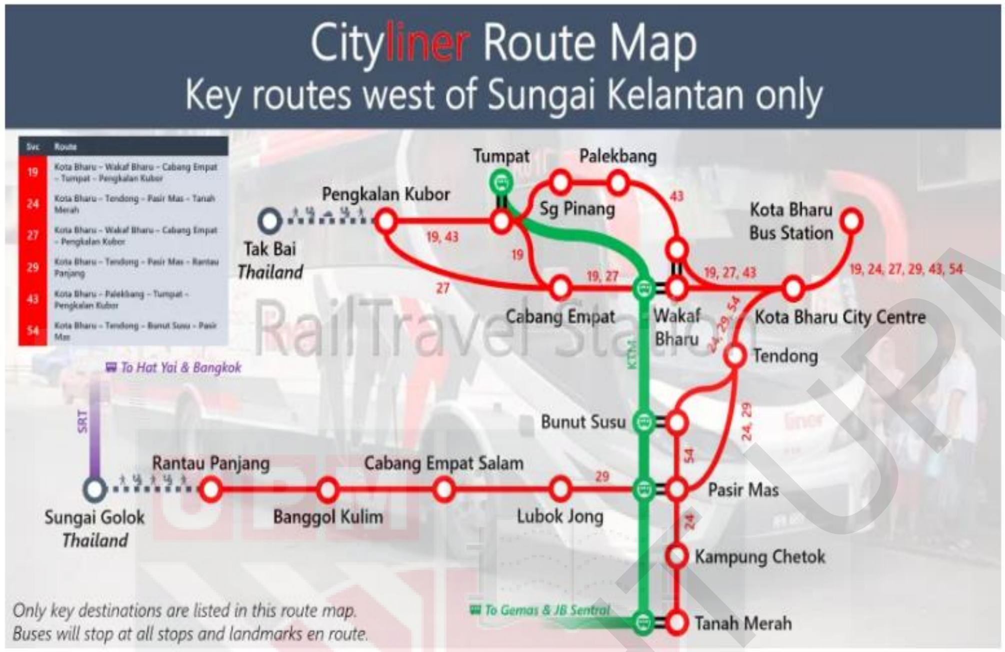

Figure 2: Route of public bus Cityliner in KB
Source: https://railtravelstation.com/

3.3 Study Duration

The sampling was conducted from February 2021 until March 2021. During the data collection, the important thing that have been considered was the pandemic issue as it influenced the number of passengers and influenced the data obtained. Therefore, the time frame for this research to be conducted is suitable for data collection.

3.4 Sampling

3.4.1 Sampling Population

The study population was the bus drivers from the private bus company named Cityliner that operated in Kota Bharu area and administrative staffs who worked in office at the main bus station in Kota Bharu as well. These groups were directly expose to air pollutants, for instance fine particle $PM_{2.5}$, CO2 and NO_2.

3.4.2 Sampling Frame

This study included bus drivers and administrative staffs (comparative group) that met the inclusion criteria. They need to fulfil the inclusive criteria as below: -

<u>Inclusive</u>

1. Aged between 20 – 56 years old
2. Male
3. At least one year of working experiences

<u>Exclusive</u>

1. Individuals with a history of respiratory diseases

3.4.3 Sampling Method

The bus drivers and administrative staffs (comparative groups) will be the study's selection as respondent. Permission have been obtained from the public bus company (Cityliner). Name list of bus drivers and administrative staffs have been obtained from a public bus company (Cityliner). Firstly, purposive sampling method was used to fulfil the inclusive criteria for both groups. Next, the list of possible respondents was randomly select to minimise the possibility of bias. All chosen respondents have been ensured involve with willingness as they need to drop their signature for approval. After that, questionnaires adapted from American Thoracic was provided to obtain the related information and started sampling of air pollutants.

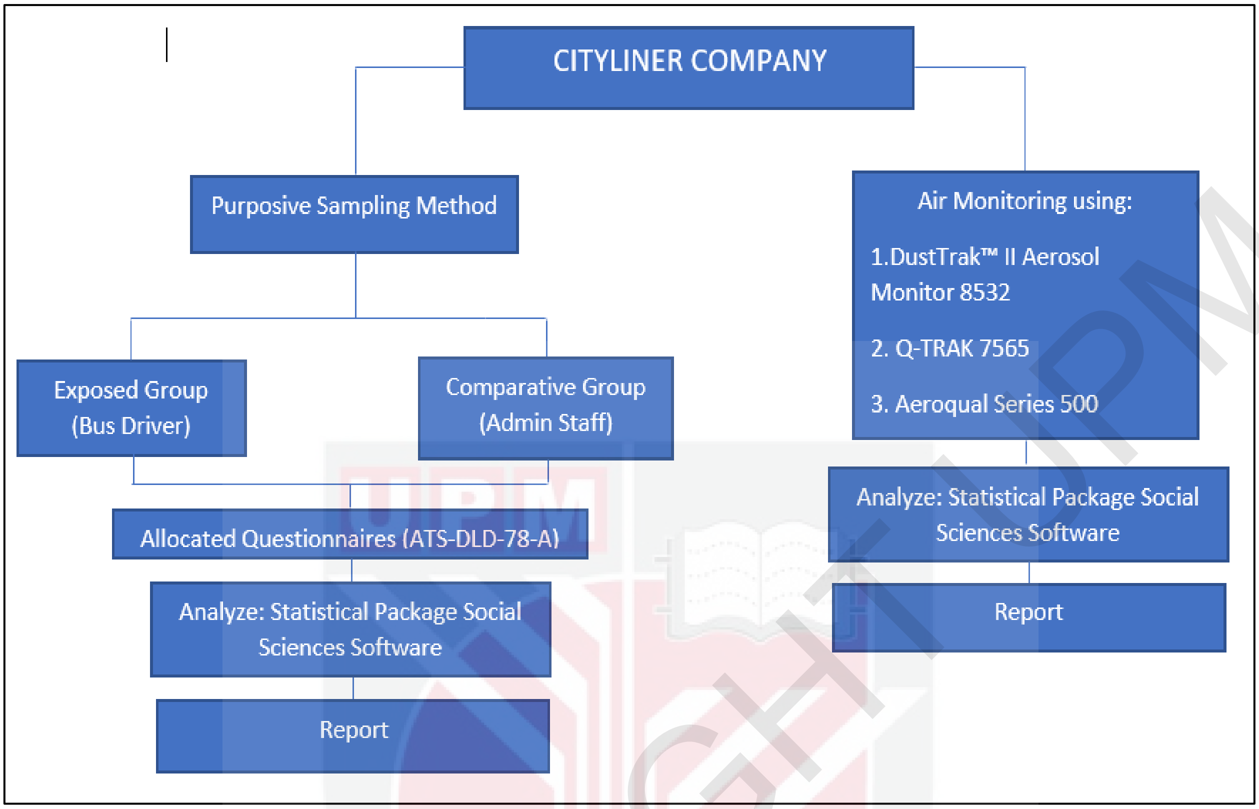

Figure 3: Data Collection Flowchart

3.4.4 Sample Size Calculation

The respondents consist of commercial bus drivers who exposed to air pollution during their working time which were selected based on criteria described in Section 3.4.2. Below is the sample size calculation.

The sample size for this study is based on Varkevisser, Pathmanathan and Brownlee (2003). The formula used is as follows.

$$n = \frac{(u + v)^2 \{p_1(100-p_1) + p_2(100-p_2)\}}{(p_1 - p_2)^2}$$

Where:

n = Sample size

u = 1.28 (probability finding a significant result in 90%)

v = 1.96 (significance level at 5%)

p_1 = Prevalence of cough symptoms from exposed group = 21.43% (Kavitha *et al.*, 2010)

p_2 = Prevalence of cough symptoms from comparative group = 1.89% ((Kavitha *et al.*, 2010)

The calculation:

$$n = \frac{(1.28 + 1.96)^2 \{(21.43 \text{ x } 78.57) + (1.89 \text{ x } 98.11)\}}{(21.43 - 1.89)^2}$$

= 51 respondents

Hence, 102 respondents from each group were selected for this study.

3.5 Questionnaire

A modified questionnaire based on two standardised international questionnaires which are set by the American Thoracic Society (ATS-DLD-78-A) for data on sociodemographic background and questionnaire about chronic respiratory symptoms such as experience of chronic phlegm, chronic cough and chest tightness. The questionnaires will be translated from English to Malay. A consent letter will be included to thoroughly explain the methodology used in this study to respondents to obtain permission and avoid unnecessary problem. Majority of questions constructed are close-response questions and can easily be answered as well as does not take much time to answer. A quick interview with respondents will be conducted upon collection of questionnaires to ensure that questionnaires have been completed successfully.

3.6 Instrument for Measuring Indoor Air Pollutant ($PM_{2.5}$, CO_2 & NO_2)

Monitoring of Particulate Matter $PM_{2.5}$

A sampling of particulate matter $PM_{2.5}$ have been carried out using DustTrak™ II Aerosol Monitor 8532. This device is a handheld battery-operated, data-logging, single-channel, light-scattering laser photometer that gives real-time aerosol mass readings. It uses a sheath air system that isolates the aerosol in the optics chamber to keep the optics clean for improved reliability and low maintenance. It is suitable for clean office settings as well as harsh industrial workplaces, construction and environmental sites, and other outdoor applications. The DustTrak II Aerosol Monitor measures aerosol contaminants such as dust, smoke, fumes, and mists. The equipment has been calibrated before the monitoring and the calibration will be recorded. The instrument has been placed near to breathing zone of the driver. $PM_{2.5}$ concentration levels have been measured for 8 hours during work hours inside the bus. Then, TRAKPRO™ data analysis software was used for analysis. For quality control, pre and post-calibration of the instrument was conducted.

Figure 4: DustTrak™ II Aerosol Monitor

Source: https://tsi.com/products/aerosol-and-dust-monitors/dust-monitors/dusttrak-ii-aerosol-monitor-8532/

Monitoring of Carbon Dioxide CO_2

The indoor air parameters include CO_2 were measured in 8 hours during the work hours. This measurement was conducted by using TSI Q-TRAK 7565 Indoor Air Quality Monitor. Other characteristics that also included are type of ventilation use and number of passengers per trip. The unit can be used for both spot sampling and long-term unattended monitoring. For quality control, firstly, the instrument was pre and post calibrated. Next, the mode changed to continuous time mode sampling in order to set up the log interval for 5 minutes per reading and the interval length will be set up along the trip. Hence, the measurement resulted a better reading.

Figure 5: Q-TRAK 7565 Indoor Air Quality

Source: https://tsi.com/discontinued-products/q-trak-indoor-air-quality-monitor-7565/ Monitor 8532

Monitoring of Nitrogen Dioxide (NO_2)

NO_2 was measured using Aeroqual Series 500. Its air quality sensor provides precise real-time surveying of common outdoor air pollutants, all in an ultra-portable handheld monitor unit of (mg/m^3). The monitors are modular in design and are comprised of two main components, a monitor and a sensor head. The instrument has been be set up according to the duration of trip for sampling time and was placed near the driver zone to measure the personal exposure of pollutants to the bus driver.

Figure 6: Aeroqual Series 500

Source: https://www.aeroqual.com/product/series-500-portable-air-pollution-monitor

3.7 Quality Control

Quality control was done at a different stage in the study, especially during the sampling period, measurement, and data analysing to ensure the reliability and validity of the data.

i. The questionnaires were pre-tested with the total respondents of 10% of the total sample size to ensure their validity and reliability. The purpose of the pre-test also was to assess the understanding of the respondents on the questionnaire. The result for Cronbach Alpha should be within the range.

ii. The distributed questionnaire was rechecked upon collecting it to ensure all the questions were answered and no blank answer left behind.

iii. Calibration of all instruments performs based on the standardised method recommended by the manufacturers. Standards operational and sampling procedures were followed throughout the sampling duration to prevent error and maintain its sensitivity.

iv. Zero calibration was performed before each sample collection to avoid error in measurement.

3.8 Study Ethics

There are some aspects of ethics that need to be reviewed prior to this study research

i. Ethics approval

The research proposal has been submitted and reviewed by Ethics Committee for Research Involving Human Subjects Universiti Putra Malaysia (UPM) to obtain approval involving a human sample for the research.

ii. Permission Letter

Permission to conduct study was obtained from the bus company prior to the assessment. Informed consent letter was provided to the respondents before sampling is conducted.

iii. Respondents

Respondents were informed and explained the type of research being conducted. They also have been informed regarding the objective, activities and impact of the study on the community. All respondents must be volunteered-based to participate in this assessment. All information regarding the respondents, obtained throughout the study was confidential and strictly use only for this research purpose.

3.9 Statistical Analysis

The data collected from the air monitoring and the questionnaire will be analysed using IBM the Statistical Package for the Social Sciences (SPSS) Version 22.0. A normality test was performed to identify the data distribution. Statistical test will be conducted according to certain study objectives which are as follows:

1. Descriptive analysis is performed to summarise and describe the information regarding the socio-demographic data obtain from the questionnaire, the concentration of air pollutants ($PM_{2.5}$, CO_2 & NO_2), as well as the respiratory symptoms.
2. To evaluate the comparison between concentration level $PM_{2.5}$, CO_2 & NO_2 in morning and afternoon, Independent T-Test or Mann-Whitney U statistical test was used (depending on the normality of the data) to compare the significant difference of mean (if data is normally distributed) or median (if data is not normally distributed).
3. The comparison prevalence of respiratory health symptom among the two groups of respondents was determined by Chi-Square test.
4. The comparison duration of working (years) among the two groups of respondents was determined by Chi-Square test.
5. Chi-Square test was performed to analyse the association of working history with the respiratory health symptoms of the respondents. This statistical test was used specifically to describe the relationship between two categorical data variables.

3.10 Flowchart of Progress

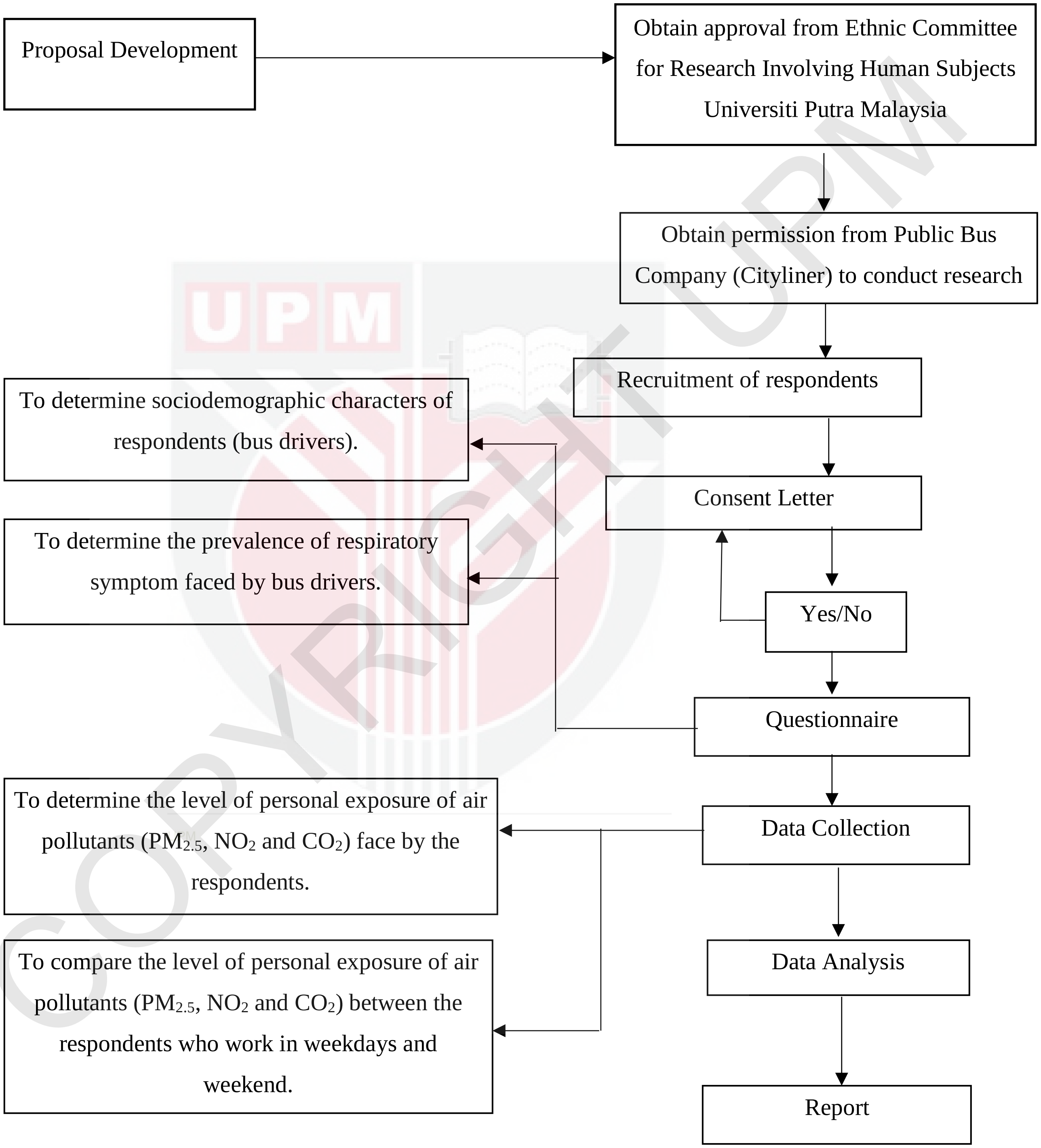

Figure 7: Flowchart of progress

3.11 Expected Outcome

1. There is a significant difference in pollutants between morning (peak hour) and afternoon (off-peak hour).
2. There is a significant difference between the reported respiratory symptoms among the respondents in the exposed and comparative group.
3. There is a significant difference in working history (years) between exposed and comparative group.
4. The working history is significantly associated with the prevalence of respiratory health symptom among the respondent.

CHAPTER 4

RESULTS

4.1 BACKGROUND INFORMATION OF RESPONDENTS

Socio-Demographic Characteristics

Table 4.1 shows the summary of sociodemographic characteristics between respondents from exposed and comparative groups. The ethnic and gender of all respondents were Malay and male. There were more respondents from age 32-60 years old (82.4%) for the exposed group. While for the comparative group, most of them from age 20-31 years old (58.8%).

For the education level, most of respondents of exposed group have a low education level (73.5%). Meanwhile, the comparative group, they were more likely to have high education level (58.8%). There were 23 (73.5%) respondents from exposed group who had smoking habit. As for the comparative group, there were 32 (62.7%) respondents who smoke.

A chi-square test was done in order to determine the socio-demographic characteristics between both groups. There was a significant difference in age and educational level for both groups at $p<0.05$, as result shown below.

Table 4.1: Socio-Demographic characteristics of respondents (N=85)

	N (%)		x^2	p-value
	Bus Drivers (Exposed Group)	Office Staffs (Comparative Group)		
	(n=34)	(n=51)		
Age				
20 to 31 years old	6 (17.6)	30 (58.8)	14.18	*<0.001
32to 60 years old	28 (82.4)	21 (41.2)		

Education Level				
Low education level -Not go to school -Primary school -Secondary school	25 (73.5)	21 (41.2)	8.60	*0.003
High education level -Diploma/STPM -Degree	9 (26.5)	30 (58.8)		
Smoking Status				
Yes	25 (73.5)	32 (62.7)	1.074	0.300
No	9 (26.5)	19 (37.3)		

*Significant at $p < 0.05$

4.2 WORKING INFORMATION

4.2.1 Working History

The working duration for both groups is shown in Table 4.2.1. The descriptive analysis shows that the mean of working history for exposed group (20 ± 8.74) years while for comparative group is (3 ± 1.22) years. Mann-Whitney U test indicates that there was a significant difference in duration years of working between these two groups at $p<0.05$.

Table 4.2.1: Comparison of Working History between Study Groups (N=85)

Variables	Bus Drivers (Exposed Group) (n=34)	Office Staffs (Comparative Group) (n=51)	Z	p-value
	Median (IQR)			
Working history (years)	21 (12)	3 (1)	-7.856	*<0.001

***Significant at $p<0.05$

4.2.2 Determining the Status of Working History among Respondents

Based on the obtained median value for both study groups which is 4 years, the working history were categorised into two groups, which are long-term and short-term. The working history of each study groups was compared with the obtain median; number of years above the median are considered as long-term (Exposed Group: >4 years; Comparative Group: >4 years). Meanwhile, number of years below the median are considered short-term (Exposed Group: ≤ 4 years; Comparative Group: ≤ 4 years). The data are shown in Table 4.2.2

Table 4.2.2: Determining the Status of Working History (Short-Term or Long-Term) among Respondents (N=85)

	N (%)	
	Bus Drivers (Exposed Group) (n=34)	Office Staffs (Comparative Group) (n=51)
Status of Working History		
Short-Term (≤ 4years)	0 (0)	44 (86.3)
Long-Term (> 4years)	34 (100)	7 (13.7)

4.2.3 Exposure to Traffic-Related Air Pollutant (TRAP) during Working Hour

Table 4.2.3 below shows the comparisons of exposure to traffic air pollutant (TRAP) among both study groups. The result based on the questionnaire given to the respondents related to their awareness of the level of exposure to TRAP during working hour by answering low, medium or high level of exposure. The result of analysis shows that most of respondents from bus drivers, exposed to high level of exposure 22 (64.7%). Meanwhile, for comparative group, the respondents were likely to expose to a low level of exposure 37 (72.5%). A Chi-Square test was done in order to evaluate whether there is any significant difference in level of exposure to TRAP between both study groups. The result shows there was a significant difference in level of exposure to trap between both study groups at p<0.05.

Table 4.2.3: Comparison of Exposure to TRAP during Working Hour (N=85)

	N (%)		x^2	p-value
	Bus Drivers (Exposed Group)	Office Staffs (Comparative Group)		
	(n=34)	(n=51)		
TRAP Exposure				
Low Exposure	0 (0)	37 (72.5)		
Medium Exposure	12 (35.3)	12 (23.5)	52.361	*<0.001
High Exposure	22 (64.7)	2 (3.9)		

*Significant at p < 0.05

4.3 RESPIRATORY HEALTH SYMPTOMS

4.3.1 Comparison of Respiratory Health Symptom between Study Groups

Table 4.3.1 shows a comparison of reported respiratory symptoms among both study groups. For the respiratory symptoms of cough, 19 (55.9%) of respondents from the exposed group reported having cough while only 7 (13.7%) from comparative group. A Chi-Square Test was done to identify whether there is any significant difference in cough between study groups. The value of the chi square statistic is 17.076 with the *p*-value of <0.001. Hence, there was a significant difference where the exposed group have a higher number of reported coughs compared to comparative group, with p-value is less than 0.05.

For the respiratory symptoms of phlegm and chronic phlegm, 25 (73.5%) and 12 (35.3) of respondents from the exposed group was reported to have the symptoms, respectively.

Meanwhile, 18 (35.3%) and 2 (3.9%) of respondents from comparative group were recorded to have the phlegm and chronic phlegm, respectively. A Chi-Square Test was done to find whether there is any significant difference of phlegm and chronic phlegm between study groups. The result of analysis for both symptoms was (x^2= 11.931, p = 0.01) and (x^2= 14.594, p < 0.001) respectively. Hence, there was a significant difference where the exposed group have a higher number of reported phlegm and chronic phlegm compared to comparative group, with p-value is less than 0.05.

Prevalence of chronic cough, wheezing and breathlessness recorded was 2 (5.9%), 2 (5.9%) and 1 (2.9%) respondents respectively from exposed group. While, 1 (2.0%), 0 (0%), 0 (0%) of respondents from comparative group was recorded to have chronic cough, wheezing and breathlessness, respectively A Chi-Square Test with continuity correction for expected value <5 was done to find whether there is any significant difference of the symptoms between study groups. The result shows that there was no significant difference in reported chronic cough, wheezing and breathlessness between study groups.

Table 4.3.1: Comparison of respiratory health symptom between study groups (N=85)

Respiratory Symptoms	N (%) Bus Drivers (Exposed Group) (n=34)	N (%) Office Staffs (Comparative Group) (n=51)	x^2	p-value
Cough				
Yes	19 (55.9)	7 (13.7)	17.076	*<0.001
No	15 (44.1)	44 (86.3)		
Chronic Cough§				
Yes	2 (5.9)	1 (2.0)	0.900	0.343
No	32 (94.1)	50 (98.0)		
Phlegm			11.931	*0.01
Yes	25 (73.5)	18 (35.3)		

No	9 (26.5)	33 (64.7)		
Chronic Phlegm				
Yes	12 (35.3)	2 (3.9)	14.594	*<0.001
No	22 (64.7)	49 (96.1)		
Wheezing§				
Yes	2 (5.9)	0 (0)		
No	32 (94.1)	51 (100)	3.738	0.053
Breathlessness§				
Yes	1 (2.9)	0 (0)	1.850	0.174
No	33 (97.1)	51 (100)		

*Significant at $p < 0.05$;
§ By x^2test with Yates' correction for expected value <5

4.3.2 Association between Working History and Respiratory Health Symptoms

Table 4.3.2 below shows the association between working history and respiratory health symptoms. Working history was divided into two categories which are long-term (n=41) and short-term (n=44) based on the obtained median of working history (years) which was 4 years. For cough, 19 (46.3%) respondents from those who are in long-term working history reported while 7 (15.9%) respondents from the worker who work in a short-term. Next, for phlegm and chronic phlegm, 31 (75.6%) and 14 (34.1%) respondents from long-term history worker were recorded, respectively. In contrast, 12 (27.3%) and 0(0%) respondents from short-term working group were recorded to have the symptoms.

A Chi-Square Test with continuity correction for expected value <5 was performed to determine the association between working history and respiratory health symptoms. The result shows there was no significant difference in reported respiratory symptoms for chronic cough, wheezing and breathlessness between these two-group working history. However, there was a significant difference in cough, phlegm and chronic phlegm with (x^2= 9.258, p = 0.002, OR = 4.565, 95% CI = 1.655 – 12.591), (x^2= 19.838, p < 0.001, OR = 8.267, 95% CI = 3.122 – 21.889) and (x^2= 17.987, p < 0.001) respectively. Hence, based on the result, those who have worked for a long term were 4 and 8 times more likely to get cough and phlegm respectively compared to those who have worked for a short-term.

Table 4.3.2: Association Between Working History and Respiratory Health Symptoms (N=85)

Respiratory Symptoms	N (%) Long Term (n=41)	N (%) Short-Term (n=44)	x^2	p-value	OR	CI 95%
Cough						
Yes	19 (46.3)	7 (15.9)	9.258	*0.002	4.565	1.66-12.59
No	22 (53.7)	37 (84.1)				
Chronic Cough§						
Yes	2 (4.9)	1 (2.3)	0.429	0.512	2.205	0.19-25.28
No	39 (95.1)	43 (97.7)				
Phlegm						
Yes	31 (75.6)	12 (27.3)	19.838	*<0.001	8.267	3.12-21.89
No	10 (24.4)	32 (72.7)				
Chronic Phlegm						
Yes	14 (34.1)	0 (0)	17.987	*<0.001	-	-
No	27 (65.9)	44 (100)				
Wheezing§						
Yes	2 (4.9)	0 (0)	2.968	0.085	-	-
No	39 (95.1)	44 (100)				
Breathlessness§						
Yes	1 (2.4)	0 (0)	1.471	0.225	-	-
No	40 (97.6)	44 (100)				

*Significant at p < 0.05**;**
§ By x^2test with Yates' correction for expected value <5

4.4 TREND OF POLLUTANTS ($PM_{2.5}$, CO_2 AND NO_2) IN THE MORNING (PEAK HOUR) AND AFTERNOON (OFF-PEAK HOUR).

A Mann-Whitney U test was run to indicate whether there is any significant difference in level of pollutant ($PM_{2.5}$, CO_2 AND NO_2) between morning (peak hour) and afternoon (off-peak hour) inside the bus cabin using the same route in five days sampling. The data was collected at 5 minutes interval within duration of 1 hour 30 minutes for each pollutant. Based on the analysis, on average, in five days sampling, mass concentration for $PM_{2.5}$ were higher in the morning, 92.11 µg/m^3 compared with afternoon, 41.39 µg/m^3 due to the traffic emission at these times rush hours. For CO_2, the mean reading recorded in the morning was slightly higher, 286.99 ppm than afternoon, 143.22 ppm due to number of

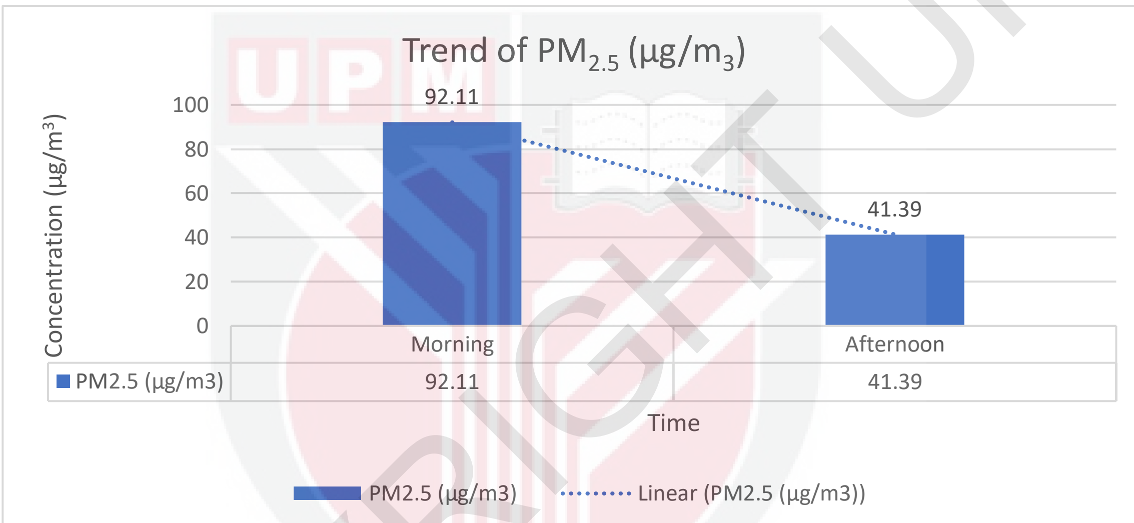

Figure 8: Trend of $PM_{2.5}$, in the morning and afternoon

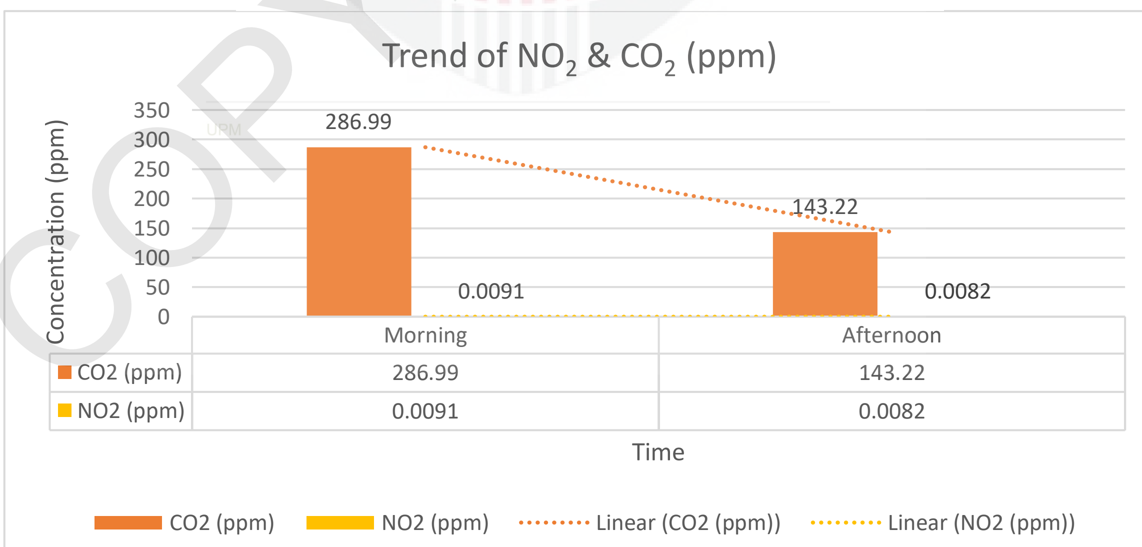

Figure 9: Trend of CO_2 & NO_2 in the morning and afternoon

Table 4.4: Comparison of Pollutants ($PM_{2.5}$, CO_2 AND NO_2) in the morning (peak hour) and afternoon (off-peak hour)

Variables	Morning (peak hour)	Afternoon (off-peak hour)	Z	p-value
	Median (IQR)			
Day 1				
$PM_{2.5}$ (µg/m^3)	73.0 (36.50)	34.50 (8.75)	-5.004	*<0.001
NO_2 (ppm)	0.001 (0.014)	0.008 (0.01)	-1.000	0.317
CO_2 (ppm)	304.50 (75)	118.0 (82)	-4.967	*<0.001
Day 2				
$PM_{2.5}$ (µg/m^3)	109.0 (46.75)	41.0 (9.75)	-5.128	*<0.001
NO_2 (ppm)	0.006 (0.016)	0.01 (0.008)	-0.558	0.577
CO_2 (ppm)	272.50 (54)	119.50 (38)	-.3909	*<0.001
Day 3				
$PM_{2.5}$ (µg/m^3)	69.50 (26.25)	38.50 (14.50)	-4.242	*<0.001
NO_2 (ppm)	0.00 (0.008)	0.003 (0.005)	-1.232	0.218
CO_2 (ppm)	204.0 (59)	82.0 (51)	-4.937	*<0.001
Day 4				
$PM_{2.5}$ (µg/m^3)	88.50 (30.50)	39.0 (13.25)	-4.953	*<0.001
NO_2 (ppm)	0.004 (0.015)	0.009 (0.008)	-0.928	0.353
CO_2 (ppm)	231.0 (83)	140.0 (52)	-.4667	*<0.001
Day 5				
$PM_{2.5}$ (µg/m^3)	88.50 (55.0)	40.50 (17.25)	-4.544	*<0.001
NO_2 (ppm)	0.007 (0.015)	0.005 (0.005)	-0.272	0.786
CO_2 (ppm)	272.0 (382)	194.50 (26)	-3.275	*0.001

***Significant at p<0.05**

CHAPTER 5

DISCUSSION

5.1 Sociodemographic Characteristic of Respondents

This study is to determine the association between exposure the exposure to indoor air pollutants with respiratory health symptoms among commercial bus drivers in Kota Bharu, Kelantan. This study was categorised into two groups which were exposed group (bus drivers) and comparative groups (office staffs). The respondents were bus drivers (34 respondents) from the private bus company named as Cityliner that operates in Kota Bharu area, and office staffs (54 respondents) who worked in office at the main bus station in Kota Bharu as well. The least returned questionnaire from the exposed group was due to the COVID-19 pandemic situation where the company have to reduce the trip of buses and lessen the number of employees who worked in a week.

The first objective of the study was to determine sociodemographic information among bus drivers as an exposed group and office staffs as a comparative group. The gender of all respondents was male as it was fixed in the inclusion criteria. Among the respondents who were included in questionnaires, the age distribution that ranges from 21-31 years old was higher in the comparative group. Meanwhile, respondents from bus driver were more likely in the range from 32-60 years old. Hence, there was a significant difference in age between the exposed group and comparative group (x^2=14.18, p<0.001).

Education level of respondents is important in order to understand the question asked in the questionnaires. Most of the bus drivers had low education level (73.5%), and only a few finished their studies at a high education level. Meanwhile, for office staffs, it is observed that more than half of them completed their education at a high education level (58.8%). Therefore, there was a significant difference in education level between these two different occupations (x^2= 8.60, p=0.003). Last of the sociodemographic information that have been collected was smoking status. As for the both study group, the respondents tend to have smoking habits. Thus, there was no significant difference in smoking status between both groups (x^2= 1.074, p=0.30).

5.2 Working History Between Bus Drivers and Office Staffs

The working duration of the study groups showed a significant difference. The mean of working history for exposed group (20 ± 8.74) years while for comparative group is (3 ± 1.22) years. Based on the observation, the exposed group had a higher working duration (years) compared to the comparative group. The bus company administration stated that these bus drivers deemed to loyal to the company instead of hoping to others employer due to age factor where most of them already aged. A previous study discovered that the drivers' ages ranged from 40 to 59, while their bus driving experience ranged from 5 to 30 years (Driverside, 2014). In addition, based on the past research, many drivers (35%) had between 6 and 10 years of driving experience (Bachok et al., 2018). On the other hand, office workers tend to work within their contract ranging only a few years and tend to shift their job after a few years. Hence, the gap of working history between both groups resulting a significant difference (Z=-7.856, p<0.001).

5.3 Exposure to Traffic Air Pollutant (TRAP) during Working Hour

According to the analysis, it is observed that there was a significant difference between these two groups in awareness of their level of exposure to TRAP during working

(x^2=52.36, p<0.001). Most of respondents from bus drivers, exposed to high level of exposure 22 respondents (64.7%). Meanwhile, for comparative group, the respondents were likely to expose to a low level of exposure 37 respondents (72.5%). Hence, based on the result, respondents were aware enough of their exposure to TRAP. According to Kavitha, Juliana and Abdah (2011), bus drivers are among the risk group exposed to highly polluted air consisting of a mixture of air pollutant for about eight hours without any personal protective equipment (Kavitha, Juliana & Abdah, 2011). However, there were few respondents from comparative subject exposed to the high level of exposure due to their work as ticket booth attendant that directly exposed to emission of TRAP.

5.4 Reported Respiratory Symptoms between Study Groups

A standardised questionnaire adapted from the American Thoracic Society (ATS-DLD-78-A) was used to assess respiratory health symptoms of bus drivers as exposed subject and office staffs as the comparative subject. The results of the returned questionnaire were examined for signs and symptoms of respiratory health such as cough, chronic cough, phlegm, chronic phlegm, wheezing, and breathlessness. The likelihood of developing respiratory symptoms is higher among respondents from the exposed group who exposed to a higher level of air pollutants than among respondents from the comparative group. Increased respiratory symptoms could be a result of bus drivers being exposed to outdoor air pollutants while on the road. A previous study found that the prevalence of respiratory symptoms among bus drivers is significantly higher than the prevalence of respiratory symptoms among the comparative group (Kavitha et al., 2010).

Table 4.3.1 shows that the proxies and reported respiratory symptoms based on the returned questioned where 25 (73.5%) and 12 (35.3%) of respondents from the exposed group, respectively, reported having respiratory symptoms of phlegm and chronic phlegm. According to Kavitha et al. (2010), bus drivers had a nearly thirteenfold and twenty times increased chance of developing cough and phlegm, respectively, compared to the control group (administrative staff). However, no significant associations were found between study groups and symptoms of phlegm, wheezing, and breathlessness. Chronic obstructive pulmonary disease (COPD) and asthma are the primary causes of wheezing (WebMD, 2020). Due to the exclusion of individuals history of respiratory diseases, both study groups experienced a low prevalence of wheezing and breathlessness symptoms.

5.5 Association between Working History and Respiratory Health Symptoms

Table 4.3.2 shows the result of the association between working history and respiratory health symptoms. The result indicates that cough, phlegm and chronic phlegm have a significant difference between long-term and short-term working history (x^2= 9.258, p = 0.002, OR = 4.565, 95% CI = 1.655 – 12.591), (x^2= 19.838, p < 0.001, OR = 8.267, 95% CI = 3.122 – 21.889) and (x^2= 17.987, p < 0.001) respectively. The work history is critical since the duration of employment may have an effect on the likelihood of developing respiratory disease. Previous researcher discovered that bus drivers experienced more respiratory symptoms as a result of the increased duration of work (years) (Bigert, 2007). A study conducted by Firdaus & Juliana (2014) found the results indicated an inverse correlation between working duration and FVC (p = 0.016, r = -0.434) and FEV1 (p = 0.013, r = -0.0450), indicating that exposure to air pollutants for an extended period of time also contributed to decreased lung function. Moreover, past researcher found that among non-smoking bus drivers of Hyderabad found having chronic respiratory diseases among drivers with over 10 years of experience in Andhra Pradesh State Road Transport

Corporation (APSRTC) (Faisal et al., 2013). Furthermore, according to these researchers, drivers who have the respiratory disease are found to be more likely to have the condition if they are over 45 years old and have been working at their job for over 20 years (Minov et al., 2019). However, in line with this, respiratory diseases were dependent on one's health status, eating habits, smoking status, and lifestyle. It is possible that respondents were exposed to indoor air pollutants for an extended period of time but maintained a healthy lifestyle and did not exhibit obvious respiratory symptoms decline (Firdaus & Juliana, 2014).

5.6 Trend of Pollutants ($PM_{2.5}$, CO_2 AND NO_2) in the Morning (Peak Hour) and Afternoon (Off-Peak Hour).

The mean exposure level of $PM_{2.5}$ in five days sampling showed that the trend of $PM_{2.5}$ is higher in the morning compared to evening where mass concentrations of $PM_{2.5}$ in the morning was 92.11 g/m^3 and in the afternoon was 41.39 g/m^3, due to traffic emissions during these rush hours. Fine particles, more precisely the $PM_{1.0}$ fraction, accounted for 79 percent of total PM in automobiles. In comparison, coarse particles $PM_{2.5\text{-}10}$ contributed the most to the fraction in buses and trains (Dayana & Russi, n.d.). During rush hours, the highest average $PM_{2.5}$ concentration was detected inside a bus (106 g/m^3) (Onat & Stakeeva, 2013). Until now, there is no specific indoor air quality standard for $PM_{2.5}$ in Malaysia. In the Malaysia Industrial Code of Practice (ICOP) on Indoor Air Quality, there is only state acceptable limit for respirable particulates. $PM_{2.5}$ with aerodynamic diameter up to 2.5 micrometres was categorised under the fine inhalable particles (US EPA, n.d.). However, World Health Organization (WHO) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) stipulates standards $PM_{2.5}$

should not exceed 25 µg/m^3 and 65 µg/m^3 respectively for the 24-hour mean (Dayana & Russi, n.d.). Besides, Occupational Safety and Health Administration (OSHA) also stipulates the standards for $PM_{2.5}$ where should not exceed 5mg/m^3 for the 8-hour mean (Dayana & Russi, n.d.).

When it comes to CO_2, the mean value recorded in the morning is a little higher, 286.99 ppm, compared to afternoon, 143.22 ppm, because passengers have a stronger influence on the CO_2 level in the morning compared to the afternoon. These findings are in line with a few epidemiological studies, which have stated the number of passengers aboard a tour bus cabin has a significant effect on the CO_2 concentrations in the cabin (Marthur, 2008; Huang & Hsu, 2009; Hsu & Huang, 2009). As the air from bus occupants helped build up CO_2 within buses, the concentrations of CO_2 were also seen as increasing if there was no opening of door or windows. Hudda and Fruin (2018) showed that CO_2 tends to accumulate and concentrations of 1000 ppm can be reached when air is recirculated. However, based on the recorded results, the mean reading was not even exceeded 500 ppm due to the bus frequently stopped during the journey that allows air to circulate in and out of buses. For CO_2, The National Institute for Occupational Safety and Health (NIOSH) recommends a range of 1000 ppm and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommends a range of 700 ppm.

However, there was no significant difference for nitrogen dioxide NO_2 between morning and evening where the average in 5 days sampling was 0.0091 ppm in morning slightly higher than afternoon, 0.0082 ppm. The reading in the morning was expected to be higher since the traffic was congested during this period due to the higher number of vehicles on the road. Studies in the past have shown that the concentrations of NOx significantly increased between 8:00 and 09:00 and decreased between 12:00 to 2:00 pm (first peak) (Abdul Halim et al., 2018). Unfortunately, the reading recorded was lower than expected outcome due to the result of this pollutant's cleansing activity caused by rains. It appears that rainfall assists in the reduction of pollutants by depositing pollutants (Lazaridis, 2011). Currently, there were no standards governing the amount of nitrogen dioxide allowed in indoor air. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and the US Environmental Protection Agency (EPA) have established a 24-hour average limit for NO_2 in outdoor air of 0.053 parts per million (ppm) (US EPA, 2017).

CHAPTER 6

SUMMARY

6.1 Conclusion

This study suggests that bus drivers who were exposed to a higher level of air pollutants had higher risk of developing respiratory symptoms. In this study, cough, phlegm and chronic phlegm symptoms were reported higher among bus drivers compared to administrative staff. Hence, there was a significant difference in reported cough, phlegm and chronic phlegm between study groups. Besides, working history and respiratory symptom were analysed in order to determine the association between these variables. However, there was a significant difference only in cough, phlegm and chronic phlegm with the working history. According to the findings, those who worked for a long period of time were four to eight times more likely to develop cough, phlegm, and chronic phlegm, respectively, than those who worked for a short period of time.

Furthermore, personnel air monitoring has been conducted in order to determine level of pollutant ($PM_{2.5}$, CO_2 AND NO_2) between morning (peak hour) and afternoon (off-peak hour) inside the bus cabin using the same route in five days sampling. Even though there is a significant in the level of $PM_{2.5}$, CO_2 and NO_2 between morning (peak hour) and afternoon (off-peak hour), the reading of these pollutant much lower and does not exceed acceptable limits stipulates by any standard that have been stated in the discussion part.

These hypotheses set in the early stage of this study had been tested statistically and those proven to be true as follows:

1. There is a significant difference between the reported respiratory symptoms among the respondents in exposed and comparative group.
2. There is a significant difference between the reported respiratory symptoms among the respondents who are in long and short working history.
3. There is a significant difference in pollutants between morning (peak hour) and afternoon (off-peak hour).

6.2 Limitations

This study has several flaws, the majority of which are due to the way it was designed. As a cross-sectional study only takes a cross-section of the population, it is only utilised to select a representative sample. It can also only be used to evaluate respiratory disease prevalence and association, not causation. Even though an association has been shown, there is insufficient evidence to demonstrate the true causality relationship. The result of this study cannot be generalised to all the bus drivers because the selection of the study population was based on some exclusive criteria. Those who are having history of respiratory diseases will be excluded from this study.

Besides, even though this study did undertake measurements of indoor air pollution inside the bus cabin, a lung function test has not been conducted. Thus, the association established may be inaccurate and can only be established based on the responses to the questionnaire. Furthermore, the personnel air monitoring that has been conducted was only limited to a few bus drivers due to the Standard Operating Procedure (SOP) of the company facing the COVID-19 situation in Malaysia, which is worsening by the day and compliance with the Movement Control Order (MCO) that was established as a preventive precaution. Hence the sample size from the exposed group was not enough.

In addition, there seems to be a risk of recall bias, which occurs when certain of bus drivers do not recall earlier events or experiences accurately or in-depth when filling out the questionnaire. Also, since this study is voluntary-oriented, the respondents tend to withdraw their participation halfway through or not completed the questionnaire since they believe that it is too lengthy and detailed to be answered.

6.3 Recommendations

To improve this research in the future, consider using a larger sample size with people of various ethnicities and ages so that the data collected can represent the entire population of Malaysia. To achieve a stronger association between the exposure to air pollutants with respiratory health symptoms among commercial bus drivers, precise air pollution exposure monitoring for every bus driver in various trip and lung function test can be conducted. For administrative control, during the bus's idle time, while the driver awaits their turn or shift to complete the trip, it is recommended that drivers wait in an area away from traffic or the bus station. It is to minimise or eliminate the risk of exposure to traffic-related air pollutants while they wait. The management could designate a designated area or room for the driver to wait in order to avoid exposure to traffic air pollutants. Additionally, the management could provide bus drivers with training or an awareness programme regarding air pollution exposure to help them better understand the issue. It is to ensure that the driver makes the correct decision or takes the appropriate action if they observe any abnormalities during their working hours. Additionally, management could provide health screenings such as lung function tests to monitor their employees, allowing for immediate action in the event of declining trends in their employees' overall health.

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APPENDICES

Appendix 1: Gantt Chart for Research Process

No	Activities	2021									
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
1	Proposal Preparation										
2	Ethic Application										
3	Pre-Study										
4	Proposal Presentation										
5	Site Visit										
6	Data Collection (Air Sampling Assessment & Physiological Assessment										
7	Data Analysis										
8	Data Interpretation										

9	Thesis Writing										
10	VIVA										
11	Thesis Review										
12	Thesis Submission										

ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS (JKEUPM)
UNIVERSITI PUTRA MALAYSIA

Research title	:	**Association Between the Exposure to Air Pollutants with Respiratory Health Effects among Commercial Bus Drivers in Kelantan.**
Study Site	:	**Kota Bharu, Kelantan**
JKEUPM Ref No.	:	**JKEUPM-2021-027**
Researcher	:	**Zhafir Adam Ayub**
Supervisor	:	**Prof. Dr. Juliana Jalaludin**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 11/1/2021
2. Respondent Information Sheet & Consent (English), Version 2 dated 9/3/2021
3. Respondent Information Sheet & Consent (Malay), Version 2 dated 9/3/2021
4. Proposal (English), Version 2 dated 9/3/2021
5. Questionnaire/Interview (Malay), Version 1 dated 11/1/2021
6. Curriculum Vitae of:
   a. Prof. Dr. Juliana Binti Jalaludin

The University Research Ethics Committee, Universiti Putra Malaysia (JKEUPM) operates in accordance to the ICH-GCP Guidelines.
Decision by JKEUPM:

[x] Approved
[x] **Permission MUST BE OBTAINED from the respective hospitals/ institutions before conducting the research**
[ ] Disapproved

Please note that the approval is **VALID UNTIL 17 MARCH 2022**

Researchers should comply with the following:

I. Complete a Study Final Report upon study completion (Form 3.2).

II. Ethical approval is required in the case of amendments/ changes to the study documents/ study sites/ study team.

III. Applicable for Clinical Trial Studies and Clinical interventional Studies only: Progress Report has to be submitted to JKEUPM at every 6 months from the date of approval (Form 3.1). Report occurrences of all Serious Adverse Events (SAEs), Suspected Unexpected Serious Adverse Reaction (SUSARs) and Protocol Deviation/ Violation at all JKEUPM approved sites to JKEUPM. SAEs are to be reported within 15 calendar days from awareness of event by investigator. Initial report of SUSARs are to be reported as soon as possible but not later than

Appendix 3: Respondent's Information Sheet and Informed Consent Form (English)

JAWATANKUASA ETIKA UNIVERSITI UNTUK PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG, SELANGOR, MALAYSIA

FORM 2.4: RESPONDENT'S INFORMATION SHEET AND INFORMED CONSENT FORM

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

1. STUDY TITLE : Association between the Exposure to Air Pollutants with Respiratory Health Effects among Commercial Bus Drivers in Kelantan.

2. INTRODUCTION:

The study seek to determine the association between the exposure to air pollutants and its implication towards respiratory health problem. There is various harmfull effect of air pollutants for example coughing and breathing difficulty. The indoor air quality also affect our respiratory health significanlty as nowadays we spend major of our times reside inside an enclosed building.

3. WHAT WILL YOU HAVE TO DO?

Respondent need to fill up the consent form to show that you are interested and willingly to participate in the study. Next, respondent need to read and understand the instructions and infromation that consisted in consent form. Then, respondent need to complete the questionnaire which consist of 2 parts. The expected duration for respondent to complete the questionnaire is about 15 minutes.

4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

Participant who should not participate in the study are female, not in range 20-56 years old and does not have at least one year experince in working.

5. WHAT KIND OF TREATMENT WILL YOU RECEIVE AFTER MY PARTICIPATION IN THE TRIAL?

No any treatment or medical care will be provided to you at the end of your participation in the study.

6. WHAT WILL BE THE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

This study will provide the respondent about the knowledge regarding to the exposure of air pollutants. Besides, the respondent also able to know the relationship between the current health condition with the level of air pollutants. You will not be given any compensation to take part in this study.

(b) TO THE INVESTIGATOR?

Firstly, this study will determine quantitative data on personal exposure of air pollutant. Next, this study also will help the investigator to determine association between the exposure to air pollutants with respiratory health effects among respondents.

7. WHAT ARE THE POSSIBLE RISKS?

There are no possible risks available since this study not involving any direct contact or clinical trial.

8. WILL THE INFORMATION THAT YOU PROVIDE AND YOUR IDENTITY REMAIN CONFIDENTIAL?

All information collected will be kept strictly confidential. Any information relating to results of the data obtained will not be identifiable in published material which the data not be disclosed to any regulatory body and this study is for research purposes only.

9. WHO SHOULD YOU CONTACT IF YOU HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?

If there any question and curiosity about this study, the respondent may contact the supervisor:

Prof. Dr. Juliana Binti Jalaludin at 017-6834103 or email juliana@upm.edu.my or the investigator of this study, Zhafir Adam Bin Ayub at 017-9190164 or email 194432@student.upm.edu.my.

Please initial here if you have read and understood the contents of this page______

10. CONSENT

I …………………………………… Identity Card No. …………………………… address…………………………………………………………………………………………………...
…………………………………………………..hereby voluntarily agree to take part in the research stated above *(clinical /drug trial/video recording/ focus group/interview-based/ questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse effects and complications (as written in the Respondent's Information Sheet). I understand that I have the right to withdraw from this research at any time without giving any reason whatsoever. I also understand that this study is confidential and all information provided with regard to my identity will remain private and confidential.

I* wish / do not wish to know the results related to my participation in the research

I agree/do not agree that the images/photos/video recordings/voice recordings related to me be used in any form of publication or presentation (if applicable)

* delete where necessary

Signature ……..…………………………… (Respondent)

Signature ……..…………………………… (Witness)

Date :…………………………………….…..

Name :…………………………………….…..

I/C No. :…………………………………..…..

I confirm that I have explained to the respondent the nature and purpose of the above-mentioned research.

Date ……..…………………………

Signature ……..…………………………… (Researcher)

Appendix 4: Respondent’s Information Sheet and Informed Consent Form (Malay)

JAWATANKUASA ETIKA UNIVERSITI UNTUK PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)

UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG, SELANGOR, MALAYSIA

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 Pendedahan Pencemaran Udara dengan Kesan Kesihatan Pernafasan di kalangan Pemandu Bas Komersial di Kelantan.

2. PENGENALAN

Kajian ini bertujuan untuk menentukan hubungan antara pendedahan pencemaran udara dan implikasinya terhadap masalah kesihatan pernafasan. Terdapat pelbagai kesan berbahaya pencemaran udara seperti batuk dan kesukaran bernafas. Kualiti udara dalaman juga mempengaruhi kesihatan pernafasan kita kerana pada masa ini kita kerap menghabiskan sebahagian besar masa kita berada di dalam tempat yang tertutup.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Responden perlu mengisi borang persetujuan untuk menunjukkan bahawa anda berminat dan rela mengambil bahagian dalam kajian ini. Seterusnya, responden perlu membaca dan memahami arahan dan maklumat yang terdiri dalam borang persetujuan. Kemudian, responden perlu melengkapkan soal selidik yang terdiri daripada 2 bahagian. Jangka masa yang diharapkan bagi responden untuk mengisi soal selidik adalah sekitar 15 minit.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Peserta yang tidak boleh mengikuti kajian ini adalah kaum wanita, bukan berumur dalam lingkungan 20-56 tahun dan tidak mempunyai pengalaman sekurang-kurangnya satu tahun dalam pekerjaan sekarang.

5. APAKAH JENIS RAWATAN YANG AKAN ANDA DAPATKAN SELEPAS PENYERTAAN SAYA DALAM PERCUBAAN?

Tidak ada rawatan atau rawatan perubatan yang akan diberikan kepada anda pada akhir penyertaan anda dalam kajian ini.

6. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Kajian ini akan memberi maklumat dan pengetahuan mengenai responden mengenai pendedahan pencemaran udara.. Selain itu, responden juga dapat mengetahui hubungan antara keadaan kesihatan semasa dengan tahap pencemaran udara yang dihadapi. Anda tidak akan diberi pampasan untuk mengambil bahagian dalam kajian ini.

b) KEPADA PENYELIDIK?

Pertama, kajian ini akan menentukan data kuantitatif mengenai pendedahan pencemaran udara yang dihadapi oleh responden. Seterusnya, kajian ini juga akan membantu penyelidik menentukan hubungan antara pendedahan pencemaran udara dengan kesan kesihatan pernafasan di kalangan responden.

7. ADAKAH IA BERISIKO?

Tiada risiko kerana kajian ini tidak melibatkan persentuhan secara langsung atau percubaan klinikal.

8. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Semua maklumat yang dikumpulkan akan dirahsiakan. Segala maklumat yang berkaitan dengan hasil data yang diperoleh tidak akan dapat dikenal pasti dalam bahan yang diterbitkan yang mana data tersebut tidak akan dikeluarkan kepada mana-mana pihak pun dan kajian ini hanya untuk tujuan penyelidikan.

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

Sekiranya terdapat pertanyaan dan rasa ingin tahu mengenai kajian ini, responden boleh menghubungi penyelia kajian: Prof Dr Juliana Binti Jalaludin di 017-6834103 atau e-mel juliana@upm.edu.my atau penyiasat kajian ini, Zhafir Adam Bin Ayub di 017 -9190164 atau e-mel 194432@student.upm.edu.my.

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

10. 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.

I 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 ……..…………………………
(*Responden*)

Tarikh :……………………………………..…..

Tandatangan ……..………………………….
(*Saksi*)

Nama :……………………………………..…..

No. K/P: ……………………………………..…..

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

Tarikh ……..…………………………

Tandatangan ……..………………………….
(*Penyelidik*)

Appendix 5: Questionnaire (Malay)

FAKULTI PERUBATAN DAN SAINS KESIHATAN

JABATAN KESIHATAN PERSEKITARAN DAN PEKERJAAN

(Borang Soal Selidik)

“ Hubungan antara Pendedahan Pencemaran Udara dengan Kesan Kesihatan Pernafasan di kalangan Pemandu Bas Komersial di Kelantan.”

Terima kasih atas kesudian pihak tuan menyertai penyelidikan saintifik ini. Kerjasama dari pihak tuan untuk memberi jawapan yang jujur adalah sangat penting dalam melaksanakan dan menjayakan kajian ini.

Kesemua maklumat yang diperolehi dalam kajian ini akan dirahsiakan dan hanyalah untuk tujuan kajian kesihatan sahaja.

RESPONDEN | | | |

TARIKH SOAL SELIDIK | | | | | | | | |

Bahagian A: Maklumat Peribadi Responden

1. No. Tel: | | | | | | | | | | | |

2. No. K/P: | | | | | | | | | | | | | | |

3. Jantina: Lelaki ☐ Perempuan ☐

4. Bangsa: Melayu ☐ Cina ☐ India ☐ Lain-lain ☐

5. Umur: | | | tahun

6. Berat Kg: | | | |

7. Tinggi (cm): | | | |

8. Status Perkahwinan: Bujang ☐ Berkahwin ☐ Lain-lain ☐

9. Taraf Pendidikan:

Tidak Bersekolah	☐	Tingkatan 5	☐
Sekolah Rendah	☐	STPM/Diploma	☐
Tingkatan 3	☐	Ijazah	☐

10. Merokok Ya ☐ Tidak ☐

Bahagian B: Makluman Pekerjaan

(I) Sejarah Pekerjaan Dahulu

1. Sebelum bekerja di syarikat sekarang, pernahkah anda bekerja di syarikat lain?

   Ya ☐ Tidak ☐

2. Jika Ya, sila nyatakan pekerjaan dan tempat kerja anda yang terakhir.

   ____

3. Berapa lamakah anda telah bekerja (Pekerjaan sebelum ini)?

   ☐☐ Tahun ☐☐ Bulan

4. Tempoh bekerja (jam/sehari): ☐☐

(II) Makluman Pekerjaan Sekarang

1. Berapa lamakah anda telah bekerja bersama syarikat sekarang?

   ☐☐ Tahun ☐☐ Bulan

2. Secara purata, berapakah tempoh masa anda bekerja dalam sehari?

   ☐☐ Jam sehari

3. Berapa jamkah anda bekerja di dalam bas dalam seminggu?

   ☐☐ Jam seminggu

4. Berapa kerapkah anda terdedah kepada asap/debu yang berbahaya serta bahan kimia dari kenderaan?

a. Sedikit ☐ b. Sederhana ☐ c. Banyak ☐

5. Adakah pekerjaan dahulu menyebabkan anda mengalami masalah gangguan kesihatan?

   Ya ☐ Tidak ☐

   Jika Ya, sila jawab soalan 6 dan jika tidak, terus ke soalan 7.

6. Sila nyatakan masalah kesihatan yang dihadapi.

   ____

7. Adakah pekerjaan sekarang menyebabkan anda mengalami masalah gangguan kesihatan?

   Ya ☐ Tidak ☐

   Jika Ya, sila jawab soalan 8 dan jika tidak, terus ke bahagian seterusnya.

8. Sila nyatakan masalah kesihatan yang dihadapi.

   ____

Bahagian C: Makluman Tentang Kesihatan

1. Adakah anda mengalami masalah gangguan atau sakit pada paru-paru sebelum berumur 16 tahun?

   Ya ☐ Tidak ☐

2. Adakah anda menghidap penyakit berikut:
   a. Asma ☐
   b. Emfisema (paru-paru mengembang) ☐

c. Barah paru-paru
d. Bronkitis
e. Lain-lain (Nyatakan)

5. Jika Ya, bilakah penyakit tersebut bermula?
   a. Sejak kecil
   b. Dewasa/sebelum kerja
   c. Setelah bekerja
   d. Tidak pasti

6. Penyakit anda disahkan oleh doktor? Ya ☐ Tidak ☐

7. Mendapat rawatan untuk penyakit tersebut? Ya ☐ Tidak ☐

8. Masih mendapat rawatan? Ya ☐ Tidak ☐

BATUK (COUGH)

	Ya	Tidak
1. Adakah anda sering mnegalami batuk-batuk? (Batuk dibuat untuk berkahak tidak kira sebagai batuk)	☐	☐
2. Adakah anda sering batuk 4 hingga 6 kali sehari atau berlarutan selama 4 hari seminggu?	☐	☐
3. Adakah anda batuk semasa bangun daripada tidur atau pada waktu Pagi?	☐	☐
4. Adakah anda batuk pada waktu siang atau malam?	☐	☐
5. Adakah anda batuk untuk selama 3 bulan berturut-turut dalam setahun?	☐	☐
6. Adakah anda mengikuti sebarang rawatan?	☐	☐

7. Berapa lamakah anda mengalami batuk tersebut?

☐☐ Bulan ☐☐ Tahun

KAHAK (PHLEGM)

	Ya	Tidak
1. Adakah anda sering berkahak bepunca daripada bahagian dada anda?	☐	☐
2. Adakah anda berkahak lebih daripada 2 kali sehari dan berlarutan Selama lebih 4 hari dalam seminggu?	☐	☐
3. Adakah anda batuk berkahak semasa bangun dari tidur atau pada waktu Pagi?	☐	☐
4. Adakah anda berkahak pada waktu siang atau malam?	☐	☐

5. Apakah warna kahak anda? ____

6. Berapa lamakah anda telah mengalami keadaan berkahak sebegini?

☐☐ Bulan ☐☐ Tahun

7. Adakah anda mengalami sesak nafas (Breathlessness)?	☐	☐
8. Adakah anda mendesah (Wheezing)?	☐	☐

Bahagian D: Sejarah Penyakit Keluarga

	Ya	Tidak
1. Asma	☐	☐
2. Emfisema	☐	☐
3. Barah paru-paru	☐	☐
4. Bronkitis kronik	☐	☐

5. Lain-lain masalah penyakit:

____