UNIVERSITI PUTRA MALAYSIA

RELATIONSHIP BETWEEN TRAFFIC-RELATED AIR POLLUTANT DURING VEHICLE IDLING AND RESPIRATORY HEALTH EFFECT AMONG PRIMARY SCHOOL CHILDREN IN SK JALAN 3, BANDAR BARU BANGI.

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ABSTRACT

RELATIONSHIP BETWEEN TRAFFIC-RELATED AIR POLLUTANT DURING VEHICLE IDLING AND RESPIRATORY HEALTH EFFECT AMONG PRIMARY SCHOOL CHILDREN IN SK JALAN 3, BANDAR BARU BANGI.

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Introduction: Car exhaust emissions contains traffic-related air pollutants (TRAP) including particulates airborne when fossil fuels is combusted as car idle or accelerates. Vehicle idling is one of the major contributors to traffic related air pollutants within school areas which give adverse health effect to school children. However, there has been little study reported adverse effects on school children's respiratory health from such exposure to vehicle idling activity. **Objectives:** This study is conducted to determine the relationship between concentrations of TRAP during vehicle idling and respiratory symptoms among primary school children. **Methodology:** This cross-sectional study was conducted from January to March 2019 where air sampling was monitored at drop off-pickup zone in a primary school located in Bandar Baru Bangi,Selangor. $PM_{2.5}$ were measured by using SidePak AM520 where the sampling were conducted for 1 hour 10 minutes during drop-off (6:30am to 7:40am) and pick-up (12:45pm to 1:50pm). The traffic density at the sampling location were calculated manual and meteorological data was observed using Kestrel 5500 Weather Meter. A validated questionnaire from International Study of Asthma and Allergies in Childhood (ISAAS) for 6-7 years old were distributed to 91 respondents from self-assessment by their parents or guardian. Lung function test was used to assess the FVC, FEV_1, FVC% predicted, FEV_1% predicted and FVC/FEV_1 % predicted using Spirometer HI-105. **Result:** The levels of $PM_{2.5}$ during drop-off were higher 78% (38.3±10.7 $\mu g/m^3$) during drop off compare to pick up time (29.7±12.5 $\mu g/m^3$). The concentrations of $PM_{2.5}$ were 1.5 times lower during the weekend compared to weekday measurements. The traffic count for the weekdays were 10 times higher compared to the weekends. There were significant association between TRAP and lung function of children where FEV_1% predicted (p=0.05), FVC/FEV_1% predicted (p=0.029). **Conclusion:** Exposure to TRAP during car idling significantly reduces the respiratory health of the children. This study suggests the school administration to consider introducing no-idling zone within their school proximity to ensure clean air for the school children. We also suggest the school management to be more strict in the number of vehicle using the school road where it encourage the students who live near the school to adopt active commuting by walking or cycling to school.

Keywords: *Vehicle idling, Traffic-Related Air Pollutants (TRAPs), Respiratory health effect*

ABSTRAK

HUBUNGKAIT ANTARA PENCEMARAN UDARABERKAITAN LALU LINTAS SEMASA MELAHU KENDERAAN DENGAN GEJALA-GEJALA KESIHATAN PERNAFASAN DALAM KALANGAN PELAJAR SEKOLAH RENDAH DI SK JALAN 3, BANDAR BARU BANGI.

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Pendahuluan: Asap kereta mengandungi bahan pencemaran udara yang berkaitan dengan lalu lintas. Melahu kenderaan adalah salah satu penyumbang utama kepada pencemar udara yang berkaitan dengan lalu lintas di sekolah yang memberi kesan buruk kepada kesihatan kanak-kanak sekolah. Terdapat kajian terhad mengenai bagaimana pencemaran daripada melahu kenderaan dapat memberi kesan kesihatan kepada kanak-kanak sekolah. **Objektif:** Kajian ini dijalankan untuk menentukan hubungan antara pencemaran udara lalu lintas semasa aktiviti melahu kenderaan dengan gejala-gejala kesihatan pernafasan dalam kalangan pelajar sekolah rendah di Bangi, Selangor. **Metodologi:** Kajian ini dijalankan dari Januari hingga Mac 2019 di mana pensampelan udara dijalankan dan penilaian pernafasan dilakukan kepada 91 murid sekolah rendah di sebuah sekolah rendah di Bangi, Selangor. PM2.5 diukur dengan menggunakan SidePak AM520 di mana pensampelan dilakukan selama 1 jam 10 minit semasa diturunkan (6:30 pagi hingga 7:40 pagi) dan semasa diambil dari sekolah (12:45 petang hingga 1:50 petang). Ketumpatan lalu lintas di lokasi pensampelan telah dikira manual dan data meteorologi diperhatikan menggunakan Kestrel 5500 Weather Meter. Borang soal selidik yang telah disahkan dari Kajian Asma dan Alergi Kanak-Kanak Antarabangsa untuk 6-7 tahun telah diedarkan kepada responden untuk penilaian oleh ibu bapa atau penjaga mereka. Ujian fungsi paru dijalankan untuk menilai FVC, FEV1, FVC% meramalkan, FEV1% meramalkan dan FVC / FEV1% meramalkan menggunakan Spirometer HI-105. **Keputusan:** Kepekatan PM2.5 semasa penurunan adalah lebih tinggi (38.3 ± 10.7 µg / m3) berbanding dengan pengambilan (29.7 ± 12.5 µg / m3). Kepekatan PM2.5 adalah 1.5 kali lebih rendah pada hujung minggu bagi kedua-dua drop-off dan pick-up yang masing-masing (20.5 ± 2.6 µg / m) dan (21.8 ± 1.6 µg / m^3). Terdapat hubungan yang signifikan antara TRAP dan fungsi paru-paru kanak-kanak di mana FEV1% meramalkan ($p = 0.05$), FVC / FEV1% meramalkan ($p = 0.029$). **Kesimpulan:** Pendedahan kepada pencemaran udara lalu lintas semasa melahu kenderaan dengan ketara mengurangkan kesihatan pernafasan kanak-kanak. Kajian ini mencadangkan pentadbiran sekolah untuk mempertimbangkan memperkenalkan zon tidak melahu kenderaan di kawasan sekolah mereka untuk memastikan udara bersih untuk kanak-kanak sekolah. Kami juga mencadangkan pengurusan sekolah menjadi lebih ketat dalam bilangan kenderaan menggunakan jalan sekolah di mana ia menggalakkan pelajar yang tinggal berhampiran sekolah untuk mengamalkan perjalanan pasif melalui berjalan atau berbasikal ke sekolah.

Kata Kunci: *Melahu Kenderaan, Pencemaran udara berkaitan lalu lintas, Gejala-gejala kesihatan pernafasan*

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LIST OF ABBREVIATIONS

<	Less than
>	More than
$\mu g/m^3$	Microgram per metre cube
ATS	American Thoracic Society
BMI	Body Mass Index
BTPS	Body Temperature and Pressure Saturated
CI	Confidence Interval
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DOSH	Department of Occupational Safety and Health
EPA	Environmental Protection Agency
FVC	Forced Vital Capacity
FEV_1	Forced Expiratory Volume in 1 Second
IQR	Interquartile Range
ISAAC	International Study of Asthma and Allergies in Childhood
km	Kilometre
L	Liters
m	Metre
MAPI	Malaysian Air Pollution Index
MOE	Ministry of Education
NIOSH	National Institute of Occupational Safety and Health
NIESH	National Institute of Environmental Health Sciences
NO_x	Nitrogen Oxides

OR	Odd Ratio
O_3	Ozone
$PM_{2.5}$	Particulate matter with up to 2.5 micrometres aerodynamic diameter
PM_{10}	Particulate matter with up to 10 micrometres aerodynamic diameter
ppb	Parts per billion
ppm	Parts per million
PR	Prevalence Rate
RH	Relative Humidity
RMAQG	Recommended Malaysian Air Quality Guideline
SD	Standard Deviation
SK	Sekolah Rendah
SPSS	Statistical Package for Social Science
TRAPS	Traffic-Related Air Pollutions
TRB	Transport Research Board
UPM	Universiti Putra Malaysia
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1. Background

Air pollution causes significant effects on human wellbeing and the environment, specifically in the developing countries including China and India (Yang&Bing, 2018). According to World Health Organization (WHO), 1 in 8 death worldwide (approximately 7 million people in 2012) are due to air pollution, of which over half are due to outdoor air pollutants for both urban and rural area. Adding to that statistic, WHO also stated that about 92% of the global pollution lives in the places where the air quality miss to meet WHO targets (Brugha, Edmondson, & Davies, 2018). Urban air pollution mostly comprises of particles and gases emerging from burning of petroleum derivatives in engines such a petrol, gasoline and diesel and in power plants (Kelly&Fussel, 2011).

Traffic related air pollution (TRAP) has become world's major concern whereby this large number of population is being exposed to air pollution which is above the WHO standard daily in the urban environment (Matt et al., 2016). According to Department of Statistic Malaysia, in Compendium of Environment

Statistics 2016, motor vehicles was the main source contributed to emission of pollutants to the air of 2.1 million tonnes, that contributed about 70% of pollutants to the atmosphere followed by 24.3% from power plant, 2.9% others such as open burning and 2.8% from industrial. It has found that vehicle idling is another major contributor for traffic related air pollution with higher emission during congested periods (Smit et al, 2008). TRAP is consisting of several components of pollutants such as gages, organic compounds, metals and particulate matters (PM) (Costa et al., 2017). Other common air pollutants that being a major concern are ozone (O3), carbon monoxide (CO), sulfur dioxide (SO2), nitrogen dioxide (NO2) and volatile organic compounds (VOC).

Increases in air pollution level has become a major concern to public health specifically to those who are living in the urban areas which high air pollution level is associated with few health outcomes, such as lung cancer, cardiovascular disease, and childhood asthma (Shmuel, White, & Sandler, 2017). Furthermore, being exposing to traffic related air pollution for long period is also associated with respiratory symptoms (Matt et al., 2016).

Besides the above, a change from private-automobile usage to active mobility like cycling or walking is often promoted as a means of reducing TRAP levels in urban areas. However, opting for active transportation has been found to increase exposure to TRAP (Knibbs et al., 2011; Zuurbier et al., 2010), which could lead to a decrease in lung function in susceptible and healthy adults (McCreanor et al., 2007; Muet al., 2014), and to a substantial increase in the inhaled dose of TRAP (Int Panis et al., 2010; Zuurbier et al., 2010; Zuurbier et al., 2009). Nazelle et al. (2016) mentioned in their study that active travel has adverse consequences of potential increased pollutant inhalation during walking or cycle, their study also proven that pedestrian expose to 1.3 to 1.5 times higher for $PM_{2.5}$.

Vehicle idling is another significant activity that releases highest amount of traffic-related air pollution (Natural Resources of Canada, 2003). According to Natural Resources of Canada, every liter of gasoline that is burned produces about 2.3kg of CO_2 , and for an average vehicle with a 3-liters engine, idling for ten minutes burn 300 milliliters (over 1 cup) of fuel and this produces 690 grams of CO_2 (Natural Resources of Canada, 2017). According to Sustainable America, increase respiratory diseases such as asthma, heart and lung disease and even cancer is closely linked with vehicle exhaust (Sustainable America, 2017). The air pollutants that are released from the vehicle idling are harmful to the health especial to kids, as their lungs are still developing and have suppress immunity (Sustainable America, 2017).

Furthermore, a study conducted in the United States showed that one vehicle dropping off and picking up children at school releases three pounds which equivalent to 1.36 kg of air pollution each month (University of Michigan, 2013). To date, in Malaysia there are many studies conducted to investigate relationship between traffic-related air pollution and health effect on children (Syed & Sharifah,

2017) however there is no studies conducted on the respiratory effect to school children due to vehicle idling at school.

In Malaysia, most of the schools are located nearby road side, in which students are exposed to excessive traffic related air pollutants other than from vehicle idling. The study is to determine the relationship between vehicle idling and respiratory health effect during vehicle idling among school children in Bandar Baru Bangi. This study could benefit the stakeholder to start a no-idling campaign at the school in order to improve the air quality at the school area as well as able to improve the health of the school children.

1.2. Problem Statement

There are three main sources of air pollution in Malaysia, such as mobile sources, stationary sources and open-burning sources. It has found that 70-75% of vehicle emissions were contributed as mobile sources in Malaysia (Department of Statistic, 2016). Pollutants that are being released from motor vehicles, such as sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), ozone (O_3), and particulate matter (PM) (Kampa and Castanas, 2008) are contributing factors to adverse human health effect. Particulate matter in air pollution is the 13th leading cause of mortality globally, in which it contributes about 800,000 premature deaths per year (WHO, 2002).

Among human body system, respiratory system is more susceptible and vulnerable to air pollution and children under 5 years old and elderly. They are among the most susceptible group in exposing themselves to asthma and chronic obstructive pulmonary diseases due to excessive exposure to pollutants (Brunkreef and Holgate, 2002). Costa et al. (2017) suggested that young individual may be particularly susceptible to air pollution-induced neurotoxicity. Furthermore, based on a study conducted in Mexico City revealed that children which exposed to high air pollution may resulted in deficit cognitive (Costa et al, 2017).

Vehicle idling plays a major role in the affecting quality of air around the school area and according to EPA trucks and locomotive engine idling emits 11 million tons of carbon dioxide annually, along with 200,000 tons of oxides of nitrogen and 5,000 tons of particulate matters (EPA, 2008). Emissions from vehicle idling activities released air pollutants such as carbon dioxide and nitrogen dioxide directly to the atmosphere and these air pollutants often linked with acute and chronic health risks (Upstream Downstream, 2018). Therefore, it is utmost important to carry out this study to determine the effect of vehicle idling and the respiratory heath effect to the children, and with this study the school can come up with policies to stop vehicle idling during dropping off and picking up their children.

1.3. Study Justification

In present there are many studies that focus on children health effect due to exposure to air pollution be it indoor air pollution or outdoor air pollution which is from industrial as well as traffic related air pollution. However, there are no studies being performed on the health effect to the school children, primary school specifically due vehicle idling activity around the school compound in Malaysia. Therefore, this study needs to be perform in order to find out possible health effect in the school children due to over exposure to traffic-related air pollution in proximity within the school areas.

Apart from that school student often wait at the bus stand or nearby the school fences meanwhile waiting for their parents or guardians or school bus. Most schools all over the world are located on high traffic roadside. Acute exposure to automobile exhaust is associated with respiratory symptoms and impaired lung function in children (Chattopadhyay et al., 2005). Study shows, children exposed to pollutants various type of pollutants at various school-related spaces for many hours. Since most of the schools are located nearby roadside, students are being exposed to traffic emission, the emission of pollutants is enhanced by additional pollutants due to drop-off and pick up traffic as children arrive to or depart from school (Kim, et al., 2016). The mean typical idling duration while waiting for a passenger is about

3-10 minutes (Jacob, 2009). Meanwhile, school children often wait for their parents to pick up from school for at least 5 minutes.

In addition, this study will create awareness to the school management and to the parents about the health impact from vehicle idling activity around the school area especially during the drop-off and pick-up period. Furthermore, this study can be a baseline study for the decision makers to come out with "No vehicle Idling" policy around the school area. This study will also highlight the importance of clean air in school and promote active commuting such as walking and cycling.

1.4 Conceptual Framework

This study aims to determine the association between traffic-related air pollution and respiratory health symptoms during vehicle idling among primary school children at Bandar Baru Bangi, Selangor. From the conceptual framework (Figure 1.1), the studied pollutant is $PM_{2.5}$. Exposure to these pollutants is from the vehicles idling at school. There are three main routes of exposure which are; ingestion, inhalation and direct contact. The exposure from inhalation is being highlighted because it is the main route for air pollutants and will give adverse health effect to student's respiratory system.

This research has focused on the traffic pollution during vehicle idling and the effect of pollutant to the student's respiratory health, where the exposure level of pollutant through inhalation during peak time was measured by the suitable instruments. The respiratory health air quality perception was assessed and determined by using questionnaire from The International Study of Asthma and Allergies in Childhood (ISAAC) 6-7 years old.

1.4 Conceptual Framework

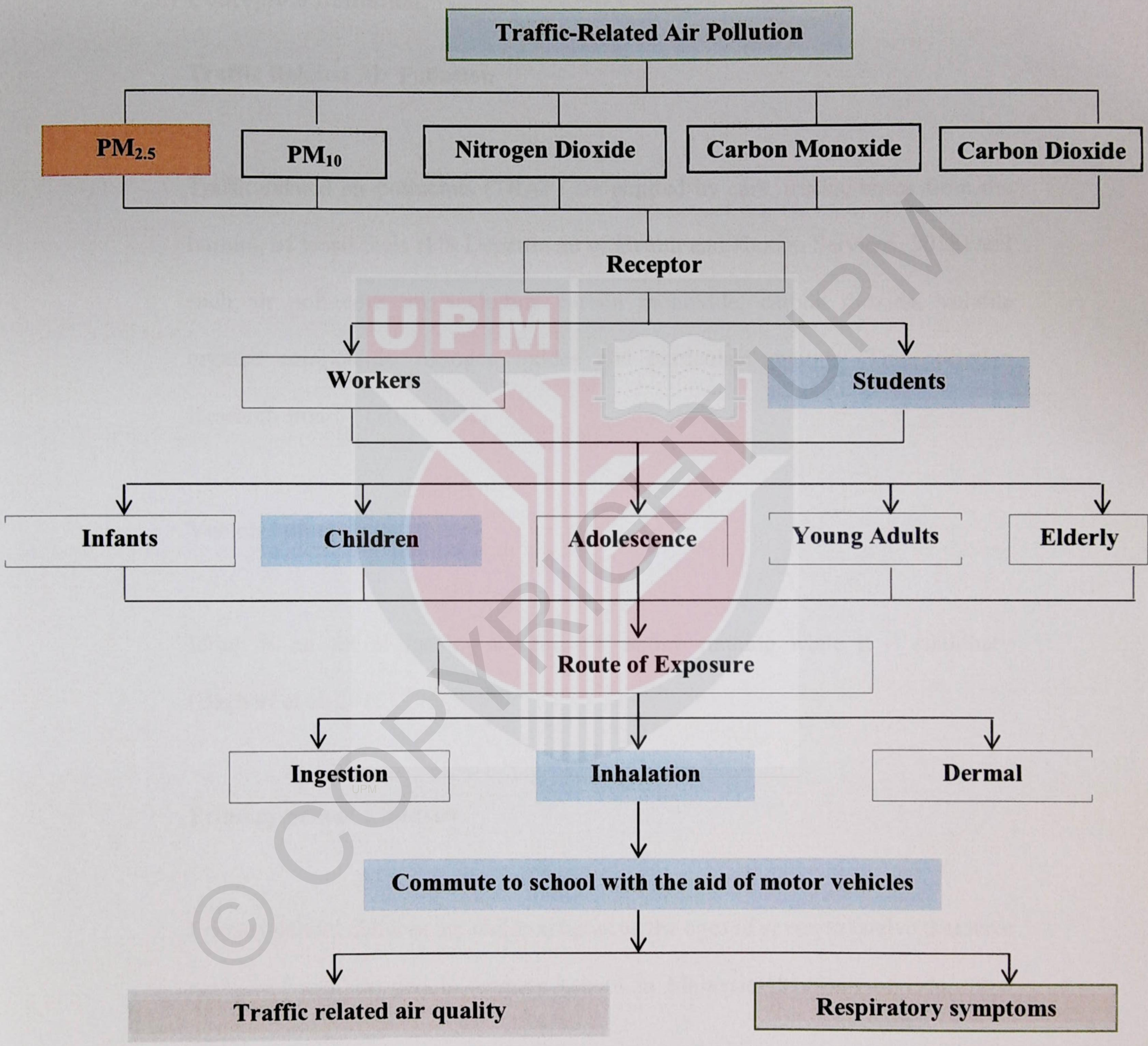

Figure 1.1 Conceptual Framework

Indicator:

Focus of study	
Dependent variable	
Independent variable	

1.5. Definition

1.5.1 Conceptual Definition

Traffic Related Air Pollution

Traffic-related air pollutants (TRAP) are emitted by cars, trucks, buses from the burning of fossil fuels (US Department of Health and Human Services, 2018) and such air pollutants are including carbon monoxide, carbon dioxide, volatile organic compounds, nitrogen oxides and particulate matters (Transportation Research Board (TRB), 2002).

Vehicle Idling

Idling is an act of leaving a vehicle's engine running while it is stationary (Bagheri et al, 2015).

Primary School Children

Primary school children are children between the ages of seven to twelve that have registered and enrolled in primary school in Malaysia (Ministry of Education, 2005).

Health Impact

Health impact is a change in body functions or cell structure that might lead to disease or health problem (ATSDR Glossary of Terms). Health impact can be divided into which is acute and chronic health impacts, acute effect is a condition where symptoms appear and change or worsen for a short period whereas chronic health conditions is a condition develops and worsens over an extended period of time (Medline Plus, 2018).

Lung function test

Lung function tests include a variety of tests that check how well the lungs work, using a spirometer. This test measures the amount of air the lung can hold and measures how forcefully one can empty air from the lungs (American Lung Association, 2018).

1.5.2 Operational Definition

Traffic Related Air Pollution

In this study, traffic-related air pollution is assessed by measuring the traffic-related air pollution in the studied location. Traffic related air pollution that will be assessed in the study is to particulate matter ($PM_{2.5}$). The pollutant is measured by using respective suitable traffic-related air pollutants instruments.

Vehicle Idling

In this study, vehicle idling is defined as any vehicles that leave vehicle's engine running while it is stationary for more than 5 minutes. The duration of vehicle idling is recorded using a stopwatch.

Primary School Children

Primary school children in Bandar Baru Bangi between the ages of ten (10) and eleven (11) which has been chose using simple random sampling.

Health Impact

Health impact in this study is defined as health symptoms experienced by the school children. The respondents are asked on the symptoms they experienced over 12 weeks. The symptoms are self-reported by the respondents using a standardized questionnaire from the International Study of Asthma and Allergies in Childhood (ISAAC) for 6-7 years old will be used.

Lung Function Test

According to Azizi and Henry (1994)

Obstructive disease	% predicted FEV1
Normal	≥80
Mild	70-79
Severe	60-69
Very severe	<60
Restrictive disease	**% predicted FVC**
Normal	≥80
Mild	70-79
Severe	60-69
Very severe	<60

Table 1.1 Test result interpretation

FEV_1=Forced Expiratory Volume in one (1) second.
FVC = Forced Vital Capacity

1.6 Research Objectives

1.6.1 General Objective

To determine the relationship between concentrations of traffic related air pollutants during vehicle idling and respiratory symptoms among primary school children.

1.6.2 Specific Objectives

i. To measure the concentration of pollutant ($PM_{2.5}$) during vehicle idling at primary school at Bandar Baru Bangi, Selangor.

ii. To determine the meteorological factor (wind speed, temperature and relative humidity) at study location.

iii. To determine the social demographic characteristics of the school children.

iv. To determine the respiratory symptoms (difficulty in breathing, bronchitis, asthma and allergies) among respondents.

v. To measure the lung function (FVC, FEV_1, FEV_1/FVC) among school children at primary school at Bandar Baru Bangi, Selangor.

vi. To determine the association between exposures to $PM_{2.5}$ during vehicle idling and lung function among school children at primary school at Bandar Baru Bangi, Selangor.

1.7 Study Hypothesis

i. There are significant a between exposure to $PM_{2.5}$ during vehicle idling and lung function among the school children.

CHAPTER 2

LITERATURE REVIEW

2.1 Air Pollution

According to Environmental Pollution Centers (2017), air pollution can be defined as the presence of toxic chemicals or compounds at levels that pose a health risk. The pollutant present in the form of solid particles, liquid droplets and gases. Air pollution can be divided into outdoor air pollution and indoor air pollution (UN Environment, n.d.). Outdoor air pollution are emissions that caused by combustion process from motor vehicles, solid fuel burning and industry, other pollution sources are smoke from bushfires, windblown.

Sources of air pollution are divided into two which are man-made and natural sources (Mondal, n.p.). Example of naturally released of air pollutants is ash from volcanic and radon which is a radioactive gas that seeps from ground (Green, 2018). Whereas, man-made air pollution is from the combustion and burning of fossil fuels, industrialization as well as excessive usage of motor vehicles (Green, 2018). Other than that, there are biological air pollutants, such as bacteria and viruses that discharged to ambient air. Irritants and allergens such a pollen, molds and bio-aerosol (Vellero, 2011).

Apart from that, air pollutants can be divided into two which is primary and secondary pollutants. A primary pollutant is a pollutant that is emitted from a single source into the air. Whereas, secondary pollutant is a pollutant that is emitted from an indirect source such as formed when two (2) or more primary pollutants react with each other in the atmosphere. For example, nitrogen oxide and hydrocarbons react with sunlight, resulting in ozone (Pariona, 2017).

Mobile source of emissions has been the major contributor to air pollution in Malaysia over the last five (5) years which at least 70-75% of total air pollution. Stationary sources have contributed 20-25% and another 3-5% is from open burning and forest fire (Diana, Halim, Talib, & Ahamad, 2018). In the year 2015, it is estimated that combined air pollutants emission load in Malaysia is 195 metric tonnes of carbon monoxide (CO), 927 metric tonnes of nitrogen oxides (NO_x) and 2 x 10^6 metric of Sulphur dioxide (SO_2), apart from that the concentration of gases such as Co, NO_2, and SO_2 in urban area were mainly influenced by the heavy traffic (Abdul et al., 2020).

2.2 Traffic Related Air Pollution (TRAP)

The United States (US) Department of Health and Human Services (2018) has defined that traffic related air pollutants are emitted from motor vehicles such as cars, trucks, buses as well as "non-road" equipment such as lawn equipment from the combustion of fossil fuels. However, traffic-related air pollution is caused by excessive usage of motor vehicles which emitted significant amount of air pollutants that directly contributing to public health and environment (Lasocka, Losacki, Siekmeier & Chlopek, 2015). A rise in the usage of private cars and other motor vehicles causes increase in the release of harmful chemicals which possess a major threat to human being (UK Environmental Law Association, n.d.).

Motor vehicle produces more than half of nitrogen oxides in air and which it acts as a number one source of global warming emissions. Apart from that, emissions from heavy-duty vehicles such as buses and trucks are another major contributor to air pollution (Union of Concerned Scientists, 2018). From the Inventory of U.S. Greenhouse Gas Emission and Sinks 1990-2015, light-duty vehicles such as cars contributed about 60% of greenhouse gases emission, whereas heavy-duty vehicles contributed about 23% of greenhouse gases emissions (USEPA, 2017). The major pollutants that are emitted from light-duty and heavy-duty vehicles are particulate matters (PM), volatile organic compounds (VOCs), nitrogen oxides (NOx), carbon monoxide (CO), carbon dioxide (CO_2), and sulfur dioxide (SO_2) (Union of Concerned Scientists, 2018). A local study conducted in Shah Alam within an industrial area had showed that the concentration of the pollutants from industrial emissions are mainly contributed by the road traffic pollutants which is PM_{10}, CO, SO_2, NO_2 and O_3 (Azhari, Talib, & Fariz, 2018).

2.3 Components of Traffic-Related Air Pollutants (TRAP)

2.3.1 Particulate Matters (PM)

Particulate matter is the mixture of solid particles and liquid droplets such as dust, dirt, soot or smoke which is large or dark that can be seen by naked eyes (US Environmental Protection Agency, 2018). Particulate matter is a heterogonous mixture of various pollutants either in solid or liquid form in which they come in different sizes and chemical composition (WHO, 2013). Particulate matter also can be called as aerosol which refers to condensed phases of suspended particle in the air (Rao and Knight, 2017). Total suspended particles, aerosol or particulate matters are particles that have diameter larger than 10nm and smaller than 50μm approximately (Liang, 2013). Particulate matter is emitted from various sectors such as from vehicles, factories, construction site, tilled fields, unpaved roads and burning of fossil fuels which eventually leads to air pollution.

Traffic related air pollutants (TRAPs) releases the highest levels of particulates matters (PM) among other anthropogenic sources and particulate matters is said to be the most dangerous and hazardous portion of air pollutant particulate (Mohammad et al., 2018). PM_{10} and $PM_{2.5}$ are two types of major concern of particulate matter in term of air pollution (US National Library of Medicine, 2017). PM_{10} is also known as inhalable thoracic particles in which it has aerodynamic diameter less than 10 μm (Monn et al., 1997).

Whereas, fine particulate matter ($PM_{2.5}$) are those with 2.5 μm or less in aerodynamic diameter. Lately, there are a lot of studies that has be done that have evidence in which respirable particles are associated with morbidity and mortality of human health effect (Li et al., 2018). Outdoor air pollution in metropolitans has resulted in maximization in the risk of pulmonary and systematic oxidative stress, immunological modification, hypoxemia, atherosclerosis, faster progression of chronic obstructive pulmonary disease (COPD), and cardiovascular diseases (Li et al., 2018).

2.3.2 Carbon Dioxide (CO_2)

Carbon dioxide is made up of one carbon atom and two oxygen atoms (National Energy Technology Laboratory, n.d). Carbon dioxide is a colourless and odourless gas in which its presence in Earth's atmosphere and plays an important in Earth's carbon cycle. Carbon dioxide is a part of greenhouse gases that function to trap the energy from the sun and keep the world at optimum temperature (Global CCS Institue, n.d.). The average level of ambient carbon dioxide is approximately 380 ppm, unfortunately due to increased anthropogenic sources, the concentration of carbon dioxide has gone up as high as 500 pm in urban area (Azuma, Kagi, Yanagi, & Osawa., 2018).

According to NASA on their research in Climate Science Investigation (2016), it has been proven that, high amount of carbon dioxide is released to the atmosphere due to human activities such as burning of hydrocarbons. Carbon dioxide also is the largest constituent of greenhouse gases that has been released due to transportation which is about 99% on CO_2e basis in the UK.

Whereas, carbon dioxide that released from motor vehicles contributing about 23% of total CO_2 emitted from the combustion of fuel, in other words, road traffic contributed almost three-quarters of CO_2 emissions (Grote, Williams, Preston & Kemp, 2015). However, excessive exposure to carbon dioxide is often liked with health effects such as panic, irregular heartbeat, vomiting, depressing respiration, cardiac activity, arrhythmias and death (Goel and Agarwal, 2014).

2.3.3 Nitrogen Dioxide (NO_2)

Nitrogen dioxide is one of the gas from the group nitrogen oxide (NO_x) which has an irritating pungent and acrid odor (Open Chemistry Database, 2018). Inert quantity of nitrogen dioxide is naturally formed in atmosphere by lighting and also from plants, soil and water. In Australia, the burning of fossil fuels such as coal, oil and gas and about 80% of nitrogen dioxide is produced from motor vehicle exhaust (Department of the Environment and Heritage, 2005). According to US Environmental Protection Agency, n.d.) Exposure over a short period can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficult breathing). The most susceptible people that possess greater health risk due to exposure to nitrogen dioxide with asthma, children and elderly.

2.4 Air Pollution at School

Children are vulnerable to the health effect due to air pollution, because they spend most of their time at school (Bennett et al., 2019). The air pollution in school can be divided into two which is indoor air pollution and outdoor air pollution. Indoor air pollutant especially $PM_{2.5}$ in school was from the infiltration of outdoor pollutants which is by-product of motor vehicles emission (Bennett et al., 2019). According to a study that has been conducted in China stated that children in the primary school surrounded by more industrial activities were exposed to about 30% higher levels of pollutants on average (Chen et al., 2019).

Besides, urban school in developing country such as Malaysia, uses natural ventilation system and often located near residential areas and busy roads where these areas have high concentrations of outdoor pollutants. Due to natural ventilation, these pollutants can be transferred into the indoor environment via open doors and windows and also leaks in the building (Othman, Talib, & Matsumi, 2019). From the study conducted by Slezakova, Oliveira, & Pereira (2019), it was found that outdoor air pollution contributed large part to total school ultra-fine particulate does which was approximately up to 70%.

2.5 Vehicle Idling

Idling is an act of leaving a vehicle's engine running while it is stationary (Bagheri, Fayazbakhsh, Thimmaiah, and Bahrami, 2015). There are varieties of situation where people idle their vehicle which is idling to warm the engine, idling whole waiting for something unrelated to traffic such as waiting to pick up children from school and idling while un traffic such as stoplights in traffic jams (Carrico, Padgett, Vandenberg, Gilligan, & Wallston, 2009). There are several reasons why people idle their cars which is lack of awareness, people are not aware that idling my cause harm to themselves as well as to the environment.

Apart from that people thought that idling vehicle is necessary for proper engine warm up this is because decades ago carburetor equipped vehicle often stalling in traffic and to prevent this from happened, it is recommended to idle or warm up the vehicle. However, due to technology advances idling vehicle less than 30 seconds is good enough before accelerates (Idle Free, n.d). According to Dudley Metropolitan Borough Council, an idling engine can produce up to twice as many exhaust emissions as an in motion (Dudley Metropolitan Borough Council, 2018).

According to Environmental Defense Fund, one pound of carbon dioxide will release into the environment by every 10 minutes of idling engines (Environmental Defense Fund, 2018) whereas children are vulnerable to poor air quality this is because they breathe faster than adults and they inhale more air per pound of body weight

(Climate Change Connection, 2018). Previous study in Malaysia shows that, the prevalence rate of asthma among children increased from 5.8% (6-7 years old) to 8.9% (13 to 14 years old) (Idris & Ghazi, 2016).

Immediate preventive measure should be taken on the behavior of car idling among Malaysian citizen. Other countries can be taken as an example in generating new policy such as London, Canada and Singapore. Our neighbor country, Singapore can be taken as prime example in combating the issue of vehicle idling where it is an offence for a driver to leave the engine running for reasons other than traffic conditions under their Environmental Protection and Management (Vehicular Emissions) Regulations (The Straight Times, 2018). Besides, In London, they educate the people by bringing forward the health effect of air pollution so that they stop car idling behavior. Meanwhile in Canada, more than 20 municipalities nationwide have implemented bylaws no car idling zone. They introduce no car idling law where they prohibit drivers from idling vehicles for more than three (3) minutes in a given 60 minute period (Rearick, 2019).

2.6 Effect of PM_{10} and $PM_{2.5}$ on lung function

Aerosol exists in both liquid and solid particulate matter in the atmosphere. It has diameter between 0.1 to 100 µm (Kong et al., 2017). Air contamination by particulate matters is often correlated with rapid industrialization, large population and heavy traffic (Gao & Ji, 2018). Effect of particulate matter is determined by the particle concentration, sizes and chemical composition at the receptor (Kulshrestha, Satsangi, Masih, and Taneja, 2009).

$PM_{2.5}$ pollutant is one of the most concerned pollutants due to size itself. $PM_{2.5}$ is a small particle matter that has the ability to penetrate to the deepest part of the lungs. One of the most susceptible groups to the health risk is children as their immune system and respiratory system are still developing (Chu, Huang, & Lin, 2014). $PM_{2.5}$ which is a fine particulate matter carries highest mutagenic activity than coarse particulate matter (Traversi and Gilli, 2011), this is because particulate matter has the ability to adsorb substances such as metals, polycyclic aromatic hydrocarbons (PAHs), aromatic hydrocarbons, phenols, organic compounds on its surface which later will be carried into the deepest part of the lungs (Belcik, Zdybek, Zaczynska, Czarny, & Piekarska, 2018).

Other than that, excessive exposure to $PM_{2.5}$ may cause injuries to the lungs by forming free radical peroxidation, in which lung cells produces free radical that induced by $PM_{2.5}$. Furthermore, $PM_{2.5}$ also causes asthma, jeopardizes lung function and even promotes cancer (Xing, Xu, Shi, and Lian, 2016).

Whereas, exposure to high concentration of PM_{10} may lead to some respiratory symptoms such as coughing and wheezing and the worse outcome due to exposure of PM_{10} are asthma attacks, bronchitis, high blood pressure, heart attack, strokes and premature death (Health and Air Pollution in New Zealand, 2012).

According to World Health Organisation (WHO) (2013), the health effect due to the exposure to inhalable particles can be divided into two which is short term (hours and days) and long term (years). Health effect due to the exposure to inhalable particles include respiratory and cardiovascular morbidity for example, aggravation of asthma, respiratory symptoms and increase in hospital admissions, whereas, the chronic effect is mortality from cardiovascular and respiratory diseases and lung cancer. Particulate matter can reduce the lung function and cause or aggravate respiratory conditions, increase the long-term risk of lung cancer or other lung disease such as emphysema, bronchiectasis, pulmonary fibrosis and cystic lungs.

2.7 Deposition mechanism of pollutants in the lungs

Deposition mechanisms can be divided into three main mechanisms which are inertial impaction, gravitational sedimentation and Brownian diffusion. Inertial impaction happens when inhaled particles follow a complex path through the respiratory tract to reach bronchiole. When the air flow in airway changes the momentum of the particles tend to keep them on their current direction making them to go amiss from streamline and eventually impact on airway walls. The deviation of particles from the airways is depending on air flow, particles mass and flow rate, in other words, the greater the air streamline, the larger the particle mass and the greater the flow rate. For particles larger than 5μm in diameter, inert impaction is the primary mechanism of deposition and for particles with diameter as small as 2 μm, usually inert impaction will occur at complex geometry of upper respiratory tract (Darquenne, 2012).

The settling of particles due to gravity action is called as gravitational sedimentation and happens mainly in small airways and alveolar, it has a small distance to be covered by the particles before touching the walls of alveolar. The gravitational sedimentation is influenced by particle size and particle residence time. In which, if there is an increase in particle size then the particle residence time is increasing as well. Normally, particle size within the range of 1-8 μm is most effective with this deposition mechanism (Darquenne, 2012).

Brownian diffusion is impact from irregular motion caused by the collision of particles with other gas molecules. It is most effective in the acinar region of the lungs where the air velocity is low. The deposition of Brownian diffusion increase when the particles size is decreasing and the mechanism is dominant for particles with diameter less than 0.5 μm (Darquenne, 2012).

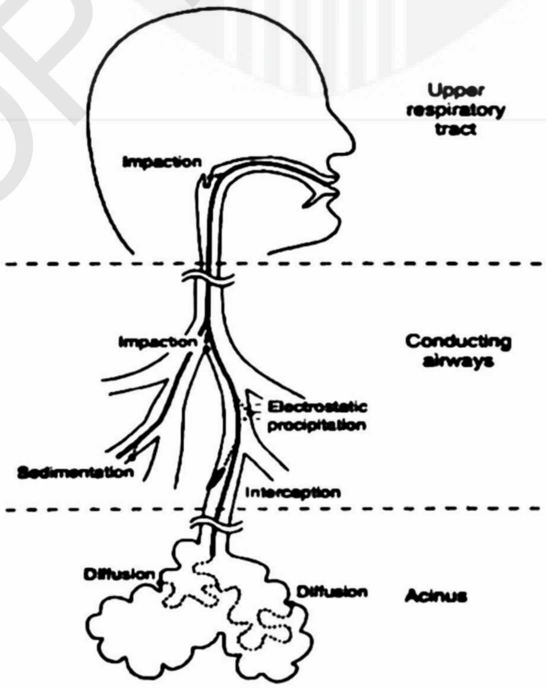

Figure 2.1 Mechanism of deposition of inhaled particles in the respiratory tract.
Sources:https://pdfs.semanticscholar.org/403a/d8fa839b979fe564f9fd027ef41e71c605e0.pdf

2.8 Children's exposure to air pollution

According to WHO report in the year 2015, there were 543000 deaths in children under 5 years due to both ambient air pollution and house air pollution (WHO, 2018). Infants and children are said to be more vulnerable and susceptible to air pollutants, this is because they generally tend to breathe more rapidly than adults which eventually increase their exposure to air pollutants. Apart from that, infants and children often breathe through their mouth and not nose which means the air pollutants are not filtered as they are bypassing the filtering effect of nose and allowing pollutants to be inhaled (Dowshen, 2018).

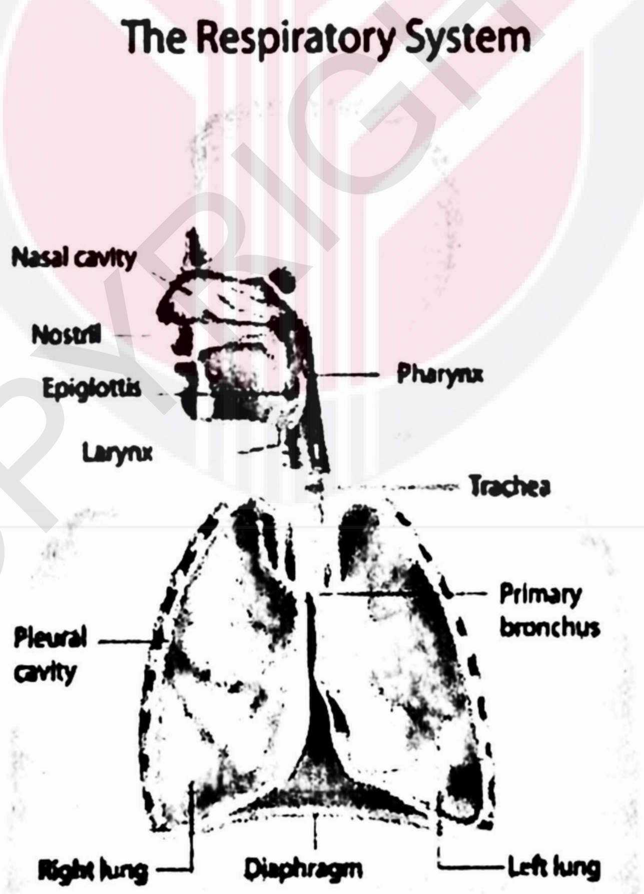

Figure 2.2 Human Respiratory System

(Source: https://www.pedilung.com/pediatric-lung-diseases-disorders/anatomy-of-a-childs-lung/)

Child's lung anatomy is similar to that of an adult. The lungs are a pair of air-filled organs comprising of elastic tissue called lung parenchyma. It has three segments made up of right lung and two segments that made up of left lungs. The function of the lungs is to enable body to get oxygen and dispose carbon dioxide and waste gases from digestion and the anatomy of children's respiratory system can be divided into two which is pediatric airway anatomy and pediatric lung anatomy (Schochet and Lie, n.d.).

Children are more susceptible to air pollutants because their immune system and developing organ in this case is their lungs are still immature. Therefore, inhalation of air pollutants may irritate or cause inflammation which eventually obstructs their narrow airways (The American Cancer Society, 2003).

Exposure of children to air pollutants increased compared to adult as they has high breathing rate and higher level of physical activity as they spend more time outdoor compared to adults (American Academy of Pediatrics, 2004). For example, when children are exercising at maximum levels, such as in sport events, they may take in 20% to 50 more air and more air pollutants (Kleinman, 2000).

2.9 Air Quality Standard and Personal Exposure Standard

2.9.1 World Health Organisation (WHO) Standards

World Health Organization has updated its Air Quality Guidelines in 2005. The guideline is intended to be relevant and applicable worldwide to protect the public health and takes into consideration large regional differences. The guideline recommends acceptable level for particulate matter, ozone, nitrogen dioxide and sulphur dioxide as well as sets the interim targets for these pollutants' concentration, encouraging gradual improvement of air quality and decreases health impacts due to air pollution (Kryzanowski & Cohen, 2008). Table 2.1 below shows the WHO air quality guidelines.

Table 2.1: National Ambient Air Quality Standards by World Health Organisation

Pollutants	Averaging Time	Ambient Air Quality Standard $\mu g/m^3$
$PM_{2.5}$	1-year	10
	24-hour	25
PM_{10}	1-year	20
	24-hour	50
SO_2	1-hour	20
	24-hour	500
NO_2	1-hour	40
	24-hour	20
O_3	1-hour	N/A
	24-hour	100

*Adapted from World Health Organisation (2005)

2.9.2 National Ambient Air Quality (NAAQ) Standards

According to USEPA their standards has been divided into two (2) which is primary standard and secondary standard. Primary standard is to provide public health protection as well as protecting the sensitive population such as elderly, children, asthmatics and pregnant women. Whereas secondary prevention is to provide public welfare protection which is protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

Table 2.2 National Ambient Air Quality (NAAQ) Standards by Environmental Protection Agency

Pollutant		Primary/Secondary	Averaging Time	Level
Carbon Monoxide (CO)		Primary	8 hours	9 ppm
			1 hour	35 ppm
Lead (Pb)		Primary and Secondary	3 months average	0.15 µg/m³
Nitrogen Dioxide (NO_2)		Primary	1 hour	100 ppb
		Primary and Secondary	1 year	53 ppb
Ozone (O_3)		Primary and Secondary	8 hours	0.070 ppm
Particulate Matters (PM)	$PM_{2.5}$	Primary	1 year	12 µg/m³
		Secondary	1 year	15 µg/m³
		Primary and Secondary	24 hours	35 µg/m³
	PM_{10}	Primary and Secondary	24 hours	150 µg/m³
Sulphur Dioxie (SO_2)		Primary	1 hour	75 ppb
		Secondary	3 hours	0.5 ppm

*Adapted from United States Environmental Protection Agency (2008)

2.9.3 Malaysian Ambient Air Quality Guidelines (MAAQG)

The Malaysian Ambient Air Quality Guidelines (MAAQG) is adapted from United States Environment Protection Agency (USEPA) Pollutants Standard Index (PSI) system which is called as Air Pollutant Index (API). However, the API is modified by Department of Environment (DOE), Malaysia to suit Malaysian Guidelines. There are five (5) major pollutants that has been included in the guidelines which is particulate matter (PM_{10} and $PM_{2.5}$) with averaging time for 1 year and 24 hours, sulphur dioxide (SO_2), nitrogen dioxide (NO_2) with averaging time 1 hour and 24 hours ,ozone (O_3) and carbon monoxide (CO) with averaging time for 1 hour and 8 hour.

Table 2.3 New Malaysian Ambient Air Quality Standard

Pollutants	Averaging Time	Ambient Air Quality Standard		
		IT-1 (2005)	IT-1 (2018)	IT-1(2020)
PM_{10}	1-year	50	45	40
	24-hour	150	120	100
$PM_{2.5}$	1-year	35	25	15
	24-hour	75	50	35
SO_2	1-hour	350	300	250
	24-hour	105	90	80
NO_2	1-hour	320	300	250
	24-hour	75	75	70
O_3	1-hour	200	200	180
	8-hour	120	120	100
*CO	1-hour	35	35	30
	8-hour	10	10	10

•Adapted from Department of Environment (2013) •$\mu g/m^3$

CHAPTER 3

METHODOLOGY

This chapter explains the methods and tool that used in this research. The sections explain the design, duration, population, and methods used for selection of research participants.

3.1 Study Location

This cross sectional study was conducted at a primary school located in Bandar Baru Bangi (2°56'46"N 101°46'42"E) (Figure 3.1). Bandar Baru Bangi is a township where it is situated in the district of Hulu Langat, in Selangor, Malaysia, named after the small town of Bangi situated further south. It is located between Kajang and Putrajaya. As of 2016, there are 16 town sections in Bandar Baru Bangi.

The primary school is located about 1 km away from the main road and located nearby residential areas such as terrace houses as well as apartments along the roadside nearby the school. There are 7 primary schools in Bandar Baru Bangi, and this study location is chosen based on purposive sampling with few inclusive criteria, which is as follows:

i. The school is not located near (not less than 500m) any major roads, because the study does not want the pollutants from the major roads to be a cofounder which might affect the level of pollutants due to car idling as there were studies reported that there were high concentration of air pollutants at major roads (Baldauf et al., 2012).

ii. No traffic lights near the school, because traffic light near school causes school-related traffic congestion, which might serves as another cofounder of the study that will affect the result of the study (*Traffic Congestion*, n.d.)

iii. The school provides waiting area during drop-off and pick-up. This criteria was set to determine the parents' car idling behavior during both drop-off and pick-up.

Figure 3.1 Location of sampling in Bandar Baru Bangi, Selangor

This field study was carried out both during the weekdays (Tuesday and Thursday) and weekend (Saturday) at the main entrance of the school (Figure 3.2), from January 2019 to March 2019.

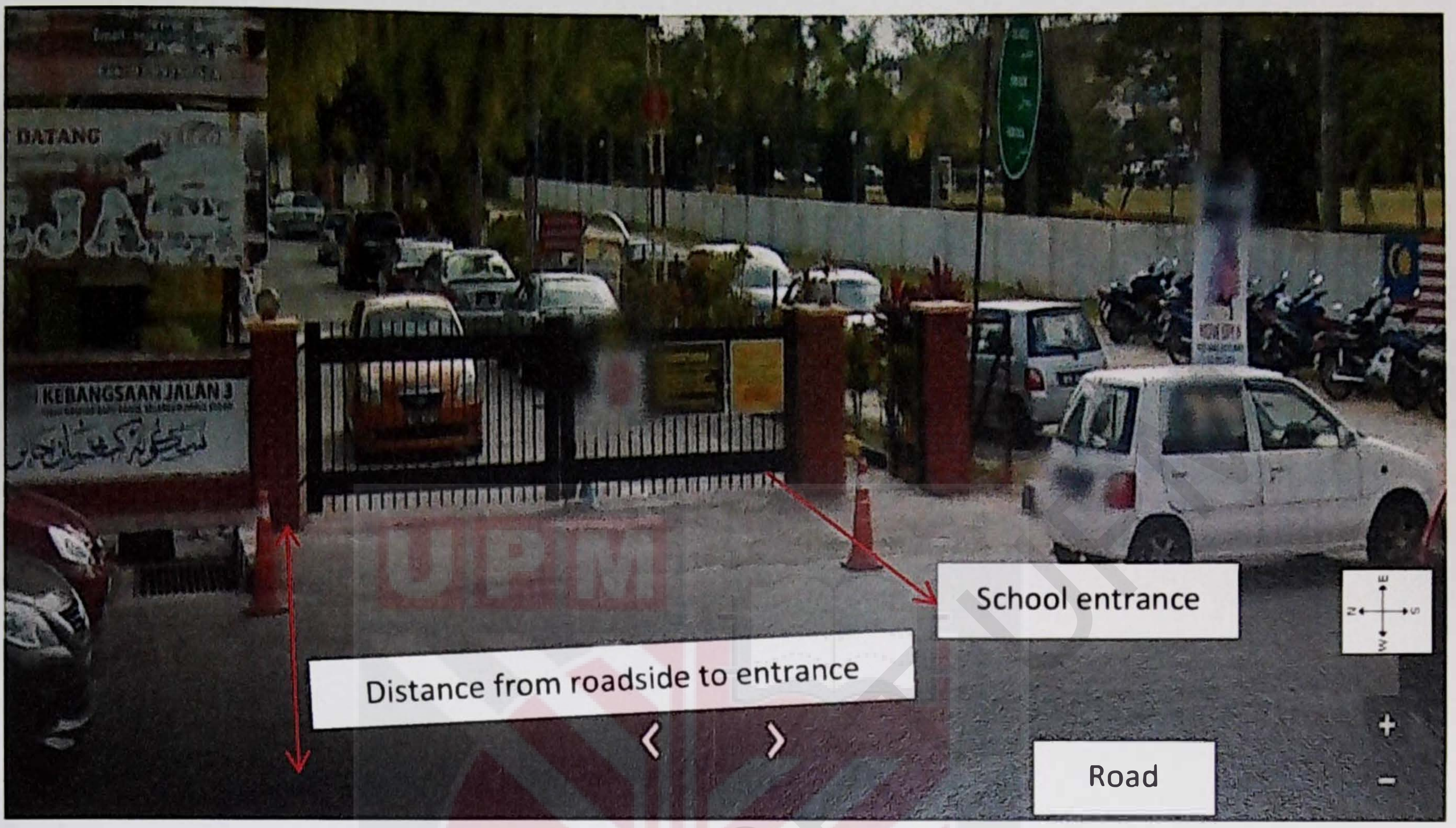

Figure 3.2: Main Entrance of location of research at Bandar Baru Bangi

Source: Google Satellite Image

(https://www.google.com/maps/place/Sekolah+Kebangsaan+Jalan+3/@2.9471277,101.776987,367m/data=!3m1!1e3!4m12!1m6!3m5!1s0x31cdc9436aaaaaab:0x9b1e3cf468e2dc25!2sSekolah+Kebangsaan+Jalan+3!8m2!3d2.946033!4d101.7790436!3m4!1s0x31cdc9436aaaaaab:0x9b1e3cf468e2dc25!8m2!3d2.946033!4d101.7790436)

Figure 3.3 Drop-off and pick-up zone at the entrance of school.

3.2 Study Design

The research used a cross sectional study design to study the relationship between concentrations of traffic related air pollution during vehicle idling and respiratory symptoms among primary school.

3.3 Study Duration

Air monitoring was conducted in two different period:

Table 3.1 Study duration

Items/Time	Background	Air Monitoring
Drop-Off	6:30 a.m. to 7:00 a.m	7:00 a.m to 7:40 a.m
	(30 minutes)	(40 minutes)
Pick-Up	12:45 p.m to 1:10 p.m	1:10 p.m to 1:50 p.m
	(30 minutes)	(40 minutes)

3.4 Sampling

3.4.1 Sampling Method

The sampling method used was simple random sampling. The respondents were only selected when fulfilled the inclusion and exclusion criteria.

3.4.2 Inclusive and Exclusive Criteria

- **Inclusive Criteria**
  a) Students from Year 4 and Year 5
  b) Waiting at the entrance of school.
  c) Commute to school by school bus, school van, car and motorbike.

- **Exclusive Criteria**
  a) Parental smoking habit
  b) Existing respiratory diseases (eg asthma)
  c) Commute to school by cycling or walking

3.4.3 Sampling Population

A total of 97 students from Year 4 and Year 5 was chosen as respondent for this study. The respondent from the school was chosen as the respondent for both questionnaire and lung function test. However, the final sampling population was **91 students** as 6 of the students were excluded due to rejection from parents.

3.4.4 Sampling Frame

The sampling frame for the study was list of students SK Jalan 3 Bandar Baru Bangi. However, only those who fulfilled the inclusion and exclusion criteria were included in this study.

3.4.5 Sampling Unit

The sampling unit for this study involved only a student who fulfilled the inclusion and exclusion criteria.

3.4.6 Sample Size

The sample size calculation is based on Lemeshhow, Hosmer, Klar and Lwanga (1990) formula for one sample study:

Formula,

$$n = \frac{Z^2{}_{1-\frac{\alpha}{2}}P(1-P)}{\delta^2}$$

Where,

n = sample size

z = level of confidence according to the standard normal distribution (for a level of confidence of 95%, z = 1.96)

p = estimated proportion of the pollution that presents the characteristic

d = tolerated margin of error (within 5%)

$$n = \frac{(1.96)^2\ (0.056)(1-0.056)}{(0.05)^2}$$

= 81 (Chen et al., 2019)

Based on the formula, 81 respondents are needed for the study. The number is increased by 20% for the strength of analysis of the study and to take account for non-responsive which in total is **97 respondents**.

3.5 Study Instrumentation and Data Collection Technique

3.5.1 Approval letter

Parents' Consent Form was distributed among the listed primary school children. Prior to the study, consent from their legal guardian and parents were obtained and the students with the parents' permission were then selected to be involved in the study. The respondents were fully informed about the procedure and objectives of the study.

3.5.2 Questionnaire

For this research, questionnaire from the International Study of Asthma and Allergies in Childhood (ISAAS) for 6-7 years old is used. The language used was Bahasa Malaysia because the respondents are from primary school and Bahasa Malaysia is an easy to understand language and the questionnaire will be filled up by the parents of the respondent. The first section of the questionnaire is about the socio demographic data of the respondent such as age, how the student commutes to school, parental smoking habit, and students waiting location after schooling hour and if they are having any respiratory disease.

The second section of the questionnaire focuses on the core questionnaire for asthma and related respiratory symptoms experienced by the respondent in the past 12 months, if any. Example of respiratory symptoms is wheezing, sleep disturbance due to wheezing, and chest sounded wheezy and dry cough.

The third section of the questionnaire is about the core questionnaire for rhinitis and related respiratory symptoms such as sneeze, runny or blocked nose, itchy-watery eyes and hay fever in the past 12 months.

Next, the forth section of the questionnaire is about core questionnaire for eczema and related symptoms such as itchy rash at ankles, knees, under the buttocks, around the neck, ears.

3.5.3 SECA Body Meter

This SECA Body meter was used to measure the height of the respondents. They stand right at the wall where the equipment was set up on it. The height of the respondents were recorded.

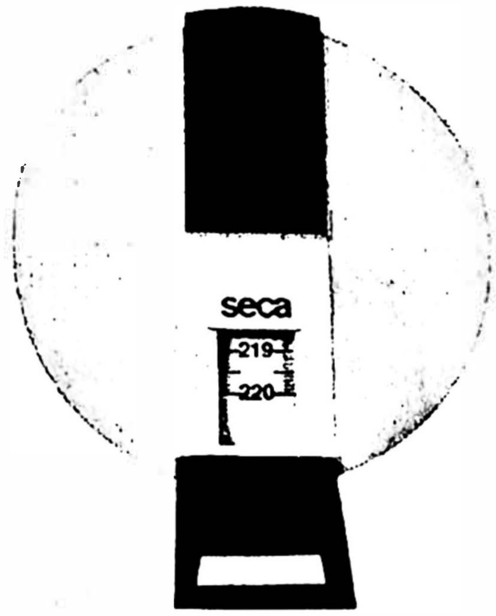

Figure 3.4: SECA Body Meter (Source: Med Shop website, 2019)

3.5.4 SECA Weighing Scale

This equipment was used to measure the weight of the respondents. The result was recoded.

Figure 3.5: SECA body weighing scale (Source: Fitness Body Equipment Website, 2019

3.5.5 Kestrel 5500 Weather Meter

This equipment was used to determine the wind speed (mph), temperature (°C) and relative humidity (%). It was set up on a tripod. The data was transferred from IOS Kestrel Apps to laptop.

Figure 3.6: Kestrel 550 Weather Meter (Source: KestrelMeters.com, 2019)

3.5.6 Traffic-Related Air Pollutant (TRAP) Assessment

The TRAPS assessment was conducted to measure $PM_{2.5}$ during dropping off and pick up period. Measurements were taken at the height of 1.5m above the ground (Jassen, Vliet, Aarts, Harrssena & Brunekreef, 2001) to represent the breathing zone level of the children. Previous studies measured these air pollutant ($PM_{2.5}$) related to higher prevalence of respiratory symptoms (Ngalai, 2004; Mukheriee et al., 2015), where this study on $PM_{2.5}$ was used as a references method in this study as there were similarities between the previous study and this study with different source of $PM_{2.5}$ where this study was aimed to identify respiratory symptom due to exposure to $PM_{2.5}$ during vehicle idling.

To assess road traffic, we determined the volume of vehicles that operated in the sampling location zone during sampling was operated. Measurements were conducted at the sampling location during drop off and pick up period. The sampling was conducted in the morning at 6:30 a.m till 7:00 a.m as background measurement and 7:00 a.m till 7:40 a.m for monitoring. Whereas, in the afternoon sampling starts at 12:45 p.m till 1:10 p.m as for background measurement and 1:10 p.m till 1:50 p.m. between January, February and March in 2019. $PM_{2.5}$ (average of one reading per one minute interval) was measured at the sampling location. The measurement were taken one (1) minute interval, to get an accurate reading as the duration for vehicle idling were 3-6 minutes in average. Direct reading instrument of air monitoring tool which is TSI SidePak™ Personal Aerosol Monitoring AM520 was used to measure aerosol with an upper particle size limit of 2.5μm.

3.5.7 Measurement of $PM_{2.5}$

SidePak™ Personal Aerosol Monitoring AM520 (Figure 3.4) was used to measure $PM_{2.5}$ in the sampling location. It is a rugged, lightweight, belt mounted laser photometer, weighing as little as 450g. It is compact and quiet. The AM520 personal aerosol monitor is easy-to-read display shows of data in both real-time aerosol mass concentration and eight-hour-time-weighted average (TWA_8). The AM520 personal air monitor can be used as personal exposure monitoring, ambient monitoring, environmental sampling and others. The data were downloaded using Trakpro Data Analysis Software to the laptop.

Figure 3.7: TSI SidePak Personal Air Monitor AM 520
(Sources: TSI Website, 2019)

3.6 Health Monitoring

3.6.1 Lung Function Test

The Chestgraph HI-105 will be used to conduct lung function test. Chestgraph H-105 has volume accuracy within ±3% or ±5% mL and flow range of 0-±14L/s as well as volume range of 0-±10L. This spirometer has incentive software for children testing which is quite suitable to conduct this study.

The operating procedure for lung function test is, respondent will be required to sit upright in a chair, with their feet on the floor and nose clipped shut. Then they will need to breath into a mouth piece (held securely between their lips and teeth) which is attached to a recorder (spirometer). They need to breathe in to their full capacity, put the device into their mouth, and then breathe out forcefully until their lungs are completely empty. This is normally for at least 6 seconds. After complete expiration they may be advised to breathe in fully again through the device. The information then be printed out onto a special chart called a spiro-gram which will used to analyze (Virtual Medical Centre, 2017).

It was used to measure the volume of air in the lung and how much total air that a person can breathe out in one (1) second. This instrument also used to determine the normality and abnormality of the lung function. Three (3) lung function parameters which is Forced Volume Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), FEV_1/FVC were obtained from this test. Abnormality of lung function can be divided into two (2) which are restrictive and obstruction. The indicator to determine restrictive respiratory problem are characterized by reduced total lung capacity (TLC) where FVC value less than 80% of predicted value. Meanwhile, the indicator for obstructive respiratory problems are FEV_1 less than 80% or FEV_1/FVC ratio less than 75%.

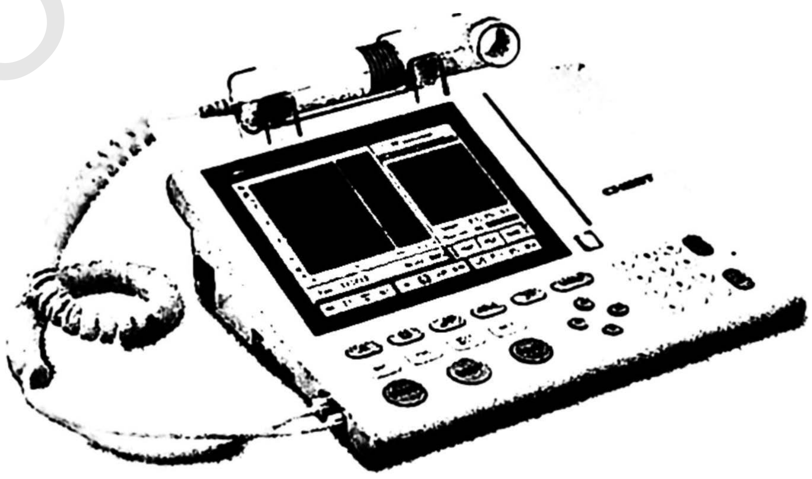

Figure 3.8: Chestgraph HI-105(Source: Chest M.I., INC. website, 2019)

3.6.2 Calibration

The spirometer was calibrated prior to sampling. Three liter (3L) of air was injected in the syringe into the spirometer. The error allowed is 3% or 50ml of air. The three (3) parameter obtained from this test are FVC Predicted, FEV_1 Predicted and FEV_1/FVC Predicted.

3.6.3 Pre sampling

a. The spirometer was checked to ensure it is well function prior to the lung function test. Then, the spirometer was calibrated, and clean mouthpiece was prepared to be used by the respondents.
b. The briefing was given to all of the respondents before the test was conducted. The age, gender, race, height and weight were measured and recorded.
c. Explanation and demonstration on doing the proper and right techniques were performed. The respondents took a deep breath after a signal was given and exhaled forcefully and completely without hesitation for a long period.
d. The respondents must not eat heavily within 2 hours prior the test.
e. They wear loose fitting clothing over the chest and abdominal area.
f. The respondents were given the chance to practice breathing into the mouthpiece before they performs the real test for their lung function.

3.6.4 During sampling

a. For accurate results, the FVC maneuver was performed with maximum effort and followed with the maximum inspiration. It should have a rapid start so that the spirogram and flow-volume curve be smooth continuous curve

b. The respondents was instructed to:

    i. Seal his/her lips around the mouthpiece.

    ii. They should fully inhale and the immediately exhale the air with maximum effort.

    iii. The procedure was be repeated for three (3) times and the average of the reading will be taken. This is to ensure that the result obtain are reliable.

3.6.5 Lung function analysis

The printed result was used to interpret the respondent's lung function. Spirometer test interpretation process was made by comparing the observed and expected test score to determine the lung function abnormalities among the respondents. FVC and FEV_1 readings are directly aligned to the unit Body Temperature and Pressure Saturated (BTPS).

3.6.6 Evaluation of Lung Function Test

The interpretation spirometer test is done by comparing the value of the reading obtained from the spirometer with the expected value using the expected equation (Table 3.2). For this study, researchers have calculated the expected value based on the expected equation by Azizi (1994). This equation is obtained from the spirometer study which consist of thousand and ninety-eight (1098) children in Malaysia aged from seven (7) years old to twelve (12) years old. Meanwhile, the evaluation of the lung function of the children was based on American Thoracic Society (1991) as shown in Table 3.3.

Table 3.2 Normal value of lung function parameters among children in Malaysia

Lung Function Test	Boy	Girl
FVC	$4.1120 \times 10^{-6} H^{2.6421}$	$6.0777 \times 10^{-7} H^{3.0112}$
FEV1	$6.2523 \times 10^{-6} H^{2.5388}$	$5.7588 \times 10^{-7} H^{3.0067}$

H = Height
FVC = Force Vital Capacity
FEV_1 = Forced Expiratory Capacity in 1 second

Source: Azizi and Henry (1994)

Table 3.3 Evaluation of lung function

Obstructive disease	**% predicted FEV1**
Normal	≥80
Mild	70-79
Severe	60-69
Very severe	<60
Restrictive disease	**% predicted FVC**
Normal	≥80
Mild	70-79
Severe	60-69
Very severe	<60

Source: Azizi and Henry (1994)

3.7 Assessment of Traffic Volume

Traffic volume assessment by vehicle type was conducted to assess the contribution of traffic related air pollutants. The survey of traffic was conducted in two (2) different period which is during drop-off and pick-up. Manual classified counting method was used to count the traffic volume (Zheng and Mike, 2012). They vehicles were categorized into five (5) categories for the survey which are motorcycles, cars and taxis, buses and coaches, light good vehicles and heavy good vehicles. The counting and classification were based on visual examination and judgment by individual observers (Zheng & Mike, 2012).

3.8 Data Analysis

Questionnaire response tabulation and graphical summarizes was completed with Microsoft Excel 2016, while statistical analysis was analyzed by using Statistical Package for Social Science (SPSS) Version 25.0. The descriptive test was used to calculate mean, median, IQR and standard deviation. Meanwhile, Kolmogorov Smirnov test and bell shape were used to determine the normality of the data. This test is very crucial in determining the appropriate test was used to further data analysis. Below were the statistical tests that were used to analyze the objectives of the study:

Objective 1: To measure the concentration of pollutants ($PM_{2.5}$ and PM_{10} mass concentration) during vehicle idling at primary school at Bangi, Selangor.

Statistical Analysis: Descriptive Test

Objective 2: To determine the meteorological data (wind speed, wind direction, humidity and temperature) at the study area.

Objective 3: To determine the social demographic characteristics of the respondents.

Statistical Analysis: Descriptive Test

Objective 4: To measure the lung function (FVC, FEV_1, FEV_1/FVC) among school children at primary school at Bangi, Selangor.

Statistical Analysis: Descriptive Test

Objective 5: To determine the respiratory symptoms among respondents.

Statistical Analysis: Descriptive Test

Objective 6: To determine the association between exposure to PM_{10} and $PM_{2.5}$ during vehicle idling and lung function among school children at primary school at Bangi, Selangor

Statistical Analysis: Chi-Square Test

3.9 Quality Control

3.9.1 Questionnaire

Validated questionnaire from ISAAC was used. The questionnaire was prepared in Malay and it underwent a back-to-back translation to ensure that the questionnaires suggest similar meaning.

Pre-testing was conducted prior to the student, approximately total of 20 respondents were chosen who fulfilled the inclusion and exclusion criteria to pre-test the questionnaire, the respondents then were excluded from the study. The problems encountered by the respondents in answering any of the questions were identified and corrected. The result was tested by using Cronbach's Alpha Test where value of 0.7 and above shows acceptable reliability and validity.

3.9.2 $PM_{2.5}$ Assessment

Instruments used in this study was zero calibrated and instruments was switched on and leave for 10 minutes to stabilize before the actual data collection were made to ensure that the instrument were in good condition when during the measurement, to eliminate any possible error of data and give an accurate result during the sampling. The manufacturer has calibrated all the equipment used in this study using standard and recommended procedure before starting the measurement. The equipment was tested before starting the measurement to maintain the quality of the data and reduce error during the data collection. The same type of equipment was used throughout the data collection period to ensure the accuracy and precision of the data to avoid systematic error.

3.9.3 Traffic Count Survey

Traffic count was carried out by screen line counts to make sure all the vehicles were counted during assessment was carried out.

3.9.4 Lung Function Test

Spirometry was conducted using ChestGraph HI-105 from Chest M.I.,Inc. following the American Thoracic Society Standards (ATS) (Crapo et al., 1995). Calibration check for the spirometer was performed with a 3L syringe prior to each spirometry test. Volume verification was performed by discharging the 3L syringe at three different flow rates varying between 0.5 and 12L/s (analogous to the flow rate anticipated during subject testing). The observed volume at each flow rate was within the accuracy requirement of ±3.5% as recommendation by ATS (Crapo et al., 1995). Height of subjects was measured by subject standing against the wall with socks on. Gender and racial data were obtained by parent report. Data on percent predicted forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), FEV_1/FVC ratio and forced expiratory flow between 25 and 75% of forced vital capacity (FEF_{25-75}) were collected as these are commonly used in clinical and research settings to monitor obstructive lung disease such as asthma. The test was performed a minimum of 3 times with the maximum number of trials limited to 5 to avoid participant fatigue (Ournal et al., 2001).

3.10 Ethical Approval

Ethical approval was obtained from the Ethical Committee for Research Involving Human Subjects in Universiti Putra Malaysia (JKEUPM) with the reference number of JKEUPM-2018-375. Meanwhile, permission to conduct the study in the selected school was obtained from Ministry of Education Malaysia (MOE) with the reference number of KPM.600-3/2/3-eras (2488), Selangor Education Department with the reference number JPNS.SPS.PPN600-1/1/2 JLD.3(50) and from the Principal of the primary school. Parental consent form was distributed to the respondents along with the questionnaire distribution and the anonymity of the participants were maintained all the times.

CHAPTER 4

RESULTS

This study presents the results and described in the following five (5) sections: (1) Traffic-related air pollutions ($PM_{2.5}$) level, (2) Meteorological data, (3) Socio-demographic data, (4) Respiratory health symptoms, (5) Lung-function test.

4.1 Traffic Related Air Pollutant

4.1.1 Summary of measurements of $PM_{2.5}$ and traffic count

Table 4.1 below shows the summary of number of measurements for each pollutant ($PM_{2.5}$) and traffic count that have been conducted simultaneously in the sampling location during drop-off (6:30am-7:40am) and pick-up (12:45pm-1:50pm). The total number of measurements and traffic count for the month of January, February and March were 6, 16 and 9 respectively.

Table 4.1: Summary of number of measurements for each pollutant

Month	Measurement (n)		
	Drop-off	Pick-up	N
January	3	3	6
February	8	8	16
March	3	3	9

4.1.2 Level of $PM_{2.5}$

Table 4.2 presents the distribution of traffic-related air pollutant ($PM_{2.5}$) during drop-off and pick-up. The median concentration of $PM_{2.5}$ during drop-off for the month of January, February and March were 25±3 μg/m^3, 32±4 μg/m^3 and 58± 25 μg/m^3 respectively. Whereas, for the pick-up period during the month of January, February, and March were 18±8 μg/m^3, 22±5 μg/m^3 and 49±24 μg/m^3 respectively. The concentration of $PM_{2.5}$ was significantly higher during the drop-off compared to pick-up. However, the concentration of $PM_{2.5}$ for both drop-off and pick-up exceeded the 24-hour WHO Air Quality Guideline 2005 standard.

Figure 4.1 shows three (3) peak values for each month which is January, February and March for the first 10 minutes. For the month of January, February and March the average peak level were 79 μg/m^3, 43 μg/m^3, and 66 μg/m^3 respectively. Hence, when compared with WHO (2006) guidelines, the three (3) peak value has exceeded the WHO standard which is 25 μg/m^3.

There were two (2) peak values for the month which is January and March for the first 10 minutes but not for February observed in Figure 4.2. For the month of January, and March the peak level were 101 μg/m^3 and 74 μg/m^3 respectively. Whereas, for the month of February the peak level was 27 μg/m^3. Hence, when compared with WHO (2005) guidelines, the two (2) peak value has exceeded the WHO standard which is 25 μg/m^3, and for the month of February, it was slightly higher than the guideline value.

Table 4.2: Concentration of $PM_{2.5}$ for the month January, February and March

Month	Time	Avg. time	$PM_{2.5}$ Mean±SD (µg/m³)	Median±IQR (µg/m³)	Minimum (µg/m³)	Maximum (µg/m³)
January	Drop-off	1h 10 min	26±9.7	25±3	17	79
	Pick-up		23±12	18±8	15	74
February	Drop-off	1h 10 min	32±4	32±4	24	44
	Pick-up		24±6.7	22±5	19	56
March	Drop-off	1h 10 min	52±15	58±25	18	72
	Pick-up		48.9±15	49±24	24	101

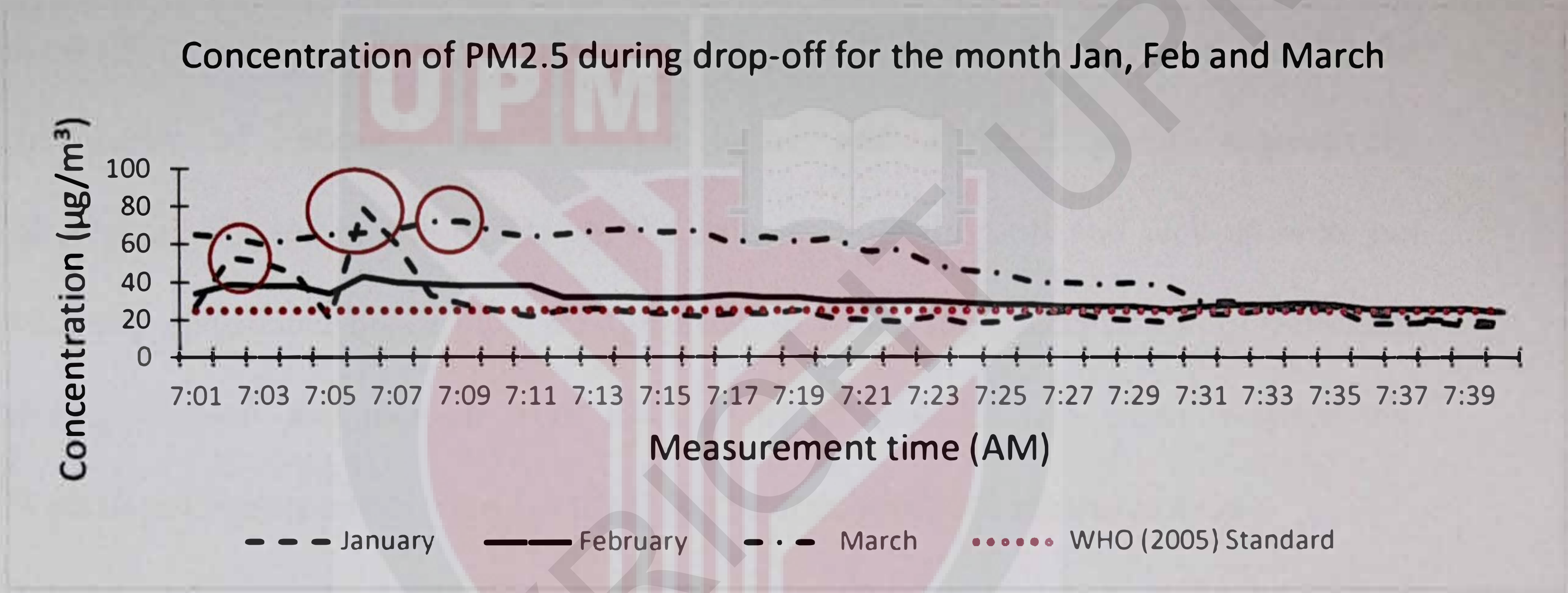

Figure 4.1 Concentration of $PM_{2.5}$ during drop-off for the month of January, February and

March

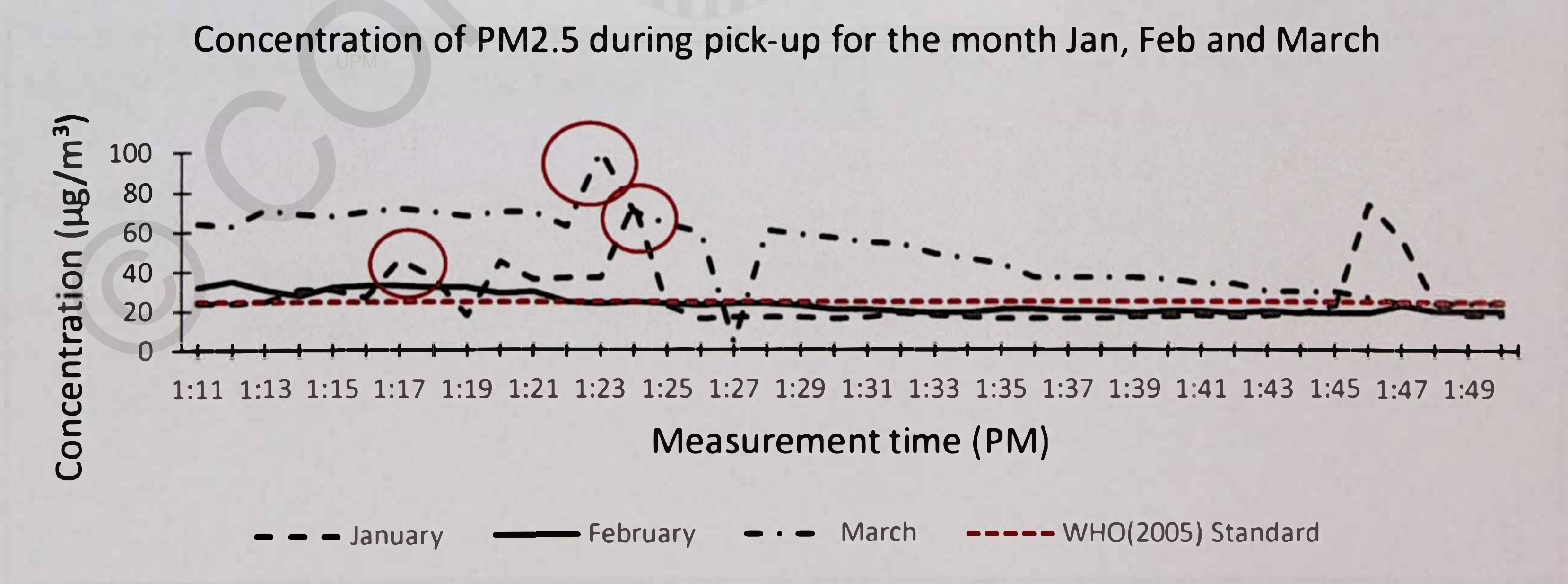

Figure 4.2 Concentration of $PM_{2.5}$ during pick-up for the month of January, February and March

4.1.3 Level of $PM_{2.5}$ during weekends

Table 4.3 shows the result of the result of level of $PM_{2.5}$ during weekends. Since the data for drop-off for the month of January were not normally disturbed, hence median±IQR taken to illustrate the data which is 12±7 µg/m³ and mean±SD is used as the data for pick-up were normally distributed which is 24.3±1.4 µg/m³. For the month of February, the data were normally distributed for both drop-off and pick-up, hence mean±SD were used. The concentration of pollutants during drop-off and pick-up for the month of February was 24.3±1.4 µg/m³ and 25.3±1.5 µg/m³ respectively. Meanwhile, for the month of March, the data for both drop-off and pick-up were not normally distributed hence median±IQR used, in which the concentration of pollutants during drop-off and pick-up were 19±1.75 µg/m³ and 23±3.75 µg/m³ respectively. Weekdays measurements were 1.5 times higher than weekend measurements.

Table 4.3 Level of $PM_{2.5}$ during weekend

Month	Time	Avg. time	Median±IQR (µg/m³)	Mean±SD (µg/m³)	Min (µg/m³)	Max (µg/m³)
January	Drop-off	1h 10 min	12±7	13±4.5	8	26
	Pick-up		12±7	24.3±1.4	8	26
February	Drop-off	1h 10 min	25±4	25.3±1.5	15	34
	Pick-up		20±7.8	20.5±5	13	34
March	Drop-off	1h 10 min	19±1.75	20±2.6	15.8	26.5
	Pick-up		23±3.75	21.8±1.6	19	25

4.1.4 Comparison of level of $PM_{2.5}$ between weekdays and weekend

From Diagram 4.3 and Diagram 4.4 the level of $PM_{2.5}$ during weekends was lower with mean±SD of 20.5±2.6 µg/m³ for both drop-off and mean±SD 21.8±1.6 µg/m³ for pick-up compared to weekdays. Apart from that, during weekends the level of pollutant was below the 24-hours WHO Air Quality Guideline 2005 which is 25 µg/m³ for both drop-off and pick-up.

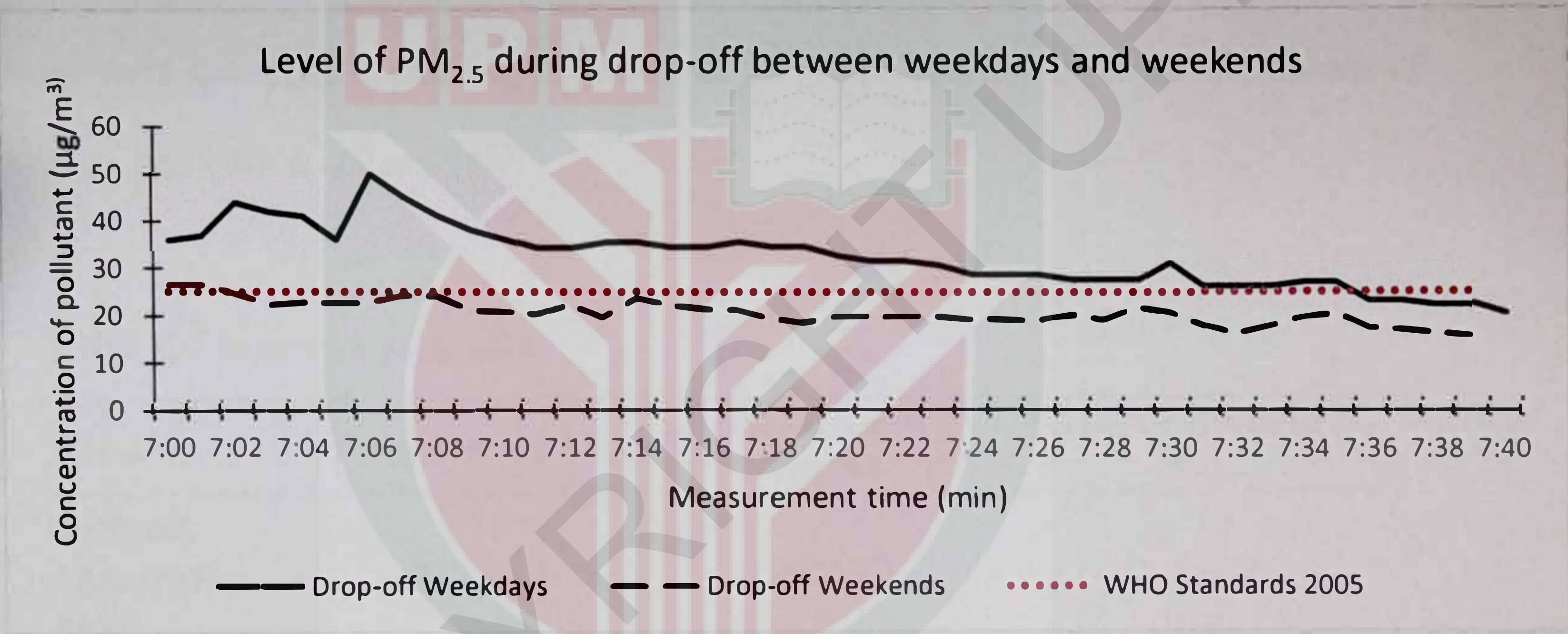

Figure 4.3 Level of $PM_{2.5}$ during drop-off between weekdays and weekends

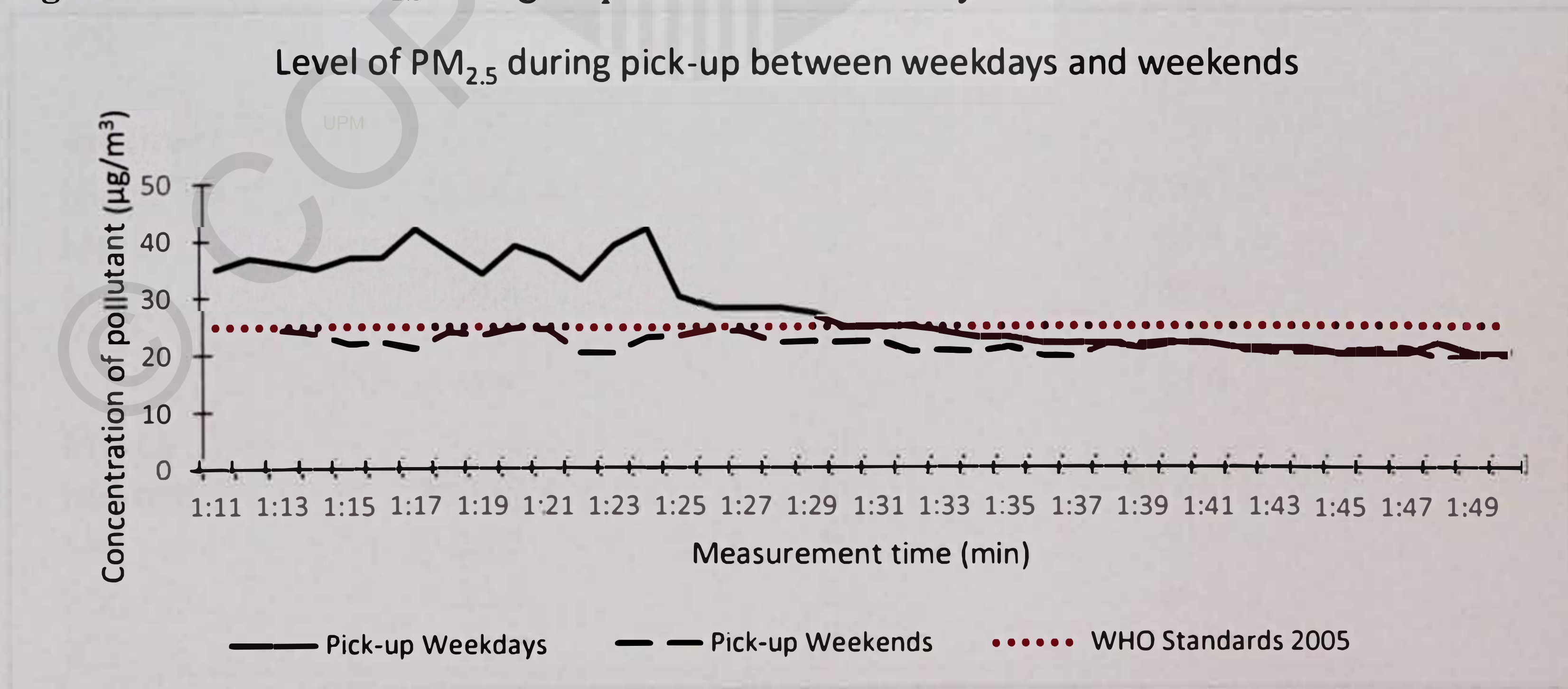

Figure 4.4 Level of $PM_{2.5}$ during pick-up between weekdays and weekends

4.2 Meteorological data

The temperature (°C), relative humidity (%) and wind speed (mph) were measured for the three (3) consecutive months which is for the month of January, February and March 2019. The month of February marked as the hottest month with 30.6 °C average temperature compared to the month of January and March with the temperature of 29.7°C. Whereas for the relative humidity, 70.4% for the month of February, followed by 69.5% for the month of January and 65.5% for the month of March. Meanwhile, there were the wind speed was recorded at 0.05 mph and 0.2 mph for the month of January and March respectively.

Table 4.4 Meteorological data

Month	Temperature (°C)	Wind speed (mph)	Relative Humidity (%)
January			
Mean±SD	29.6±2.6	0.05±0.2	63.2±9.8
Min	25.8	0	56.4
Max	31.4	1.1	76.1
IQR	4.8	0	19.1
February			
Mean±SD	28.8±2.4	0	72.3±7.2
Min	25.5	0	67.4
Max	30.6	0	81.6
IQR	4.6	0	14.0
March			
Mean±SD	28.8±2.4	0	65.6±16
Min	25.5	0	50.9
Max	30.6	0	86.8
IQR	4.6	0	31.0

*Abbreviations: SD, standard deviation. IQR, interquartile range.

4.3 Measurement of Traffic Volume

Table 4.5 shows the total number of vehicles including motorcycle, car and taxis, buses, light good vehicle (LGV) and heavy good vehicle (HGV) for the month of January was 3663 where there were 532 motorcycles, 2860 cars, 202 buses and 1 LGV. Meanwhile for the month of February, the total traffic volume was 8548 which it includes 1074 motorcycle, 7089 cars and taxis, 367 buses, 11 LGV and 7 HGV. Besides, for the month of March, the total volume measured was 2990 which it includes 362 motorcycle, 2472 cars and taxis, 144 buses, 8 LGV and 4 HGV.

Table 4.5: Measurement of Traffic Volume

Month	Observational traffic volume					
	Total	Motorcycle	Car and Taxis	Buses	LGV	HGV
January	3663	532	2860	202	1	0
February	8548	1074	7089	367	11	7
March	2990	362	2472	144	8	4

Notes:
LGV: Light Good Vehicles
HGV: Heavy Good Vehicles

Table 4.6: Measurement of Traffic Volume during Drop-off

Month	Observational traffic volume					
	Total	Motorcycle	Car and Taxis	Buses	LGV	HGV
January	1748	267	1403	78	0	0
February	4872	738	3931	189	7	7
March	1477	172	1236	64	3	2

Notes:

LGV: Light Good Vehicles
HGV: Heavy Good Vehicles

Table 4.7: Measurement of Traffic Volume during Pick-Up

Month	Observational traffic volume					
	Total	**Motorcycle**	**Car and Taxis**	**Buses**	**LGV**	**HGV**
January	**1737**	265	1457	124	10	5
February	**3676**	336	3158	178	4	0
March	**1513**	190	1236	80	5	2

Notes:
LGV: Light Good Vehicles
HGV: Heavy Good Vehicles

Table 4.8 shows the traffic volume measured during the weekends for the month of January, February and March the total number of vehicles including motorcycle, car and taxis, buses, light good vehicle (LGV) and heavy good vehicle (HGV) for the month of January was 254. Meanwhile for the month of February, the total traffic volume was 449 which it includes 135 motorcycles, 313 cars and taxis, and 1 bus. Besides, for the month of March, the total volume measured was 198 which it includes 59 motorcycles, 138 cars and taxis and 1 bus. The traffic volume was 10 times higher during the weekdays compared to weekends.

Table 4.8: Measurement of Traffic Volume on Weekends

Month	Observational traffic volume					
	Total	**Motorcycle**	**Car and Taxis**	**Buses**	**LGV**	**HGV**
January	**254**	72	181	1	0	0
February	**449**	135	313	1	0	0
March	**198**	59	138	1	0	0

Notes:
LGV: Light Good Vehicles
HGV: Heavy Good Vehicles

4.4 Response Rate

This study comprises of primary school children aged between 10 to 11 years the primary school located in Bandar Baru Bangi. The respondent from the school was chosen as the respondent for both questionnaire and lung functions test. However, the final sampling population was 91 students as 6 of the students were excluded due to rejection from parents with contribute to 93.8% response rate.

4.5 Socio-Demographic Data of School Children

This study has been carried out among a total of 91 respondents. Selection of the respondents was based on the representativeness and the fulfillment of the respondents to the inclusive and exclusive criteria.

In Table 4.9 below shows the respondents distribution of age, gender, race, height, weight, body mass index (BMI), ethnicity, and transportation to school. The respondents aged old between 10 to 11 years old, where 38 (41.8%) of them were aged 10 years p and 53 (58.2%) were aged 11 years old. In term of gender majority of respondents were female which were 51 (56%) and male were 40 (44%) whereas for ethnicity 91 (100%) of the respondents were Malay. For the mode of transportation to school, 17 (18.7%) of the respondents use motorcycle as the mode of transportation followed by 51 (56%) by car and 23 (25.3%) by school van.

Whereas Table 4.10, represent the anthropometric data of the respondents, since the data for weight (kg) and Body Mass Index (BMI) were not normally distributed, median (IQR) is taken to tabulate the data which is 28±11 kg and 15.6 ±5.1 respectively. Meanwhile, the data for height (cm) was normally distributed, hence mean (SD) was taken to tabulate the data which is 135.7±8.4 cm.

Table 4.9: Demographic data of the respondents (N=91)

Variables	n(%)
Age (years old)	
10 years	38(41.8)
11 years	53(58.2)
Gender	
Male	40(44)
Female	51(56)
Transportation to school	
Motorcycle	17(18.7)
Car	51(56)
School Van	23(25.3)
Spirometric paramters (Mean±SD)	
FVC	1.33±0.37
FEV_1	1.25±0.39
Lung function status	
FVC<80% predicted	41(45.1)
FEV_1<80% predicted	41(45.1)
FVC/FEV_1<80% predicted	4(4.4)

Table 4.10: Anthropometric result of all respondents (N=91)

Anthropometric data	Mean (SD)	Median (IQR)	Min	Max
Height (cm)	135.7 (8.4)	134.9(11.30	113.2	156.2
Weight (kg)	30.9(9.4)	28.0 (11)	16	72
Body Mass Index (BMI)	16.6(3.7)	15.6 (5.1)	11.4	30.9
Underweight [n(%)]		25(27.5)		
Over weight [n(%)]		18(19.8)		
Healthy weight [n(%)]		48(52.7)		

4.6 Lung Function

Table 4.11 shows both of FVC (liter) and FEV_1 (liter) are normally distributed, thus mean (SD) is used to interpret the data in which for both FVC (liter) and FEV_1 (liter) the result obtained were 1.34 (0.41) and 1.26 (0.42) respectively. Meanwhile, for FVC % predicted, FEV_1 % predicted and FEV_1/FVC % predicted the data were not normally distributed, thus median (IQR) were used to interpret the data, in which 81.4(26.0) for FVC % predicted, 82.8(29.3) FEV_1 % predicted and 97.3(10.9) for FEV_1/FVC % predicted.

Table 4.11: Interpretation of lung function test

Variables	Mean (SD)	Median (IQR)
FVC (liter)	1.34(0.41)	
FEV_1 (liter)	1.26(0.42)	
FVC % predicted		81.4(26.0)
FEV_1 % predicted		82.8(29.3)
FEV_1/FVC % predicted		97.3(10.9)

4.7 Respiratory Health Effects

The findings were based on fourth objective of the study. From the table 4.12, there were 10 (11%) and 7 (7.7%) of the respondents that has the history of wheezing and asthma respectively in the past. Whereas, within the 12 months, about 6 (6.6%) of the respondents has the occurrence of wheezing, 1 (1.1%) of the respondent had more than four (4) wheezing attack, 6 (6.6%) of the respondents had sleeping problem or wake up at night due to breathing difficulties. About 6 (6.6%) of the respondents had severe wheezing issue right after physical activities whereas 1 (1.1%) of the respondent had wheezing attack without doing any physical activities. Besides, 16 (17.6%) of the respondents had dry cough at night.

For the rhinitis, about 32 (35.2%) of the respondents had a problem with sneezing, or runny or blocked nose when she/he did not have a cold or flu and another 32 (35.2%) of the respondents had experienced hay fever in the past. Whereas within the 12 months, 32 (35.2%) of the respondents has nose problem and 25 (27.5%) of the respondents has nose problem accompanied by itchy-watery eyes. Besides, about 23 (25.3%) of respondents has reported that this nose problem accompanied by itchy-water eyes has interrupted their daily activities.

For eczema, about 23 (25.3%) of the respondents has reported that they had an itchy rash which was coming and going for at least six (6) months and about 6 (6.5%) of the respondents mentioned that they had itchy rash in the past 12 months and 55

(58.5%) of the respondents mentioned that their rash cleared completely during the past 12 months. Furthermore, 15 (16.5%) of the respondents reported that they experienced waking at night due to itchy rash and 13 (14.3%) of the respondents has the history with eczema.

Table 4.12 Reported respiratory symptoms among respondents

Symptoms	Yes		No	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Wheeze ever	10	11	81	89
Asthma ever	7	7.7	84	92.3
Symptoms within 12 months				
1)Wheeze	6	6.6	85	93.4
2) >4 attacks	1	1.1	90	98.9
3) Night wake	6	6.6	85	93.4
4) Exercise	6	6.6	85	93.4
5) Night cough	16	17.6	75	82.4
6)Wheeze at rest	1	1.1	91	98.9
Itchiness in nose ever	32	35.2	59	64.8
Hay fever ever	32	35.2	59	64.8
Symptoms within 12 months				
1) Nose	32	35.2	59	64.8
2) Itchy	25	27.5	66	72.5
3) Activity	23	25.3	68	74.7
Rash ever	23	25.3	68	74.7
Eczema ever	13	14.3	78	85.7

Symptoms within 12 months				
1)Rash	6	6.5	85	93.5
2) Rash clear	55	58.5	36	39.6
3) Night waking	15	16.5	76	83.5

4.8 Association between $PM_{2.5}$ levels and Lung Function among Respondents

In order to associate traffic-related air pollutions with lung function, the pollutants were categorized based on their median value of 28 µg/m³ for both measurements during drop-off and pick-up time. A value that was higher than median was categorized as high (≥28 µg/m³) while the value that was lower than median was categorized as low (<28 µg/m³). Table 4.13 shows the association between $PM_{2.5}$ and lung function of the respondents.

The Pearson's Chi Square test result shows there are significant association between $PM_{2.5}$ with FEV_1 % predicted (X^2=0.107, p=0.005) and FVC/FEV_1 % predicted (X^2=1.093, p=0.029). However, there is no significant association between FVC% predicted and $PM_{2.5}$.

Table 4.13: Association between $PM_{2.5}$ levels and Respiratory Symptoms among Respondents

Variable	Status	High $PM_{2.5}$ levels ($\geq 28\mu g/m^3$)	Low $PM_{2.5}$ levels ($< 28\mu g/m^3$)	X^2 Value	p value	OR	95% CI
FVC% Predicted	Normal	24(48)	26(52)	0.289	0.591	0.797	0.349-1.824
	Abnormal	22(53.7)	19(46.3)				
FEV_1% Predicted	Normal	22(53.7)	19(46.3)	0.107	0.005*	0.645	0.253-1.787
	Abnormal	24(48)	26(52)				
FVC/FEV_1% Predicted	Normal	1(25)	3(75)	1.093	0.029*	3.214	0.322-32.121
	Abnormal	45(51.7)	42(48.3)				

*significant at $p<0.05$, Odd Ratio (OR) significantly at 95% Confidence Interval (CI)>1

CHAPTER 5

DISCUSSION

5.1 Levels $PM_{2.5}$ from vehicle idling emissions

Our study found the average $PM_{2.5}$ concentrations were relatively higher during drop-off (38 µg/m^3) compared to pick-up (30 µg/m^3) and exceeded the 24-hours WHO Air Quality Guidelines 2005. For the month of January 2019, the median concentrations for drop-off and pick-up were below the 24-hours WHO Air Quality Standard 2005 which is 25 µg/m^3 and 18 µg/m^3 respectively. However, for the month of February, the median concentrations for $PM_{2.5}$ during drop-off and exceeded the 24-hour standard which was 32±4 µg/m^3 but low during pick-up which was 22±5 µg/m^3 and for the month of March, both median concentration during drop-off and pick-up exceeded the 24-hours standard which id 58±25 µg/m^3 and 49±24 µg/m^3 respectively. The differences between the 3 months were due to the sampling days when the study was conducted, where in January the study was conducted for 3 days, in February for 10 days and in March for 3 days. Apart from that, the differences were contributed by traffic count where February marks the highest traffic count (8548) compared to January (3663) and March (2990). Meteorological factors which is temperature (°C) and relative humidity (%) has contributed to the differences as well. This was affected by the measurement days were conducted. The highest traffic count in February was due to ten (10) days traffic count, meanwhile January and March were only three (3) days measurement.

From our visual observation and observation diaries, it was found that all vehicles especially school vans and school buses were letting the engine running during drop-off. However, the scenario was different during pick-up period where all the school vans and buses turned their vehicle engine off while waiting for the children. This is because most of the parents and bus drivers wants to save time before they transit to other places. This behavior of the school bus or school van drivers has contributed to the release of higher level of $PM_{2.5}$ during drop-off compared to pick-up. From the traffic count survey, school bus and school vans contributing about 5% of the total vehicle count. Other than that, most of the school vans and school buses were using an old and unmaintained diesel engine. This is in line with study that has been conducted by T. Leggett (2018) where diesel engines which is used by most school vans and school buses produces higher level of particulates in which includes soot of black carbon rom the combustion process.

Furthermore, about 95% of the vehicles were comprises of motorcycles and private cars which uses petrol engine and all of these motorcycles and private cars tend to let the engine running during drop-off and pick-up period. Therefore, the combustion of both diesel and petrol fuels that occurs in automobile engines produces combustion-derived particulate matters (Wu, Zhang, Lou, Li, and Chen, 2017) which contributed to the release of $PM_{2.5}$ during car idling. According to Zuurboer et al., fuel type significantly influences the concentration of traffic-related air pollutants.

Based on the traffic count survey, the number of small size vehicles (motorcycle) (1,968) and medium size vehicles (car and taxis) (12,421) were the highest among large size vehicles (buses, light and heavy good vehicles). Even though, the small size vehicles producing low concentrations of traffic-related air pollutants but with the high number of small size vehicles will contribute to high emission of traffic-related air pollutants (Zuurboer et al., 2010). Road transportations are responsible for low height emission which contributing to air pollution (Guilbert et al., 2019). Additionally, emission from the tailpipe of the vehicles and wear and tear from abrasions of brake, tyre, and clutch and road dust re-suspension are responsible for the emission for particulate matters (Kalaiarasan, Balakrishnan, & Sethunath, 2018).

Vehicle idling activities has been the major contributor to the release of traffic-related air pollutants (TRAPs) within the school compound especially from diesel exhaust vehicles. There are more than 40 toxic air pollutants in diesel exhaust and it is a major contributor to ambient particulate matter such as $PM_{2.5}$ and ultrafine particulate matter (Costa et al., 2017). Previous study also found that, there were higher concentration of pollutants from vehicles in places where idling is frequent such as bus stops, rest stops and near schools. Besides, there were high emissions formation and fuel residue in the exhaust due to vehicle idling behavior (Shancita et al., 2014). Idling emission is considered more harmful as this condition has an association with high exposure to air pollutants due to the lack of turbulent dispersion or the high dispersion of the pollutants normally created by the wake of moving vehicle (Mcnabola, Broderick, & Gill, 2009). Our study had minimized the confounding factor from other

TRAP source from the main road where the study location was located approximately away from the main road. Previous study conducted by Levy et al (2015), found that there were strong association between ultrafine particle concentrations with traffic pattern, with particle number concentrations a factor of five greater at peak traffic period than at night. Their study has proved that the concentration of ultrafine particles was lower at night due to less traffic.

Furthermore, our study was conducted during weekends to compare the level of air pollutants released between weekdays and weekends for both drop-off and pick-up. We observed concentrations of $PM_{2.5}$ were 1.5 times lower during the weekend and below than 24-hours WHO Air Quality Guideline 2005 value. Similar findings were found by Gour et al. (2013) in New Delhi where the level of pollution on weekend (Saturday and Sunday) has significantly lower concentrations compared to that on weekdays (Monday to Friday) by almost 2 to 6 times.

Apart from that, the behavior of vehicle use towards car idling is another major factor that contributing to release of traffic-related air pollution from car idling. This can be related to the weather in Malaysia which experiencing hot and humid climate throughout the year with very small variation (Kaffashi et al., 2016). The hot and humid weather makes the car user choose to sit in the car while idling where most of the cars are equipped with air conditioner. A survey has been conducted to assess behavior of Malaysian residents towards the use of air conditioner by Ahmad et al. (2018). Previous study has found that Malaysian uses air conditioner more frequently for longer period even the outdoor temperature is not affecting the indoor temperature (Ahmad, Fadhilah, Hanip, Hagishima, and Yakub, 2018).

5.1.1 Influence of meteorological data

The study also measured the meteorological data which includes temperature (°C), relative humidity (%) and wind speed (mph) at the study location. As the air pollution is not only affected by traffic emission, but also closely related to the meteorological factors (Cheng, Cheng, Li, and Ning, 2019). Apart from that, understanding behavior of meteorological parameters is important because atmosphere is the medium in which air pollutants are transported away from the source, which is governed by the meteorological parameters such as atmospheric wind speed, wind direction and temperature (Jayamurugan, Kumaravel, Palanivelraja, and Chockalingam, 2013). The influence of meteorological parameters such as temperature, relative humidity, and wind speed is proven from the study that has been conducted by Dominick et al. (2012) in Malaysia, where it was found temperature has a positive correlation to the concentration of pollutants from vehicles.

The meteorological data were presented in Table 4.4. From the result, the average temperature through the data collection period was 30 °C, with relative humidity of 68.5 % and with 0.08 mph of wind speed. Ambient temperature is one of the important factor that influences the air pollutants, this is because temperature has long been known as a catalyst in which it enhance the chemical reaction between the pollutants where it creates synergistic effects to human health and temperature speeds up the chemical reaction of air pollutants too (Kalisa, Fadlallah, Amani, Nahayo, and Habiyaremye, 2018). Meteorological Department of Malaysia had released their current press statement where Selangor was strike by Level 1 heatwave in February 2019 (Malaysian Meteorological Department, 2019) which influences the level of pollutants during the study were conducted. The study conducted by Kalisa et al. (2018) has proven that air pollutants increases with increasing temperatures, particularly during heat wave where during prolonged heat waves high levels of pollutants has conclusively been found to be more prevalent. The relative humidity were low where it were 67±11% with ranging from 58.2% to 81.5%.This is in line with the study conducted by Lou.C et al. (2017), where the study were conducted by explore the spatial relationship between particulate and meteorological factor for 173 cities in China and the relationship between relative humidity (RH) and concentration of particulate matter ($PM_{2.5}$ and PM_{10}) were analysed by categorizing relative humidity which is very-dry (RH<45%), dry (RH=45-60%) and low-humidity (RH=60-70%) and found that these three (3) level of humidity were positively affected by $PM_{2.5}$.

The last meteorological parameter that was measured in the study was wind speed. Wind speed and wind direction is another factor that influences the dispersion of air pollutants (Heisler, 1990). The wind speed measured at the study location was consider very low (with average of 0.08 mph), this is due to the topography at the study location. The school is situated within the residential areas and apartment complexes of flat type therefore these will act as an obstruction to the wind speed. This supported by the study conducted by (Hyung, Kim, & You, 2014) that found the wind speed reduced by 40% or maximum due to the lateral sides of the buildings. Thus, we can conclude that, the wind speed does not affect the level of pollutants in our study.

5.2 Socio-demographic data of school children

Information on the socio-demographic of the respondents had been carried out by a set of questionnaires. Inclusive and exclusive criteria had been taken into considerations during the selection phase of the respondents. The respondents were consisting of Malay ethnicity, this is because majority of residents that staying in Bangi were Malay, and according to Admission Division of Selangor, about 57.1% of total population in Selangor were consist of Malay ethnicity, followed by Chinese ethnicity (28.6%), Indian ethnicity (13.5%) and others ethnicity (0.8%). The result showed that majority (58.2%) of the respondents were aged 11 years old. Majority (56%) of the respondents were female. The study found that about 19.8% of the respondents were overweight, 27.4% were underweight and 52.7% were in the range of healthy weight. This is in line with previous where in Malaysia, the prevalence of obesity among children which were less than 18 years was about 11.9% and higher prevalence (12.1%) were reported in urban than in rural (11.2%) area (Joseph et al., 2019).

Besides, majority (56%) of the respondents used car as their primary mode of transportation to school. Vitale et al. (2019) reported that about 40% of urban or suburban students' used car to commute from home to school although their home is located within walking distance. More over in last 5 years, there were 22 million registered vehicles in Malaysia, of which 16 million vehicles are actively used on the road and private vehicle ownership by 2012 had grown 35% over the 2008 (Kaffashi et al., 2016) which contribute to the usage of car as primary mode of transportation in Malaysia.

5.3 Reported respiratory symptoms due to TRAP exposure during vehicle idling

The reported respiratory symptoms due to exposure to traffic related air pollutant during vehicle idling were analyzed as children spend much of their time in the school environment are affected by high concentration of $PM_{2.5}$ (Othman, Talib, & Matsumi, 2019). The respiratory symptoms in the study were evaluated by using standardized questionnaire from the International Study of Asthma and Allergies in Childhood (ISAAC) year 6-7 years old. The parameters used to analyze the respiratory symptoms were wheezing, rhinitis, allergies and eczema and the result were tabulated in Table 4.10.

The first reported symptoms were wheezing where 10(11%) of the respondents experienced wheezing in the past. There are high prevalence of children whom exposed to $PM_{2.5}$ associated with increased prevalence of wheezing (Norbäck et al., 2019). Previous study shows that, children are highly susceptible for traffic-related air pollutants due to their physiological factor where they have high breathing rate and behavioral factor where they have high physical activity (Rivas, Querol, Wright, and Sunyer, 2018).

The next parameter was rhinitis and allergies, where 32 (35.5%) of the respondents experience itchy nose and hay-fever in the past 12 months which it is closely associated with rhinitis and allergies. High concentration of air pollutants are associated with a high incidence of superficial ocular disorder such as watery-eyes, redness, eye irritation and eye strain (Mimura, Ichinose, Yamagami, Fujishima, and Kamei, 2014). Nikasinovic, Just, Sahraoui, Grimfeld, and Momas (2002) found that exposure to $PM_{2.5}$ influences nasal inflammation in asthmatic children.

For the rashes and eczema, about 23 (25.3%) and 13 (14.3%) respondents have the symptoms of both rashes and eczema respectively. Childhood eczema results from an interplay of genetic and environmental factor including traffic related air pollutants (Schnass et al., 2018). Previous study shows that the risk of eczema was 2.2 for the children living less than 50m from streets with heavy traffic (Sugiri et al., 2009).

5.4 Association between Lung Function and $PM_{2.5}$ emissions from vehicle idling

Lung function test was performed among the respondents. The procedure for this test was adopted from the recommended procedure by American Thoracic Society (ATS), 1991. The lung function among the study population evaluated based on FVC (liter), FEV_1 (liter), FVC % predicted, FEV_1 % predicted and FEV_1/FVC % predicted. Since the study group were children, normal lung function value of lung function parameters among children in Malaysia by Azizi and Henry (1994) was used to calculate the FVC and FEV_1 predicted.

Table 4.11 shows the association between $PM_{2.5}$ levels and lung function of respondents. The finding shows that, there were significant association (X^2=0.107, p=0.005) between $PM_{2.5}$ levels and FVC% predicted and FVC/FEV_1 % predicted which is X^2=1.093 and p=0.029 but no significant differences between $PM_{2.5}$ and FVC % predicted.

According to Franklin & Fruin (2017) long term exposure to traffic-related air pollution leads to a reduction in the lung development in children. Besides, epidemiologic finding shows that there were significant negative health effect on healthy children's lung function which influences the development of both large and small airways due to long term exposure to traffic-related air pollutants (Chen et al., 2018). There is an evidence in the study conducted by Zeng et al. (2016) where both cross-sectional and longitudinal studies have shown the link between traffic-related air pollution exposure and lung function impairment in children.

Hence, hypothesis four in the study was failed to be rejected since there was a significant association between the level of $PM_{2.5}$ and lung function of the respondents.

CHAPTER 6

CONCLUSION, RECOMMENDATION AND LIMITATION

6.1 CONCLUSION

As a conclusion, this preliminary study is first study in Malaysia on the effect of traffic-related air pollutants during car idling to respiratory health effects of school children. The study is important to serve as a baseline data for future study, as school compound has become a prominent spot vehicle idling activity which eventually it will affect the health of the school children in long period of exposure.

From the finding above we can conclude that the level of traffic-related air pollutant during vehicle idling were relatively high on daily school days especially during the peak period which was during the dropping-off (average of 38.3±10.7 $\mu g/m^3$) and pick-up (average of 29.7±12.5 $\mu g/m^3$), where the level of PM2.5 were exceeded the recommended standards. Researcher also compared the level of pollutant between weekdays and weekends during the course of sampling period and it was proven that the level of pollutants during the weekdays were 1.5 times higher compared to the weekend. Meanwhile, for the average traffic count during drop-off and pick-up were 2699 and 2308 respectively whereas average traffic count during the weekend were 300. The average wind speed, temperature and relative humidity from January to March 2019 were 0.05±0.2 mph, 29.1±2.5 °C and 67.0±11 % respectively. Besides, it is also found that, exposure to traffic-related air pollutants has effects on the lung function of the children as well as there were respiratory symptoms reported in the study.

Furthermore, this study also proven that the level of pollutants measured has no influence from the main-roads or industrial activities but majorly from vehicle idling activities and high numbers of vehicles during drop off and pick up periods. The findings of the study should, therefore, be taken into account by policy makers as well as the school management in formulating policies such as "No Car Idling Zone" around school compound to provide clean air for our future generations to live with their maximum health and wellbeing.

This study has proved that traffic-related air pollutant ($PM_{2.5}$) during vehicle idling has effect on school children's respiratory health.

6.2 RECOMMENDATION

6.2.1 Government

Government should take serious action regarding vehicle idling activities at common places especially around school area by taking example from Singapore. "Low Emission Zone" and "No Car Idling Zone" policy should be introducing and implemented immediately to create awareness among the public on the effect of such behavior. Apart from that, fine should be imposed to those who fail to follow the rule.

6.2.2 School Management

Managing air quality around the school compound should be consider as first priority because the student's performance in class are significantly associated with their health and well-being. The school management together with Parent Teacher Association should join hand together and start to implement "No Car Idling Zone" around school compound. This is because, this study has found that emission from vehicle idling has been the major factor that contributing to air pollution around the school area. Other than that, the school management can encourage the students to use passive commuting by cycling or walking to the school.

6.2.3 Parents and Private School Bus Owner

Parents and private school bus owner should be more cooperative to the school management if "No Car Idling Zone" is implemented in school. Parents support is vital to make the policy has a success by turn off the engines while waiting to pick up and drop off the children, by maintaining vehicles to eliminate any visible exhaust and by spread the word to family and friends and encourage others to eliminate unnecessary idling.

6.2.4 Recommendation for Future Studies

The present study has on take into account on one traffic-related air pollutant which is $PM_{2.5}$. Further research need to be conducted in the future on measurement if other traffic related air pollutants (carbon monoxide, black carbon, sulphur dioxide, nitrogen dioxide, and VOCs) and particles in depth with their mixture component in order to determine in detail the significant differences with a large number of sample sizes. Moreover, intervention study should be conducted to cultivate the behavior of no vehicle idling among parents as well as private school bus drivers. Intervention study also important to evaluate the difference in knowledge, attitude and practice before and after the study. Besides, separate questionnaire should be distributed to the parents and drivers to determine the factors that initiate them to idle their vehicles. This study also should include exposed and unexposed group to vehicle idling effects. This will make comparable for health effects from exposure to traffic related air pollution.

More research should be conducted regarding the health effect on car idling to school children in Malaysia, so that the finding can be generalized to the affected group of people and by involve of government in generating policy regarding car idling behavior.

Lastly, research should be conducted to other population group such as public transport users which uses public transport as their primary mode of transportation where their health might be affected due to prolonged exposure to traffic-related air pollutants.

6.3 LIMITATION

The present study conducted was through cross-sectional design, which we cannot predict whether certain variables precedes the other, such as the traffic-related air pollutants during cat idling was causing respiratory health symptoms or whether it is after they have respiratory health symptoms, they exposed to the traffic-related air pollutants. This also applies to other variables, where causal relationship was not being able to establish. This study also did not explore on exposed and non-exposed group between the respondents. Therefore, it is recommended to further expand for data analysis for both exposed and unexposed group to make data analysis more reliable.

Other limitation in this study was the parameter measured in the study, where only one parameter was taken into account when then study was conducted. Then, recall bias when the parents answer the questionnaire, as the questions were about reporting the respiratory health symptoms that happened in past 12 weeks. Besides, the difficulty in getting cooperation from the respondents due to young age was one of the limitations of the study. The time constraints for the observation period and the equipment faulty have limited our monitoring activities for this study.

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APPENDIX I

QUESTIONNAIRE FORM

ID Responden:

Tarikh:

UNIVERSITI PUTRA MALAYSIA

BERILMU BERBAKTI

PENGENALAN

Selamat pagi / tengah hari / petang. Saya **Tiruchelvi Subramaniam** pelajar tahun akhir **Bacelor Sains Kesihatan Persekitaran dan Persekitaran** di **Fakulti Perubatan dan Sains Kesihatan, Universiti Putra Malaysia.**

Saya sedang menjalankan kajian yang bertujuan untuk mengetahui hubungan antara kepekatan pencemaran udara yang berkaitan dengan trafik semasa ibu bapa menunggu di kereta dengan enjin kereta yang masih jalan dan gejala pernafasan di kalangan kanak-kanak sekolah rendah di Bandar Baru Bangi, Selangor. Oleh itu, kerjasama tuan / puan dalam kajian ini sangat penting.

Saya sangat menghargai dan berterima kasih sekiranya tuan / puan mengambil sedikit masa untuk menjawab set soalan kaji selidik ini. Semua maklumat yang tuan / puan sumbangkan akan digunakan untuk kajian projek ilmiah tahun akhir saya dan adalah sulit.

PERSETUJUAN

Saya.. No Kad Pengenalan. .... beralamat.. ....dengan ini secara sukarela bersetuju membenarkan *anak / jagaan saya .... menyertai **penyelidikan tersebut di atas *(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 yang tercatat dalam Helaian Penerangan). Saya memahami bahawa *anak / jagaan saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti *anak / jagaan saya akan dirahsiakan.

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

I setuju/tidak bersetuju untuk imej/gambar/rakaman video/ rakaman suara berkaitan dengan anak/ jagaan saya digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan ....
(*Ibubapa/ Penjaga*)

Tarikh :...

Tandatangan ....
(*Saksi*)

Nama :...

No. K/P: ....

Saya mengesahkan bahawa saya telah menerangkan kepada ibubapa/penjaga responden mengenai sifat dan tujuan penyelidikan tersebut di atas.

Tarikh ....

Tandatangan ....
(*Penyelidik*)

BAHAGIAN A: DATA DEMOGRAFI

Tandakan (√) pada ruangan yang telah disediakan.

1. Berapakah umur anak anda?

☐ 10 tahun ☐ 11 tahun

2. Bagaimanakah anak anda hadir ke sekolah?

☐ Menggunakan bas sekolah, van sekolah, kereta / motorsikal

☐ Berjalan kaki / menggunakan bisikal

3. Adakah anak anda akan menunggu di pintu pagar sekolah selepas waktu sekolah?

☐ Ya ☐ Tidak

4. Adakah ahli keluarga anda mempunyai tabiat merokok?

☐ Ya ☐ Tidak

5. Adakah anak ada menghidapi penyakit pernafasan (contoh lelah, penyakit paru-paru keradanagan dan seumpamanya).

☐ Ya ☐ Tidak

JIKA JAWABAN ANDA ADALAH "TIDAK", SILA KE BAHAGIAN B

BAHAGIAN B: SOAL SELIDIK UNTUK ASMA

Tandakan (√) pada ruangan yang telah disediakan.

1. Pernahkan anak anda mengalami bunyi "*wheezing*" (berdesis) atau bunyi "*whistling*" (bersiul) di bahagian dada sebelum ini?

☐ Ya ☐ Tidak

JIKA JAWABAN ANDA ADALAH "TIDAK", SILA KE SOALAN NO. 6

---

2. Adakah anak anda pernah mengalami bunyi "*wheezing*" (berdesis) atau bunyi "*whistling*" (bersiul) di bahagian dada dalam tempoh 12 bulan yang lepas?

☐ Ya ☐ Tidak

JIKA JAWABAN ANDA ADALAH "TIDAK", SILA KE SOALAN NO. 6

---

3. Berapa banyak serangan "wheezing" (berdesis) yang anak anda alami dalam 12 bulan yang lepas?

☐ Tiada ☐ 1-3 kali ☐ 4-12 kali ☐ Lebih 12 kali

4. Berapa kerap, secara purata, tidur anak anda terganggu akibat "*wheezing*" (berdesis) dalam tempoh 12 bulan yang lepas?

☐ Tidak pernah ☐ Sekali dalam seminggu/kurang ☐ Lebih daripada sekali dalam seminggu

5. Pernahkan anak anda mengalami "wheezing" (berdsis) yang teruk sehingga hanya mampu bercakap sepatah dua sahaja dalam tempoh 12 bulan yang lepas?

☐ Ya ☐ Tiada

---

6. Pernahkah anak anda mengalami asma/lelah?

☐ Ya ☐ Tiada

7. Pernahkah anak anda mengalami bunyi "*wheezing*" (berdesis) di semasa atau selepas bersukan dalam tempoh 12 bulan yang lepas,

☐ Ya ☐ Tiada

8. Pernahkan anak anda mengalami batuk kering pada waktu malam selain batuk yang dikaitkan pada waktu sejuk atau jangkitan dada dalam tempoh 12 bulan yang lepas?

☐ Ya ☐ Tiada

BAHAGIAN C: SOAL SELIDIK UNTUK RINITIS

Tandakan (√) pada ruangan yang telah disediakan.

1. Pernahkan anak anda mengalami masalah bersin, atau hidung berair, atau hidung tersumbat apabila dia tidak mengalami selsema?

☐ Ya ☐ Tidak

JIKA JAWABAN ANDA ADALAH "TIDAK", SILA KE SOALAN NO. 6

---

2. Pernahkan anak anda mengalami masalah bersin, atau hidung berair, atau hidung tersumbat apabila dia tidak mengalami selsema dalam tempoh 12 bulan yang lepas?

☐ Ya ☐ Tidak

JIKA JAWABAN ANDA ADALAH "TIDAK", SILA KE SOALAN NO. 6

---

3. Pernahkah anak anda mengalami masalah hidung disertai dengan mata berair dan gatal dalam tempoh 12 bulan yang lepas?

☐ Ya ☐ Tidak

4. Berapa kerap masalah hidung ini mengganggu aktiviti harian anak anda dalam tempoh 12 bulan yang lepas?

☐ Tidak ada sama sekali ☐ Serhana
☐ Sedikit ☐ Banyak

5. Pernahkah anak anda mengalami demam?

☐ Ya ☐ Tidak

BAHAGIAN C: SOAL SELIDIK *ECZEMA*

1. Pernahkah anak anda mengalami ruam gatal sekali sekala sekurang-kurangnya dalam tempoh masa 6 bulan?

☐ Ya ☐ Tidak

JIKA JAWABAN ANDA ADALAH "TIDAK", SILA KE SOALAN NO.7

---

2. Pernahkah anak anda mengalami ruam gatal ini dalam 12 bulan yang lepas?

☐ Ya ☐ Tidak

JIKA JAWABAN ANDA ADALAH "TIDAK", SILA KE SOALAN NO.7

---

3. Pernahkah ruam gatal ini terjejas mana-mana tempat berikut:

Lipatan siku, di belakang lutut, di hadapan pergelangan kaki, di bawah punggung, atau di sekitar leher, telinga atau mata?

☐ Ya ☐ Tidak

4. Pada umur berapakah ruam gatal ini mula berlaku?

☐ Bawah 2 tahun ☐ 2-4 tahun ☐ 5 tahun ke atas

5. Adakah ruam ini telah sembuh dalam masa 12 bulan yang lepas?

☐ Ya ☐ Tidak

6. berapa kerap, secara purata, anak anda telah terjaga dari tidur pada waktu malam disebakan oleh ruam gatal dalam tempoh 12 bulan yang lepas?

☐ Tidak pernah ☐ Sekali dalam seminggu/kurang ☐ Lebih daripada sekali dalam seminggu

---

7. Pernahkan anak anda mengalami eczema sebelum ini?

☐ Ya ☐ Tidak

Soal selidik telah tamat. Terima kasih atas kerjasama.

APPENDIX II

CONSENT FORM

BORANG 2.5: PENERANGAN DAN PERSETUJUAN IBUBAPA/PENJAGA

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

1.TAJUK KAJIAN

Hubungan antara kepekatan pencemaran udara yang dikeluarkan dari enjin kenderaan yang melahu (*idling*) dan gejala pernafasan di kalangan kanak-kanak sekolah rendah di SK Jalan 3, Bandar Baru Bangi.

2. PENGENALAN

Enjin kereta yang melahu adalah antara menyebab utama terhasilnya pencemaran udara. Melahu membawa maksud di mana enjin kereta masih hidup ketika parkir dan tidak bergerak di atas jalan raya. Fenomena ini kerap berlaku di kawasan luar sekolah, di mana ibu bapa yang menunggu untuk menjemput anak mereka selepas waktu persekelolahan kerap tidak matikan enjin kereta. Melahu enjin kereta sering dihubungkaitkan dengan pencemaran udara, malahan ramai tidak tahu bahawa tabiat melahu kenderaan juga sebenarnya membawa impak negatif kepada kesihatan, terutamanya kanak-kanak, warga emas serta wanita mengandung. Kajian juga menyatakan bahawa melahu enjin kenderaan menghasilkan *Greenhouse Gases* (GHG) dua kali ganda lebih tinggi daripada kenderaan yang bergerak.

Selain itu, haba yang dihasilakan oleh enjin hidup serta bau pemakaran bahan adalah berbahaya terhadap kesihatan manusia, terutamanya kanak-kanak. Kanak-kanak mempunyai risiko yang sangat tinggi untuk mengalami masalah pernafasan, hal ini demikian kerana, kanak-kanak bernafas dua kali lebih pantas berbanding orang dewasa, lalu secara tidak langsungnya badan mereka menerima dua kali lebih banyak bahan pencemeran udara yang berbahaya ini.

Oleh itu, kajian ini dijalankan untuk mengenal pasti tahap pencemaran udara di kawasan sekolah ketika enjin kereta melalu dan hubungannya terhadap gejala pernafasan kanak-kanak.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Mendapatkan data demografi pelajar.

Pemantauan tahap pencemaran udara di kawasan sekolah

Menjalankan ujian fungsi paru-paru terhadap sampel.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Mereka yang mempunyai masalah kesihatan yang melibatkan pernafasan.

Mereka yang datang ke sekolah dengan berjalankan atau berbasikal.

Jika ada ahli keluarga yang mempunyai tabiat merokok.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANAK/JAGAAN SAYA SEBAGAI PESERTA?

Boleh mengetahui adakah kesihatan anak terjejas akibat pendedahan yang terlampau kepada gas pencemar udara.

b) KEPADA PENYELIDIK?

Boleh menyediakan data asas yang boleh diperluaskan untuk penyelidikan masa depan.

6. ADAKAH IA BERISIKO?

Tidak.

7. ADAKAH MAKLUMAT DAN IDENTITI ANAK/JAGAAN SAYA KEKAL RAHSIA?

Ya.

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

Tiruchelvi Subramaniam 018 209 0203

Dr. Nor Eliani Binti Ezani 019 289 4449

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

9. PERSETUJUAN

Saya... No Kad Pengenalan. .... beralamat... ....dengan ini secara sukarela bersetuju membenarkan *anak / jagaan saya .... menyertai **penyelidikan tersebut di atas *(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 yang tercatat dalam Helaian Penerangan). Saya memahami bahawa *anak / jagaan saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti *anak / jagaan saya akan dirahsiakan.

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

I setuju/tidak bersetuju untuk imej/gambar/rakaman video/ rakaman suara berkaitan dengan anak/ jagaan saya digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan ....
(*Ibubapa/ Penjaga*)

Tarikh :...

Tandatangan ....
(*Saksi*)

Nama :...

No. K/P: ....

Saya mengesahkan bahawa saya telah menerangkan kepada ibubapa/penjaga responden mengenai sifat dan tujuan penyelidikan tersebut di atas.

Tarikh ....

Tandatangan ....
(*Penyelidik*)

APPENDIX III

ETHICAL APPROVAL

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

Research title	:	**The Relationship Between Concentrations of Traffic Related Air Pollution During Car Idling and Respiratory Symptoms Among Primary School Children at SK Putrajaya Prescient 8 (2)**
Study Site	:	**SK Putrajaya Prescient 8 (2)**
JKEUPM Ref No.	:	**JKEUPM-2018-375**
Researcher	:	**Tiruchelvi Subramaniam**
Supervisor	:	**Dr. Nor Eliani Ezani**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 29/10/2018
2. Respondent Information Sheet & Guardian's/Parent's Consent (Malay), Version 1 dated 29/10/2018
3. Proposal (English), Version 1 dated 29/10/2018
4. Questionnaires/ Interviews (Malay), Version 1 dated 29/10/2018
5. Curriculum Vitae of:
   a. Dr. Nor Eliani Ezani

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 16 NOVEMBER 2019**

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.

Rujukan: UPM/FPSK/JKPP/182491

Prof. Dr. Zamberi Sekawi
Chair
Ethics Committee for Research Involving Human Subjects
Universiti Putra Malaysia

30 November 2018

Dear Prof/ Dr. /Mr. / Ms.,

AMENDMENT TO THE STUDY LOCATION AND STUDY TITLE

With reference to our previous ethics application to JKEUPM (Ref. No: UPM/TNCPI/RMC/JKEUPM/1.4.18.2), I would like to inform you that there is slight change made for our application. As research advisor for final year student, BSc Environmental and Occupational Health, **Tiruchelvi Subramaniam (182491)**, I would like to inform that there is a change in the study location and study title for the research project entitled **'The Relationship Between Concentration of Traffic-Related Air Pollution during Car Idling and Respiratory Symptoms among Primary School Children at SK Putrajaya Prescint 8(2)'**

2. The study location has been changed from **SK Putrajaya Prescient 8(2)** to **SK Jalan 3, Bandar Baru Bangi**. We had found that the initial study location did not meet the inclusive criteria that have been set for our study. Please refer Appendix 1 for further details.

3. The study title has been changed from **'The Relationship Between Concentration of Traffic-Related Air Pollution during Car Idling and Respiratory Symptoms among Primary School Children at SK Putrajaya Prescint 8(2)'** to **The Relationship Between Concentration of Traffic-Related Air Pollution during Car Idling and Respiratory Symptoms among Primary School Children at SK Jalan 3, Bandar Baru Bangi'**.

3. We also had been given approval by the Ministry of Education to conduct our study at SK Jalan 3, Bandar Baru Bangi, Selangor. Please refer to Appendix 2 for your review.

I would be grateful if the JKEUPM will approve the amendment for Tiruchelvi final year project study location. Please do not hesitate to contact me at 03-86092937 or e-mail elianiezani@upm.edu.my if there is any clarification and concerns.

Thank you.

Yours sincerely,

Nor Elaini Binti Ezani
Senior Lecturer
Department of Environmental and Occupational Health
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia

KEMENTERIAN PENDIDIKAN MALAYSIA
BAHAGIAN PERANCANGAN DAN PENYELIDIKAN DASAR PENDIDIKAN
ARAS 1-4, BLOK E8
KOMPLEKS KERAJAAN PARCEL E
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Tarikh : 30 November 2018

TIRUCHELVI A/P SUBRAMANIAM
NO. KP : 950302055218

NO 390 PEKAN JOHOL
73100 JOHOL
NEGERI SEMBILAN

Tuan,

KELULUSAN UNTUK MENJALANKAN KAJIAN DI SEKOLAH, INSTITUT PENDIDIKAN GURU, JABATAN PENDIDIKAN NEGERI DAN BAHAGIAN DI BAWAH KEMENTERIAN PENDIDIKAN MALAYSIA

Perkara di atas adalah dirujuk.

2. Sukacita dimaklumkan bahawa permohonan tuan untuk menjalankan kajian seperti di bawah telah diluluskan.

" RELATIONSHIP BETWEEN CONCENTRATION OF TRAFFIC-RELATED AIR POLLUTION DURING VEHICLE IDLING AND RESPIRATORY SYMPTOMS AMONG PRIMARY SCHOOL CHILDREN AT SK JALAN 3, BANDAR BARU BANGI "

3. Kelulusan adalah berdasarkan kepada kertas cadangan penyelidikan dan instrumen kajian yang dikemukakan oleh tuan kepada bahagian ini. Walau bagaimanapun kelulusan ini bergantung kepada kebenaran Jabatan Pendidikan Negeri dan Pengetua / Guru Besar yang berkenaan.

4. Surat kelulusan ini sah digunakan bermula dari **2 Januari 2019** hingga **30 April 2019** .

5. Tuan dikehendaki menyerahkan senaskhah laporan akhir kajian dalam bentuk *hardcopy* bersama salinan *softcopy* berformat pdf dalam CD kepada Bahagian ini.Tuan juga diingatkan supaya mendapat kebenaran terlebih dahulu daripada Bahagian ini sekiranya sebahagian atau sepenuhnya dapatan kajian tersebut hendak diterbitkan di mana-mana forum, seminar atau diumumkan kepada media massa.

Sekian untuk makluman dan tindakan tuan selanjutnya. Terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

Ketua Sektor
Sektor Penyelidikan dan Penilaian
b.p. Pengarah
Bahagian Perancangan dan Penyelidikan Dasar Pendidikan
Kementerian Pendidikan Malaysia

salinan kepada:-

JABATAN PENDIDIKAN SELANGOR

* SURAT INI DIJANA OLEH KOMPUTER DAN TIADA TANDATANGAN DIPERLUKAN *

APPENDIX IV

PICTURES

Figure 1: Manual Traffic Count and $PM_{2.5}$ Measurement at Study Location

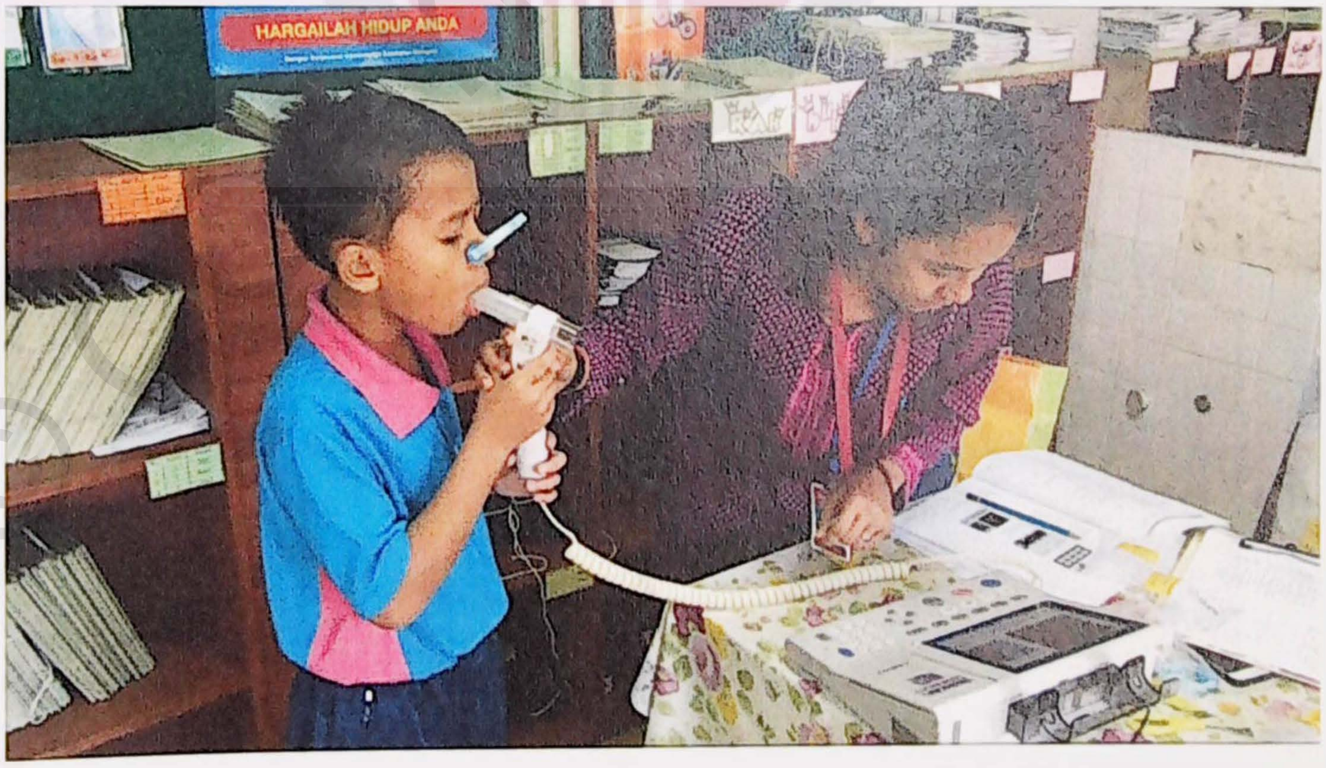

Figure 2: Lung Function Test

Figure 3: Idling Activity by School Van Drives

Figure 4: Equipment Set-Up at Study Location