UNIVERSITI PUTRA MALAYSIA

ASSOCIATION ON EXPOSURE OF PM_{10} AND $PM_{2.5}$ WITH RESPIRATORY HEALTH SYMPTOMS AND LUNG FUNCTION AMONG CHILDREN LIVING NEAR PALM OIL ACTIVITY IN SEMENYIH SELANGOR

FARIS SYAHMI BIN MOHD SHAHIDIN

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BY

FARIS SYAHMI BIN MOHD SHAHIDIN

Thesis submitted in fulfilment of the requirement for the degree of Bachelor Science (Environmental and Occupational Health) from the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia

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ABSTRACT

ASSOCIATION OF EXPOSURE TO PM_{10} AND $PM_{2.5}$ WITH RESPIRATORY HEALTH SYMPTOMS AND LUNG FUNCTION STATUS AMONG CHILDREN LIVING NEAR PALM OIL ACTIVITY IN SEMENYIH SELANGOR

FARIS SYAHMI BIN MOHD SHAHIDIN

Introduction: The implementation of biomass fuels in palm oil boilers produced pollutants into the air such as particulate matters (PM). PM has been related to cause many respiratory health symptoms to human, especially children. Children were vulnerable as their air intake is larger per kilogram body if compared to an adult. **Objective:** To determine the association on exposure to PM_{10} and $PM_{2.5}$ with respiratory health symptoms and lung function status among children that lived in 5 kilometres radius from palm oil activity. **Methodology:** A cross sectional study was carried out among primary school children in Hulu Langat and Semenyih, Selangor. 86 children were selected as comparative group with the aged between 9-11 years old randomly from two primary schools in Hulu Langat while 50 children from two primary schools in Semenyih as studied group. A validated questionnaire from American Thoracic Society (ATS-DLD-78-C) was used to determine respondents' background, previous past illness and respiratory symptoms. Evaluation of PM_{10} and $PM_{2.5}$ were done in schools and houses of the respondents by using TSI DustTrak DRX Aerosol Monitor Model 8534 and Escort LC Personal Sampling Pump. A Chestgraph HI-101 Spirometer was used to obtain lung function status among children. **Results:** Statistical analysis showed significant differences between exposure to PM_{10} and $PM_{2.5}$ at studied and comparative school at $p<0.05$. Studied group recorded higher PM_{10} and $PM_{2.5}$ than in comparative area. Significant differences were also showed between the exposure of PM_{10} and $PM_{2.5}$ in houses for studied and comparative group. Houses in studied area recorded higher concentrations of PM_{10} and $PM_{2.5}$ than in comparative area. FVC (litre), FEV_1 (litre), FEV_1/FVC (litre), FVC%, FEV_1% and FEV_1/FVC% predicted values were significantly lower among the studied group than in the comparative group. The risk of developing lung function abnormalities increased due to the exposure to PM_{10} and $PM_{2.5}$ among the studied group (OR=3.58; 95% CI 1.964-7.546), (OR=7.14; 95% CI 3.246-15.698) and (OR=6.30; 95% CI 2.713-14.602). The exposure to PM_{10} were associated with wheezing and chest tightness in the studied group (OR=26.00; 95% CI=3.032-222.928), (OR=9.00; 95% CI=2.048-39.545) and the exposure to $PM_{2.5}$ was associated with wheezing in the studied group (OR=4.68; 95% CI=1.258-17.417). FVC status had significant relationships with the concentrations of PM_{10} (PR=1.020; 95% CI= 1.002-1.038) and FEV_1 among studied children after controlling the confounder in this study (PR=1.020; 95% CI= 1.002-1.038). **Conclusion:** The study concluded that the exposures to high concentrations of PM_{10} and $PM_{2.5}$ increase the risk of developing lung function abnormalities and respiratory illness among the respondents.

Keywords: PM_{10}, $PM_{2.5}$, lung function, children, respiratory illness

ABSTRAK

HUBUNGKAIT ANTARA PENDEDAHAN TERHADAP PM_{10} DAN $PM_{2.5}$ DENGAN SIMPTOM KESIHATAN PERNAFASAN DAN FUNGSI PARU-PARU KANAK-KANAK YANG TINGGAL BEDEKATAN AKTIVITI KELAPA SAWIT DI SEMENYIH, SELANGOR

FARIS SYAHMI BIN MOHD SHAHIDIN

Pengenalan: Pengunaan bahan api biomas dalam dandang kelapa sawit menghasilkan bahan pencemar ke dalam udara seperti zarah terampai. Zarah terampai telah menyebabkan pelbagai simptom penyakit pernafasan kepada manusia terutamanya kanak-kanak. Kanak-kanak amat terdedah kerana pengambilan udara mereka lebih besar per kilogram jika dibandingkan dengan orang dewasa. **Objektif:** Untuk menentukan hubungkait antara pendedahan PM_{10} dan $PM_{2.5}$ dengan simptom kesihatan pernafasan dan fungsi paru-paru di kalangan kanak-kanak yang tinggal dalam lingkungan 5-kilometer dari aktiviti kelapa sawit. **Kaedah:** Satu kajian keratan rentas telah dijalankan dalam kalangan kanak-kanak yang tinggal di Hulu Langat dan Semenyih. Seramai 86 orang kanak-kanak telah dipilih sebagai kumpulan perbandingan dan 50 orang kanak-kanak telah dipilih sebagai kumpulan kajian. Borang soal selidik yang diadaptasikan daripada ATS-DLD-78-C telah diedarkan kepada untuk mengenal pasti latar belakang respoden dan sejarah penyakit pernafasan. Penilaian PM_{10} dan $PM_{2.5}$ di sekolah dan di rumah responden telah dibuat menggunakan TSI DustTrak DRX Aerosol Monitor Model 8534 dan Escort LC pam persampelan peribadi. Fungsi paru-paru kanak-kanak telah dinilai menggunakan Chestgraph HI-101 Spirometer. **Hasil:** Analisis statistik menunjukkan perbandingan signifikan antara pendedahan PM_{10} dan $PM_{2.5}$ dalam sekolah perbandingan dan sekolah kajian pada $p<0.05$. Kumpulan kajian merekod PM_{10} dan $PM_{2.5}$ yang lebih tinggi berbanding kumpulan perbandingan. Pendedahan PM_{10} dan $PM_{2.5}$ di rumah kumpulan perbandingan dan kumpulan kajian juga menunjukkan perbandingan signifikan. Rumah di kumpulan kajian menunjukkan PM_{10} dan $PM_{2.5}$ adalah lebih tinggi berbanding kumpulan perbandingan. Nilai bagi FVC (liter), FEV_1 (liter), FEV_1/FVC (liter), FVC%, FEV_1% dan FEV_1/FVC% adalah signifikannya lebih rendah dalam kalangan kumpulan kajian. Risiko untuk mendapat fungsi paru-paru abnormal meningkat dengan pendedahan kepada PM_{10} dan $PM_{2.5}$ dalam kalangan kumpulan kajian (OR=3.58; 95% CI 1.964-7.546), (OR=7.14; 95% CI 3.246-15.698) dan (OR=6.30; 95% CI 2.713-14.602). Pendedahan kepada PM_{10} berkait kepada nafas berbunyi dan sesak dada dalam kumpulan kajian (OR=26.00; 95% CI=3.032-222.928), (OR=9.00; 95% CI=2.048-39.545) dan pendedahan kepada $PM_{2.5}$ berkait dengan nafas berbunyi dalam kumpulan kajian (OR=4.68; 95% CI=1.258-17.417). FVC mempunyai hubungan signifikan dengan pendedahan PM_{10} (PR=1.020; 95% CI= 1.002-1.038) dan FEV_1 juga mempunyai hubungan signifikan dengan pendedahan PM_{10} selepas mengawal factor pembauran (PR=1.020; 95% CI= 1.002-1.038). **Kesimpulan:** Kajian ini mendapati pendedahan kepada PM_{10} dan $PM_{2.5}$ yang tinggi mempunyai risiko tinggi dalam pembentukan penyakit pernafasan dan fungsi paru-paru tidak normal dalam kalangan responden.

Kata kunci: PM_{10}, $PM_{2.5}$, fungsi paru-paru, kanak-kanak, penyakit pernafasan

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ABBREVIATION

$\mu g/m^3$	Microgram per meter cube
PM_{10}	Particulate Matter 10
$PM_{2.5}$	Particulate Matter 2.5
EPA	Environmental Protection Agency
ATS	American Thoracic Society
FVC	Forced Vital Capacity
FEV1	Force Expiratory Volume in one second
OPT	Oil Palm Trunk
OPF	Oil Palm Frond
PPF	Palm Pressed Fibre
NIOSH	National Institute of Occupational Safety and Health
WHO	World Health Organization
MPOB	Malaysia Palm Oil Board
L/min	Liter per minute
PVC	Poly Vinyl Chloride
MCE	Mixed Cellulose Ester Membrane

CHAPTER 1

INTRODUCTION

1.1 Study Background

Palm oil was one of the most successful economical industries in Malaysia. It was known as one of many pillars that uphold Malaysian economics. Malaysia had achieved its best milestone as it come out as the second largest oil palm producer in the whole wide world. It was also estimated that the annual export of Malaysia's palm oil for the year 2016 was at RM 64.59 billion (Kushairi, 2017). 2017 remarks the 100th years of commercial oil palm cultivation and proves Malaysia's palm oil were capable to compete other palm oil producer nation (MPOB, 2017). Abdul Samad (2018) reported that 1.017 million hectares around Malaysia had successfully gained Malaysian Sustainable Palm Oil Scheme certification (MSPO). Malaysia Sustainable Palm Oil certificate was a national standard that full filled the needs of global demand on concerning issues on environmental pollutions. MSPO was a Malaysian-driven standard and focus on pertaining the principles and also criteria of sustainable palm oil industries.

Malaysian Palm Oil Board (2017) stated that there was a decrease of 13.2% of crude palm oil production between 2015 and 2016 from 19,961,581 tons of crude palm oil to 17,319,177 tons of crude palm oil production. Comparison between palm oil plantations around Malaysia had increased around 1.7% from 5,642,943 hectares in 2015 to 5,737,985 hectares in 2016. Apart from the decrease of crude palm oil production between those two years, the export revenue for the total palm oil production including as follow; palm oil, palm kernel oil, palm kernel cake, oleochemicals, biodiesel, finished products and other palm products had increase 7.3%. The total revenue for palm oil industry increased from RM 60,169.49 million in 2015 to RM 64,591.82 million.

Table 1.1: Summary on the Performance of the Malaysian Oil Palm Industry, 2016 and 2015

	2016	**2015**	**Difference (%)**
Planted Area (Hectares)	5,737,985	5,642,943	1.7
Crude Palm Oil Production (Tonnes)	17,319,177	19,961,581	13.2
Total exports (Tonnes)	23,294,140	25,370,294	8.2
Total revenue (RM million)	64,951.82	60,169.49	7.3

Source: Kushairi, 2017. Overview of the Malaysian Oil Palm Industry 2016. MPOB Palm Oil Statistics. Malaysian Palm Oil Board.

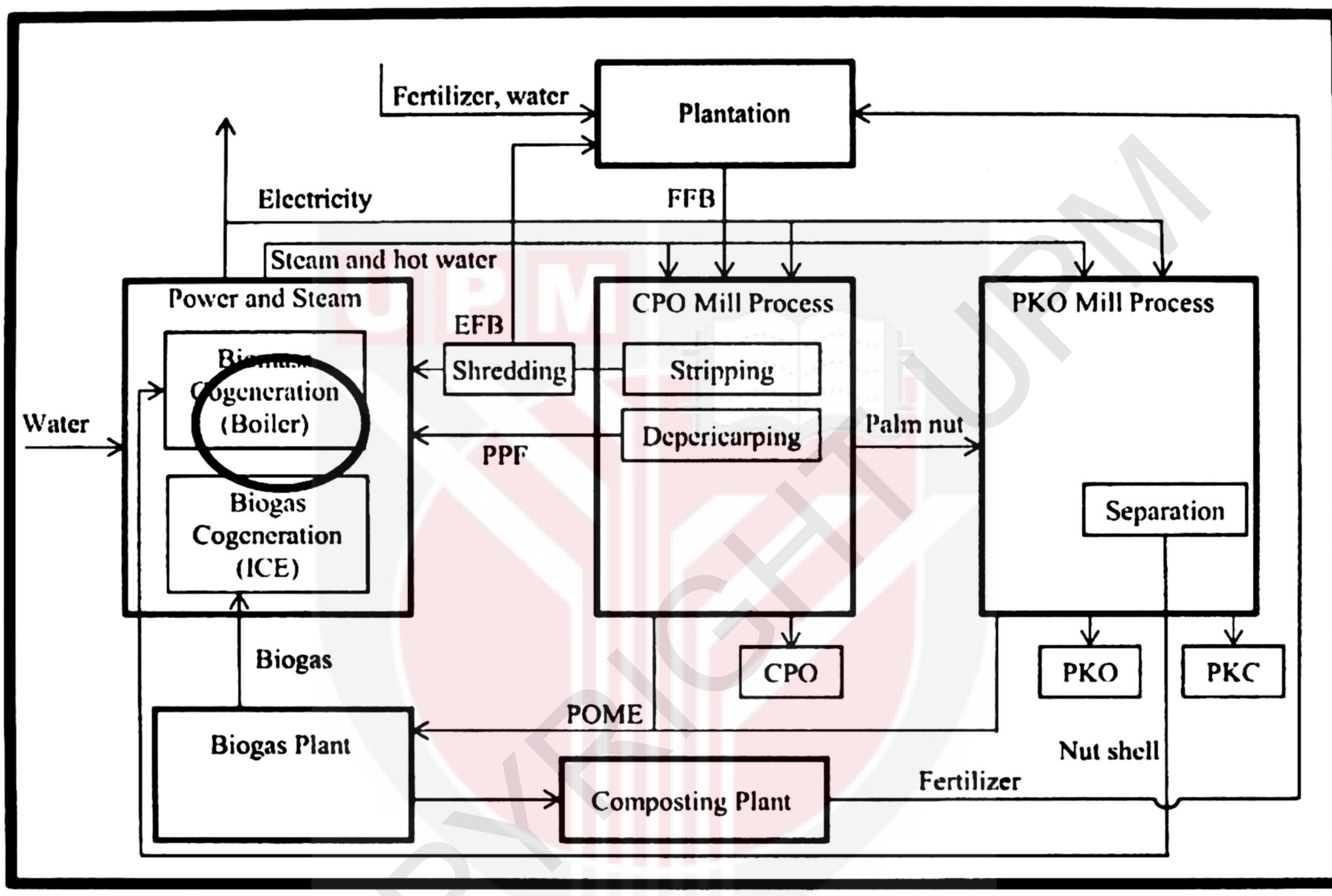
Palm oil plantation produced lot of other product other than crude palm oil. According to Nasution et. al (2017) fresh fruit bunches (FFB) produced per year was about 10 to 35 tons from one hectare of palm oil plantation. These palm oil plants had a lifespan of 200 years and the economic beneficial lifespan for these plants are 20 to 25 years. Parveen *et. al* (2010) stated that 45 percent of yield fresh fruit bunches (FFB) from fleshy mesocarp were harvested as palm oil and other 40 percent were harvested from the kernel of the fresh fruit bunches (FFB).

Despite of the contribution and the financial gained from palm oil industry, many criticized the environmental impacts from palm oil activities. The oil extraction process produced high quantities of by-product that may rise to environmental pollution (Rosnah, 2010). Examples of waste products are palm kernel shells, oil palm fronds (OPF), oil palm trunks (OPT), palm pressed fibers (PPF) and empty fruit bunches. These by products were used by palm oil factory as a biomass fuel for the low-pressure boilers for energy production (Hussin and Jalaludin, 2016). Previous studies had identified the gaseous emissions from the biomass combustion in palm oil factory (Rashid, *et. al*, 2014). The combustion of palm fibers and palm shell in the form of empty fruits shell emitted palm oil mill boiler fly ash (POMBFA) which will pollute the surrounding environment.

During the palm oil production process, the fresh fruit bunch (FFB) were transferred into palm oil mill. The palm fruits gave out two different oil as two different products. The first products were the lauric oil obtained from the kernel of the palm while the other products were the palm oil extracted from the fibrous mesocarp.

According to Rupani. *et al* (2010), the whole process of palm oil processing were seen in Figure 1.1.

Figure 1.1: Schematic material and energy flows of the proposed integrated CPO and PKO processes



Source: Aziz *et al.* (2015).

Based on Figure 1.1, the main contributor of the palm oil mill pollutants came from the activity of boiler. Palm oil boiler used the excess palm shells and palm fibers as biomass fuels. The process cremating of empty fruit bunches produced fibers produce suspended solids that were known as palm oil mill sludges (POMS).

1.2 Problem Statement

Air pollution was one of the most concerning issue arising in developing country. It was one of the main challenges that need to be address and far to be neglected. Exposure of air pollution affected the health of people thus increasing the prevalence of health disease among the community. Garcia et. all (2018) stated that children the most vulnerable from air pollutant as the physiological characteristic of air intake was larger per kilogram body if being compare to the physiology of an adults. Among concern air pollutants towards children were particulate matters. Prolong exposure of PM_{10} and $PM_{2.5}$ caused children to exhibit respiratory symptoms such as asthma, wheezing, dry cough at night and wheezing after doing exercise. According to Garcia et. all (2018), the most concern were $PM_{2.5}$ and nitrogen oxides. It was found that there were increase in morbidity and mortality rate in individuals especially among children population. Children that were exposed may exhibit autism, impairment in cognitive function, and arrhythmias. Previous study showed that there was a relationship between children exposure towards air pollutants and prevalence of diabetes disease (Garcia et. all, 2018).

According to Ohimain et al. (2013) air pollution such as burning of biomass fuels from the palm oil activity received much concern from the community surrounding the palm oil activity. Complaints from the community were founded if the palm oil activity was situated near residential areas and schools. The emission was concerned to have contribution in the increase of respiratory problems specifically among children that live near palm oil activity and was the source of ambient air pollutant in the area. The byproduct of burning biomass fuel for the low-pressure boiler decrease the ambient air quality due to the increase of outdoor air pollutant. Throughout this study, the concentration of PM_{10} and $PM_{2.5}$ were measured and recorded. Moreover, the lung function status of the children was evaluated with respiratory symptoms. This study aimed to increase awareness residential community focusing on the adverse health symptoms due to prolong exposure of ambient air pollutant.

1.3 Study Justification

The objective of this study was to determine association on exposure of PM_{10} and $PM_{2.5}$ with respiratory health symptoms and lung function among children that lived near palm oil activity (exposed group) and lived far from palm oil activity (comparative group).

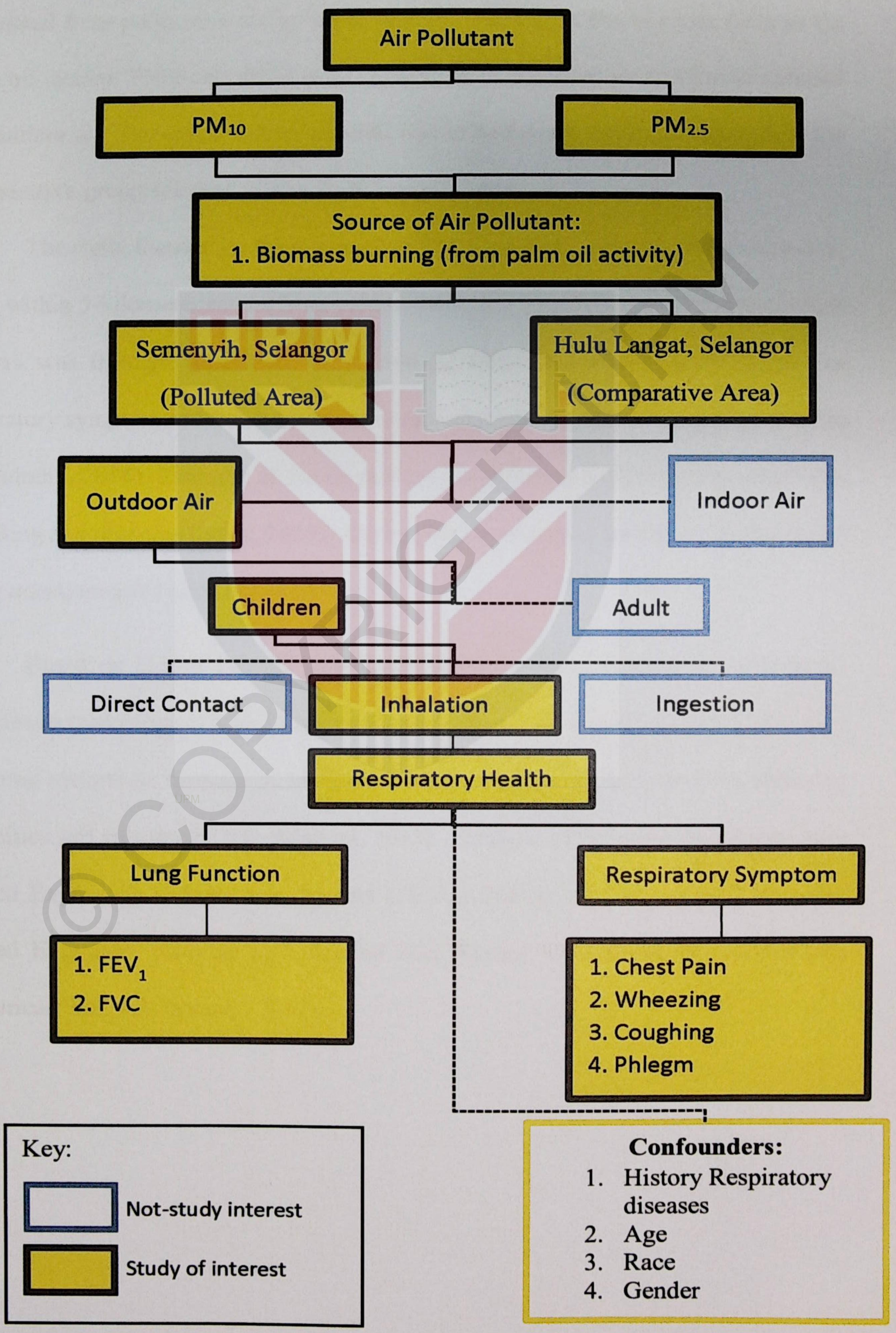
Through this study, it was hope that the awareness among parents of the children lived nearby palm oil activity regarding to the ambient air pollutant will increase. Community must be informed and participated with health information and awareness campaign that can be done whether it was from the local authorities, health department or residence association. Clean environment was also very important for the development at young age. Thus, residential community must play important role to control and voice out air pollutant exposure within residential area.

According to Hussain and Jalaludin (2016), it was shown that there was a link between palm oil activities and its health impacts towards the children's respiratory system. This study was aimed to full fill the gap of knowledge and find new evidence that the activity from the palm oil activity emits particulate matter and risk the children that live near the palm oil activity. According to Syahirah, *et al* (2016), the emission of particulate matter (PM_{10}) from the boiler of palm oil activity was found to be very alarming as it exceeded the permissible exposure of PM_{10} as stated in the new Clean Air Regulation 2014.

The emphasize of this study should be directed to the palm oil activity management. Evaluation of existing control and practices should be done not only to comply occupational and environmental settings, but to ensure the human health elements were considered thoroughly. The findings of this study were also to cater the needs of abundant data in helping the government to maintain the wellbeing of every citizen in this nation.

1.4 Conceptual Framework

Figure 1.2: Conceptual framework of the whole study.



Based on Figure 1.2, the figure showed the conceptual framework of the study. The air pollutants identified were PM_{10} and $PM_{2.5}$. These two pollutants were originated from palm oil activity which was the burning of the biomass fuels in the palm oil factory. PM_{10} and $PM_{2.5}$ were released to the ambient air and would polluted the outdoor air. The exposed area selected was in Semenyih, Selangor meanwhile the comparative group selected was in Hulu Langat, Selangor.

The study focused on the exposure of PM_{10} and $PM_{2.5}$ towards the children that lived within 5-kilometer radius from palm oil activity. The exposure of the particulate matters was through inhalation. Inhalation of PM_{10} and $PM_{2.5}$ would affect the respiratory symptoms of the children and would exhibit respiratory symptoms (Hussin & Jalaludin, 2016). Example of the respiratory symptoms were chest pain, wheezing, coughing and phlegm (Ratini, 2014). The respiratory symptoms data was collected by using questionnaire (refer Figure 3.4).

Based on Figure 1.2, the lung function status was measured by Chestgraph Spirometer (refer Figure 3.4). Lung function test was used to evaluate any respiratory and lung symptoms through quantification of the volume of lung with its diffusing capacities and spirometry test (Mithani, 2013). Example of lung function status were Forced Expiratory Volume in 1 Second (FEV_1), Forced Vital Capacity (FVC) and Forced Expiratory Volume in 1 Second over Forced Vital Capacity (FEV_1/FVC) (American Thoracic Society, 2017).

1.5 Study Objectives

1.5.1 General objective

To study the exposure of PM_{10} and $PM_{2.5}$ in the air and its association with respiratory symptoms and lung function among children in Semenyih, Selangor.

1.5.2 Specific Objectives

1. To compare the concentration level of $PM_{2.5}$ and PM_{10} between schools near palm oil activity and comparative area.
2. To compare the concentration level of $PM_{2.5}$ and PM_{10} between the respondent's house near palm oil activity and comparative area.
3. To compare the respiratory health symptoms between children that live near to the palm oil activity and children that live in comparative area.
4. To compare lung function test results between children that live near to the palm oil activity and children that live in comparative area.
5. To determine the association between the concentration level of $PM_{2.5}$ and PM_{10} with the lung function test result of children who live near palm oil activity and children who live in comparative area.
6. To determine association between level of $PM_{2.5}$ and PM_{10} and respiratory symptoms among children who live near palm oil activity and children who live in comparative area.

1.6 Study Hypotheses

1. The concentration level of $PM_{2.5}$ and PM_{10} between schools near palm oil activity was higher than in the schools of comparative area.
2. The concentration level of $PM_{2.5}$ and PM_{10} between the respondent's house near palm oil activity was significantly higher than in comparative area.
3. The respiratory symptom between the children that live near to the palm oil activity was significantly higher than the children that live in the comparative area.
4. FVC and FEV_1 result of children that live near to the palm oil activity was significantly lower than the children who lived in comparative area.
5. There was a significant association between exposure of $PM_{2.5}$ and PM_{10} with the FVC and FEV_1 result of children who lived near palm oil activity and children who lived in comparative area.
6. There was association between the concentration level of $PM_{2.5}$ and PM_{10} and respiratory symptoms among children who lived near palm oil activity and children who lived in comparative area

1.7 Definition of Variables

1.7.1 Conceptual Definition

a) Respirable Particles ($PM_{2.5}$)

The subscript 2.5 in the $PM_{2.5}$ means the size of the particulate matter was 2.5 micrometers in diameters. Therefore, any particles that had aerodynamic diameter length of 2.5 micrometers and less was considered as $PM_{2.5}$. $PM_{2.5}$ was a fine particle that entered directly via inhalation through the respiratory track and may ended up in the blood vessels. These fine particles consist of fine microscopic solids and droplets that were inhaled and cause various respiratory health problems (EPA, 2018). Particulate matter had different chemical characteristic depending on various origin of the particles.

b) Inhalable Particles (PM_{10})

Inhalable particles had a range of aerodynamic diameter between 10 micrometers and 2.5 micrometers. (EPA, 2018). The aerodynamic diameter of PM_{10} penetrated the respiratory symptoms but not as deep as particulate matter with the size of 2.5 micrometers and less. PM_{10} were most likely to deposit in the mouth, throat or the upper part of respiratory organ such trachea. Elhadi. *et al.* (2017) stated that PM_{10} had being identified to cause multiple health problems such as chronic pulmonary disease and heart disease. These suspended solids and liquid droplets in the were also one of the main players in the compositions of haze in some region (EPA, 2018).

c) Chest Pain

According to Hickam *et al.* (1990) chest pain cause discomfort to the patient in ways that was painful, the feeling of pressure and discomfort that were coming from the chest. Chest pain may become one of the determining indicator for cardiovascular disease such as heart failure.

d) Wheezing

According to Henry *et al.* (1990), wheezing was defined as an action where wheeze, a sound that was produced by the lung that has high-pitched profile and produced by the obstruction of compressed or narrowed airways in the lungs. The narrowed airways were because of the inflammation due to the body's immune system or many more. It is very difficult to breathe in and out due to the compression of the airways. Wheezing was normally an indicator for asthmatic attack due to the similarities between booth symptoms. Henry *et al.* (1990) explained that wheezing caused by the obstruction from the larynx to small bronchi. This obstruction was caused by bronchoconstriction due to the tumor and foreign body in the airways.

e) **Coughing**

According to National Heart, Lung and Blood Institute (2018), coughing was defined as sudden air expulsion from the lungs. This air expulsion was the action of body to prevent or clear any foreign body that had entered the airways of lungs. Such foreign body may come in the form of dust and many more. The action of cough was one of the body self-defense system to prevent the respiratory tract from damage.

f) **Phlegm**

Phlegm was a mucus that produced by the action of coughing. It was also known as the sputum produced when a person is coughing and spit out form the respiratory airways. Phlegm was secreted by the lining tissues of the respiratory tract in a form of thick mucus layer. (Farzan, 1990).

g) **Forced Vital Capacity (FVC)**

Hankinson, *et al* (2015) stated that Forced Vital capacity were maximal volume of air exhaled proportional with the maximal effort forced from a point of maximal inspiration with consideration of performance of vital capacity in a maximal forced expiratory effort expressed in liters at body temperature and ambient pressure saturated with water vapor.

h) Forced Expiratory Volume in 1 Second (FEV_1)

Hankinson, *et al* (2015) stated that forced expiratory volume in one second was the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration and was expressed in liters.

1.7.2 Operational Definition

a) Respirable Particles ($PM_{2.5}$)

In measuring the exposure of particulate matter with the size of 2.5 micrometers ($PM_{2.5}$), the TSI Dust-TRAK DRX Aerosol Monitor 8534 measured the mass concentration of particles floating in the air by using the detection of scattered light. The principle used by the TSI Dust-TRAK DRX Aerosol Monitor 8534 were the photometric principles. The TSI Dust-TRAK DRX Aerosol Monitor 8534 were come with $PM_{2.5}$ impactor, PM_{10} impactor and PM_1 impactor. The detection range for the device were from 0.001 mg/m^3 to 100 mg/m^3. This device gave out real time monitoring reading in measuring aerosol contaminants.

The ambient air was also measured by using Escort LC Personal Sampling Pump by Zefon International Inc with Mixed Cellulose Ester (MCE) filter. The method used for calculation used for measuring the concentration of $PM_{2.5}$ was NIOSH Manual of Analytical Method, fourth edition. The flow rate of the air sampling pump is also determined by the NMAM standard 0600, SKC Air Sampling Solutions and Experts and based on the type of cyclone used.

b) Inhalable Particles (PM_{10})

In measuring the exposure of particulate matter with the size of 10 micrometers (PM_{10}), the TSI Dust-TRAK DRX Aerosol Monitor 8534 measured the mass concentration of particles floating in the air by using the detection of scattered light. The principle used by the TSI Dust-TRAK DRX Aerosol Monitor 8534 were the photometric principles. The TSI Dust-TRAK DRX Aerosol Monitor 8534 were come with $PM_{2.5}$ impactor, PM_{10} impactor and PM_1 impactor. The detection range for the device were from 0.001 mg/m3 to 100 mg/m3. This device gave out real time monitoring reading in measuring aerosol contaminants.

The personal air exposure was also measured by using Escort LC Personal Sampling Pump by Zefon International Inc. with Poly Vinyl Chloride (PVC) filter. The method used for calculation used for measuring the concentration of PM_{10} was NIOSH Manual of Analytical Method, fourth edition. The flow rate of the air sampling pump is also determined by the NMAM standard and based on the type of cyclone used.

c) Chest Pain

Chest pain cause discomfort to the patient in ways that was painful, the feeling of pressure and discomfort that were coming from the chest. The assessment of chest pain was done by using a validated questionnaire by American Thoracic Society (ATS-DLD-78-C).

d) Wheezing

Wheezing was defined as an action where wheeze, a sound that was produced by the lung that had high-pitched profile and produced by the obstruction of compressed or narrowed airways in the lungs. The assessment of wheezing was done by using a validated questionnaire by American Thoracic Society (ATS-DLD-78-C).

e) Coughing

Coughing was defined as sudden air expulsion from the lungs. This air expulsion was the action of body to prevent or clear any foreign body that had entered the airways of lungs. The assessment of coughing was done by using a validated questionnaire by American Thoracic Society (ATS-DLD-78-C).

f) Phlegm

Phlegm was a mucus that produced by the action of coughing. It was also known as the sputum produced when a person was coughing and spited out form the respiratory airways. The assessment of phlegm was done by using a validated questionnaire by American Thoracic Society (ATS-DLD-78-C).

g) Forced Vital Capacity (FVC)

Forced Vital capacity were maximal volume of air exhaled proportional with the maximal effort forced from a point of maximal inspiration with consideration of performance of vital capacity in a maximal forced expiratory. The FEC was measured by using the chest graph of Spirometer and it is measured in liters.

h) Forced Expiratory Volume in 1 Second (FEV_1)

The forced expiratory volume in one second was the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration. The FEV_1 were measured by using the chest graph of Spirometer and it was measured in liters.

i) Exposed Group

The exposed group was defined as respondents that live 5 kilometers radius between the location of palm oil activity and the location of the schools. The measurement of kilometer was done based on the data obtained from global positioning system (GPS) through Google Maps application.

i) Non-Exposed Group

The non-exposed group was defined as respondents that lived in an area with no palm oil activities in the radius of 5 kilometers surrounding the schools. The measurement of kilometer was done based on the data obtained from global positioning system (GPS) through Google Maps application.

CHAPTER 2

LITERATURE REVIEW

2.1 Palm oil activity and the use of biomass fuels

The usage of biomass fuels in palm oil operation gave lots of advantages in term of economic views. It was because palm oil operation gave out lots of by product from the extraction of palm oil that was used as biomass fuels. Such by products that were heavily used in biomass fuels were the palm fruits fibers, palm fruits shells and empty fruit bunches. These by products were very abundant and another form of renewable energy. The usage of biomass fuels in operating the palm decrease the dependency of the palm oil mill to depends solely on electrical energy, thus reducing the pollution come from the burning of coal in electricity generation plant. Despite of the benefits gained switching from non-renewable energy towards a renewable energy, the usage of biomass fuels in a boiler was also concerning. Kun, *et al.* (2013) stated that the implementation of biomass fuels in boilers created another serious dimension of threat to human health. It was due to the concern of the pollutant emitted from the combustion process of the boiler.

Rashid, et al. (2013) stated that the usage of biomass fuels in the burning process released a huge amount of particulate matter. This large emission of particulate matter affected to the air pollution in near area. As the largest palm oil producer in the world, Malaysia had been one of the nation that were vulnerable to particulate pollution from palm oil activities. Malaysia had around 417 oil palms estimated in 2009 and the numbers were increasing by time to time (Kun, Y. C., et al, 2013). These increased in palm oil mill activities had given a great burden to our atmosphere. This was portrayed by the increasing of 95,042 hectares of palm oil industry from 2015 to 2016 (Kushairi, D. 2017). The particulate emission from the palm oil mill were classified as two different type of particulates. The first type of particulates were fine mode and coarse mode. The fine mode of particles was caused by the burning process that undergone growth and coagulation process of particles. The course mode of particles was caused by formation of unburn biomass fuels due to the incomplete combustion process in the boiler.

Boilers were very important in running a palm oil mill as it was reported that each of the palm oil mill needed at least one boiler per each operation of palm oil mill (Hussin and Jalaludin, 2016). Most of the design of the boiler used a suspension firing method that used fluidize bed combustion system to ensure the combustion of biomass fuel was complete. Unfortunately, this design of conventional boilers produced a high dust emission as high as 80%. An older design of boiler produced less dust emission at 20% to 30% and used spreader stroke to burn the fuel in suspension structured (Boon, Kyi, 1990).

The dust generation from the burning activity of biomass fuels combustion in the palm oil mill's boiler posed a significant threat to human health. Ghanbari and Rezazadeh (2018) stated that the chimney plays an important role to ventilated air from inside a building or space. As the particulate matters discharged from the boilers through chimney duct, the air pollutant affected the surrounding ambient air quality. According to the Environment Protection Agency, the criteria for air pollutant that were found in the ambient air quality were carbon monoxide, lead, ground-level ozone, nitrogen dioxide, Sulphur dioxide and particulate matter. The different sizes of particulate matter caused different effects on health symptoms. High exposure of ultra-fine particles ($PM_{2.5}$) were proved to cause accelerated atherosclerosis, pulmonary inflammation and heart failure thus led towards cardiovascular mortality (Kolluru *et al.*, 2018). Prolong exposure of PM_{10} and $PM_{2.5}$ caused respiratory symptoms such as asthma, wheezing, dry cough at night and phlegm production.

2.2 Particulate Matters and Palm Oil Activity

Particles that had aerodynamic diameter length of 2.5 micrometers and less was considered as $PM_{2.5}$. $PM_{2.5}$ was a fine particle that entered directly via inhalation through the respiratory track and may end up in the blood vessels. These fine particles consist of fine microscopic solids and droplets that were inhaled and caused various respiratory health problems (EPA, 2018). The aerodynamic diameter of particulates with 10 micrometers penetrated the respiratory system but not as deep as particulate matter with the size of 2.5 micrometers and less. According to Rashid et al. (2014), it was found that 26% of PM_{10} measured from particulate emitted from the boiler were represented as $PM_{2.5}$ with finer size fraction. These particulate matters were produced from the burning of biomass fuels obtained from the byproduct of palm fruits.

According to Rashid, *et al.* (1998), there were two type of boilers that were usually used in palm oil mill. These palm oil mill boilers were fire-tube (FT) boiler and water-tube (WT) boiler. The biomass fuels were then fed into the boilers for the generation of steams to run the palm oil mill. If comparison was being made between fire-tube (FT) boilers and water-tube (WT) boilers regarding the fuel consumption and production of fly ash, the water-tube boilers were found to consume more biomass fuels and produced more fly ash pollutant. This palm oil mill boiler fly ash (POMBFA) was the product emitted from the boiler (Rashid, *et. al,* 2014). Nevertheless, the study showed that fire-tube boiler generated finer particulates size distributions compared to water-tube type boiler which contributed a significant difference in particulate emission concentration between them. According to Yusoff (2006), it was estimated that by the year 2020, the generation of palm oil mill boiler fly ash (POMBFA) reached to 39 million tons.

2.3 $PM_{2.5}$ and PM_{10}

The key indicator for a polluted environment focused on the level of particulate matters that exist in the ambient air. The level of exposure depended on how much duration a person which exposed to the polluted air. Ambient air pollutants such as $PM_{2.5}$ and PM_{10} exist throughout the day and it was different between the exposure in occupational settings because of the duration of a person exposed to it. World Health Organization stated that particulate matter was one of the most widespread air pollutant in compare with other pollutant. It was because particulate matter did not react with other chemicals and stay suspended in the air in some manner of time. As a mixture of solid and liquid particles, its physical and chemical properties might vary according to the location of the source. This was because the weather condition and climate change area changed and affected the compositions of the particulate mixture. The common constituents of chemicals in particulate matters included inorganic ions such as magnesium and calcium, organic compounds, particle-bound water, metals and polycyclic aromatic hydrocarbons (PAH). As a small mixture of liquid and solid droplets, it was also one of the common site for biological components such as microbial function, allergen, pollen and many more.

Particulate matters existed in different sizes and shapes. Therefore, to differentiate between particulate matters, Environment Protective Agency (2018) categorized particulate matter into two groups namely inhalable dust and fine dust. The main different between these two were the size of its aerodynamic diameter. EPA (2018) characterize inhalable dust as particulate with the size of 10 micrometres until 2.5 micrometres. Inhalable dust, also known as PM_{10}, penetrated the respiratory tract. But most of them were only able to deposits in the mouth, nose, throat and trachea due to their size. The second categorized of particulate matters were the fine particle. Fine particles were defined as particulate matter that had an aerodynamic diameter 2.5 micrometres and less. $PM_{2.5}$ was the most concern particulate pollutants as it had penetrated deeper into the alveolus and eventually into the blood vessels. According to the study by Kim *et al.* (2015), exposure to different sizes of particulate matters ($PM_{2.5}$ and PM_{10}) had been proven to have a link to become major cause of health problems towards people. Thus, a conclusion was made that the smaller the size of a particulate, the deeper the penetration and deposition of the particulate.

Table 2.1: Health effects exposure to airborne particulate matter

Concentration ($\mu g/m^{-3}$)	Health Effects
400 to 600	Alveolar macrophages, neutrophils and Tlymphocytes in bronchoalveolar lavage fluid
200	Increase in respiratory diseases such as pneumonia, chronic obstructive pulmonary disease, and asthma
150	Increase the likelihood of respiratory symptoms and aggravation of lung disease
120	Increase in hospital admissions of children with respiratory disease
Increases of 20 $\mu g/m^{-3}$ of PM in same day	8% increase of lower respiratory illness among children
Increases of 10 $\mu g/m^{-3}$ of PM in same day	1.9% and 3.3% respective increases in respiratory

Source : Kim *et al.* (2013)

2.4 Respiratory System of Children

Yong children had a smaller respiratory system than an adult. The shape of the lungs itself changed from a shape of round in infant stage to the shape of less flattened gradually to the shape of a normal lung in adults (Goldizen, Sly, & Knibbs, 2016). The structure of lungs was made of microscopic air-filled sacs organs located on both thorax (chest). The microscopic air-filled sacs of organ were known as alveoli. The exchange of oxygen and carbon dioxide happened between the alveoli and blood vessels in the lungs. The oxygen from the inhaled air were absorbed into the blood by following the gradient of concentration and vice versa with the concentration of carbon dioxide in the vein. This enable the human body to gain the needed oxygen and excreted the carbon dioxide in the body system. Any obstruction of the trachea airways affected the efficiency of air intake. This obstruction was in the form of inflammation or abnormal amount of mucus layer covering the lining of the trachea (Ratini, 2014).

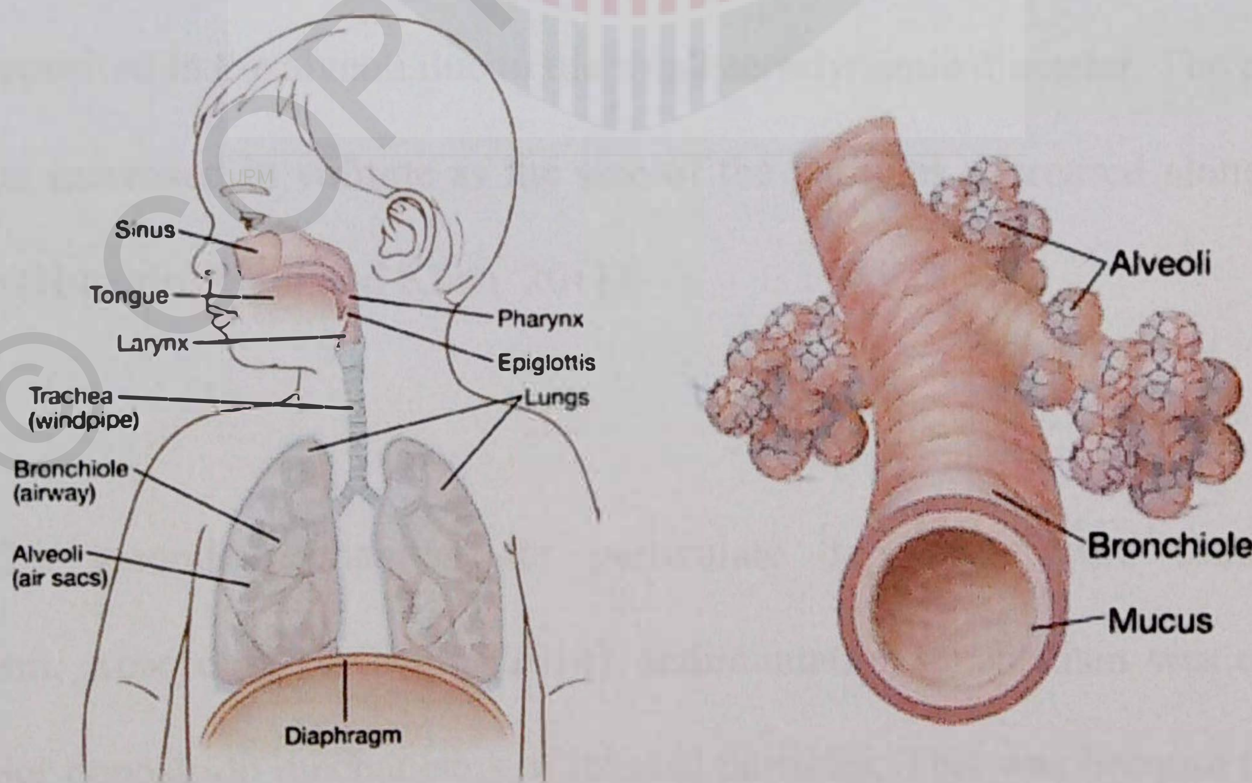


Figure 2.1: Respiratory of Children

Sources: Fairview Foundation (2018)

2.5 Mechanism of Particle Deposition

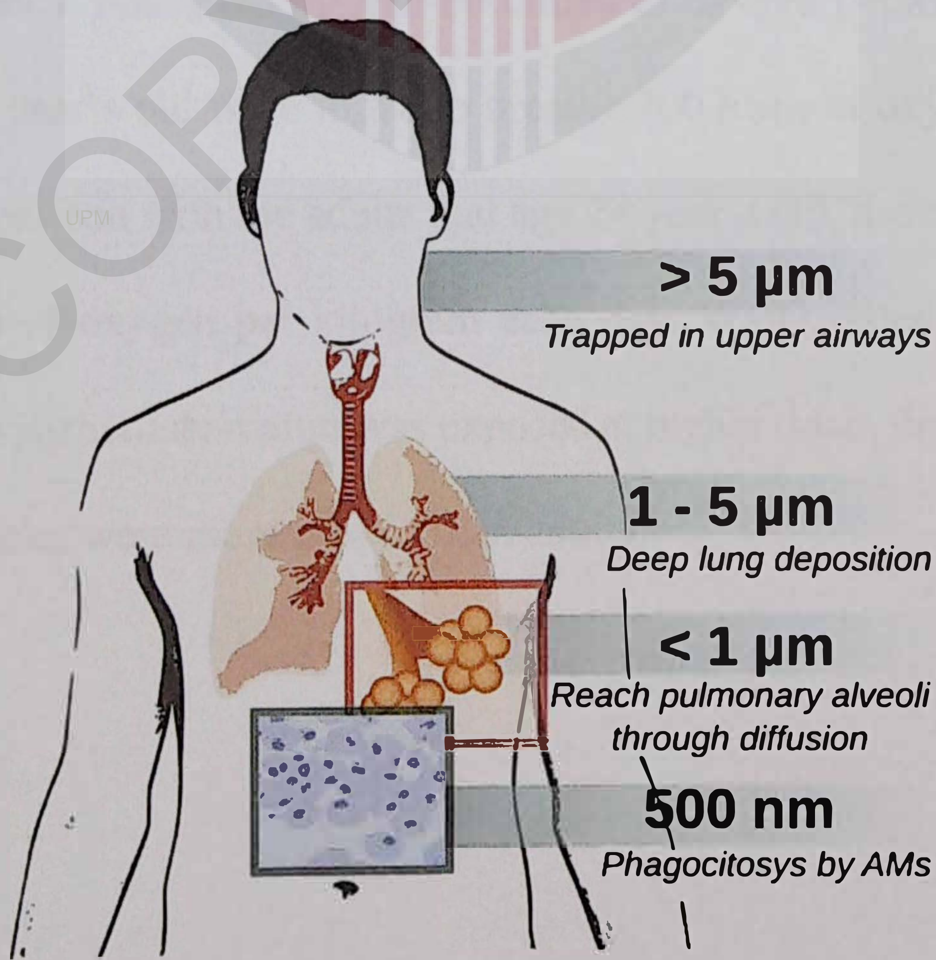
The human lung structures consist of expanding and contracting processes of the lung. The volume of air increased when expansion occurs and the volume of air decrease as the lung structure contracted itself. The deposition of aerosols in the lungs highly depended on the air flows in the respiratory system. Hussain, Madl and Khan (2011) define particle deposition as the adherence event of particulates to the lining of the respiratory track. There were three types of mechanism for an airborne particulate matter deposited inside our respiratory symptoms. The three mechanisms were diffusion, sedimentation and impaction.

The diffusion mechanism was specific for the particulates that had the range of size smaller than 0.2 μm (Cheng, 2014). The deposition through diffusion occurred through the collision between particulate matters and air molecules. This particulate mostly deposited in the alveoli due to the small aerodynamic diameter. The particulate deposition increased in volume as the size of the particles decreased along with the flow rate (Hussain, Madl and Khan, 2011).

The second mechanism for particulate deposition were sedimentation mechanism. According to Cheng (2014), sedimentation mechanism was one of the most major deposition mechanisms of inhaled particles. This was because the size of the particulate matters that followed sedimentation mechanism were from the size of 0.5 μm (Hussain, Madl and Khan, 2011) or 0.2 μm (Cheng, 2014). The mechanism itself used gravitational concept exerting on the particulate matters over the resistance of the air.

The third mechanism for particulate deposition in respiratory tracts were the impaction mechanism. This mechanism followed the rules of momentum and inertia. it was applied for particulate matters that had large-sized aerodynamic diameter. According to Hussain, Madl and Khan (2011), particulate with the size larger than 1 µm had the large tendency to deposit through impaction mechanism. Other studies by Cheng (2014) suggested a smaller value of the particulate size (>0.5 µm) were ones which were likely to deposit in through this mechanism. Therefore, it was said that any particulates that full filled both requirement would had deposited in the lungs through these three mechanisms.

Figure 2.2: Site of Particles Deposition and Phagocytosis of Alveolar Macrophage



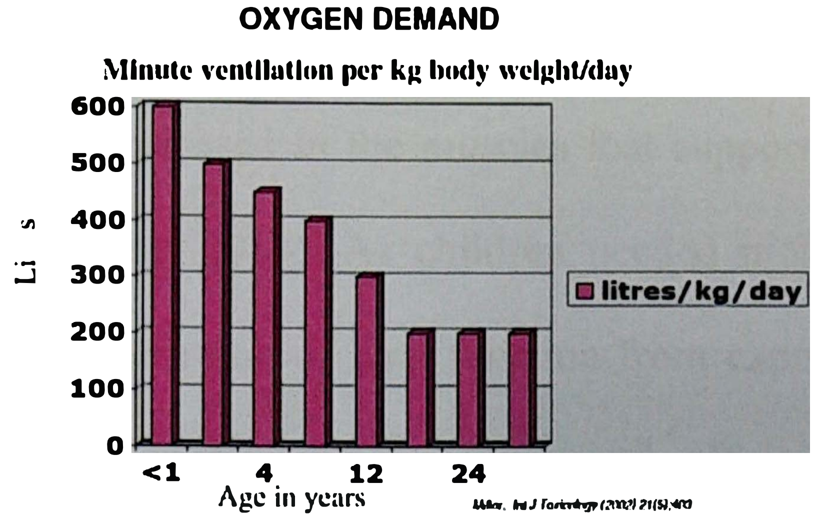
Sources: Costa *et al.* (2016)

2.6 Effects of Particulate Matters on Children's Health

Children's environment cannot be assumed as sufficient as adults' counterparts. This was because children had different and unique exposure that might affected them but not to the adults. According to the World Health Organization, children's unique dynamic developmental physiology caused them to be more vulnerable towards pollutants that were found in air, water, food and surrounding environment. Children's physiological structured were not as matured as the one found in the adults' body. Therefore, children were unable to process, metabolize and prevent all these pollutants to affect their physiological development.

Previous study stated that children had a large tendency to inhaled large amount of air comparing to the adults (Lovinsky-Desir et al., 2018). It was found that children in the age less than 1 year's old inhaled 600 litres of oxygen per kilogram each day. Children with 12 year's old were found to breathe 300 litres of oxygen per kilogram each day. In comparison with the adults that age 24 year's old, the oxygen intake was around 200 litres of oxygen per kilogram each day. WHO stated that surrounding pollutants such as particulate matter was exposed at higher doses than the adults. This was because children were more actives than adults.

Figure 2.3: Bar chart of Minute ventilation per kg body weight/day



Sources: Miller, *et al* (2002)

Chen *et al.* (2018) stated that children were the most susceptible groups to the airborne pollutants. It was because of the immature physiological development and their immunity were still in development stages. These exposures caused heavily health effects to the groups of population that were susceptible to it especially among school children (He, *et al.*, 2010). It was found that there was an association between the increase in the level of outdoor pollutants and the children's respiratory symptoms (Pan, 2010). Xing, *et al.* (2015) stated that mortality cases that were associated with respiratory cases increased with the value of 0.58 % for the increase of PM_{10} by 10 $\mu g/m^3$ PM_{10}. The rate of people admitted to hospital were increased by 8% due to an increase of $PM_{2.5}$ by 10 $\mu g/m^3$. This was an indication as elevation of air pollutant was associated with serious health effects. The reported health effects were respiratory tract disease, lung function, morbidity and mortality.

The increase on concentration of $PM_{2.5}$ was found to be associated with the decrease of lung function test. A study in Poland by Zwozdziak *et al.* (2016) shows that there was a significant reduction in the forced vital capacity (FVC) among school children aged 13 to 14 year's old. It was proved that the increase of $PM_{2.5}$ showed significant health effects on lung function test. A decrease in lung function tests may derived towards the decrease of air intake in every breath, decrease in lungs exchanged of oxygen with blood and decreased in the muscles that support breathing process (National Library of Medicine, 2014). As children needed more oxygen demand compared to the adults, the decrease of lung function from exposure of particulate matters would manifest in respiratory problems and affect the physiological development of children.

2.7 Lung Function Test

Lung function test was used to evaluate any respiratory and lungs symptoms through the quantification of the volume of lung with its diffusing capacities and spirometry test (Mithani, 2013). The usage of spirometry testing was widely used around the globe due to its minimal risk towards respondents and was easy to operate. This test also took roughly around 10 to 15 minutes for everyone. According to the US Department of Health Services (2012), the usage of lung function test was a standard among medical practitioner to diagnose respiratory disease. From this test, researcher evaluated the signs and symptoms such as breath shortness and any respiratory disease such as chronic obstructive lung disease and asthma.

The key parameters that were being measured in the lung function test were the forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV_{1s}). American Thoracic Society (1995) classified respiratory disorder into two main category namely as restrictive disorder and obstructive disorder. Restrictive disorder was the condition when the effort for breathing was increased due to the restriction of lung's expansion. Suspected caused for this disorder varied from pneumonectomy to lung fibrosis. Most of the restrictive disorder cases were irreversible.

The second category of respiratory disorder was obstructive disorder. According to Mitani (2013), patients that developed obstructive disorder was defined with a reduction of airflow limits. This was because the airways inside the respiratory symptoms were obstructed. This condition was measured by the reduced forced expiratory volume in 1 seconds over the forced vital capacity (FEV_{1s}/FVC). This condition was also one of the early sign of developing asthma or chronic obstructive pulmonary disorder. Obstructive disorder was a reversible disorder in example of asthma cases were cured by using a bronchodilator.

CHAPTER 3

METHODOLOGY

3.1 Study Design

This study was a comparative cross-sectional study that focussed on the association on exposure of $PM_{2.5}$ and PM_{10} with respiratory health symptoms and lung function test among children living near palm oil activity in Semenyih, Selangor. The study groups were chosen among primary school children that lived near the area of palm oil activity and primary school children that lived far away from palm oil activity. This study was focussed on the respiratory effects and lung function of respirable dust ($PM_{2.5}$) and inhalable dust (PM_{10}) exposure towards primary school children that live near palm oil activity and primary school children that live far away from palm oil activities. Permission was be obtained from the Ministry of Education before the study was be conducted.

3.2 Study Location

The study location was selected among two different areas. The first selected area was the area that was polluted by the palm oil activity in Semenyih, Selangor. The comparative group were the area that was not polluted by the palm oil activity which was in Hulu Langat, Selangor.

Based on Figure 3.1 and Figure 3.2, the primary school selected for the polluted area were Sekolah Kebangsaan Bandar Rinching, Semenyih and Sekolah Jenis Kebangsaan Tamil Ladang Rinching, Semenyih. From the scoping activity around the area, there were four residential area that located near to the palm oil activity. These schools and four residential areas were suspected to have high exposure of particulate matter due to the palm oil activities. Both selected schools are in 3.6 kilometres and 650 metres radius from the palm oil activity.

Figure 3.1: Distance between Sekolah Jenis Kebangsaan Tamil and palm oil activity

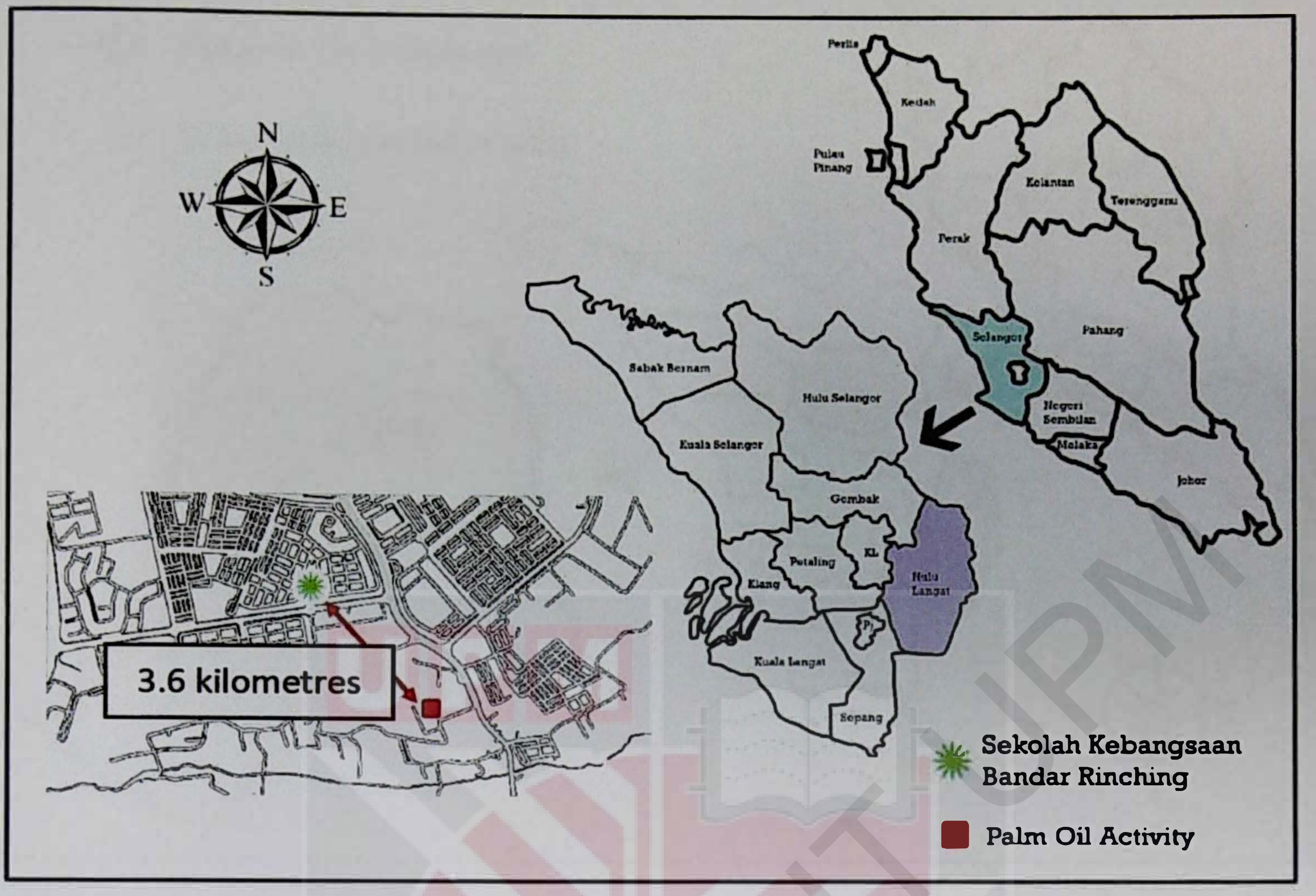


Figure 3.2: Distance between Sekolah Kebangsaan Bandar Rinching and palm oil activity

Based on Figure 3.3, the comparative area was in Hulu Langat, Selangor. There was no any palm oil activity activities and industrial areas are found near the selected primary schools. Hulu Langat district was popular with its natural surroundings and for its famous for Nuang Mountains. Reviewing these criteria enable Hulu Langat to become the perfect comparative area for this study. The primary schools that were selected for the comparative studies were Sekolah Kebangsaan Dusun Tua, Hulu Langat and Sekolah Kebangsaan Lubuk Kelubi. The schools and the residential areas in Hulu Langat were expected to have a lower concentration of $PM_{2.5}$ and PM_{10} compared to the pollutant area.

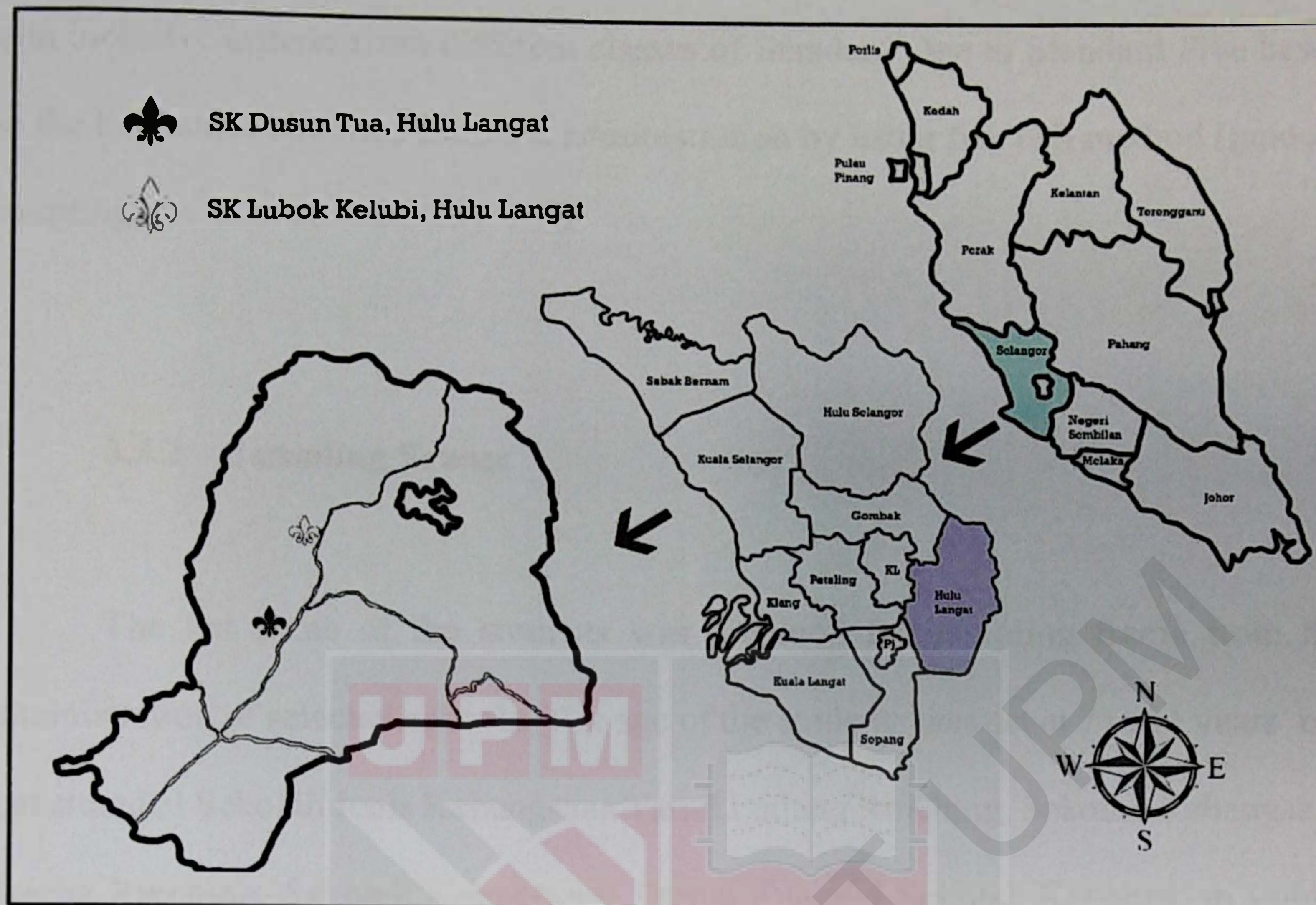


Figure 3.3: Maps of comparative schools Hulu Langat District

3.3 Sampling

3.3.1 Study Population

The studied population were selected from primary school children that studies in primary school. The children were selected from Sekolah Jenis Kebangsaan Tamil Ladang Rinching, Semenyih and Sekolah Kebangsaan Bandar Rinching, Semenyih. The primary school children were selected based on the age of 7 to 11 year's old and both genders (male and female) were selected to avoid gender bias of collected data. The comparative population were selected from primary school children that studies in primary school. The children were selected from Sekolah Kebangsaan Dusun Tua and Sekolah Kebangsaan Lubuk Kelubi. The selection of the children were included with inclusive criteria from different classes of Standard One to Standard Five based on the list names obtained from the administration by using fish ball method (random sampling).

3.3.2 Sampling Frame

The list name of the students was obtained for sampling frame from the administration of selected schools. The age of the students was set at 7 to 11 years' old that attended Sekolah Jenis Kebangsaan Tamil Ladang Rinching, Sekolah Kebangsaan Bandar Rinching, Sekolah Kebangsaan Dusun Tua and Sekolah Kebangsaan Lubuk Kelubi.

3.3.3 Study Unit

The study samples were selected among 70 children from both genders (male and female) that are currently studying at selected four primary schools. The participation from the students were needing their parental approval. Before the children participated in this study, the children were ensured to full filling the inclusion criteria of the study.

3.3.4 Sample Size

3.3.4.1 Comparing the lung function status between exposed group and comparative group

The sample size was calculated using the formula by Lemeshow, Klar and Lawanga (1990):

$$n = \frac{\{Z^{1-\alpha/2}\sqrt{2\bar{p}(1-\bar{p})} + z_{1-\beta}\sqrt{P_1(1-P_1)+P_2(1-P_2)}\}^2}{(P_1-P_2)^2}$$

where,

$\bar{p} = (P_1 + P_2) / 2$

P_1 = estimated proportion (larger)

P_2 = estimated proportion (smaller)

P_1 = 0.904 (Hussin and Jalaludin, 2016).

P_2 = 0.588 (Hussin and Jalaludin, 2016).

$\bar{p}$ = 0.746

$Z_{1-\alpha}$ = Standard error associated with confidential interval, 95% C1= 1.96

$z_{1-\beta}$ = Standard error associated with power, 80% of power = 0.842

$$n = \frac{\{(1.96\sqrt{2(0.746)(1-0.746)}+0.842\sqrt{0.904(1-0.904)}+0.588(1-0.588)\}^2}{(0.904-0.588)^2}$$

n= 29

∴ Sample size for each group (children in Semenyih and Hulu Langat) were 29. Total number of sample size were 58. The number of respondents was increased by 20 % for the strength of analysis of the study and to consider on non-responsive respondents, missing data and errors. Therefore, the total number of samples that were included in this study was 70 respondents include 35 respondents for exposed group and comparative group.

3.3.4.2 Prevalence value of primary school children with cough among exposed and comparative group

The sample size was calculated using the formula by Lemeshow, klar and Lawanga (1990):

$$n = \frac{\{Z^{1-\alpha/2}\sqrt{2\bar{p}(1-\bar{p})} + z_{1-\beta}\sqrt{P_1(1-P_1)+P_2(1-P_2)}\}^2}{(P_1-P_2)^2}$$

where,

$\bar{p} = (P_1 + P_2) / 2$

P_1 = estimated proportion (larger)

P_2 = estimated proportion (smaller)

$P_1 = 0.53$ (A.N., *et al*, 2014)

$P_2 = 0.18$ (A.N., *et al*, 2014)

$\bar{p} = 0.349$

$Z_{1-\alpha}$ = Standard error associated with confidential interval, 95% C1= 1.96

$z_{1-\beta}$ = Standard error associated with power, 80% of power = 0.842

$$n = \frac{\{(1.96\sqrt{2(0.349)(1-0.349)}+0.842\sqrt{0.53(1-0.53)+0.18(1-0.18)}\}^2}{(0.53-0.18)^2}$$

n= 29

∴ Sample size for each group (children in Semenyih and Hulu Langat) would be 29. Total number of sample size was 58. The number of respondents were increased by 20 % for the strength of analysis of the study and to consider on non-responsive respondents, missing data and errors. Therefore, the total number of samples that were included in this study was 70 respondents include 35 respondents for exposed group and comparative group.

3.3.4.3 Selection for sample size on this study

Based on the sample size calculations from specific objectives, the number of children choose as respondents were 70 respondents including 35 respondents for exposed group and comparative group according to Lemeshow, Klar and Lawanga (1990).

3.3.5 Sampling Method

This research applied the used of purposive sampling as its sampling methods. The selection of the primary schools was purposively based on the location of the schools with the location of the nearest palm oil activity. Two schools were selected for exposed groups and comparison groups. The respondents that fitted to inclusive criteria from different classes of Standard One to Standard Five were chosen based on the list names obtained from the administration by using fish ball methods. The respondents were chosen after the children get approvals from their parents before participating in this study. The letter of approval from their parents were required before the sampling started. All the children were needed to full fill the inclusive criteria before participated the study. A validated questionnaire was distributed among all the respondents. Measurement of $PM_{2.5}$ and PM_{10} in schools were taken from 8 a.m. until 1 p.m. (6 hours) to represent duration of children in schools. Meanwhile the measurement in the respondent's house was taken for 24 hours to represent the duration of children in home. The measurement of FVC and FEV_1 of the respondents was taken by the help of medical assistants and was taken for three times. The duration of the measurement of FVC and FEV_1 was around 3 to 5 minutes per respondent.

3.3.6 Inclusion Criteria

Table 3.1: Table of Inclusion Criteria

Inclusion Criteria	Items
Primary school children	1. Aged between 7 to 11 years' old 2. Boy and girl 3. Study at selected schools
Healthy	1. Respondents were free from any forms of respiratory disease
Nationality	1. Children with Malaysian nationality will be selected to participate

There were several inclusion criteria that were included in this study. The first inclusion criteria were the respondents must be from primary school children. The school children were selected based on the age, gender and schools. The age of the respondents was selected between 7 to 11 years' old and studied in selected schools registered under Ministry of Education. The 12 years' old children had not been selected due to the restriction from the Ministry of Education as 12 years' old children will be having UPSR examination. The children selected must include both gender of male and female. The children participating this study must also had a good health and free from any forms of respiratory disease. The children must be picked from Malaysian nationality.

3.3.7 Exclusion Criteria

Table 3.2: Table of Exclusion Criteria

No	Exclusion Criteria
1	Children that does not have consent and permission from parent and guardian to participate in this study.
2	Children that have previous history of respiratory disease and any known medical problems. It was because any previous history could affect the growth of the children lungs thus affecting the FVC and FEV_1 results. (Salvi, 2007)

Throughout the study, the exclusion criteria for the children that were selected were no children that does not have consent and permission from their parent or guardian can participated in this study. Children that have previous history of respiratory disease also could not be participated in this study. According to Salvi (2007), the children with those problems could not participated as the lung growth has found to be impaired with the children that had been exposed. This could had affected the reading of FVC and FEV_1 results.

3.3.8 Sampling Procedure

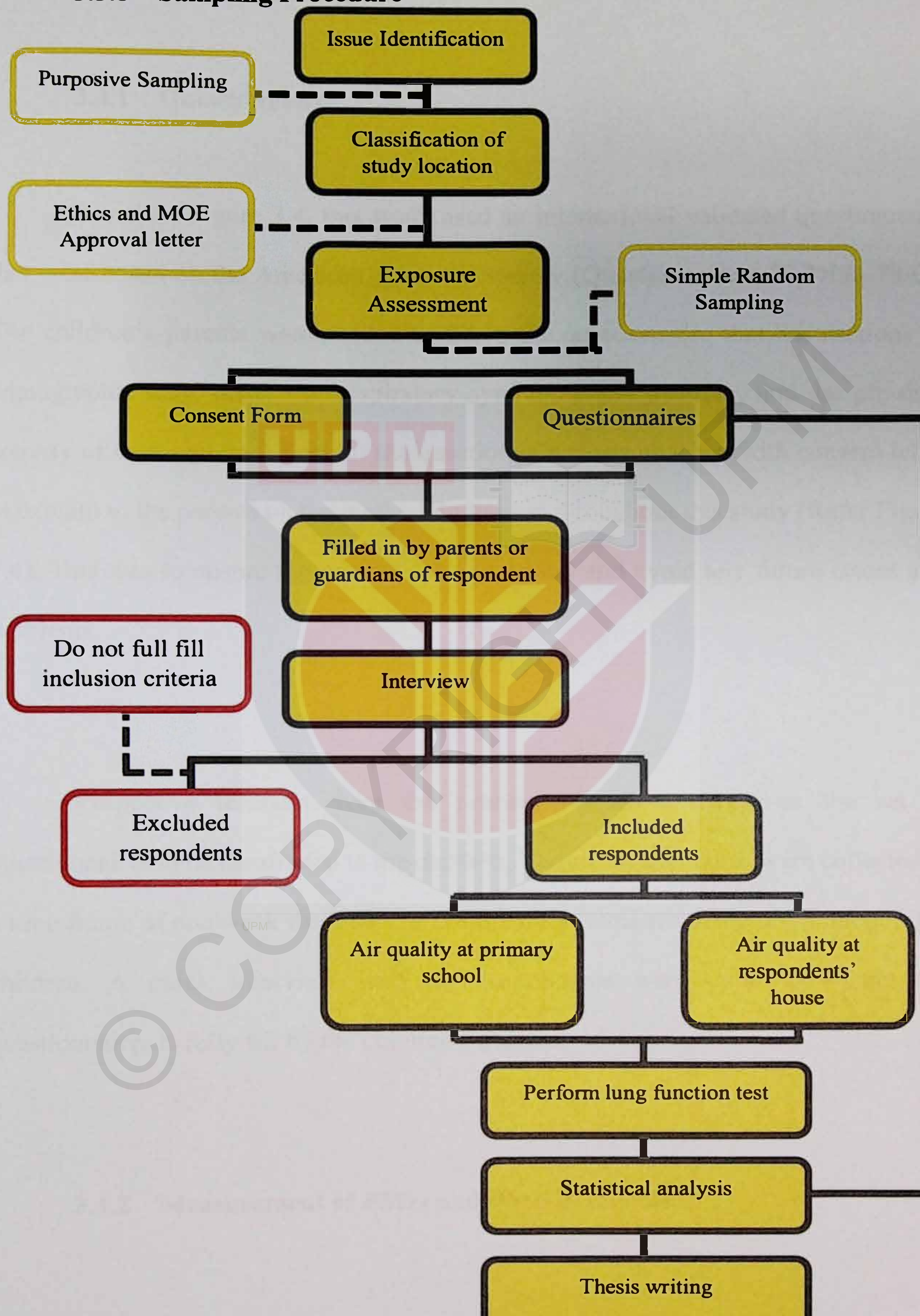


Figure 3.4: Sampling Method Flow Chart

3.4 Instrumentation

3.4.1 Questionnaire

Based on Figure 3.4, this study used an international validated questionnaire that were based on the American Thoracic Society (Questionnaire ATS-DLD-78-C). The children's parents were needed to fill in the questionnaire that has sections of demographic data, history of respiratory symptoms and disorder, and the physical activity of their children. Each of the questionnaires was attached with consent letter to explain to the parents on the methodology used throughout this study (Refer Figure 3.4). This was to ensure the parents are understand and avoid any future issues and problems.

Respective teachers from the primary schools were given the set of questionnaires to be distributed to the children. These questionnaires were collected in a time frame of one week from the date of the questionnaires being distributed to the children. A quick interview with the respondents were done to ensure the questionnaires is fully fill by the children's parents.

3.4.2 Measurement of $PM_{2.5}$ and PM_{10} in schools

Based on Figure 3.4, the evaluation of the concentration level of respirable dust ($PM_{2.5}$) and inhalable dust (PM_{10}) are carried out outside of the classroom at all of the schools, Sekolah Jenis Kebangsaan Tamil Ladang Rinching, Sekolah Kebangsaan

Bandar Rinching, Sekolah Kebangsaan Dusun Tua and Sekolah Kebangsaan Lubuk Kelubi. These measurements were taken during the school hours using TSI DustTrak DRX Aerosol Monitor Model 8534 to ensure the timing of measurement is equivalent to the timing exposure of the children in the school. Both $PM_{2.5}$ and PM_{10} were measured by TSI DustTrak DRX Aerosol Monitor Model 8534 and the placement of the instrument were placed as same as the breathing zone of the children (1.0 metres above the floor) and 1.5 metres away from the windows. The sampling points were selected to ensure no disruption due to the movement and attraction from the children itself. The sampling for $PM_{2.5}$ and PM_{10} in schools were taken for a duration of 6 hours in the respondent's classrooms to represent the classrooms exposure.

Figure 3.5: DustTrak DRX Aerosol Monitor Model 8534

Sources: TSI (2018)

3.4.3 Measurement of $PM_{2.5}$ and PM_{10} in Respondents' House

The concentration level of PM_{10} and $PM_{2.5}$ were determined by using NIOSH Manual of Analytical Methods (NMAM) 0600: Particulates Not Otherwise Regulated, Respirable. The measurement was taken at the children's house by using Escort LC Personal Sampling Pump by Zefon International Inc.

The measurement of the level of PM_{10} and $PM_{2.5}$ were done by leaving the personal sampling pump for 24 hours to obtain the particulates exposure of the children (Refer Figure 3.4). The filter papers that were used during the measurement of $PM_{2.5}$ are Mixed Cellulose Ester Membrane (MCE) filter with the pore size of 5μm while the filter papers that were used during the measurement of PM_{10} are Poly Vinyl Chloride (PVC) filter with the pore size of 5μm. The samplings' flow rate was standardized at 1.7 L/min according to the NIOSH Manual of Analytical Methods (NMAM) 0600: Particulates Not Otherwise Regulated, Respirable. $PM_{2.5}$ were measured by using impactor recommended by SKC Inc (2018) and the flow rate used was 3.0 L/min.

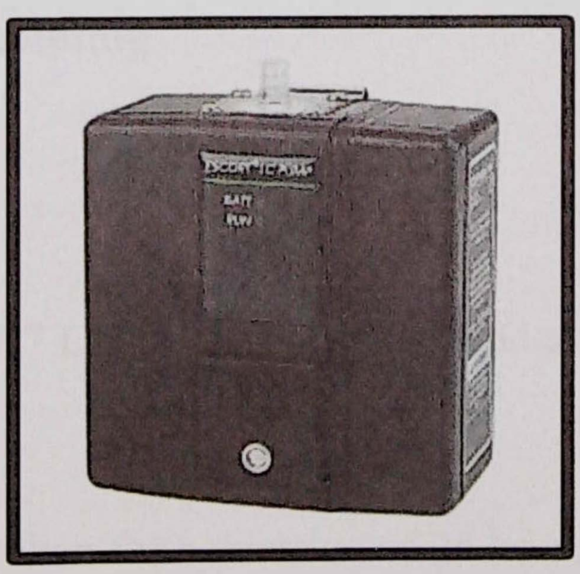


Figure 3.6: Escort LC Personal Sampling Pump

Sources: Zefon International Inc.

3.4.3.1 Procedure of Personal Sampling Pump

3.4.3.1.1 Preparation Before Sampling

1) The filter papers were weighted in a control environment area.
2) The filter papers were assembled into the cassettes before closing it firmly to avoid any openings from environment contamination.
3) The opening of the cassettes was closed by using the plugs provided.
4) Before the usage, the cyclones grift cap was removed and inspected. The cyclones were discarded if they were found to be any defect in the dust separation characteristic was altered. The interior of the cyclone was cleaned to prevent any contamination from the re-entrainment of large particles.
5) The alignment of filter holder and cyclone in the sampling head were assembled and checked to prevent any leakage.

3.4.3.1.2 During Sampling

1) The flow rate of 1.7 L/min were set as a standard flow rate for each personal sampling pump.
2) The sample was taken for a duration of 24 hours in the respondents.

3) The top and bottom plugs were removed from the filter cassette before the sampling start. The cassette was equilibrated for 2 hours in a desiccator as control environment.

3.4.3.1.3 Quality Control

1) The filter paper was weighted and recorded according to the procedures.
2) The filter papers were brushed by electrostatic discharged brush to avoid interference of electrostatic elements.
3) The microbalance was re-zero before all weighing take place. All the weighing of the filter papers was used with the same microbalance before and after the sample is collected.
4) Replicate of field samples were exposed to the same dust environment using the same type of equipment, routines and procedures.
5) Each sampling pump used was calibrated by using calibration jar before and after the sampling done.

3.4.3.1.4 Measurement

The measurement of the filter papers including the field blanks were weight. Any remarkable details regarding to filter papers such as wet, torn and leakage were recorded.

3.4.3.1.5 Calculation

The concentration of the respirable dust was calculated in C ($\mu g/m^3$) and air volume sampled in V (L) using the following calculation:

$$C=\frac{(W2-W1)-(B2-B1)}{V}.\ 10^3,\ mg/m^3$$

Indicators: W1= tare weigh of filter before sampling (mg)

W2= Post sampling weight of sample-containing filter (mg)

B1= Mean tare weight of blank filters (mg)

B2= mean post-sampling weight of blank filter (mg)

V= Volume as sampled at the nominal flow-rate

3.4.4 Anthropometry Measurement

The anthropometry measurement was an important part of the assessment to determine the nutritional conditions of the respondents (Martinez *et al.* 2012). The measurement of weight and height of the respondents were recorded in the time of the lung function test. The height of the children was measured by using SECA 208 Body Meter. The measurement was taken in centimetres (cm). The respondents were required to stand in a straight position without wearing shoe or slipper (bare foot). The weight of the children was measured by a standard weighing scale. The measurement was taken in kilograms (kg). The weighing scale was placed in an even surface to ensure the measurement as accurate as possible.

3.4.5 Lung Function Test

The primary school children were required to undergoes lung function test by using a spirometer to evaluate the lung function of the children. The instrument that was used was the Chestgraph HI-101 Spirometer. The spirometer was calibrated by using a 3L syringe injecting air into the spirometer. Each of the respondents had personal mouthpieces and nose clip to ensure there was no contamination. Before the assessment was conducted with the children, the researcher had showed a demonstration on the correct technique to the children. Before the lung function test was taken placed, the respondent was required to undergoes anthropometric measurement. The respondents were asked to breathe through a mouthpiece attached to the spirometer during the spirometry test. Then, they were required to inhaled as full as possible before the forced exhalation can be done. The forced exhalation duration took 3 seconds for the respondents or until the subjects were not able to exhale anymore. The measurement was replicate three times to ensure the data obtained are the best data. The data that was obtained were in the form of spirogram. The determination of the lung function performance was compared with the value of standard. Thorough the assessment of lung function was accompanied by medical assistant at the field. Other required data such as name, age, sex, weight and date was recorded before the assessment of spirometer. The assessment of lung function performance will be done based on American Thoracic Society (1991) classification whether it was normal or abnormal.

Figure 3.7: Chestgraph HI-105 Spirometer

Sources: Prometheus Healthcare Website (2018)

The calculation of force expiratory volume in one second (FEV_1), forced vital capacity (FVC) and FEV_1/FVC ratio was calculated using the findings from Azizi (1994).

Table 3.3: Equation to calculate FEV1 and FVC among Children in Malaysia

Lung function test	Boy	Girl
FEV_1	$6.2523 \times 10^{-6} H^{2.5388}$	$5.7588 \times 10^{-7} H^{3.0067}$
FVC	$4.1120 \times 10^{-6} H^{2.6421}$	$6.0777 \times 10^{-7} H^{3.0112}$

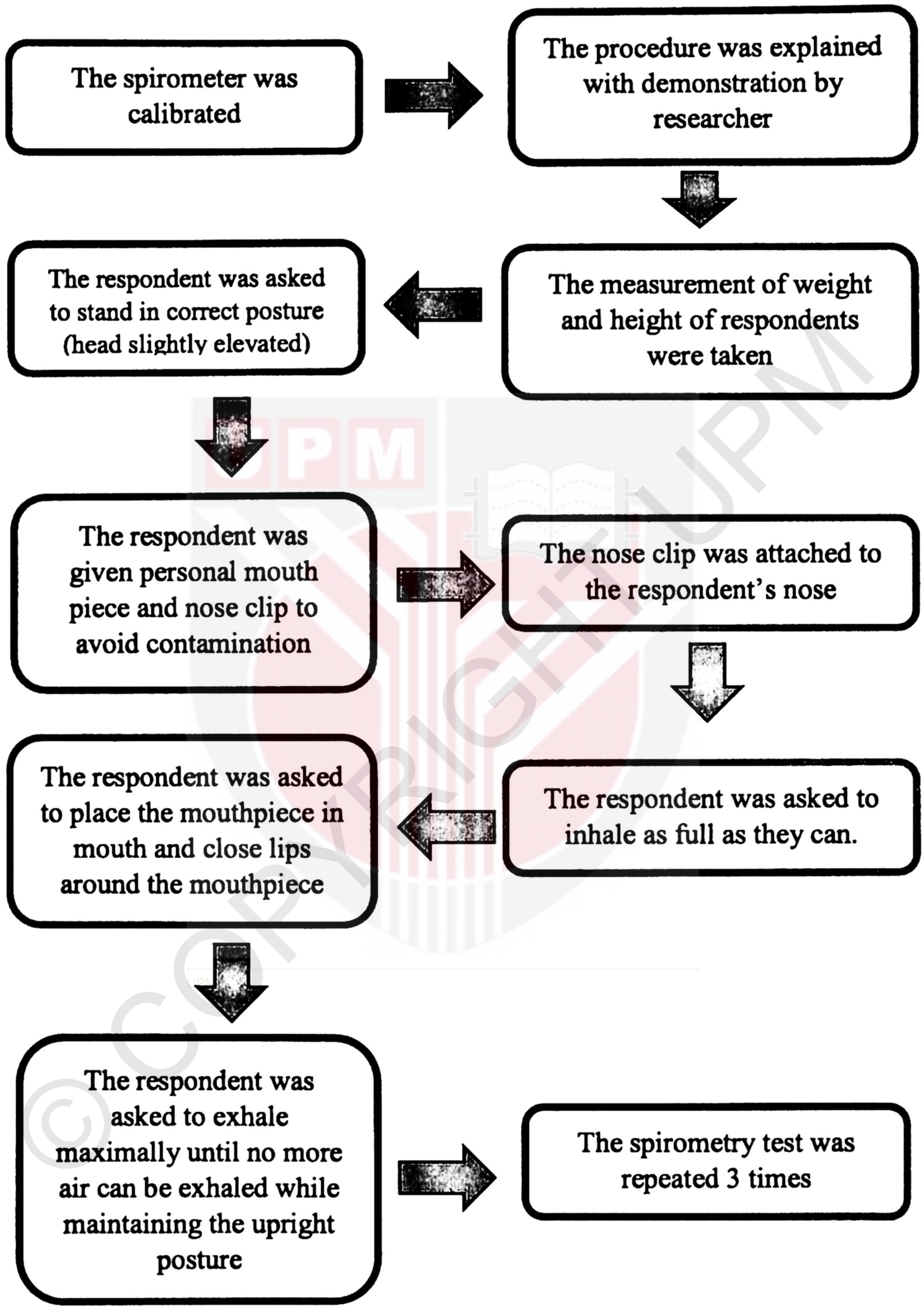
Sources: Azizi and Henry (1994)

Table 3.4: Evaluation of Lung Function Performance

Obstructive Disease	FEV_1 %
Normal	≥ 80
Mild	70-79
Severe	60-69
Very Severe	< 60
Restrictive Disease	**FVC %**
Normal	≥ 80
Mild	70-79
Severe	60-69
Very Severe	< 60
	FEV_1/FVC %
Normal	≥ 85
Abnormal	< 85

Sources: American Thoracic Society (1991)

Figure 3.8: Lung Function Test Procedure



Sources: American Thoracic Society (1991)

3.4.6 Statistical Analysis

3.4.6.1 To compare the concentration level of $PM_{2.5}$ and PM_{10} in ambient air at the exposed area and comparative area.

Statistical Analysis:

Parametric:	Independent t-test
Non-Parametric:	Mann-Whitney U test

3.4.6.2 To compare the concentration level of $PM_{2.5}$ and PM_{10} between schools at exposed area and comparative area.

Statistical Analysis:

Parametric:	Independent t-test
Non-Parametric:	Mann-Whitney U test

3.4.6.3 To compare the respiratory health symptoms between children that live near to the palm oil activity and children that live in comparative area.

Statistical Analysis:

Parametric:	Chi-square
Non-parametric:	Chi-square

3.4.6.4 To compare lung function test results between children that live near to the palm oil activity and children that live in comparative area

Statistical analysis:

Parametric:	Independent t-test
Non-Parametric:	Mann-Whitney U test

3.4.6.5 To determine the association between the concentration level of $PM_{2.5}$ and PM_{10} with the lung function result of children who live near palm oil activity and children who live in comparative area.

Statistical analysis:

Parametric:	Pearson Correlation test
Non-Parametric:	Spearman Rho's test

3.4.6.6 There was association between the concentration level of $PM_{2.5}$ and PM_{10} and respiratory symptoms among children who live near palm oil activity and children who live in comparative area

Statistical analysis:

Parametric:	Pearson Correlation test
Non-Parametric:	Spearman Rho's test

3.5 Ethical Approval

The ethical approval for running this study was obtained from the Research Ethic Committee of Universiti Putra Malaysia (Refer Appendix 1). The approval from Ministry of Education and the administration of all the primary schools involve were acquired before the study was being done. The study used the principle of voluntary basis where all respondents were briefed on the conduct of the experiments and they could choose whether or not they want to participate in the study. Written approvals forms (consent forms) was given to all the parents who had their children involved as a respondent in the study. Any form of written or recorded data were confidential and cannot be reveal to anyone that do not had any relationship to the study.

3.6 Expected Outcomes

The most concerned pollutants were the respirable dust. These respirable dusts contained a complex mixture of different sizes of particulate matters and mixture of solid-liquid substances suspended in the air. Particulate matters existed in different sizes and the most concern particulate matters were inhalable coarse particles (PM_{10}) and respirable course particles ($PM_{2.5}$). It was expected that the concentration levels of $PM_{2.5}$ and PM_{10} were higher in the residential area near the palm oil activity (Semenyih, Selangor) when compared to the residential area that were far from palm oil activity activities (Hulu Langat, Selangor). In addition, the outcomes of the lung function of children who were exposed to high level of $PM_{2.5}$ and PM_{10} was lower than the children who were exposed to low level of $PM_{2.5}$ and PM_{10}. There was an expected outcomes conclusion that there was a significant association between the concentration level of $PM_{2.5}$ and PM_{10} with the lung function test result of children who lived near palm oil activity and children who lived in comparative area.

3.7 Declaration of conflict of interest

There was no potential conflict of interest by the researcher during this study.

3.8 Study Limitation

The limitation found in this study was it only focussed on the association level between variables and were not able to identify cause-effect association due to cross sectional study design used. The measurement obtained through this study may not represented the actual averages value of pollution that were exposed to the children. Time constraint existed during the sampling due to the sudden local election. The exposed school was selected as voting centre and was closed for 1 weeks. Lastly, the questionnaires were answered by the respondents were acceptable, without recall bias. All the answers were given by the parents were assumed to be true.

CHAPTER 4

STUDY RESULTS

4.1 Information of Respondents

A total of 160 questionnaires were distributed to the selected schools and only 150 questionnaires were returned to the researchers. After the exclusion of the respondents that did not fulfilled the criteria, only 136 respondents (response rate = 85%) school children were selected to participated in the study. The number of samples were 66 children more than the sample size required at 70 children.

Table 4.1: Total number of respondents according to gender and study location.

Location	Total	Gender	
	n=136	Boy (%)	Girl (%)
Studied group	50	22(44.00)	28(56.00)
Comparative group	86	33(38.37)	53(61.63)

Based on the participation from the respondents from Table 4.1, the total amount of the respondents obtained in this study were 136, 50 of the respondents came from studied group and 86 of the respondents from comparative group. All respondents were Malay by race. According to the gender distribution among the respondents, majority of the respondents were girls in studied area (56%). This was similar in comparative area with majority of girls (61.63%).

Table 4.2: Anthropometrical data among studied and comparative group

Variables	Studied group n= 50	Comparative group n= 86	t-value	P-value
	Mean ± SD			
[1]Age (years)	10.00 ± 0.00	10.14 ± 3.34	0.295	0.768
[1]Height (cm)	133.06 ± 6.37	128.44 ± 6.75	-3.922	**<0.001**
[1]Weight (kg)	30.38 ± 9.03	32.90 ± 25.23	0.682	0.497

[1]Independent sample T-test

***Significant at p<0.05**

Based on Table 4.2, the three variables for anthropometrical data selected were age, height and weight. These three variables are analyse in datasheet to obtain the mean and standard deviation between the two groups. The mean of the age among the comparative groups was 10.00 ± 0.00 years old while the mean of the age among the studied groups was 10.14 ± 3.34 years old. Based on the mean and standard deviation data, the mean difference of the age 0.14 and the standard deviation difference was 3.34. The t-value was 0.295 while P value was 0.768, >0.05 The mean of the height among the comparative groups was 128.44 ± 6.75 cm while the mean of the height among the studied group were 133.06 ± 6.37 cm. The mean differences of the height were 4.62 and the standard deviation difference was -0.38. The t-value was -3.922 while P-value was <0.001, <0.05. The mean of the weight among comparative groups was 32.90 ± 25.23 kg while the mean of the height among the studied group were

30.38 ± 9.03 kg. The mean differences of the weight were 2.52 and the standard deviation difference 16.2. The t-value was 0.682 while the P-value was 0.497.

Table 4.3: Education level of respondents' parents

Variables	Studied group n=50	Comparative group n=86	x^2	p-value
	Total (%)	Total (%)		
Father's education level				
Primary school	5 (10.0)	5 (5.8)		
PMR	3 (6.0)	11 (12.8)	10.38	**0.04**
SPM	16 (32.0)	31 (36.0)		
STPM/Diploma	13 (26.0)	31 (36.0)		
Degree/Master/PhD	13 (26.0)	7 (8.1)		
Mother's education level				
Primary school	3 (6.0)	8 (9.3)		
PMR	2 (4.0)	2 (2.3)	7.96	0.09
SPM	16 (32.0)	35 (40.7)		
STPM/Diploma	10 (20.0)	26 (30.2)		
Degree/Master/PhD	19 (38.0)	15 (17.4)		

[1]Pearson's Chi Square
***Significant at p<0.05**

Based on Table 4.3, comparison between two groups, it was found that the education level between the respondents' father in both group shows similarity (education level = SPM). The highest percentage of education level for parents were SPM (40.7%). Meanwhile, the lowest education percentage level for parents were primarily school (5.8%).

Based on the Pearson's Chi Square analysis, the value of Pearson's Chi Square for the father's educational level were 10.38. The degree of freedom was 1. The P-value obtained from the test was 0.04 which was less than 0.05. There was a significant difference between father's educational level with comparative and studied group. Based on the Pearson's Chi Square analysis, the value of Pearson's Chi Square was 7.96. The degree of freedom was 1. The P-value obtained from 0.09 which was more than 0.05. There was no significant difference between mother's educational level with comparative and studied group.

4.2 Respondents' Environment

Table 4.4: Background of respondents' house

Variables	Studied group n=50	Comparative group n= 86
	Total (%)	Total (%)
Distance from main road		
<100 meters from house	27 (54.0)	10 (11.6)
>100-500 meters from house	15 (30.0)	6 (7.0)
>500-1000 meters from house	5 (10.0)	3 (3.5)
> 1000 meters from house	3 (6.0)	67 (77.9)
Distance from palm oil activity		
<500 meters	4 (8.0)	-
>1-1.5 km	20 (40.0)	-
>1.5-3 km	16 (32.0)	-
>3 km	10 (20.0)	86 (100.0)
Perception on surrounding area		
Very dusty	7 (14.0)	2 (2.3)
Moderate dusty	33 (66.0)	54 (62.8)
Less dusty	10 (20.0)	30 (34.9)

Based on table 4.4, most of the respondents' house in studied group was less than 100 meters from the main road (54.0%) and the least distance were more than 1000 meters from the house (6.0%). In contrast, 77.9% of the respondent's house in the comparative group were more than 1000 meters from the main road. Majority of the respondents' house (40.0%) in the studied group live within >1-1.5 km from the palm oil activity in contrast with the 100.0% of the respondent's house in comparative group live >3 km from the palm oil activity. Both groups show similar perception on the surrounding environment with 66.0% of the studied groups feels that their environment were moderate dusty and 62.8% of the comparative groups gave similar comments. 14.0% of the respondents had perception that their house is very dusty in the exposed group meanwhile 2.3% of the respondent living in the comparative group showed similar perception.

Table 4.5: Respondents Housing Type

Variables	Studied group n=50	Comparative group n= 86
	Total (%)	Total (%)
Type of Housing Area		
Village	0 (0.0)	66 (76.7)
Flat	4 (8.0)	7 (8.1)
Apartments	0 (0.0)	4 (4.7)
Single-story House	15 (30.0)	1 (1.2)
Double-story House	30 (60.0)	2 (2.3)
Bungalow	1 (2.0)	3 (3.5)
Semi-D House	0 (0.0)	3 (3.5)

Table 4.5 shows the respondents housing type for both studied and comparative group. Majority of the respondents for studied group lived in double-story house (60.0%) meanwhile majority of the respondents in comparative group live in village house (76.7%).

4.3 Respondents' Exposure

Table 4.6: The concentration different of PM_{10} and $PM_{2.5}$ at studied and comparative schools.

variable	Studied schools n=10	Comparative schools n=10	t-value	p-value
	Mean ± SD			
[1,2] PM_{10} ($\mu g/m^3$)	105.21 ± 46.11	53.92 ± 12.37	3.323	**0.014**
[1,2] $PM_{2.5}$ ($\mu g/m^3$)	68.83 ± 13.03	13.03 ± 17.45	2.287	**0.040**

[1]Independent sample T-test
[2]Sampling measurement for 24 hours
***Significant at p<0.05**

The value of the P from the Levene's test for equality of variance was 0.059. Since the outcome of P was more than 0.05, the equality of variance was assumed. The difference of the mean between the concentration of PM_{10} at studied school and comparative schools was 51.29 and the t value was at 2.843. The p-value of the test was 0.014 < 0.05. It shows that there was a significant difference in concentration of PM_{10} between the comparative schools and studied schools. The mean concentration at comparative school was higher than the mean at studied school. The confidence level was at 95% and the difference was between 12.31 and 90.28.

The value of the P from the Levene's test for equality of variance was 0.287. Since the outcome of P was more than 0.05, the equality of variance was assumed. The difference of the mean between the concentration of $PM_{2.5}$ at studied school and comparative schools was 18.03 and the t value was at 2.287. The p-value of the test was $0.04 < 0.05$. It showed that there was a significant difference in concentration of $PM_{2.5}$ between the comparative schools and studied schools. The mean concentration at comparative school was higher than the mean at studied school. The confidence level was at 95% and the difference was between 1.00 and 35.06.

Table 4.6.1: Comparison of concentration of PM_{10} and $PM_{2.5}$ according to schools

Variable	Studied School		Comparative School	
	S1	S2	S3	S4
[1]PM_{10} ($\mu g/m^3$)	93.30	117.13	71.32	69.00
[1]$PM_{2.5}$ ($\mu g/m^3$)	61.44	76.22	57.32	59.10

S1: Sekolah Kebangsaan Bandar Rinching
S2: Sekolah Jenis Kebangsaan Tamil Ladang Rinching
S3: Sekolah Kebangsaan Lubok Kelubi
S4: Sekolah Kebangsaan Dusun Tua
[1]Sampling measurement for 24 hours

From table 4.6.1, the concentration of PM_{10} in the studied school were higher than the concentration of PM_{10} in the comparative school. The concentration of PM_{10} in Sekolah Kebangsaan Bandar Rinching was 93.30 $\mu g/m^3$ while the concentration of PM_{10} in Sekolah Jenis Kebangsaan Tamil Ladang Rinching was 117.13 $\mu g/m^3$. In the comparative group, the concentration of PM_{10} in Sekolah Kebangsaan Lubok Kelubi was 71.32 $\mu g/m^3$, meanwhile the concentration of PM_{10} in Sekolah Kebangsaan Dusun Tua was 69.00 $\mu g/m^3$.

The concentration of $PM_{2.5}$ in the studied school were higher than the concentration of $PM_{2.5}$ in the comparative school. The concentration of $PM_{2.5}$ in

Sekolah Kebangsaan Bandar Rinching was 61.44 μg/m^3 while the concentration of $PM_{2.5}$ in Sekolah Jenis Kebangsaan Tamil Ladang Rinching was 76.22 μg/m^3. In the comparative group, the concentration of $PM_{2.5}$ in Sekolah Kebangsaan Lubok Kelubi was 57.32 μg/m^3, meanwhile the concentration of $PM_{2.5}$ in Sekolah Kebangsaan Dusun Tua was 59.10 μg/m^3.

Table 4.7: PM_{10} and $PM_{2.5}$ concentration level at studied and comparative respondents' house.

Variable	Studied group (n =30)	Comparative group (n=30)	t/z-value	p-value
	Mean ± SD			
[1,2]PM_{10} (μg/m^3)	104.29 ± 58.70	32.14 ± 58.70	3.16	**0.017***
[1,2]$PM_{2.5}$ (μg/m^3)	74.29 ± 42.57	22.86 ± 36.73	2.42	**0.032***

[1]Independent sample T-test
[2]Sampling measurement for 24 hours
***significant at p<0.05**

Based on Table 4.7, the maximum and the minimum value of concentrations of PM_{10} in the comparative group were 165.00 μg/m^3 and 5.00 μg/m^3. In addition, the maximum and minimum concentration of PM_{10} for studied group were 60.00 μg/m^3 and 15.00 μg/m^3.

The Levene's Test for equality of variance gave a P value of 0.010. Since the P value was less than 0.05, the equality of variance was not assumed. The mean and standard deviation for PM_{10} concentration in comparative group was 32.14 ± 58.70 μg/m^3 meanwhile the mean and standard deviation for PM_{10} concentration in the studied group was 104.29 ± 58.70 μg/m^3. The t-value for the difference between the comparative group and studied group was 3.16. The difference in mean of PM_{10} concentration between the comparative group and studied group was 72.15. The P value obtained from the test was 0.017, < 0.05. It shows that there was a significant difference in mean concentration of PM_{10} between studied and comparative respondents' house.

Based on Table 4.7, the maximum and the minimum value of concentrations of $PM_{2.5}$ in the comparative group were 105.00 μg/m^3 and 5.00 μg/m^3. In addition, the maximum and minimum concentration of $PM_{2.5}$ for studied group were 160.00 μg/m^3 and 40.00 μg/m^3.

The Levene's Test for equality of variance gave a P value of 0.626. Since the P value was more than 0.05, the equality of variance was assumed. The mean and standard deviation for $PM_{2.5}$ concentration in comparative group was 22.86 ± 36.73 μg/m^3 meanwhile the mean and standard deviation for $PM_{2.5}$ concentration in studied group was 74.29 ± 42.57 μg/m^3. The t-value for the difference between the comparative group and studied group was 2.42. The difference in mean of $PM_{2.5}$ concentration between the comparative group and studied group was 51.43. The P value obtained from the test was 0.032, < 0.05. It showed that there was a significant difference in mean concentration of $PM_{2.5}$ between studied and comparative respondents' house.

Table 4.8: Exposure to level of concentration of PM_{10} and $PM_{2.5}$ among studied and comparative group

Variables	Studied group n=30	comparative group n=32	x^2	P-value	OR	95% CI
	Total (%)					
PM_{10}						
[1]High (>150 μg/m³)	23 (76.67)	6 (18.75)	20.86	**<0.001**	**14.24**	**4.17-48.53**
[1]Low (<150 μg/m³)	7 (23.33)	26 (81.25)				
$PM_{2.5}$						
[1]High (>75 μg/m³)	20 (66.67)	2 (6.25)	24.69	**<0.001**	**30.00**	**5.936-151.62**
[1]Low (<75 μg/m³)	10 (33.33)	30 (93.75)				

[1]Pearson Chi-square

***significant at p<0.05**

Based on the Pearson's chi square analysis in Table 4.8, the value of Pearson's chi square for the exposure to high and low concentration of PM_{10} among studied and comparative group were 20.86. The degree of freedom for the test was 1. The P-value obtained from the test is 0.00 which was less than 0.05 ($0.00 < 0.05$). 76.67% of the studied group were exposed high concentration of PM_{10} in compared with 18.75% of the comparative group were exposed with high concentration of PM_{10}. There was a significant difference between the level of PM_{10} exposure with the two different groups. The respondents in studied group were 14.24 times more likely to be exposed to high concentration of PM_{10}, (OR=14.24, 95% CI 4.18-48.53).

Based on the Pearson's chi square analysis, the value of Pearson's chi square for the exposure to high and low concentration of $PM_{2.5}$ among studied and comparative group were 24.69. The degree of freedom for the test was 1. The P-value obtained from the test was 0.00 which was less than 0.05 ($0.00 < 0.05$). 66.67% of the studied group were exposed high concentration of $PM_{2.5}$ in compared with 6.25% of the comparative group were exposed with high concentration of $PM_{2.5}$. There was a significant difference between the level of $PM_{2.5}$ exposure with the two different groups. The respondents in studied group were 30.00 times more likely to be exposed to high concentration of $PM_{2.5}$, (OR=30.00, 95% CI 5.94-151.62).

4.4 Prevalence of Respiratory Symptoms

Table 4.9: Reported respiratory symptoms among studied and comparative group.

Variables	Studied group n=50	Comparative group n=50	x^2	p-value	OR	95% CI
	Total (%)					
[1]**Cough**						
Yes	16 (32.0)	0 (0.0)	19.05	**<0.001***	**2.47**	**1.91-3.20**
No	34 (68.0)	50 (100.0)				
[1]**Phlegm**						
Yes	13 (26.0)	0 (0.0)	14.94	**<0.001***	**2.35**	**1.84-3.00**
No	37 (74.0)	50 (100.0)				
[1]**Wheezing**						
Yes	14 (28.0)	1 (2.0)	13.26	**<0.001***	0.05	0.07-0.42
No	36 (72.0)	49 (98.0)				
[1]**Chest tightness**						
Yes	13 (26.0)	2 (4.0)	9.49	**0.002***	0.12	0.03-0.56
No	37 (74.0)	48 (96.0)				

[1]Pearson's chi square
***significant at p<0.05**

Based on Table 4.9, the total number of the respondents in both groups that develop cough were 16. All of them come from studied group. The value obtained for the Pearson's chi square analysis was 19.05 and the degree of freedom was 1. The P-value obtained from the test were <0.001 which was less than 0.05. The minimum expected count for cough was 8.00. There was significant difference between the two groups of respondents and the development of cough. The respondents were 2 times of risk to develop cough, (OR=2.41, 95% CI 1.91-3.20).

Based on Table 4.9, the total number of the respondents in both groups that develop phlegm are 14. All of them came from studied group. The value obtained for the Pearson's chi square analysis was 14.94 and the degree of freedom was 1. The P-value obtained from the test was <0.001 which was less than 0.05. The minimum expected count for phlegm was 6.50. 26% of the respondents in studied group developed phlegm. There was significant difference between the two groups of respondents and the development of phlegm. The respondents were 2 times more risk to develop phlegm, (OR=2.35, 95% CI 1.84-3.00).

Based on Table 4.9, the total number of the respondents in both groups that develop wheezing were 15. 14 of them were from the studied group and 1 of them come from comparative group. The value obtained for the Pearson's chi square analysis was 13.26 and the degree of freedom was 1. The P-value obtained from the test was <0.001 which was less than 0.05. The minimum expected count for wheezing was 7.50. Only 2.0% of respondents developed wheezing in comparative group while 28.0% of the respondents in studied group develop wheezing. There was significant difference between the two groups of respondents and the development of wheezing. The respondents were 0.05 more risk to develop wheezing, (OR=0.05, 95% CI 0.07-0.42).

Based on Table 4.9, the total number of the respondents in both groups that develop chest tightness were 15. 13 of them were from the studied group and 2 of them come from comparative group. The value obtained for the Pearson's chi square analysis was 9.49 and the degree of freedom was 1. The P-value obtained from the test were 0.002 which was less than 0.05. The minimum expected count for chest tightness was 7.50. Only 4.0% of respondents developed chest tightness in comparative group while 26.0% of the respondents in studied group developed chest tightness. There was significant difference between the two groups of respondents and the development of chest tightness. The respondents were 0.12 more risk to develop chest tightness, (OR=0.12, 95% CI 0.03-0.56).

Table 4.10: Two concentration of PM_{10} with respiratory symptoms

Symptoms	High PM_{10} (>150 µg/m^3) n= 50	Low PM_{10} (<150 µg/m^3) n= 50	x^2	P-value	OR	95% CI
	Total (%)					
Cough						
Yes	10 (62.5)	6 (37.5)	1.98	0.159	2.38	0.702-
No	14 (41.2)	28 (58.8)				8.073
Phlegm						
Yes	8 (61.5)	5 (38.5)	0.08	0.784	1.20	0.326-
No	20 (57.1)	15 (42.9)				4.414
Wheezing						
Yes	13 (92.9)	1 (7.1)	14.29	**<0.001***	**26.0**	**3.032-**
No	12 (33.3)	24 (66.7)				**222.298**
Chest tightness						
Yes	10 (76.9)	3 (23.1)	9.92	**0.002**	**9.00**	**2.048-**
No	10 (27.0)	27 (73.9)				**39.545**

***Significant at p<0.05**

Based on Table 4.10, The total respondents being exposed to the high level of concentration of PM_{10} were 24. Based on the exposure of high concentration of PM_{10} to the respondents, 10 (62.5%) of them were reported to develop cough and 14 (41.2%) of them were not. The total respondents that were exposed to the low concentration of

PM_{10} were 26 persons. 6 (37.5%) of them developed cough and 20 (58.8%) of them were not. The value of Pearson's chi square was 1.98 and the degree of freedom was 1. The p-value from this test obtained was 0.159 > 0.05. The minimum expected count was 7.68 which was more than 5. From the p-value, there was no significant difference between the development of cough and the two categories of PM_{10}. The exposure of high level of concentration of PM_{10} to the respondents were 2 times more risk to develop cough, (OR=2.38, 95% CI=0.702-8.073).

Based on the exposure of high concentration of PM_{10} to the respondents, 8 (61.5%) of them were reported to develop phlegm and 20 (57.1%) of them were not. The total respondents that were exposed to the low concentration of PM_{10} were 20 persons. 5 (38.5%) of them developed phlegm and 15 (42.9%) of them are not. The value of Pearson's chi square was 0.08 and the degree of freedom was 1. The p-value from this test obtained was 0.784 > 0.05. The minimum expected count was 5.42 which was more than 5. From the p-value, there was no significant difference between the development of phlegm and the two categories of PM_{10}. The exposure of high level of concentration of PM_{10} to the respondents were 1.2 times more risk to develop phlegm, (OR=1.20, 95% CI=0.326-4.414).

Based on the exposure of high concentration of PM_{10} to the respondents, 13 (92.9%) of them were reported to develop wheezing and 12 (33.3%) of them were not. The total respondents that were exposed to the low concentration of PM_{10} were 25 persons. 1 (7.1%) of them developed wheezing and 24 (66.7%) of them were not. The value of Pearson's chi square was 14.29 and the degree of freedom was 1. The p-value from this test obtained was <0.001 which was lower than 0.05. The minimum expected count was 7.00 which is more than 5. From the p-value, there was a significant difference between the development of wheezing and the two categories of PM_{10}. The exposure of high level of concentration of PM_{10} to the respondents were 26 times more risk to develop wheezing, (OR=26.00, 95% CI=3.032-222.928).

Based on the exposure of high concentration of PM_{10} to the respondents, 10 (76.9%) of them were reported to develop chest tightness and 10 (27.0%) of them were not. The total respondents that were exposed to the low concentration of PM_{10} were 30 persons. 3 (23.1%) of them developed chest tightness and 27 (73.0%) of them are not. The value of Pearson's chi square was 9.98 and the degree of freedom was 1. The p-value for Fisher's Exact Test obtained was $0.002 < 0.05$. The minimum expected count was 5.20 which is more than 5. From the p-value, there was a significant difference between the development of chest tightness and the two categories of PM_{10}. The exposure of high level of concentration of PM_{10} to the respondents were 9 times more risk to develop chest tightness, (OR=9.00, 95% CI=2.048-39.545).

Table 4.11: Two category of $PM_{2.5}$ concentration level with respiratory symptoms

	High $PM_{2.5}$ (≥75.00 µg/m³) n= 50	Low $PM_{2.5}$ (<75.00 µg/m³) n= 50	x^2	P-value	OR	95% CI
	n (%)					
Cough						
Yes	6 (37.5)	10 (62.5)	8.52	**0.004***	0.16	0.042-0.576
No	27 (79.4)	7 (20.6)				
Phlegm						
Yes	7 (53.8)	6 (46.2)	1.01	0.314	1.92	0.535-6.872
No	14 (37.8)	23 (62.2)				
Wheezing						
Yes	9 (64.3)	5 (35.7)	5.70	**0.017***	**4.68**	**1.258-17.417**
No	10 (27.8)	26 (72.2)				
Chest tightness						
Yes	9 (69.2)	4 (30.8)	0.624	0.430	1.714	0.446-6.583
No	21 (56.8)	16 (43.2)				

***Significant at p<0.05**

Based on Table 4.11, the total respondents were exposed to the high level of concentration of $PM_{2.5}$ were 33 persons. Based on the exposure of high concentration of $PM_{2.5}$ to the respondents, 6 (37.5%) of them were reported to develop cough and 27 (79.4%) of them were not. The total respondents that were exposed to the low concentration of $PM_{2.5}$ were 17 persons. 10 (62.5%) of them developed cough and 7 (20.6%) of them were not. The value of Pearson's chi square was 8.52 and the degree of freedom was 1. The p-value from this test obtained was $0.004 < 0.05$. The minimum expected count was 5.44 which was more than 5. From the p-value, there was a significant difference between the development of cough and the two categories of $PM_{2.5}$. The exposure of high level of concentration of $PM_{2.5}$ to the respondents were 0.16 times more risk to develop cough, (OR=0.156, 95% CI=0.042-0.576).

The total respondents being exposed to the high level of concentration of $PM_{2.5}$ were 21. Based on the exposure of high concentration of $PM_{2.5}$ to the respondents, 7 (53.8%) of them were reported to develop phlegm and 14 (37.8%) of them were not. The total respondents that were exposed to the low concentration of $PM_{2.5}$ were 29 persons. 6 (46.2%) of them develop phlegm and 23 (62.2%) of them were not. The value of Pearson's chi square was 1.01 and the degree of freedom was 1. The p-value obtained was $0.314 > 0.05$. The minimum expected count was 5.46 which is more than 5. From the p-value, there was no significant difference between the development of phlegm and the two categories of $PM_{2.5}$. The exposure of high level of concentration of $PM_{2.5}$ to the respondents were 1 times more risk to develop phlegm, (OR=1.917, 95% CI=0.535-6.872).

The total respondents were exposed to the high level of concentration of $PM_{2.5}$ were 19. Based on the exposure of high concentration of $PM_{2.5}$ to the respondents, 9 (64.3%) of them were reported to develop wheezing and 10 (27.8%) of them were not. The total respondents that were exposed to the low concentration of $PM_{2.5}$ were 31 persons. 5 (35.7%) of them developed wheezing and 26 (72.2%) of them were not. The value of Pearson's chi square was 5.702 and the degree of freedom was 1. The p-value was 0.017 < 0.05. The minimum expected count was 5.32 which was more than 5. From the p-value, there was a significant difference between the development of wheezing and the two categories of $PM_{2.5}$. The exposure of high level of concentration of $PM_{2.5}$ to the respondents were 4 times more risk to develop wheezing, (OR=4.68, 95% CI=1.258-17.417).

The total respondents were exposed to the high level of concentration of $PM_{2.5}$ were 30. Based on the exposure of high concentration of $PM_{2.5}$ to the respondents, 9 (69.2%) of them were reported to develop chest tightness and 21 (56.8%) of them were not. The total respondents that were exposed to the low concentration of $PM_{2.5}$ were 20 persons. 4 (30.8%) of them develop chest tightness and 16 (43.2%) of them were not. The value of Pearson's chi square was 0.624 and the degree of freedom was 1. The p-value was 0.43 > 0.05. The minimum expected count was 5.20 which was more than 5. From the p-value, there was no significant difference between the development of chest tightness and the two categories of $PM_{2.5}$. The exposure of high level of concentration of $PM_{2.5}$ to the respondents were 1 times more risk to develop chest tightness, (OR=1.714, 95% CI=0.446-6.583).

4.5 Lung Function among Respondents

Table 4.12: Comparison of lung function between two study groups

variables	Studied group n=50	Comparative group n=86	x^2	p-value	OR	95% CI
	Total (%)					
[1]FVC						
Abnormal	26 (52.0)	20 (23.3)	11.67	**0.001***	**3.58**	**1.964-7.546**
Normal	24 (48.0)	66 (76.7)				
[1]FEV$_1$						
Abnormal	31 (62.0)	16 (18.6)	26.33	**<0.001***	**7.14**	**3.246-15.698**
Normal	19 (38.0)	70 (81.4)				
[1]FEV$_1$/ FVC						
Abnormal	24 (48.0)	11 (12.8)	20.51	**<0.001***	**6.30**	**2.713-14.602**
Normal	26 (52.0)	75 (87.2)				

[1]Pearson's chi square
***significant at p<0.05**

Based on Table 4.12, the total number of the respondents in both groups that had abnormal FVC were 46. 20 of them were from the comparative group and 26 of them came from studied group. The value obtained for the Pearson's chi square analysis was 11.67 and the degree of freedom was 1. The P-value obtained from the test were 0.001, < 0.05. The minimum expected count for cough was 16.91. Only 23.3% of respondents had abnormal FVC in comparative group while 52.0% of the respondents in studied group had abnormal FVC. There was a significant difference between the two groups of respondents and the abnormality in FVC. The respondents were 3.58 times likely to develop cough, (OR=3.58, 95% CI 1.964-7.546).

The total number of the respondents in both groups that had abnormal FEV_1 were 47. 16 of them were from the comparative group and 31 of them came from studied group. The value obtained for the Pearson's chi square analysis was 26.33 and the degree of freedom is 1. The P-value obtained from the test were 0.000, < 0.05. The minimum expected count for cough was 17.28. Only 18.6% of respondents had abnormal FEV_1 in comparative group while 62.0% of the respondents in studied group had abnormal FEV_1. There was significant difference between the two groups of respondents and the abnormality in FEV_1. The respondents were 7.14 times likely to develop cough, (OR=7.14, 95% CI 3.246-15.698).

The total number of the respondents in both groups that had abnormal FEV_1/FVC were 35. 11 of them were from the comparative group and 24 of them came from studied group. The value obtained for the Pearson's chi square analysis was 20.51 and the degree of freedom was 1. The P-value obtained from the test were 0.000, < 0.05. The minimum expected count for cough was 12.87. Only 12.8% of respondents had abnormal FEV_1/FVC in comparative group while 48.0% of the respondents in studied group had abnormal FEV_1/FVC. There was significant difference between the two groups of respondents and the abnormality in FEV_1/FVC. The respondents were 6.30 times likely to develop cough, (OR=6.30, 95% CI 2.713-14.602).

Table 4.13: Association between concentration of PM_{10} and $PM_{2.5}$ and FEV_1/FVC

Variables	Normal	Abnormal	x^2	p-value	OR	95% CI
	N=136					
	n (%)					
[1]PM_{10}						
High (≥150.00 μg/m^3)	36 (35.0)	18 (54.5)	4.01	**0.045***	2.23	1.008-4.950
Low (<150.00 μg/m^3)	67 (65.0)	15 (45.5)				
[1]$PM_{2.5}$						
High (≥75.00 μg/m^3)	36 (35.0)	19 (57.6)	5.31	**0.021***	2.53	1.134-5.623
Low (<75.00 μg/m^3)	67 (65.0)	14 (42.4)				

[1]Pearson's chi square

***significant at p<0.05**

Based on Table 4.13, the value obtained for the Pearson's chi square analysis was 4.01 and the degree of freedom was 1. The P-value obtained from the test were 0.045, < 0.05. The minimum expected count for cough was 13.10. 54.5% of respondents had abnormal FEV_1/FVC when exposed to high concentration of PM_{10} while 45.5% of the respondents exposed to low concentration of PM_{10} had abnormal FEV_1/FVC. There was significant difference between the level of exposure of PM_{10} and the abnormality in FEV_1/FVC. The respondents were 2.23 times likely to develop cough, (OR=2.23, 95% CI 1.008-4.950).

The value obtained for the Pearson's chi square analysis was 5.31 and the degree of freedom was 1. The P-value obtained from the test were 0.021, < 0.05. The minimum expected count for cough was 13.35. 57.6% of respondents had abnormal

FEV_1/FVC when exposed to high concentration of $PM_{2.5}$ while 42.4% of the respondents exposed to low concentration of $PM_{2.5}$ had abnormal FEV_1/FVC. There was significant difference between the level of exposure of $PM_{2.5}$ and the abnormality in FEV_1/FVC. The respondents were 2.53 times likely to develop cough, (OR=2.53, 95% CI 1.134-5.623).

Table 4.14: FVC%, FEV_1% and FEV_1/FVC% among studied and comparative **group**

Variables	Studied group n= 50	Comparative group n= 86	t-value	p-value
	Mean ± SD			
[1]FVC (Litres)	1.59 ± 0.24	1.44 ± 0.24	3.66	**< 0.001***
[1]FEV_1 (Litres)	1.47 ± 0.21	1.33 ± 0.21	3.67	**<0.001***
[1]FVC %	77.62 ± 19.48	89.96 ± 20.10	-3.49	**0.001***
[1]FEV_1 %	71.06 ± 21.35	91.30 ± 20.77	-5.42	**< 0.001***
[1]FEV_1/FVC %	84.50 ± 14.82	95.71 ± 22.26	-3.17	**0.002***

[1]Independent Sample T-Test

***significant at p<0.05**

Based on Table 4.14, the P value of Levene's test for equality of variance was 0.931. Since the P value was more than 0.05, the equality of variance was assumed. The mean and standard deviation for FVC% in the studied group was 77.62 ± 19.48

meanwhile the mean and standard for FVC% in the comparative group was 89.96 ± 20.10. The value for t-value from the test was -3.49. The p-value obtained was 0.001 < 0.05. Therefore, there was significant different in mean of FVC% between studied group and comparative group.

The P value of Levene's test for equality of variance was 0.812. Since the P value was more than 0.05, the equality of variance was assumed. The mean and standard deviation for FEV_1% in the studied group was 71.06 ± 21.35 meanwhile the mean and standard for FEV_1% in the comparative group was 91.30 ± 20.77. The value for t-value from the test was -5.42. The p-value obtained was less than 0.001 which was lesser than 0.05. Therefore, there was significant different in mean of FEV_1% between studied group and comparative group.

The P value of Levene's test for equality of variance was 0.454. since the P value was more than 0.05, the equality of variance was assumed. The mean and standard deviation in the studied group for FEV_1/FVC% was 84.50 ± 14.82 meanwhile the mean and standard deviation in the comparative group for FEV_1/FVC% was 95.71 ± 22.26. The t-value from the test was -3.17. The p-value obtained was 0.02 <0.05. Therefore, there was significant different in the mean of FEV_1/FVC% between studied group and comparative group.

Table 4.15: Relationship between PM_{10} concentration and respondents' lung function

PM_{10} ($\mu g/m^3$)	Studied group n= 50		Comparative group n= 86	
	r	p	r	p
[1]FVC%	-0.332	**0.018***	0.150	0.297
[1]FEV_1%	-0.438	**0.001***	0.180	0.212
[1]FEV_1/FVC%	0.191	0.184	-0.048	0.743

[1]Pearson's Correlation Test

***significant at p<0.05**

Based on the result of Pearson's Correlation test in Table 4.15, it was found that for parametric test, that there were significant correlations between exposure level of PM_{10} with FVC% (r=-0.332, p=0.018) in studied group. There was significant correlation between exposure of PM_{10} with FEV_1% (r=-0.438, p=0.001). There was insignificant correlation between exposure of PM_{10} with FEV_1/FVC% (r=0.191, p=0.184) in studied group. In the comparative group, there was a insignificant correlation between PM_{10} with FVC% (r=-0.150, p=0.297). There was insignificant correlation between FEV_1% with PM_{10} (r=0.180, p=0.212) and an insignificant negative correlation between FEV_1/FVC% with PM_{10} (r=-0.048, p=0.743). From the studied group, as concentration of PM_{10} increase, the FVC% and FEV_1% will be decreased. From the comparative group, as the concentration of PM_{10} increased, the FVC% and FEV_1% will be decreased except for FEV_1/FVC%.

Table 4.16: Relationship between $PM_{2.5}$ concentration and respondents' lung function

$PM_{2.5}$ ($\mu g/m^3$)	Studied group n= 50		Comparative group n= 50	
	r	p	r	p
[1]FVC%	-0.012	0.932	-0.117	0.906
[1]FEV_1%	0.269	0.059	-0.042	0.773
[1]FEV_1/FVC%	-0.090	0.532	-0.015	0.916

[1]Pearson's Correlation Test

***significant at p<0.05**

Based on Table 4.16, the result from the Pearson's correlation showed there was insignificant negative correlation between concentration $PM_{2.5}$ with FVC% (r=-0.012, p=0.932) in the studied group. There was insignificant positive correlation between concentration $PM_{2.5}$ with FEV_1% (r=0.269, p=0.059). There was insignificant negative correlation between concentration $PM_{2.5}$ with FEV_1/FVC% (r=-0.090, p=0.532) in the studied group. In comparative group, there was insignificant negative correlation between concentration $PM_{2.5}$ with FVC% (r=-0.117, p=0.906), between concentration $PM_{2.5}$ with FEV_1% (r=-0.042, p=0.773), and between FEV_1/FVC% (r=-0.015, p=0.916). From the studied group, as the concentration $PM_{2.5}$ increased, the FVC% and FEV_1/FVC% will be increased except for FEV_1%. From the comparative group, as the concentration of $PM_{2.5}$ decreased, the FVC%, FEV_1% and FEV_1/FVC% will be increased.

Table 4.17: Comparison of Indoor Outdoor Ratio of PM_{10} and $PM_{2.5}$ in the School.

Group	Indoor PM_{10} ($\mu g/m^3$)	Outdoor PM_{10} ($\mu g/m^3$)	Indoor/Outdoor Ratio of PM_{10}	Indoor $PM_{2.5}$ ($\mu g/m^3$)	Outdoor $PM_{2.5}$ ($\mu g/m^3$)	Indoor/ Outdoor Ratio of $PM_{2.5}$
Studied group (n=2)	72.46	137.98	0.74	60.68	76.98	0.79
Comparative group (n=2)	42.30	62.11	0.64	44.56	76.71	0.59

Based on Table 4.17, the calculation of indoor outdoor ratio was based on the calculation of indoor concentration and outdoor concentration (Deng et al., 2017). Based on the table 4.16, the I/O ratio for PM_{10} in the studied school was higher (0.74) in compared with the comparative school (0.64). The I/O ratio for $PM_{2.5}$ in the studied school was also higher at 0.79 than the I/O ratio found in the comparative school at 0.59.

Table 4.18: Factors Influenced the Abnormality of FVC Among the Studied Children After Control All Confounder in The Study.

Independent Variables	B	S.E	p-value	PR	95% CI
Constant	0.164	1.307	0.900		
Concentration of PM_{10}	0.020	0.009	**0.028***	**1.020**	**1.002-1.038**
Father's educational level	-1.329	1.961	0.498	0.265	0.006-12.357
Mother's educational level	-1.234	1.879	0.511	0.291	0.007-11.569
Total salary	0.000	0.000	0.423	1.000	1.000-1.00

N=50
95% CI= 95% Confident Interval
B=Regression Coefficient
S.E= Standard Error
Nagelkerke R square = 0.313
***Significant at p<0.05**

Based on Table 4.18, logistic regression was conducted to determine the main factor that influenced the abnormality of FVC among studied children after controlling the confounder in this study. Table 4.18 shown that FVC had significant relationship with the concentration of PM_{10} (PR=1.020, 95% CI= 1.002-1.038).

Table 4.19: Factors Influenced the Abnormality of FEV_1 Among the Studied Children After Control All Confounder in The Study.

Independent Variables	B	S.E	p-value	PR	95% CI
Constant	-0.645	1.237	0.602		
Concentration of PM_{10}	0.018	0.008	**0.023**	**1.018**	**1.002-1.035**
Father's educational level	0.236	1.881	0.900	1.266	0.032-50.545
Mother's educational level	-2.397	2.217	0.281	0.092	0.001-7.054
Total salary	0.000	0.000	0.304	1.000	1.000

N=50
95% CI= 95% Confident Interval
B=Regression Coefficient
S.E= Standard Error
Nagelkerke R square = 0.243
***Significant at p<0.05**

Based on Table 4.19, logistic regression was conducted to determine the main factor that influenced the abnormality of FEV_1 among studied children after controlling the confounder in this study. Table 4.18 shown that FEV_1 had significant relationship with the concentration of PM_{10} (PR=1.018, 95% CI= 1.002-1.035).

CHAPTER 5

DISCUSSION

5.1 Discussion on Respondents' Background, Respiratory Symptoms, Measurement of PM_{10} and $PM_{2.5}$ and Lung Function.

5.1.1 Respondents' Background

This study was a comparative cross-sectional study that focussed on the association on exposure of $PM_{2.5}$ and PM_{10} with respiratory health symptoms and lung function test among children living near palm oil activity in Semenyih, Selangor. The study groups were chosen among primary school children that live near the area of palm oil activity and primary school children that live far away from palm oil activity. The comparative group was selected among primary school children that lived in Hulu Langat, Selangor (Refer Figure 3.1, Figure 3.2 and Figure 3.3). The sample size selected for this study was based on the sample size calculation by by Lemeshow, Klar and Lawanga (1990). From the sample size calculation, it was found that the number of samples requires to participate in the study was 70 respondents. However, the total respondents that agreed to volunteer in this study after the distribution of questionnaire was 136 respondents. All the respondents were required to obtain written parental permission attached to the questionnaire given (Refer Figure 3.4). They were also needed to fulfil the inclusive criteria before being selected as respondents in this study

(Refer Table 3.1). All the respondents selected was from Malay ethnic; this was because to avoid any confounders in heredity that could affect the result of $FEV_1/FVC\%$. Most of the ethnic found living in both groups were Malay.

The composition of respondents from both groups were 50 respondents for studied group and 86 respondents from the comparative group; in total of 136 respondents. The selection of the schools were made based on purposive sampling. The school selected from the studied group must in within 5.00 kilometre radius from any palm oil activity meanwhile the selected school from the comparative group must not have any palm oil activity within 5.00 kilometre radius. The selection on the respondents were based on random sampling from the list that had been given from the school administration. Based on the questionnaire screening, the respondents must be healthy and did not have any past medical history on pneumonia, asthma, emphysema, bronchitis and any other respiratory disorder. The respondents selected must studied in the selected school aged from 7 to 11 years old. For the studied group, the respondents must live near any palm oil activity (Semenyih, Selangor), while the respondents in the comparative group lived far away from any palm oil activity (Hulu Langat, Selangor).

5.1.2 Socio-demographic Information of Respondents

Based on the anthropometrical data comparison between respondents from the studied group and comparative group, it was found that they had similar characteristic based on mean comparison for each anthropometrical variable (age, height and weight). The mean age between studied group and comparative group were closely similar at 10.00 years (studied group) and 10.14 years (comparative group). The mean height between studied group and comparative group were also very close at 133.06 cm (studied group) and 128.44 cm (comparative group). The mean weight between studied group and comparative group were also very close at 30.38 kg (studied group) and 32.90 kg (comparative group).

Based on Table 4.3, the education level of respondents' father was similar between two groups. The highest education levels for respondents' father in the studied groups was SPM (32.0%) meanwhile the highest education levels for respondents' father in comparative group were SPM (36.0%) and STPM/Diploma (36.0%). The highest education levels for respondents' mother in the studied group was degree/master/PhD (38.0%) meanwhile the highest education levels for respondents' mother in the comparative group was SPM (40.7%).

Based on Table 4.4: Background of Respondents' House, majority of the respondents from the studied group live less than 100 meters from house and main road (54.0%). The least distance from the main road to the respondents' house in the studied group was more than 1000 meters (6.0%). From the comparative group, majority of the respondents' distance between home and main road was more than 1000 meters (77.9%). The least distance from the respondents' house from the main road in the comparative group was more than 500 to 1000 meters (3.5%). Therefore, majority of the respondents in studied group live less than 100 meters from the main roads. Majority of the respondents lived 1 km to 1.5 km between their houses with palm oil activity (40.0%) meanwhile all the respondents in the comparative group lived more than 3.0 km from palm oil activity (100.0%). It was found that both groups showed similar perception on the surrounding environment; studied group (66.0%) and comparative group (62.8%) felt that their environment was dusty. Despite of the similar perception, the perception on very dusty environment was found higher in studied group (14.0%) than in comparative group (2.3%). Therefore, it was found that the studied group had higher very dusty environment than in comparative group.

5.1.3 Comparison of Exposure of $PM_{2.5}$ and PM_{10} at Respondents' Schools between Studied Group and Comparative Group.

Based on Table 4.6, the comparison of the exposure of $PM_{2.5}$ and PM_{10} were made within 4 different schools. It was found that the exposure of $PM_{2.5}$ and PM_{10} was higher in the schools from the studied group than the schools from the comparative group. The mean of the concentration of PM_{10} in the studied schools were 105.21 ± 46.11 $\mu g/m^3$ meanwhile the mean concentration of PM_{10} in the comparative schools were 53.92 ± 12.37 $\mu g/m^3$. The mean concentration of $PM_{2.5}$ in studied schools were 68.83 ± 13.03 $\mu g/m^3$ meanwhile the mean concentration of $PM_{2.5}$ in comparative schools were 13.03 ± 17.45 $\mu g/m^3$. Table 4.6.1 showed the comparison between concentration of PM_{10} and $PM_{2.5}$ according to schools. School no 2 showed the highest concentration of PM_{10} (117.3 $\mu g/m^3$) and $PM_{2.5}$ (76.22 $\mu g/m^3$) because of the distance from the location of palm oil activity were within 5 km radius.

Both measurement fall under the concentration limit under the New Malaysian Ambient Air Quality Standard (2013) which was 150 μg/m^3 for PM_{10} and 75 μg/m^3 for $PM_{2.5}$. Hussain and Jalaludin (2016) stated that the concentration of the $PM_{2.5}$ and PM_{10} were high due from the palm oil activity that existed near the school area. Palm oil activity was located within 5 kilometres distance from the studied schools and houses. The palm oil factory was established as early as the development of the modern housing development in the area. The primary school children were mostly lived in the area since birth. Others than palm oil activity, there were others industrial activity such as small aluminium smelter and industrial building brick factory that actively operated within 10 kilometres radius from the studied schools. Mix pollution from industrial areas and human activity such as traffic within the area might contributed towards the concentration of pollutants (Gao et al., 2015). The ventilation system that being used in the schools were open ventilation. Ventilation system was very important as it supply fresh air into a room and ensure the indoor parameter (Vachaparambil, Cehlin, & Karimipanah, 2015).

5.1.4 Comparison of Exposure of $PM_{2.5}$ and PM_{10} at Respondents' Houses between Studied Group and Comparative Group.

From the table 4.7, it was found that the concentration of PM_{10} and $PM_{2.5}$ were high in the studied group in compared with the concentration of PM_{10} and $PM_{2.5}$ in the comparative group. The mean for PM_{10} in studied group was 104.29 μg/m^3 meanwhile the mean for PM_{10} in the comparative group was 32.14 μg/m^3. The concentration of PM_{10} was found very high in an urban area that had many industrial activities (Khan et al., 2019). Contributing factors such as palm oil activity had direct impact on the exposure of the respondents to PM_{10}. Previous study shown that in a dense industrial area, the mean of PM_{10} concentration was 79.00 $\mu g/m^3$ meanwhile the mean of PM_{10} concentration in less exposed area was 49.00 $\mu g/m^3$ (Ayuni, Juliana, & Ibrahim, 2014).

The mean concentration for $PM_{2.5}$ in the studied group was 74.29 $\mu g/m^3$ meanwhile the mean concentration for $PM_{2.5}$ in the comparative group was 22.86 $\mu g/m^3$. From table 4.6, we saw that the concentration of the $PM_{2.5}$ exposed in studied group was higher than in the comparative group. The measurements of PM_{10} and $PM_{2.5}$ were under the concentration limit by the New Malaysian Ambient Air Quality Standard (2013) that regulated outdoor air which was 150 $\mu g/m^3$ for PM_{10} and 75 $\mu g/m^3$ for $PM_{2.5}$. The result obtained was parallel with the concentration of $PM_{2.5}$ found in normal urban condition which was 72.60 $\mu g/m^3$ (Li, Qin, & Feng, 2017). Hussain and Jalaludin (2016) also reported that the respondents house exposure of $PM_{2.5}$ in the studied area was 41.26 $\mu g/m^3$ meanwhile the respondents house exposure of $PM_{2.5}$ in the comparative group was 23.54 $\mu g/m^3$.

The measurement of the exposure of $PM_{2.5}$ and PM_{10} at the respondents' house was taken by using personal air sampling pumps. The personal air sampling pump was operated for 24 hours inside the houses. Based on table 4.7, 30 respondents were selected from the studied group and 32 respondents were selected from the comparative group. In the studied group, it was found that 76.67% of the respondents had exposed to high concentration level of PM_{10} and 66.67% of the respondents had exposed to high concentration level of $PM_{2.5}$. 81.25% of the respondents in the comparative group had exposed to low concentration of PM_{10} and 93.75% of the respondents had been exposed to low $PM_{2.5}$. From the result obtained alone, it showed that the respondents in the studied group had exposed more towards high concentration level of PM_{10} and $PM_{2.5}$.

Emphasizing palm oil activity by increasing the land proclamation and the focus of harvesting and producing palm oil product were actively targeted year by year (Kushairi, 2017). Based on Ghanbari and Rezazadeh (2018), the chimney that exist in every palm oil factory may lead towards the transmission of the pollutant from the palm oil activity in the factory to the environment around them. This would be reflected by high concentration level of PM_{10} and $PM_{2.5}$ that were found near the studied group specifically in 5 kilometres radius (Amos, 2014).

5.1.5 Comparison of Respiratory Symptoms Experience by the Respondents

Exposure towards air pollution such example as $PM_{2.5}$ and PM_{10} caused an increase in prevalence of respiratory disease (Xing, Xu, Shi, & Lian, 2016). Particulate such as $PM_{2.5}$ and PM_{10} would exhibit various of respiratory disorder and respiratory symptom such as asthma, respiratory inflammation, cough, chest tightness, wheezing and affect the lung functions. The prevalence of respiratory mortality had increased by 0.58% for each the 10 $\mu g/m^3$ increase of PM_{10} (Xing et al., 2016). The study also stated that every increase of 10 $\mu g/m^3$ of $PM_{2.5}$ would increase hospitalization 8% and prevalence rate by 2.07%. From the study, the respondents in the studied group were found to be more prone towards respiratory symptoms. The development of respiratory symptoms was very high in the studied group when compared with comparative group. The respondents in the studied group were more likely to develop cough, phlegm, wheezing and chest tightness.

Rodopoulou et al., (2014) stated that there was a strong effect of PM_{10} with the risk of respiratory illness with estimation from 3.2% to 3.9% for the increase of 10 $\mu g/m^3$ of concentration. The higher cases of respiratory illness were found in higher average concentration of PM_{10} (108 $\mu g/m^3$) than in lower average concentration of PM_{10} (74 $\mu g/m^3$) (Luong, *et al* 2017). There was an evidence that correlate the respiratory illness with the short-term exposure of $PM_{2.5}$ (Kloog et al., 2014). The increase of 10 $\mu g/m^3$ of the concentration of $PM_{2.5}$ led towards the increase of 2.2% in respiratory symptoms and illness. There was significant value $p<0.05$ of the wheezing between high concentration of PM_{10} and low concentration of PM_{10}. The development of wheezing was 26 times more risk, chest tightness was 9 times, and of wheezing in studied area was 5 times to occur in the studied group than in the comparative. There was a significant value of $p<0.05$ of cough, wheezing and chest tightness between high concentration of $PM_{2.5}$ and low concentration of $PM_{2.5}$. The development of cough was 0.16 times more, wheezing as high as 2 times more risk to occur in studied group. Development of wheezing in area with high concentration of PM_{10} and $PM_{2.5}$ that came from palm oil mill was also significant. (Hussain and Jalaludin, 2016). Therefore, it was believed that exposure towards PM_{10} and $PM_{2.5}$ increased the possibilities of risk towards developing wheezing and chest tightness in studied group. Isiugo et al., (2019) stated the odds of developing wheezing and cough was high among children that was exposed to indoor $PM_{2.5}$ and PM_{10} as same as exposure towards outdoor $PM_{2.5}$ and PM_{10}. Therefore, the study proved exposure on high concentration of PM_{10} and $PM_{2.5}$

in the studied group showed stronger association with development of respiratory illness.

5.1.6 Lung Function between Studied Group and Comparative Group

In this study, all the respondents were compulsory to participate in lung function test. From this study, the respondents from the studied group showed that they had several abnormalities in their lung function results. It was found that most of the respondents that have abnormal FVC were from the studied group. Based on table 4.12, the total number of respondents that had abnormal FVC was 46 respondents and 52.0% of the studied group developed this abnormality which was less than 85% (American Thoracic Society, 2017). The total number of respondents that develop abnormal FEV_1 was 47 respondents and 62.0% of the respondents from the studied group developed this abnormality. It was found in the previous study that every increased in 1 $\mu g/m^3$ was associated with an decrease of 5.4% in the FEV (Ali, *et al.* 2018). The FVC of the studied group were found 3 times more risk to be abnormal than in comparative group (OR=3.58, 95% CI 1.964-7.546). The FEV_1 of the studied group were found 7 times more risk to be abnormal than in comparative group (OR=7.14, 95% CI 3.246-15.698). The FEV_1/FVC of the studied group were found 6 times more risk to be abnormal than in comparative group (OR=6.30, 95% CI 2.713-14.602).

From the Pearson's chi-square, it was found that the respondents that developed abnormal ratio of FEV_1/FVC in the studied group had develop abnormal

FVC. As the FEV reading was abnormal (low), the respondents would develop obstructive lung function. It was also found that some of the respondents had develop abnormal FVC. As the FVC reading was abnormal (low) the respondents would develop restrictive lung function. One of the possible causes for the establishment of restrictive was the prolong exposure towards PM_{10} and $PM_{2.5}$ from the palm oil activity near them.

18.6% of respondents had abnormal FEV_1 in comparative group while 62.0% for the respondents in studied group. There were significant differences between the two groups of respondents and the abnormality in FEV_1. The respondents were 7.14 times likely to develop cough. Among all of lung function parameters, the children were most risk towards FEV_1 abnormality. The reasons for the increased in abnormality results in studied group were because on prolong exposure to high concentration of PM_{10} and $PM_{2.5}$. The children spend mostly of their life in the studied area and being exposed to PM_{10} and $PM_{2.5}$ produced by the palm oil factory. This claim was supported by Navaneethan et al. (2016) where prolong exposure to PM_{10} and $PM_{2.5}$ were significantly associated in the higher odds of developing respiratory illness such as restrictive lung function. At worst, longer exposure and decreased in FEV_1 could cause the children to develop more chronic disease such as chronic obstructive pulmonary disease (Kesten, Celli, Decramer, Liu, & Tashkin, 2011). 12.8% of respondents had abnormal FEV_1/FVC in comparative group while 48.0% of the respondents in studied group. There were significant differences between the two groups of respondents and the abnormality in FEV_1/FVC. The respondents were 6 times likely to develop cough (OR=6.30, 95% CI 2.713-14.602). The high number of abnormalities in the studied group came from the exposure to PM_{10} and $PM_{2.5}$ from palm oil activity. Guarnieri & Balmes, (2014) support the claimed as there was association between the exposure of $PM_{2.5}$, lung function and the prevalence of reported asthma among children.

5.1.7 Relationship between Lung Function of Respondents with $PM_{2.5}$ and PM_{10}

From table 4.14, the mean and standard deviation for the percentage of FVC, FEV_1 and ratio of FEV_1 and FVC were lower in the studied group in compared with the comparative group. All the parameters including FVC%, FEV_1% and FEV_1/FVC% had shown significant difference at $p<0.05$. Based on the previous study, finding in the analysis showed that all lung function parameter including FVC, FEV_1, FVC% and FEV_1% were significantly higher in the comparative group in compared with the studied group at $p<0.05$ (Chua, *et al.* 2015). From table 4.15, there were significant correlations between exposure level of PM_{10} with FVC% (r=-0.332, p=0.018) in studied group. There was significant correlation between exposure of PM_{10} with FEV_1% (r=-0.438, p=0.001). From the comparative group, as the concentration of PM_{10} increased, the FVC% and FEV_1% will be decreased except for FEV_1/FVC%. From the studied group, as the concentration $PM_{2.5}$ increased, the FVC% and FEV_1/FVC% will be increased except for FEV_1%. From the comparative group, as the concentration of $PM_{2.5}$ decreased, the FVC%, FEV_1% and FEV_1/FVC% will be increased.

The forced expiratory volume in one second (FEV_1) and forced vital capacity are the most commonly used spirometry measurement to identify the development of air way obstruction and air way restriction. (Riley et al., 2015). Among all the lung function parameters, the risk of obtaining abnormal FEV_1 was alarming at 7 times more risk. Exposure of prolong particulate matter were significantly associated with the higher odds in expecting restrictive lung function (Navaneethan et al., 2016). Previous study also showed similar results as the increased concentration of $PM_{2.5}$ and PM_{10}, the FEV_1 value decreased among children that have respiratory disease (Isiugo et al., 2019). The reduced of FEV_1 value indicates that the children might develop more chronic respiratory illness such as bronchiectasis, pulmonary cavitation and excessive inflammation. Isiugo et al., (2019) believed that there was strong association between the concentration of $PM_{2.5}$ with asthma among asthmatic children. Therefore the correlation between the exposure of $PM_{2.5}$, lung function and the prevalence of reported asthma among children were strong (Guarnieri & Balmes, 2014).

5.1.8 Factors influenced the abnormality of FVC and FEV_1 among the exposed children after controlling all the confounders in the study

The statistical test reported significant regression between the abnormality of FVC and the concentration of PM_{10} exposed to the children after the logistic regression was conducted. Concentration of PM_{10} was the only predictor which showed significant regression association with the abnormality of FVC. The higher concentration of PM_{10} increased the abnormality of FVC by 0.02 and the prevalence rate was 1.02 times of getting FVC abnormality when exposed to PM_{10} and $PM_{2.5}$. The statistical test reported significant regression between the abnormality of FEV_1 and the concentration of PM_{10} exposed to the children after the logistic regression was conducted. Concentration of PM_{10} was the only predictor which was significant regression association with the abnormality of FEV_1. The higher concentration of PM_{10} will increase the abnormality of FEV_1 by 0.018 and the prevalence rate is 1.018 times of getting FVC abnormality when exposed to PM_{10} and $PM_{2.5}$ (PR=1.018, 95% CI= 1.002-1.035).

Study showed the factors influenced the abnormality of FVC among children in studied area after controlling all the confounders. There was a significant regression association at $p<0.05$ between the concentrations of PM_{10} and abnormality of FVC. The study showed that the concentration of PM_{10} from the palm oil activity was the main confounder in the development of abnormal FVC among the exposed children after controlling all the confounders. The claimed was supported by Zwozdziak et al. (2016) that there was a significant reduction in FVC among studied school children aged from 13 to 14 years old with exposure to PM. The study denied the socioeconomic factors as major factors affecting the abnormality of FVC at $p>0.05$. Although study by Polak et al. (2019) stated that socioeconomic status was one of the predictors of pulmonary health, it varies according to the income status of the household. To control this confounder, the researcher selected respondents either both parents or one of them contributed an income to the family. This was to ensure that the cause of the decreased in lung function was from the exposure of PM_{10} and not from immune-deficiency due to poverty.

This study showed the factors that influenced the abnormality of FEV_1 among children in studied area after controlling all confounders. There was a significant association between the concentrations of PM_{10} and abnormality of FEV_1 (P value = 0.023). The study showed that the concentration of PM_{10} was the main confounder in the development of abnormal FEV_1 among the exposed children. Previous study had showed that exposure to high concentration of PM significantly decreased the FEV_1 after 5 to 7 days of exposure (Weiden et al., 2015). Previous study also agreed that increased in concentrations of $PM_{2.5}$ and PM_{10} caused the FEV_1 value to decrease among children who have respiratory disease (Isiugo et al., 2019). This study denied educational level as one of the factors influencing the abnormality of FEV_1 at $p>0.05$ for both mother and father's educational levels. A study by Tabak and Smit (2009) stated that low educational level was associated with a lower FEV_1.

5.1.9 Comparison of Indoor Outdoor Ratio of PM_{10} and $PM_{2.5}$ in Schools

Based on Table 4.17, the indoor/outdoor ratio for PM_{10} in studied group was 0.74 in compared with 0.64 in comparative group. The indoor/outdoor ratio for $PM_{2.5}$ in studied group was 0.79 meanwhile the indoor/outdoor ratio for $PM_{2.5}$ in the comparative group was 0.59. Both ratio was below 0.8 which proved that the indoor concentration was less than outdoor concentration. Based on previous study by Deng et al., (2017), the indoor/outdoor ratio was used to determine the indoor/outdoor relationship between pollutants such as PM_{10} and $PM_{2.5}$. The indoor/outdoor ratio for PM_{10} indicated that the indoor concentration of the school was lesser than outdoor concentration. The result was similar with the indoor/outdoor ration for $PM_{2.5}$ as well. The possible cause for the concentration was the ventilation in the school classroom used open windows and open doors. Any pollutants such as PM_{10} and $PM_{2.5}$ might cross transferred from the outdoor into the indoor by wind through the openings. Since there was no proper ventilation system in school classroom, the indoor/outdoor ratio shows equilibrium concentration between indoor and outdoor concentration of PM_{10} and $PM_{2.5}$.

5.2 Conclusion

In conclusion, this study confirmed that the respondents in the studied group had exposed to a higher concentration level of $PM_{2.5}$ and PM_{10}. The high reported cases of respiratory health symptoms were also caused by the exposure of the respondents towards high level of $PM_{2.5}$ and PM_{10}. This study proved that exposure towards the $PM_{2.5}$ and PM_{10} were the contributing factors among the prevalence of respiratory health symptoms and the poor performance of lung function result among school children that lived near palm oil factory.

The hypothesis of this study was in line with the findings that were related to this study. This study proved that school children had more risks in developing respiratory illness such as cough (two times more likely) and phlegm (two times more likely) when they were exposed by the palm oil activity. The exposure of PM_{10} in the studied school was high (105.21 $\mu g/m^3$) meanwhile the exposure of PM_{10} in comparative schools was low (53.92 $\mu g/m^3$). The exposure of $PM_{2.5}$ in the studied school was found higher (68.83 $\mu g/m^3$) than the exposure of $PM_{2.5}$ in the comparative schools (13.03 $\mu g/m^3$). Based on 24 hours of air sampling, in schools and respondents' houses exposure towards concentration of PM_{10} and $PM_{2.5}$ were lower than the Malaysian Ambient Air Quality Standard (2013). The finding of the study suggested that there were association between exposure on PM_{10} and $PM_{2.5}$ in both schools and respondents' houses.

The study suggested that there was a significant negative correlation between PM_{10} with FVC% and FEV_1%. Increase in PM_{10} concentration caused the FVC and FEV_1 indicator reduced. The children in the studied group showed poorer lung function performance in compared with the children that lived in comparative area. More children in comparative area showed normal performance of FVC than the children that live in studied area. The children in the studied group had more abnormal FEV_1, and the respondents may had developed obstructive lung function in the future. The lung function components of the children lived in the studied area were all lower than the children that live in the comparative area. Thus, it showed that prolong exposure towards high concentration level of PM_{10} and $PM_{2.5}$ would cause respiratory illness towards the children that live in polluted area. Ignorance on the exposure may lead to serious respiratory disease such as lung impairment and cancer.

5.3 Recommendation

In determining the recommendations needed to overcome the problems, the main issue must be addressed first. The problems were found in the studied area was that high concentration level of particulate matters. This study provides foundation and preliminary pillar that gave overview within the exposure of the children towards the pollutants. Further study must be conducted in prospective cohort study, so that the main source of pollutant can be fully identified and medical recommendation can also be being made to the children that were exposed to high level of pollutants. Moreover, government agencies such as Federal's Department of Environment and State's Department of Environment must conduct a whole health impact assessment towards the residents that lived near any potential causes of air pollutant. Other than monitoring the palm oil effluent from palm oil activity, the Department of Environment must be proposed a control in the mitigation of air pollutant from palm oil activity area towards the residential area. Moreover, Department of Occupational Health must had emphasized on surrounding human health in enforcing the current law and regulation. Even though the operation of an industrial area complied with the law, the Department should look upon the possibilities of mix pollutant and its health effect towards human health. By emphasizing human health on each enforcement, the problems regarding respiratory especially towards children would never happens.

Other than that, the sources of air pollutant were believed originated from palm oil activity as it was the oldest running operation in the studied area. The management of the palm oil activity must be concerned on residence complaints and the reported case of respiratory illness that came from their activity. They must hold responsibilities and believed that even though they had complied with the current law, they need to look upon on the health of surrounding person that might affected by the by-product from palm oil activity. They also need to be improved and maintained their air filtration system in their chimney and the dust condition in their working premises. Improvement such as regularly wet the road that being used by lorry can reduce the suspended particle in the air dust reducing the concentration of dust in the area.

In addition, the land developer had conducted health impact assessment to any housing development before conducting the project. By the current law, Environment Impact Assessment did not emphasize the effect of the housing development near high industrial area towards human health. As a responsible land developer, they need to ensure that the project that they delivered to their customer exposed the least risk as possible towards the human health.

Lastly, the residents of the nearby should limit their activity outdoor. This was because the exposure of air pollutant was less than the exposure of air pollutant in the polluted area. Other than constraining their outdoor activities, they had to install proper ventilation system such as air purifier or air filter to filter out excessive air pollutant that might migrate indoor by physical mechanism such as debris on our shoes and clothes. The residents should also seek for immediate medical need when they have developed any sign and symptoms of respiratory illness such as cough, wheezing, chest tightness or chest pain. In addition, regular medical check-up was also crucial to ensure the well-being of our health.

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APPENDIX 1

ETHIC CONSENT LETTER

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

Research title	:	**Association on Exposure of PM_{10} And $PM_{2.5}$ With Respiratory Health Symptoms and Lung Function Test Among Children Living Near Palm Oil Mill in Semenyih Selangor**
Study Site	:	**Semenyih, Selangor**
JKEUPM Ref No.	:	**JKEUPM-2018-364**
Researcher	:	**Faris Syahmi bin Mohd Shahidin**
Supervisor	:	**Assoc Prof. Dr. Juliana Jalaludin**

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 2 dated 18/12/2018
3. Proposal (English), Version 2 dated 18/12/2018
4. Questionnaires/ Interviews (Malay), Version 2 dated 18/12/2018
5. Curriculum Vitae of:
    a. Assoc Prof. Dr. Juliana Jalaludin

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

Decision by JKEUPM:

[X] Approved

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

[ ] Disapproved

Please note that the approval is **VALID UNTIL 4 JANUARY 2020**

Researchers should comply with the following:

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

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

III. Applicable for Clinical Trial Studies and Clinical interventional Studies only: Progress Report has to be submitted to JKEUPM at every 6 months from the date of approval (Form 3.1). Report

APPENDIX 2

APPROVAL LETTER

APPENDIX 3

PARTICIPANT CONSENT LETTER

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

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

Hubungkait Antara Pendedahan Terhadap PM_{10} Dan $PM_{2.5}$ Dengan Fungsi Paru-Paru Kanak-Kanak Yang Tinggal Berdekatan Kilang Kelapa Sawit, Semenyih.

2. PENGENALAN

Proses mengekstrak minyak kelapa sawit menghasilkan bahan buangan yang sangat tinggi dan boleh mencemarkan alam sekitar. Antara bahan buangan daripada kelapa sawit ialah serat EFB dan tempurung kelapa sawit. Bahan-bahan buangan tersebut boleh diguna pakai sebagai sumber tenaga biomas kepada kilang kelapa sawit untuk menjana dandang bertekanan rendah (*low-pressure boilers*). Kajian terdahulu menunjukkan bahawa penggunaan tenaga biomas ini menghasilkan bahan pencemar seperti PM_{10} Dan $PM_{2.5}$ yang mampu masuk ke dalam sistem pernafasan kanak-kanak. Pendedahan kepada PM_{10} Dan $PM_{2.5}$ mampu memberi simptom masalah pernafasan seperti asma, berdeham dan batuk kering pada waktu malam.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Anda perlu membaca dan memahami butiran di dalam Borang Penerangan ini. Jikalau anda bersetuju secara sukarela untuk menjadi responden dalam kajian ini, anda perlu mengisi dan menandatangani persetujuan di halaman muka surat 3. Borang penerangan dan persetujuan ibu bapa / penjaga perlu dikembalikan selepas selesai diisi. Anda diminta untuk mengisi borang soal selidik mengenai maklumat kanak-kanak dan keluarga, maklumat persekitaran di dalam rumah, maklumat kesihatan kanak-kanak, maklumat penyakit berkaitan dan sejarah kesihatan keluarga. Fungsi paru-paru kanak-kanak, ukuran ketinggian dan ukuran berat kanak-kanak akan diambil pada waktu persekolahan di sekolah masing-masing. Ukuran pendedahan kepada Pm_{10} Dan $Pm_{2.5}$ akan diambil di rumah kanak-kanak tersebut selama 24 jam menggunakan alat pemantauan khas. Pengukuran fungsi paru-paru akan diambil dengan pemantauan Pegawai Perubatan / Pembantu Pegawai Perubatan.

Fungsi paru-paru akan diambil menggunakan alat Chestgraph HI-01 Spirometer. Setiap kanak-kanak akan mendapat satu pelekap mulut dan satu klip hidung untuk mengelakkan kontaminasi. Sebelum bacaan dilakukan, penyelidik akan menunjukkan demonstrasi ujian fungsi paru-paru. Pertama sekali, kanak-kanak akan diminta untuk mengambil satu nafas yang dalam. Kanak-kanak akan meletakkan pelekap mulut di dalam mulut mereka. Mereka akan diminta untuk menghembuskan nafas sepenuhnya dengan posisi badan tegak. Ujian fungsi paru-paru ini akan dilakukan sebanyak tiga kali. Setiap ujian fungsi paru-paru akan mengambil masa selama 10 minit sahaja.

Penglibatan anak / jagaan anda didalam kajian ini adalah secara sukarela. Anda berhak untuk menarik diri daripada kajian ini dan tidak akan ada sebarang denda dikenakan diatas penarikan diri.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Kanak-kanak yang:

1. Berumur kurang daripada 7 tahun
2. Berumur melebihi 11 tahun
3. Bukan warganegara Malaysia
4. Mempunyai sejarah lampau penyakit pernafasan

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANAK/JAGAAN SAYA SEBAGAI PESERTA?

Melalui kajian ini, anda akan dapat mengetahui tahap fungsi paru-paru, paras Pm_{10} Dan $Pm_{2.5}$ dalam kawasan sekolah dan persekitaran anak/jagaan anda.

b) KEPADA PENYELIDIK?

Maklumat daripada kajian ini akan memberi maklumat dan informasi mengenai tahap pendedahan kanak-kanak terhadap Pm_{10} Dan $Pm_{2.5}$ Dengan Fungsi Paru-Paru Kanak-Kanak Yang Tinggal Berdekatan Kilang Kelapa Sawit. Dapatan kajian ini juga memberi maklumat asas kepada penyelidikan di masa hadapan dan juga sebagai panduan kepada program kesihatan yang boleh dilakukan untuk menangani pencemaran Pm_{10} Dan $Pm_{2.5}$.

6. ADAKAH IA BERISIKO?

Kajian ini mempunyai risiko yang sangat rendah kerana ia hanya melibatkan pengukuran fungsi paru-paru, ukuran ketinggian dan juga ukuran berat badan.

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

Segala maklumat mengenai respondan adalah rahsia dan hanya akan digunaan untuk tujuan akademik sahaja. Penyelidik tidak akan mendedahkan nama dan sebarang maklumat responden kepada pihak-pihak lain.

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

Jika ada sebarang pertanyaan, anda boleh menghubungi:

Penyelidik:
Faris Syahmi bin Mohd Shahidin
013-8995449
farissyahmims@gmail.com

Penyelia:
Prof. Madya Dr. Juliana Jalaludin
03-89472401
juliana@upm.edu.my

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.

Saya 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 4

QUESTIONNAIRE

Tarikh: ______ ID No: ______

Borang Kaji Selidik

NO.	TAJUK KAJIAM	NAMA PENYELIDIK
1	HUBUNGKAIT ANTARA PENDEDAHAN TERHADAP PM_{10} DAN $PM_{2.5}$ DENGAN FUNGSI PARU-PARU KANAK-KANAK YANG TINGGAL BERDEKATAN KILANG KELAPA SAWIT, SEMENYIH.	FARIS SYAHMI BIN MOHD SHAHIDIN

Arahan

Borang kaji selidik ini mempunyai 6 bahagian:

1. Bahagian A: Maklumat Peribadi Kanak-Kanak Dan Keluarga
2. Bahagian B: Maklumat Persekitaran Dalam Rumah
3. Bahagian C: Maklumat Persekitaran Luar
4. Bahadian D: Maklumat Taraf Kesihatan Kanak-Kanak
5. Bahagian E: Penyakit-Penyakit Lain
6. Bahagian F: Kesihatan Keluarga
7. Bahagian G: Kebenaran Mengambil Sampel Di Rumah Kanak-Kanak

Adalah dimaklumkan bahawa anda adalah dipilih sebagai seorang responden di dalam kajian ini. Segala maklumat yang diberi didalam borang soal selidik ini adalah rahsia dan hanya digunakan bagi tujuan pembelejaran sahaja. Sila jawab semua soalan yang tertera di dalam borang kaji selidik ini. Sebarang kerjasama pihak tuan/puan saya dahului dengan ucapan terima kasih.

BAHAGIAN A: MAKLUMAT PERIBADI KANAK-KANAK DAN KELUARGA

1. No. Responden: ☐☐☐

2. Nama kanak- kanak : ____________________

3. Alamat :

____

____

4. Tinggi Kanak- kanak : ☐☐☐ cm Berat kanak- kanak : ☐☐ ☐ kg

5. Umur : ☐☐ tahun

6. Tarikh Lahir : ☐☐ hari ☐☐ bulan ☐☐ tahun

7. Jantina : ☐ lelaki perempuan

8. Bangsa : ☐ Melayu ☐ Cina ☐ India ☐ Lain- Lain

9. Tempat di mana kanak-kanak dilahirkan, sila nyatakan negeri dan bandar:

____

10. Sudah berapa kanak-kanak tinggal di alamat sekarang? __________ tahun __________ bulan

11. Sila senaraikan tempat- tempat di mana kanak-kanak ini pernah tinggal selama 6 bulan atau lebih sejak lahir hingga sekarang.

a) ____________________

b) ____________________

12. Berapakah umur kanak-kanak yang paling muda yang tinggal di dalam rumah ini?

☐ < 6- 17 bulan ☐ 18 -29 bulan 3 ☐ 0 bulan dan < 5 tahun

☐ 5-9 tahun ☐ ≥10 tahun

BAHAGIAN B; MAKLUMAT PERSEKITARAN DALAM RUMAH

1. Berapa orangkah yang tinggal di dalam rumah ini?

   ________ orang

2. Berapa buah bilikkah yang terdapat di dalam rumah ini?

   ________ bilik

3. Apakah bahan api yang digunakan untuk memasak?

   ☐ Elektrik ☐ Minyak tanah ☐ Arang

   ☐ Gas ☐ Kayu Api

4. Berapa kali dalam sehari anda gunakan untuk memasak ?

   ____________ kali sehari

5. Semasa anda memasak, adakah anda membuka tingkap atau pintu untuk membenarkan pengaliran udara di dalam rumah?

   ☐ Ya ☐ Tidak

6. Alat apakah yang digunakan untuk menyejukkan udara di dalam rumah?

   ☐ Penyaman udara ☐ Kipas

   ☐ Lain-lain ________________(nyatakan)

7. Adakah anda mempunyai binatang peliharaan di dalam rumah?

   ☐ Ya ☐ Tidak

8. Jika ' Ya', Sila nyatakan : ____________________

9. Adakah anda menggunakan bahan tertentu untuk mengelakkan serangan nyamuk?

   ☐ Ya ☐ Tidak

10a. Jika ya, jenis apakah yang selalu digunakan?

   ☐ Lingkaran biasa ☐ Semburan aerosol

   ☐ Elektrik ☐ Lain-lain ________________(nyatakan)

10b. Berapaka kalikah anda menggunakannya dalam seminggu?

________________ kali seminggu

10c. Dimanakah ianya ditempatkan di dalam rumah?

☐ Di ruang tamu sahaja ☐ Di bilik tidur ☐ Bilik tidur dan ruang tamu

10. Adakah terdapat sesiapa/ahli keluarga yang merokok di persekitaran dalam rumah? (bermaksud sekurang kurangnya 1 batang rokok sehari atau 1 aun tembakau dalam masa satu bulan) jika TIDAK, teruskan ke no. 14

☐ Ya ☐ Tidak

11. Senaraikan individu yang merokok di dalam rumah

☐ Bapa ☐ Bapa saudara

☐ Abang ☐ Datuk ☐ Lain-lain

12. Berapa batang rokokkah yang dihisap oleh individu di atas (di persekitaran dalam rumah anda sahaja)?

________________ batang sehari

13. Apakah alat yang digunakan untuk membersihkan rumah anda?

Sila nyatakan: ____________________

14. Berapa kerapkah dalam seminggu anda membersihkan rumah anda?

________________ kali seminggu

15. Adakah anda menggunakan karpet di kediaman anda

☐ Ya ☐ Tidak

BAHAGIAN C: MAKLUMAT PERSEKITARAN LUAR

1. Bahan binaan rumah kanak-kanak

☐ Batu/simen ☐ kayu/papan ☐ Lain-lain ________________(sila nyatakan)

2. Jenis kawasan perumahan:

- ☐ Kampung
- ☐ Flat
- ☐ Rumah Teres Setingkat
- ☐ Banglo
- ☐ Rumah Teres dua tingkat

3. Lokasi rumah dari jalan raya:

- ☐ < 100 meter dari jalanraya
- ☐ > 100- 500 meter dari jalanraya
- ☐ > 500 - 1000 meter dari jalanraya
- ☐ > 1000 meter dari jalanraya

4. Lokasi rumah anda dari kilang

- ☐ < 500 meter dari kilang
- ☐ > 1 – 1.5 kilometer dari kilang
- ☐ > 1.5- 3 kilometer dari kilang
- ☐ > 3 kilometer dari kilang

5. Lokasi rumah anda dari kilang minyak kelapa sawit

- ☐ < 500 meter dari kilang minyak kelapa sawit
- ☐ > 1 – 1.5 kilometer dari kilang minyak kelapa sawit
- ☐ > 1.5- 3 kilometer dari kilang minyak kelapa sawit
- ☐ > 3 kilometer dari kilang minyak kelapa sawit

6. Apakah pendapat anda mengenai persekitaran rumah anda?

- ☐ Sangat berhabuk
- ☐ Sederhana berhabuk

☐ Kurang berhabuk

7. Apakah kenderaan yang digunakan oleh anak anda untuk ke sekolah?

☐ Kereta ☐ Basikal ☐ Berjalan Kaki

☐ Bas ☐ Motosikal

Soalan –soalan berikut merupakan soalan – soalan mengenai taraf kesihatan di bahagian dada anak anda, sila beri jawapan samada **ya atau tidak** jika anda tahu jawapannya. Jika didapati soalan tersebut tidak merujuk kepada anak tuan, sila tandakan pada bahagian **tidak berkenaan.** Jika sekiranya anda ragu-ragu samada jawapannya **ya atau tidak**. Sila tindakan **tidak**

BAHAGIAN D: MAKLUMAT TARAF KESIHATAN KANAK-KANAK

BATUK

1. Adakah anak anda selalu mengalami batuk berserta selesema?

☐ Ya ☐ Tidak

2. Adakah anak anda mengalami batuk sahaja?

☐ Ya ☐ Tidak

2a. Jika ya, adakah dia batuk pada keseluruhan hari (4 hari atau lebih dalam masa seminggu atau selama 3 bulan berturut-turut dalam masa setahun)

☐ Ya ☐ Tidak

2b. Sudah berapa tahunkah anak anda mengalami batuk seperti ini?

_______________tahun

KAHAK

1. Adakah anak anda selalu mengalami kesesakan nafas serta mengeluarkan kahak dan juga mengalami selsema?

☐ Ya ☐ Tidak

DADA BERBUNYI /WHEEZING

1. Adakah anak anda mengalami masalah pernafasan berbunyi di dada?

☐ Ya ☐ Tidak

1a. Apabila dia mengalami selsema?

☐ Ya ☐ Tidak

1b. Kadang kala walaupun tidak mengalami selsema

☐ Ya ☐ Tidak

1c. Hampir setiap hari (waktu siang dan juga malam)

☐ Ya ☐ Tidak

Jika jawapan anda ya untuk soalan 1b dan 1c di atas sila jawabkan soalan berikut:

1d. Sudah berapa lamakah anak anda mengalami masalah ini(dada berbunyi)

...........................tahun ☐ Tidak berkenaan

2. Adakah anak anda pernah mengalami masalah dada berbunyi yang menyebabkan dia mengalami sesak nafas?

☐ Ya ☐ Tidak

Jika ya bagi soalan 2 di atas sila jawab soalan berikut:

2a. Adakah dia memerlukan rawatan dan ubatan untuk masalah ini?

☐ Ya ☐ Tidak

2c. Adakah dia boleh bernafas secara normal semasa ia mengalami serangan ini?

☐ Ya ☐ Tidak

3. Adakah anak anda mengalami masalah ini setelah ia melakukan aktiviti seperti senaman atau latihan?

☐ Ya ☐ Tidak

KESAKITAN DADA

1. Sejak 3 tahun lepas, adakah anak anda pernah mengalami kesesakan di bahagian dada yang menghalang anak anda daripada melakukan aktiviti biasa selama 3 hari?

☐ Ya ☐ Tidak

Jika ya bagi soalan 1 sila jawab soalan berikut

1a. Berapa kali anak anda mengalami penyakit seperti berikut dalam 3 tahun lepas?

☐ Kurang daripada sekali dalam setahun

☐ Sekali dalam setahun

☐ 2-5 kali dalam masa setahun

☐ >5 kali dalam setahun

☐ Tidak berkenaan

1b. Berapa kalikah penyakit seperti ini berlaku sekurang-kurangnya selama 7 hari?

....kali ☐ Tidak berkenaan

2. Adakah anak anda pernah dimasukkan ke hospital kerana mengalami masalah jangkitan di dada yang serius sebelum berumur 2 tahun?

☐ Ya ☐ Tidak

BAHAGIAN E: PENYAKIT-PENYAKIT LAIN

1. Adakah anak anda mengalami penyakit-penyakit seperti berikut? jika ya, pada umur berapakah ia didiagnoskan mengalami penyakit berikut?

a) Bronkitis ☐ Ya ☐ Tidak Umur didiagnoskan......................................

b) Emfisema ☐ Ya ☐ Tidak Umur didiagnoskan......................................

c) Asma(lelah) ☐ Ya ☐ Tidak Umur didiagnoskan......................................

d) Pneumonia (jangkitan paru-paru) ☐ Ya ☐ Tidak Umur didiagnoskan......................................

Lain-lain nyatakan.. Umur didiagnoskan......................................

2. Adakah doktor pernah mengatakan bahawa anak anak menghidap asma?

☐ Ya ☐ Tidak

Jika jawapan anda ya bagi soalan 3 sila jawab soalan-soalan berikut

3a. Pada umur berapakah anak anda mengalami asma?

..................................tahun

3b. Adakah sekarang anak anda masih mengalami asma?

☐ Ya ☐ Tidak

3d. Pada umur berapakah anak anda disahkan tidak mengidap asma lagi?

..................................bulan/tahun

3. Adakah anak anda pernah mengalami pembedahan di bahagian dada?

☐ Ya ☐ Tidak

4. Adakah anak anda pernah di diagnoskan sebagai mengidap penyakit jantung?

☐ Ya ☐ Tidak

5. Semasa anak anda lahir adakah dia pernah tinggal dihospital untuk beberapa hari? jika ya, nyatakan mengapa..

☐ Tidak

ALLERGI/ALAHAN

1. Adakah doktor pernah menyatakan bahawa anak anda mengalami alahan kepada makanan atau ubatan tertentu?

☐ Ya hanya kepada makanan tertentu sahaja, nyatakan.........................

☐ Ya hanya kepada ubatan tertentu sahaja, nyatakan.........................

☐ Ya kepada ubatan dan makanan tertentu, nyatakan.........................

☐ Tidak

2. Adakah doctor pernah menyatakn bahawa anak anda mengalami alahan kepada debu?

☐ Ya ☐ Tidak

3. Adakah doktor pernah menyatakan bahawa anak anda mengalami alahan kepada detergen atau bahan kimia tertentu?

☐ Ya ☐ Tidak

BAHAGIAN F

SEJARAH KESIHATAN KELUARGA

Adakah kedua ibu bapa kanak-kanak mengalami masalah-masalah berikut

IBU

a. Bronkitis kronik	☐ Ya	☐ Tidak	☐ Tidak tahu
b. Emfisema	☐ Ya	☐ Tidak	☐ Tidak tahu
c. Asma	☐ Ya	☐ Tidak	☐ Tidak tahu
d. Barah paru-paru	☐ Ya	☐ Tidak	☐ Tidak tahu
e. Lain-lain masalah paru-paru	☐ Ya	☐ Tidak	☐ Tidak tahu

BAPA

a. Bronkitis kronik	☐ Ya	☐ Tidak	☐ Tidak tahu
b. Emfisema	☐ Ya	☐ Tidak	☐ Tidak tahu
c. Asma	☐ Ya	☐ Tidak	☐ Tidak tahu
d. Barah paru-paru	☐ Ya	☐ Tidak	☐ Tidak tahu
e. Lain-lain masalh paru-paru	☐ Ya	☐ Tidak	☐ Tidak tahu

BAHAGIAN G

KEBENARAN MENGAMBIL SAMPEL DI RUMAH KANAK KANAK

Sampel dua jenis habuk (inhalable dust PM_{10} dan fine particle $PM_{2.5}$) akan diambil di rumah kanak-kanak untuk mengukur pendedahan kanak-kanak di rumah. Pengambilan sampel ini akan dibuat dengan menggunakan Escort LC Personal Sampling Pump dan kertas turas dengan liang bersaiz 5µm. Pam tersebut akan ditinggalkan selama 24 jam di rumah kanak-kanak dan akan diletak kan pada paras bernafas bagi kanak-kanak tersebut. Pengambilan sampel di rumah kanak-kanak tidak akan mengganggu aktiviti seharian di dalam rumah kanak-kanak.

Persetujuan Ibu Bapa / Penjaga

Saya…………………………………………… No Kad Pengenalan. …………………………… beralamat……………………………………………………………………………………………………… ………………………..dengan ini secara sukarela membenarkan / tidak membenarkan penyelidik untuk mengambil sampel di rumah saya

Tandatangan ……..………………………..
(Ibubapa/ Penjaga)

No. Telefon: ....

Tarikh :………………………………………

APPENDIX 5

PHOTOGRAPH

Photo 1: Anthropometric Measurement

Photo 2: Lung function test

Photo 3: Measurement of ambient PM_{10} and $PM_{2.5}$ at school

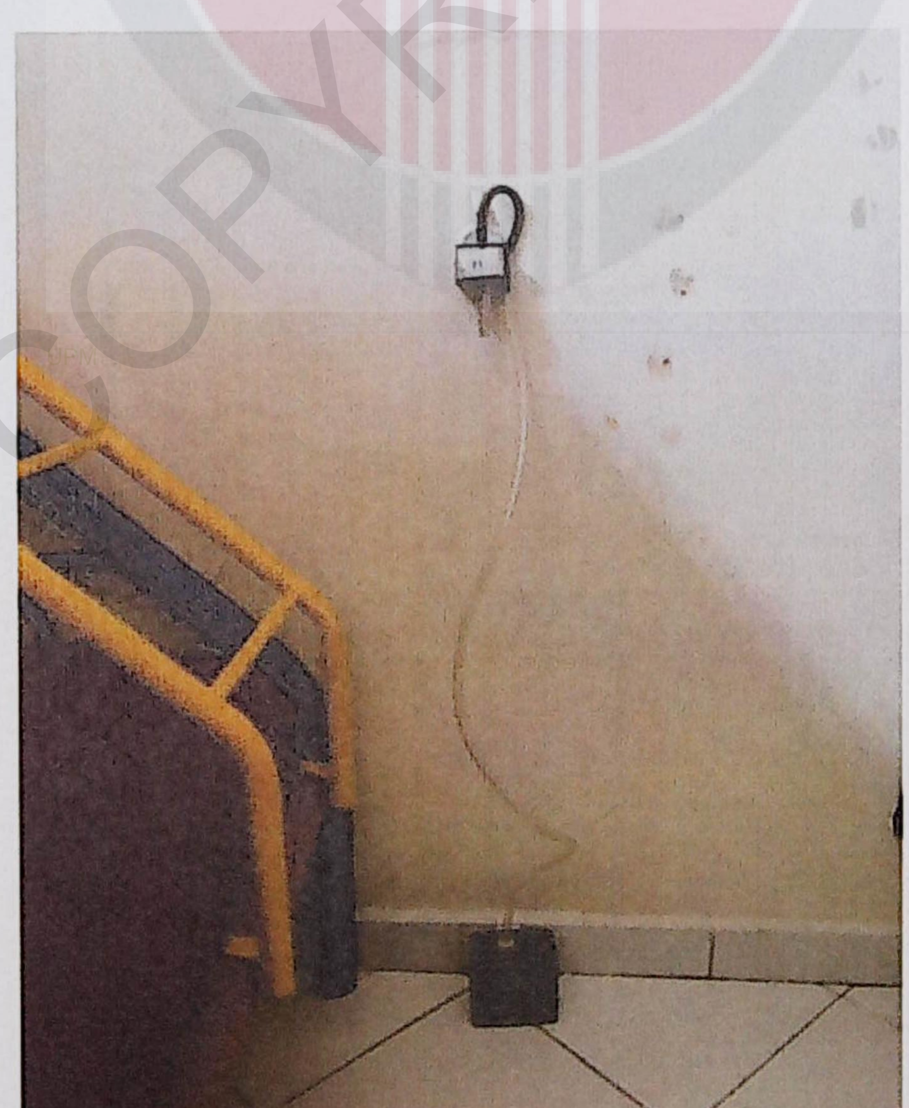

Photo 4: Measurement of PM_{10} and $PM_{2.5}$ at respondents' house