UNIVERSITI PUTRA MALAYSIA

EXPOSURE TO INDOOR PM10 AND RESPIRATORY HEALTH AMONG CHILDREN LIVING IN INDUSTRIAL AREA, KAJANG, SELANGOR

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ABSTRAK

PENDEDAHAN KEPADA PARTIKEL TERNAFAS (PM_{10}) DAN KESIHATAN RESPIRATORI DI KALANGAN KANAK-KANAK DI KAWASAN PERINDUSTRIAN, KAJANG, SELANGOR

NUR FAZHILAH BINTI ABDUL RAZAK

Pengenalan: Pendedahan kepada pencemaran udara boleh membawa kesan negatif kepada kesihatan kanak-kanak dan perkembangan mereka. Kanak-kanak adalah golongan yang sensitif terhadap pencemaran udara ini (PM_{10}). Objektif kajian ini adalah untuk menentukan kaitan di antara pendedahan kepada partikel ternafas (PM_{10}) dan kesihatan respiratori di kalangan kanak-kanak di kawasan perindustrian. **Kaedah:** Enam puluh Sembilan (69) kanak-kanak telah dipilih melalui kaedah persampelan dimana rumah mereka berhampiran dengan kilang-kilang, jalanraya dan tapak pembinaan. Borang soal selidik yang diadaptasi daripada *American Thoracic Society,* ATS, DLD-78C WHO (1982) telah digunakan untuk mendapatkan maklumat latar belakang, sejarah pendedahan dan gejala-gejala respiratori daripada ibu bapa kanak-kanak yang terlibat. Pam persampelan udara Gillian di gunakan untuk mengukur kepekatan PM_{10} di dalam rumah kanak-kanak selama 24 jam. GIS telah digunakan dalam kajian untuk menentukan kepekatan PM_{10} antara lokasi. **Hasil kajian:** Ujian khi-kuasa dua menunjukkan bahawa terdapat perbezaan yang signifikan berdasarkan lokasi dengan kepekatan PM_{10} (x^2 = 6.696, $p<0.001$), ujian Mann U Whitney menunjukkan bahawa terdapat perbezaan yang signifikan antara fungsi paru-paru kanak-kanak berdasarkan kategori pendedahan tahap kepekatan PM_{10} kepada paras tinggi (> 80µg/m^3) dan tahap kepekatan PM_{10} kepada paras rendah (< 80µg/m^3) FVC % jangkaan ($z= -2.91$, $p<0.05$), $FEV_{1\ \%}$ jangkaan ($z= -2.50$,$p <0.05$) , FVC ($z= -2.63$, $p<0.05$) dan FEV_1 ($z = -2.68$, $p <0.05$) , terdapat kolerasi songsang antara fungsi paru-paru kanak-kanak, FVC($r =-0.388$, $p<0.001$) dan FEV_1 ($r = -0.379$, $p<0.001$) dengan kepekatan PM_{10} dalaman di dalam rumah. Bagi gejala respiratori pula,simptom batuk dan berkahak adalah gejala yang biasa berlaku di kalangan kanak-kanak di kawasan kajian ini. Kesimpulannya, kajian ini mendapati pendedahan kanak-kanak kepada partikel ternafas boleh mengakibatkan penurunan fungsi paru-paru serta peningkatan gejala respiratori.

Kata kunci: *partikel ternafas (PM_{10}), gejala respiratori, fungsi paru-paru, kawasan perindustrian*

ABSTRACT

EXPOSURE TO PM_{10} AND RESPIRATORY HEALTH AMONG CHILDREN IN INDUSTRIAL AREA, KAJANG, SELANGOR

Introduction: Exposure to air pollution can bring negative effect to children's health and their development. Children are the most susceptible and vulnerable groups. The objective of this study was to determine the association between exposure to particulate matter (PM_{10}) and respiratory problem among children in industrial area. **Method:** Sixty nine (69) children were selected through purposive sampling in this study where their house was near to factories, near to road, and construction sites. Questionnaires adapted from, *American Thoracic Society* was used to determine the respondent's background information, their exposure history and respiratory symptoms. The indoor PM_{10} was measured with Gillian Air Sampling Pump and children's lung functions were measured with Spirolab II Spirometer. A GIS spatial analysist technique was used to describe the distribution of PM_{10} by residential location. **Results**: The chi-square test shows that there has significant different between locations and concentration of PM_{10} ($x^2 = 6.696$, $P<0.001$), the Mann U Whitney Test shows that there were significant reduction of lung function between the group who exposed in high concentration level of PM_{10} ($> 80\mu g/m^3$) and the group who exposed in low concentration level of PM_{10} ($< 80\mu g/m^3$) which FVC % predicted ($z = -2.91$, $p<0.05$), $FEV_{1\ \%}$ predicted ($z = -2.50$, $p <0.05$) , FVC ($z = -2.63$, $p<0.05$) and FEV_1 ($z = -2.68$, $p <0.05$), there was an inverse correlation between the children's lung functions; FVC (Liter) and FEV_1 (Liter) with ($r= -0.388$, $p<0.001$) and ($r= -0.379$, $p<0.001$) respectively with concentration level of PM_{10}. As for respiratory symptoms, cough and phlegm were the common symptom occurs among children in the study area which PM_{10} concentration **Conclusion:** It can be concluded that PM_{10} affects the children's respiratory system in term of abnormality of their lung functions and also the increases of their respiratory symptoms.

Keywords *: lung function, respirable particle (PM10), respiratory symptoms, industrial area*

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LIST OF TERMS

ATS	*American Thoracic Society*
EPA	*Environmental Protective Agency*
NIOSH	National Institute Occupational Safety and Health
SPSS	Statistical Package for Science Social
GIS	Geographical Information Systems
WHO	World Health Organization
$\mu g/m^3$	Microgram per cubic
PM_{10}	Particulate Matter

CHAPTER 1

INTRODUCTION

1.1 Background

Industrial area in Malaysia has increased extensively over last 10 years. Industrial area include the build up of factories, construction site, quarry, mining and other that can contribute to produce any product to suppert a daily life or demands. Malaysia is one of the developing country and increasingly number of population. According the increasing number of population, a basic life is needed including food supply, residency, and occupational. To fulfill the request, a lot of factories are built without concerning the kind of place. However, the rapidly growth of developing country are actually leads to a lot of complication especially at industrial area near to residential area. (Department of Statistic, Malaysia. 2011)

In 1987, EPA replaced the earlier Total Suspended Particulate (TSP) air quality standard with a PM_{10} standard. The new standard focuses on smaller particles that are likely responsible for adverse health effects because of their ability to reach the lower regions of the respiratory tract. The PM_{10} standard includes particles with a diameter of 10 micrometers or less (0.0004 inches or one-seventh the width of a human hair). EPA's health-based national air quality standard for PM_{10} is 50 $\mu g/m^3$ (measured as an annual mean) and 150 $\mu g/m^3$ (measured as a daily concentration). Major concerns for human health from exposure to PM_{10} include: effects on breathing and respiratory systems, damage to lung tissue, cancer, and premature death. The elderly, children, and people with chronic lung disease, influenza, or asthma, are especially sensitive to the effects of particulate matter. Acidic PM_{10} can also damage human-made materials and is a major cause of reduced visibility in many parts of the U.S.

However, many of us do not realize that indoor air pollution may caused adversely affect on children other than outdoor air pollution. Study done by Environment Protection Agency (EPA) found that levels of indoor air pollutants can be up to 2 to 5 times from ambient air. Previous studies found that most people including children will have spends a total of 90% of their time doing in the house or building. (EPA, 2010).There are also researches which indicate that people spend approximately 90 percent of their time indoors (EPA,2006). Therefore, for many people the risks to health may be greater due to exposure to air pollution indoor rather than outdoors especially to children. In addition, people who may be exposed to indoor air pollution

for longest periods of times are often those who are most susceptible to the effects of indoor air pollution. Such groups include the children, the elderly, and the chronically ill, especially those suffering from respiratory or cardiovascular disease.

Children and infants are among the most susceptible and vulnerable populations to many of their immature respiratory. The different composition of air pollutants, the dose and time of exposure and the fact that humans are usually exposed to a diversity of effects on human health. Asthma is a common condition that gives rise to considerable morbidity and mortality. Its prevalence is increasing and a local study found 13.8% of primary school children in Kuala Lumpur to be asthmatic. One of the problems is childhood asthma is that the diagnosis is frequently missed (Azizi *et al.*, 1990).

There is an urgent need to better understand children's exposure to environmental risks during their lifetime and most specifically during the "critical windows of susceptibility" when the timing of exposure becomes more important than the dose. Despite rapid progress and economic gains, a number of challenges still remain for children and young people. Underpinning these is the issue of disparity, social and economic, resulting in the marginalisation of some communities. Under Malaysian's 2020 states that rapid population growth coupled with a tremendous pace of development and industrialisation has increased the rate of urbanisation. The urban

population swelled from 37% in 1981 to 57% in 2000 and to 63.5% in 2008. Although urbanisation generally results in more educational opportunities, improvements in the status of women and children, increased life expectancy and lower infant mortality, it can also bring with it a range of risks, threats and stresses.

The prevalence of asthma and other respiratory disorders in childhood has increased considerably over recent decades, and the influence of exposure to air pollutants has attracted considerable interest. Epidemiologic studies suggest that chronic exposure to traffic-related pollutants, photochemical pollutants, and particulate matter (PM) have adverse effects on lung growth and pulmonary function and increase respiratory morbidity and mortality in children, especially in heavily polluted cities in developing countries. Most studies have concentrated on the health effects of outdoor air pollutants, especially PM and traffic-related pollutants.

Air is defined as a prime life subsistence resource to all living thing in the earth. Therefore, we are needed the clean and fresh air to prevent from any health problem related to respiratory problems. In every day, we are assumed that inhaled the air that contains several gaseous such as oxygen, carbon dioxide, nitrogen, water vapors, and others. All the gaseous will goes through from nasopharyngeal, trachea, bronchus, bronchiole and ending at alveolus. The gaseous exchange will occurs between oxygen

and carbon dioxide and no corrupted exchange if there is no disturbance in respiratory tract.

In addition, about 3 phases of industrial area in Bukit Angkat, Kajang and situated on 160-acres, Taman Sutera is located in an area known as Bukit Angkat and Sungai Balak. Most of the activities carried out heavy industrial enterprise for example metals, chemicals, steel and others. In addition, there was nearby Kajang- Silk Highway and main road which most of users from residential area and lorries from industrial area will used the road. In addition, there was also a construction site which the third phase of residential of Taman Sutera. Therefore, residential areas of Taman Sutera were selected for studied area because of consisting industrial area, construction site and highway or main roads that contribute to exposure of PM_{10}.

1.2 Problem statements

The increase in industrial area all over the world was major contribute to increase of pollution in order to indoor air pollutant. In addition, the problems were faced nowadays when the industrial near to residential area which consists of a lot of community. This can cause unhealthy environment to exposed community. Nowadays, most of our community had just concerned about the outdoor air pollutant, but they do not realize about indoor air pollutant which can also give harmful effect to the health especially respiratory health.

Exposure to indoor PM_{10} emitted has been associated with adverse health outcomes in several epidemiological studies of children. Children are among the most susceptible and vulnerable and easy exposed to variety factors in their home. The body of children was different compare to adult which is their respiratory system are still in development stage. Besides, their respiratory ductus is narrower and this can because more pollutant particle can easily trap to their respiratory system. There are many sources of indoor air pollution in any home. These include combustion sources such as oil, gas, coal, wood for cooking purpose, tobacco smoke and combustion of mosquito coil. Among sources identified, these are several familiar activities among Malaysian that contribute to indoor air pollutant. It was included cooking activities, tobacco smoke and combustion of mosquito coil (Azizi, 1990).

The health effects from exposure to PM_{10} may be showed after long period of exposure. In early stage of symptoms related to respiratory health are irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue. Immediate effects may become repeated exposure. In addition, it can be treated usually short term effects. Others symptoms diseases including asthma, pneumonitis, and allergic may also appear after prolong expose to some indoor air pollutants. Therefore, immediate reaction depends on several factors. Age and preexisting medical conditions are two important influences. In other cases, whether a person reacts to a pollutant depends on individual sensitivity, which varies tremendously from person to person. Some people can become sensitized to biological pollutants after repeated exposures, and it appears that some people can become sensitized to chemical pollutants as well (EPA, 1996).

Children are the most vulnerable group and very sensitive when exposed to air pollutant. This is because their immune systems and developing organs are still immature. Children breathe more air relative to their weight and lung surface than adults do. Therefore, because of the susceptibility of the children, they were selected as a target group in this research.

There are limited studies related to exposure to PM_{10} and respiratory health among children at industrial area in Malaysia. From this study, researcher can evaluate

the exposure to PM_{10} and its association with respiratory health among children. In addition,

1.3 Study Justification

The aim of this study is to determine the exposure to PM_{10} and the association with respiratory health among children at residential area in nearby industry area that exposed to PM_{10}. This study is very important so that early prevention measures among communities can be taken to creat better and comfortable environments. It also aims to prevent this problem from becoming more serious and thus avoid a negative impact on children's development in terms of health and well-being as a result of exposure to PM_{10}.

Additionally, this study will creat awareness among community living at residential area near to industrial area especially to parents pertaining to risk of exposure to PM_{10} among their children. According to the study later, parents will be more concern about the health effects of the exposure to PM_{10} towards to their children's implication of health. This study also determines the correlation between the distance of industrial area and indoor PM_{10}. Hence, this study also has implications

regarding the need for health education programmes to inform parents and children of the inherent risk involved in exposure to indoor PM_{10}.

This study will help policy drafting to government by doing their management of the industrial area to evaluate the effectiveness of their control measures to minimize the emission of pollution. Other responsible agency may think the other alternatives to control measures to give more effective to minimize the emission of exposure from the industrial area to the community of residential area especially to children.

This study can also serve as a baseline data for future researchers to study the indoor air quality and health implications of the respiratory systems in children.

1.4 Conceptual Framework

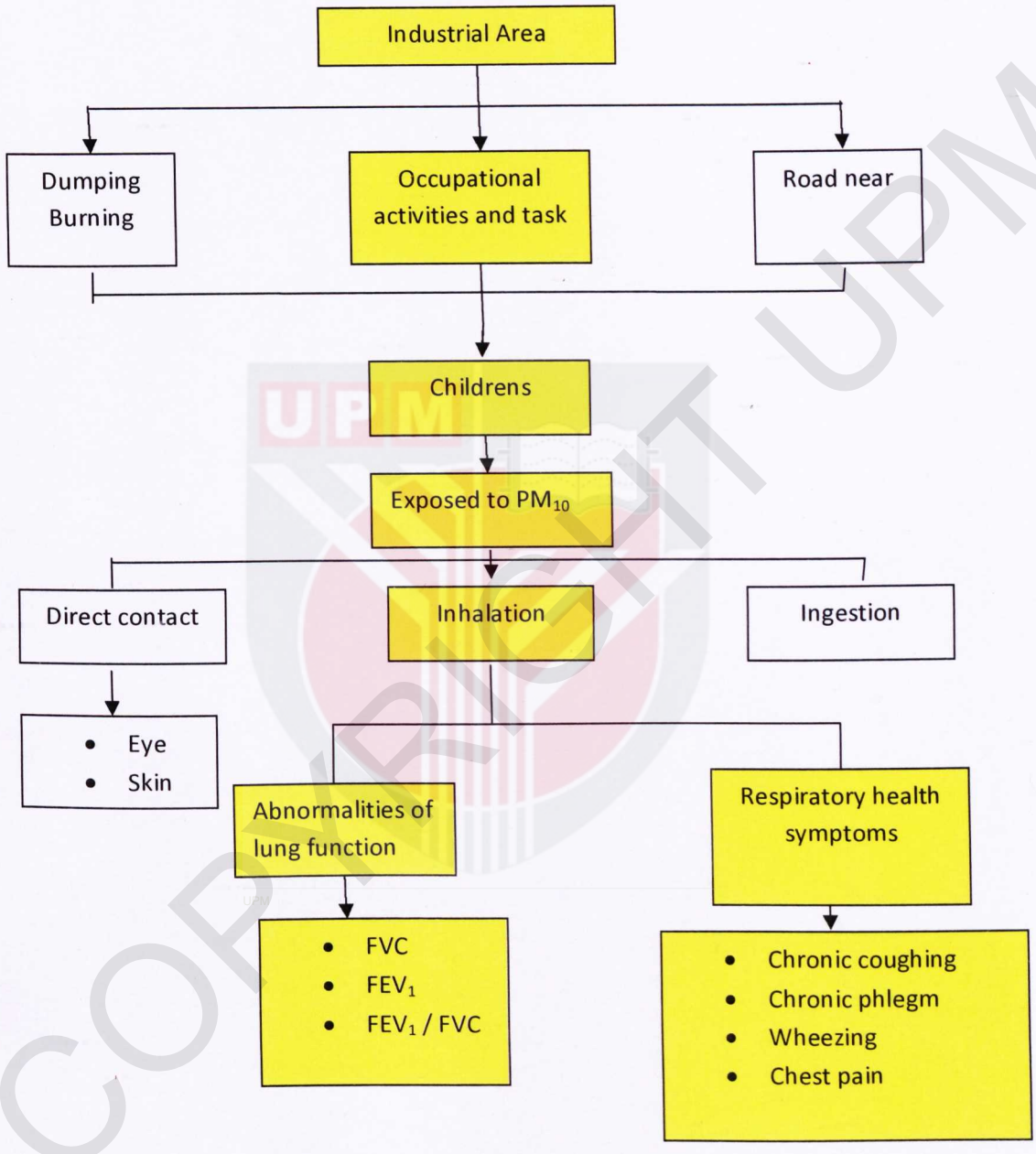

Figure 1 : Conceptual Framework

1.4.1 Conceptual Definition

a) Particulate matters (PM_{10})

Particulates with mass median aerodynamic diameter of less than 10 μm and particle that can enter the airways to the alveoli of the lungs (EPA, 1997)

b) FVC – Forced Vital Capacity (Capacity Vital Forced)

Measurement of the expiratory volume of air (liters) and maximum forced by using spirometer (ATS, 1994).

c) FEV_1 – Forced expiratory volume in one second

FEV_1 is the maximal amount of air you can forcefully exhale in one second. It is then converted to a percentage of normal. For example, your FEV_1 may be 80% of predicted based on your height, weight, and race (ATS, 1994).

d) Chronic Cough

Previous symptoms on most days for 3 consecutive months or more during the year (Chen *et al.*,1998).

e) Chronic phlegm

Having phlegm for at least 4 days in one week for at least 3 consecutive months during the year (ATS, 1978).

f) Tight chest

Pain and tingling or burning feeling in the breasts and chest area. It gets worse when people cough and breath deeply (ATS,1978)

g) Wheezing

The sound produces by the individual during breathing (the sound just like sound of the whistle). (ATS,1978).

h) Age

Age of respondent from the day of birth until the day of interview obtained from the study questionnaire (ATS, 1978)

i) Geographical Information System

Information on traffic counts in major roads, building densities and community population figures were collected in a geographical information system. This information was used to calculate different potential traffic-based predictors such as daily traffic flow and maximum traffic intensity of buffers with radii from 50 to 10 000m, distances to main roads and highways. (Matthias et al, 2005).

j) Group Exposed to High Concentration Level of PM_{10} (> 80µg/m^3)

Children who stay in area with high concentration level of pm_{10} (> 80µg/m^3) based on mean of concentration level of PM_{10}. (Aminatul, 2005)

k) Group Exposed to Low Concentration Level of PM_{10} (> 80µg/m^3)

Children who stay in area with low concentration level of pm_{10} (< 80µg/m^3) based on mean of concentration level of PM_{10}. (Aminatul, 2005)

1.4.2 Operational Definition

a) Particulate matters (PM_{10})

Exposure to particulate matter (PM_{10}) were measured by using air sampling pump with filter paper based on gravimetric principle in mg/m^3.

b) FVC- Force Vital Capacity

Measurement of maximally and forcefully exhales the volume of air by using Spirolab II Model. (American Thoracic Society, 1978)

Expected value of FVC % = FVC (spirometer) / FVC (FVC expected value) x 100

c) FEV $_1$ – Force expiratory volume in one second

The percentage value of FEV_1 (value from spirometer reading) divided by expected value for a respondents. (American Thoracic Society, 1978)

Expected value of FEV_1 % = FEV_1 / (FEV_1 expected value) x 100

d) Chronic Cough

Chronic cough identified from the Questionaire based on American Thoracic Society. (ATS, 1978)

e) Chronic Phlegm

The signs and symptoms experienced by respondent like coughing, phlegm, wheezing, and tight chest are recorded in questionnaire based on *American Thoracic Society* (ATS, 1978).

f) Tight Chest

Tight chest identified from the Questionaire based on American Thoracic Society. (ATS, 1978)

g) Wheezing

Wheezing identified from the Questionaire based on American Thoracic Society. (ATS, 1978).

h) Age

Age of respondents determined from the study questionnaire based on the American Thoracic Society. (ATS, 1978)

i) Geographical Information System

Information on traffic counts in major roads, building densities and community population figures were collected in a geographical information system. This information was used to calculate different potential traffic-based predictors such as daily traffic flow and maximum traffic intensity of buffers with radii from 50 to 10 000m, distances to main roads and highways. (Matthias et al, 2005)

l) Group Exposed to High Concentration Level of PM_{10} (> 80µg/m^3)

Children who stay in area with high concentration level of pm_{10} (> 80µg/m^3) based on mean of concentration level of PM_{10}. (Aminatul, 2005)

m) Group Exposed to Low Concentration Level of PM_{10} (> 80µg/m^3)

Children who stay in area with low concentration level of pm_{10} (< 80µg/m^3) based on mean of concentration level of PM_{10}. (Aminatul, 2005)

1.5 OBJECTIVES

1.5.1 General Objectives

To determine the association between exposure to particulate matter (PM_{10}) and respiratory among childrens in industrial area.

2.2 Specific Objectives

1. To identify socioeconomic status and exposure history of respondent
2. To compare the indoor PM_{10} concentration among children at different location (factories, construction site and main road)
3. To compare the distribution of PM_{10} concentration among children at different location (factories, construction site and main road) based on GIS application.
4. To compare the respiratory symptoms between the children who exposed in high concentration level of PM_{10} and the children who exposed in low concentration level of PM_{10}.
5. To compare lung function between the children who exposed in high concentration level of PM_{10} and the children who exposed in low concentration level of PM_{10}.
6. To determine the association between exposure to indoor PM_{10} concentration and lung function among studied children.
7. To determine the association between exposure to indoor PM_{10} concentration and respiratory symptoms children at different location

3.0 HYPOTHESIS

1. The indoor PM_{10} concentration among children was significantly difference for different location (factories, construction site, main road)
2. The prevalence of respiratory symptoms among studied children was significantly difference between the children who exposed in high concentration level of PM_{10} compared to the children who exposed in low concentration level of PM_{10}.
3. Lung function of studied children was significantly lower among children who exposed in high concentration level of PM_{10} and the children who exposed in low concentration level of PM_{10}.
4. There was a significant association between the indoor PM_{10} concentration and lung function among studied children.
5. There was a significant association between the indoor PM_{10} concentration and respiratory health symptoms among studied children.

CHAPTER 2

LITERATURE REVIEW

2.1 What is PM_{10}?

According to Environmental Protection Agency (EPA) 2010, the range of particle sizes of concern for air emission evaluation is quite broad; the range divided this range into smaller categories. Particulate matter represents a broad class of chemically and physically diverse substances. Particles can be described by size, formation mechanism, origin, chemical composition, atmospheric behavior and method of measurement. The concentration of particles in the air varies across space and time, and it is related to the source of the particles and the transformations that occur in the atmosphere. Table 2.1 displays the EPA terminology along with the corresponding particle sizes.

Table 2.1 : EPA Terminology for Particle Sizes

EPA Description	**Particle sizes**
PM_{10} (super coarse)	>10μm
$PM_{10-2.5}$ (coarse)	2.5μm-10μm
$PM_{2.5}$ (Fine)	0.1μm-2.5μm
Ultrafine	<0.1μm

Source: EPA,2010

In 1987, EPA replaced the earlier Total Suspended Particulate (TSP) air quality standard with a PM_{10} standard. The new standard focuses on smaller particles that are likely responsible for adverse health effects because of their ability to reach the lower regions of the respiratory tract. The PM_{10} standard includes particles with a diameter of 10 micrometers or less (0.0004 inches or one-seventh the width of a human hair). EPA's health-based national air quality standard for PM_{10} is 50 $\mu g/m^3$ (measured as an annual mean) and 150 $\mu g/m^3$ (measured as a daily concentration). Major concerns for human health from exposure to PM_{10} include: effects on breathing and respiratory systems, damage to lung tissue, cancer, and premature death. The elderly, children, and people with chronic lung disease, influenza, or asthma, are especially sensitive to the effects of particulate matter. Acidic PM_{10} can also damage human-made materials and is a major

cause of reduced visibility in many parts of the U.S. New scientific studies suggest that fine particles (smaller than 2.5 micrometers in diameter) may cause serious adverse health effects. As a result, EPA is considering setting a new standard for $PM_{2.5}$. In addition, EPA is reviewing whether revisions to the current PM_{10} standards are warranted (EPA,2010).

2.2 Indoor Air Pollutant

According to Environmental Protective Agency (EPA), indoor pollution sources that release gases or particles into the air are the primary cause of indoor air quality problems in homes. Inadequate ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the home. High temperature and humidity levels can also increase concentrations of some pollutants.

However, many of us do not realize that indoor air pollution may caused adversely affect on children other than outdoor air pollution. Study done by Environment Protection Agency (EPA) found that levels of indoor air pollutants can be up to 2 to 5 times from ambient air. Previous studies found that most people including

children will have spends a total of 90% of their time doing in the house or building (EPA, 2010).

There are many sources of indoor air pollution in any home. These include combustion sources such as oil, gas, kerosene, coal, wood, and tobacco products; building materials, asbestos-containing insulation, wet or damp carpet, and cabinetry or furniture made of certain pressed wood products; products for household cleaning and maintenance, personal care, or hobbies; central heating and cooling systems and humidification devices; and outdoor sources such as radon, pesticides, and outdoor air pollution (EPA,2010).

Strongly evidence through study of Azizi, there are many sources of indoor air pollution in any home. These include combustion sources such as oil, gas, coal, wood for cooking purpose, tobacco smoke and combustion of mosquito coil. Between the sources identified, these are several familiar activities among Malaysian that contribute to indoor air pollutant. It is include cooking activities, tobacco smoke and combustion of mosquito coil (Azizi, 1990).

The relative importance of any single source depends on how much of a given pollutant it emits and how hazardous those emissions are. In some cases, factors such as

how old the source is and whether it is properly maintained are significant. For example, an improperly adjusted gas stove can emit significantly more carbon monoxide than one that is properly adjusted.

Some sources, such as building materials, furnishings, and household products like air fresheners, release pollutants more or less continuously. Other sources, related to activities carried out in the home, release pollutants intermittently. These include smoking, the use of unvented or malfunctioning stoves, furnaces, or space heaters, the use of solvents in cleaning and hobby activities, the use of paint strippers in redecorating activities, and the use of cleaning products and pesticides in house-keeping. High pollutant concentrations can remain in the air for long periods after some of these activities.

2.3 PM_{10} and Industrial Area

Particulate matters were highest in industrial area compare with CO and NO2 were highest in urban. Rural area showed a lower level concentration of pollutants as compared to urban and industrial areas. The PM_{10} concentrations were significantly different between industrial and rural area respectively. According to International Study of Asthma and Allergies in Childhood (ISSAC), states that the finding to date have shown that these diseases are increasing in developing countries and that they have

little to do with allergy, especially in the developing world. In addition, futher population studies are urgently needed to discover more about the underlying mechanisms of non- allergic cause asthma, rhinitis and eczema and the burden of these conditions (ISAAC, 2011).

PM_{10} is placed in the law as pollutants because of its size that can be inhaled. In other words, particles of less than 10 micrometers can enter up to or in the lower respiratory tract. Most particles are produced from industrial process. Construction activity is one of the main contributors to PM_{10} pollution in the air. The PM_{10} concentration of indoor air was found to be higher than those of the outdoors in the industrial area of Balakong, Selangor (Norela,2005).

Industrial area will produce outdoor air pollutant is caused by small particles and ground level ozone that comes from car exhaust, smoke, road dust and factory emissions. Outdoor air quality is also affected by pollen from plants, crops and weeds. Particle pollution can be high any time of year and are higher near busy roads and where people burn wood. When inhaled, outdoor pollutants from industrial area and pollen can aggravate the lungs, and can lead to chest pain, coughing, digestive problems, dizziness, fever, lethargy, sneezing, and shortness of breath, throat irritation

and watery eyes. Outdoor air pollution from industrial area and pollen may also worsen chronic respiratory diseases, such as asthma. (EPA,2010).

Study done by Abdul Mujid *et al.*, (2003) was investigate the respirable particulate matter (PM_{10}) and its association with the respiratory systems of school children in Sungai Siput, Perak based on the comparison of the concentration of PM_{10}. His result shows that mean of PM_{10} concentration is highest at exposed location compared to comparative location. However, the level of PM_{10} concentration is allowed by Department of Environmental which is at 150μg/m^3 level.

2.4 Effect of PM_{10} and Children's Health

The prevalence of asthma and other respiratory disorders in childhood has increased considerably over recent decades, and the influence of exposure to air pollutants has attracted considerable interest. Epidemiologic studies suggest that chronic exposure to traffic-related pollutants, photochemical pollutants, and particulate matter (PM) have adverse effects on lung growth and pulmonary function and increase

respiratory morbidity and mortality in children, especially in heavily polluted cities in developing countries (Steven et al, 1992).

Suspended particles were common name for the whole of the fine particles floating in the air environment. Suspended particles or aerosols are solid or liquid particles of dust, smoke, fume (fume), and mist (mist). In addition, as well as particulate materials such as hydrocarbons, sulfates, nitrates and metals for example lead, tin, and cadmium (American Thoracic Society, 1978) The main source of pollution is from the factory activities, general industry and vehicle fumes. Therefore, the construction industry is one of the contributors to air pollution.

Total suspended particles (PM_{10}) are the particle size of less than 10 μm can be inhaled into the lungs of children (Robert et al., 2003). Its size is very fine and small particles allow this to enter the respiratory system such as the bronchi, bronchioles, and further into the interior of the respiratory tract. The number of particles accumulated in the respiratory tract depending on the size, shape and density.

Based on the physiology of the children respiratory system, the particle diameter of 0.1μm to 1.0 μm gives gives a very significant impact on health. Thus particle size has the ability to penetrate the lungs to the alveoli where gas exchange occurs between oxygen and carbon dioxide. While the particle size of 1.0 μm is stuck in the nasopharynx, trachea or bronchus. These particles can be produced but normally healthy individuals through mechanism such as sneezing, coughing or by swallowing. However, particles with a size smaller than 0.1 μm will act like a gas and then get to the alveoli. However, it can be removed by the process together with expiration of air exhaled. Thus, the only particle size between 0.1 μm to 1.0 μm will stay in the lungs. Thus, the particles will move to membran alveolar epithelium layer and will then cross into the lymphatic system or blood (EPA,2002)

According to EPA (1997) those exposed to levels of total suspended particles (PM_{10}) exceeding 1000 $\mu m/m^3$ would run the risk of respiratory diseases. Particle effects on the respiratory system depend on its chemical content. The chemical compositions of particles are different and it depends on the source where it is produced. Therefore, the PM_{10} is a health related issues that should be considered accordingly. Particulate matters will not only settled deeper into the lungs, but it contains aquantity of organic materials is large and will cause significant long-term

effects. According to NIOSH (1994), the standard level of exposure to particulate matters allowed is 1000 $\mu g/m^3$ for a period of 8 hours of work.

Children are more susceptible than adults to the adverse health effects of air pollution for a variety of reasons. First, children are more active than adults and therefore breathe more rapidly. Second, compared to adults, children have more lung surface area compared to their body weight meaning that they inhale more air for their size. In fact, they breathe 50% more air per pound of body weight than adults do. As children's respiratory systems are still developing, they generally are more susceptible to environmental threats than healthy adults. Damage caused by air pollution can mean they never reach their potential lung development. Exposure to PM_{10} is associated with increased frequency of childhood illnesses, which are of concern both in the short run, and for the future development of healthy lungs in the effected children. Babies and young children are especially susceptible to particulate matter. (EPA,2002).

In addition, the study of Junaidah *et al.*, (2010), about the PM10 concentration was significance differences between the areas. There was an association between the prevalence of respiratory and allergic symptoms such as difficulty in breathing, chest tightness wheezing, skin rashes and itchy watery eyes and nose among respondents by

locations. Higher prevalence of symptoms was shown among urban children followed by industrial and rural children.

2.5 Effect of PM_{10} and Lung Function

According to American Thoracic Society, (1978) states that pulmonary function tests (PFT's) measure how well to childrens can move air in and out of his or her lungs. PFT's, also called breathing tests, will help the researchers to tell if childrens has lung disease, how severe it is and what medications may help. Children may be asked to do PFT's in your healthcare provider's office or in a pulmonary function laboratory (lab).

Lung function test is one of test that is done by health care specialist and facilities. These tests measure the ability of the lung function and breathing again breathing the air. It can also be measured after the lung is to carry out a process of exchande of oxygen into the blood effectively. Tools such as spirometer to measure lung are immediately exhaled. The information obtained from this especially asthma and chronic obstructive lung (COPD). (WHO, 2011)

According to Zailina et al., (2004), findings showed that there was a significant difference in the FEV,% predicted (p=0.002), FEV/FVC % predicted (p <0.05) and the %FEV/FVC (p=0.002) between male children in the two areas. However, only the FEV,% predicted (p<0.05) was significantly different between the female children in the two areas. Significant correlation was also found between the frequency of asthma attacks with FEV)% predicted (p=0.008), FEV/FVC % predicted (p<0.05) and % FEV/FVC (p=O.OOI) among the asthmatic children Kuala Lumpur but no significant correlation was found among the asthmatic children in Terengganu.

Table 2.2: Abnormalities of Lung Function

Obstructive Disease	**FEV_1% expected**
Normal	≥80
Mild	79-70
Moderate	70-60
Severe	<60
Restrictive disease	**FVC % expected**
Normal	≥80
Mild	79-70
Moderate	70-60

(Source: *ATS*, 1991)

FEV_1/FVC ratio should exceed 75% of healthy individuals over the age of 60 years did not pass. It is considered a problem of obstructive if the percentage of FEV_1/FVCis less than 75% (Miller, 2007).

Based on research of indoor particulate matter and lung function among children living near busy road in cheras, Kuala Lumpur, the finding shows that Indoor particulate matter concentration was significantly higher exposed which children living near busy road than comparative group which children living far from busy road with (t=-2.496, p=0.014). Respondents in exposed group were having significantly higher number of lung function abnormality than comparative group with (<2=17.926, p=0.000) for predicted FEV% and (<2=7.259, p=0.007) for predicted FVC%. As for respiratory symptoms, exposed group showed higher number of respondents having respiratory symptoms than comparative group. (Sofiah, 2010)

2.6 Chronic respiratory symptoms and health problems among children exposed to PM_{10}

Study of Anderson et al. (2001) states that two meta-analyses on the short-term effects of PM_{10} on children's respiratory health have previously been performed reviewed the effects on cough and medication In their review, they found no effect of PM_{10} on cough in children [odds ratio (OR) = 0.999 for 10-$\mu g/m^3$ increase in PM_{10}; 95% confidence interval (CI), 0.987–1.011]. Ward and Ayres et al, (2004) performed a meta-analysis of worldwide panel studies published through 2002 that included asthmatic and healthy children. They found a significant effect of PM_{10} on cough wheeze and on peak expiratory flow (PEF) In both meta-analyses, the results of the large multicenter European PEACE study had a strong influence because of its primarily null results.

In addition, study done by Abdul Mujib which respirable particulate matter, PM_{10} and its association with the respiratory systems of school children in Sungai Siput, Perak, the finding shows that coughing was common symptom among children living near and far from quarry. However, phlegm was common symptoms among children living near quarry at Sungai Siput, Perak. Although children in this study was grow in the same district, but presence of cement plant and quarry in exposed area reported

result in a higher risk of respiratory symptoms among children living in exposed area because of high concentration level of PM_{10}. Increased risk of both respiratory symptoms such as cough and phglem was predicted to occur in children living near the cement plant and quarry. Risk of experiencing respiratory symptom of phlegm was 2 times whereas 8 times for symptom of cough. This study also shows that even the concentration level still below 150μg/m^3, children were still at risk of these respiratory problems (Mujib, 2003).

Supported by previous study done by Enriqa, which respiratory symptoms in children living near busy roads and their relationship to vehicular traffic: results of an Italian multicenter study found that overall traffic density was weakly associated with asthma symptoms but there was a stronger association with cough or phlegm (high traffic density OR = 1.24; 95% CI: 1.04, 1.49). Car and truck traffic were independently associated with cough or phlegm. The results of the external validation did not support the existence of a reporting bias for the observed associations, for all the self-reported traffic indicators examined. The internal validations showed that the observed association between traffic density in the zone of residence and respiratory symptoms did not appear to be explained by an over reporting of traffic by parents of symptomatic subjects. (Enriqa, 2009)

In addition, recently published results of the Swiss study provide further evidence that rates of respiratory illness and symptoms, but not of allergies, were associated with moderately increased levels of air pollution. Additionally, a recently published Polish cross-sectional study of 1,129 children reported an association between outdoor air pollutants and chronic phlegm (OR: 4.2). The findings were consistent with those of the Harvard Six Cities study and the Swiss SCARPOL study, which also showed an association between air pollution and bronchitis, but not with wheezing. (Joachim et.,1999)

2.7 Pyhsiology of Children's Lung and Deposition Mechanism of PM_{10}.

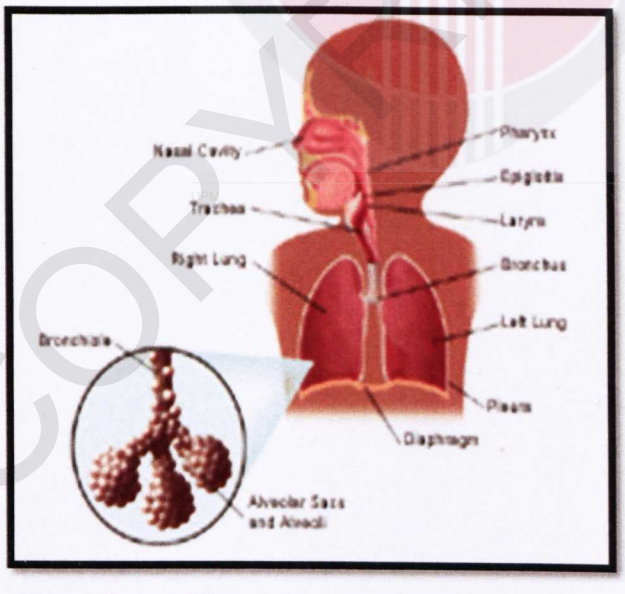

Figure 2.1: Children Respiratory Systems

Basicly, breathing is so vital to life that it happens automatically. All of this breathing couldn't happen without the respiratory system, which includes the nose, throat, voice box, windpipe, and lungs. At the top of the respiratory system, the nostrils (also called nares) act as the air intake, bringing air into the nose, where it's warmed and humidified. Tiny hairs called cilia protect the nasal passageways and other parts of the respiratory tract, filtering out dust and other particles that enter the nose through the breathed air.

Air can also be taken in through the mouth. These two openings of the airway (the nasal cavity and the mouth) meet at the pharynx, or throat, at the back of the nose and mouth. The pharynx is part of the digestive system as well as the respiratory system because it carries both food and air. The larynx, or voice box, is the uppermost part of the air-only pipe. This short tube contains a pair of vocal cords, which vibrate to make sounds. The trachea, or windpipe, extends downward from the base of the larynx. It lies partly in the neck and partly in the chest cavity. The walls of the trachea are strengthened by stiff rings of cartilage to keep it open. The trachea is also lined with cilia, which sweep fluids and foreign particles like PM_{10} out of the airway so that they stay out of the lungs.

However, respiratory symptoms such cough was indicator of airway irritant stimuli to air pollutants, cough may occur early in response to irritant receptor in the airway to enhanced secretion of mucus by the gland lining in the airway because of ineffective clearance of airway mucus by a damage mucociliary system. (David, 1999)

CHAPTER 3

METHODOLOGY

3.1 Study Design

This study was a cross sectional study design to study the exposure to PM_{10} concentration and its association with respiratory health among children at residential near industrial area, Kajang. At the same time, this study was conducted to determine the lung function level among respondents.

3.2 Location

This study was conducted among children living at industrial area in Kajang. The industrial area is located close to residential areas where they are at risk for problems of air pollution (PM10). Figure 3.1 will show the study of location at Kajang. Study area were involved <100m, 100m-500m,500m-1000m, ≤ 2000m from industrial area to respondents houses.

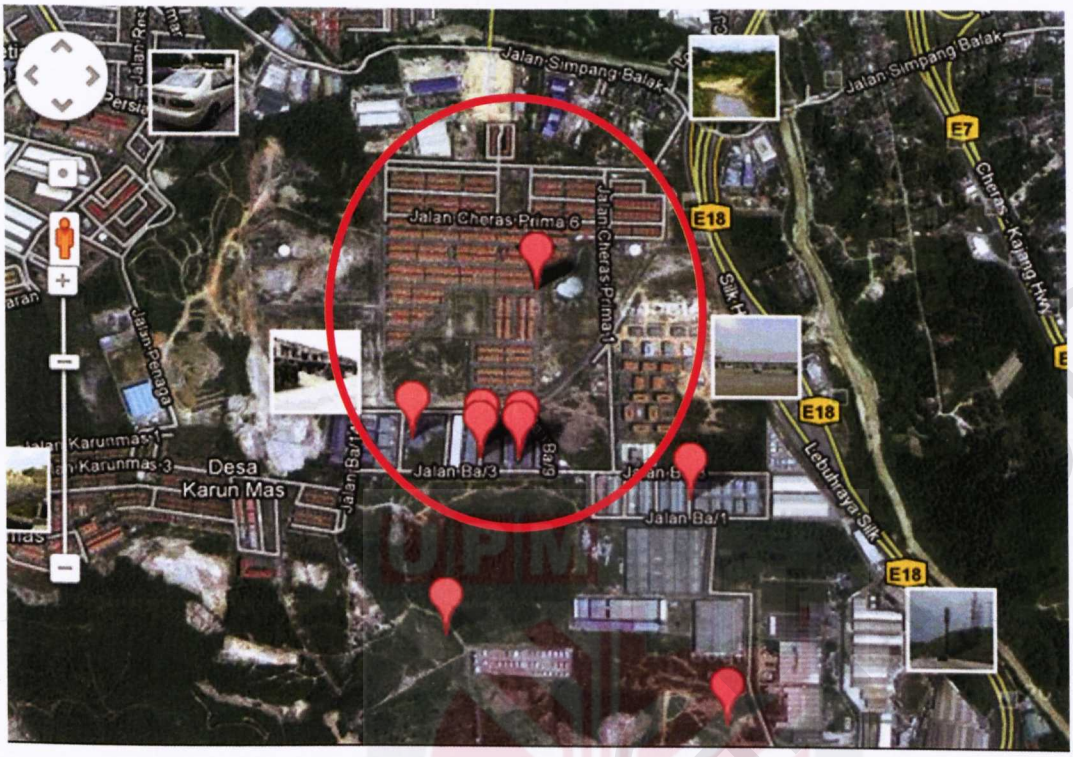

Figure 3.1 : Study Location Map

Legend

Studied Area which near to factories (<100m, >100m-500m,>500m-1000m, ≤ 2000m)

Residential Area of Taman Sutera, Kajang Selangor

Industrial Area in Bukit Angkat, Kajang, Selangor

Main road and Kajang-Silk Highway

3.3 Study Population

Study populations were among children who exposed to particulate matters (PM_{10}) that live near the industrial area. All respondents were between ages of 5 to 7 years.

3.4 Sampling Frame

In this study, sampling frame was obtained based on the list of the students' names attending kindergarten from their teacher in area of residential of Taman Sutera, Kajang, Selangor.

3.5 Sampling technique

All respondents were chosen will undergo the interview session at their nearby kindergarten following the standard questionnaire from American Thoracic Society,(1978). All respondent's informations were obtained based on the questionnaire form of American Thoracic Society.

3.5 Sampel unit

The sample unit was composed of children aged 5 years to 7 years old and Malaysian Nationality.

3.6 sample size

The study sample was calculated based on the formula of Rubinson and Neutens (1987) as below :

N = $n = (z/e)^2 (p)(1-p)$

N = sample size

z = the standard score corresponding to given confidence level

= 1.96

E = the proportion of sampling error in a given situation

= 0.10

p_1 = prevalence of abnormal FEV_1% predicted among studied children (Sofiah 2010).

= 17.926%

Therefore, the minimum sample size for studied children was 58 children. For the purpose of study this study, the sample size was added by 20% to overcome problems of non-responses. Hence, the sample size is 69.

3.7 Instrumentation

3.7.1Questionaire Form

Questionnaire used in this study was based on the American Thoracic Society – ATS-DLC-78-C WHO (1982). The questionnaire determines the socio-economic status of disease, exposure history and respiratory symptom among respondents. The parents were interviewed based on questionnaire.

3.6.2 Air sampling pump

a. Monitoring in Kindergarten

Measurement of the indoor air pollutant (PM_{10}) inside the classrooms of kindergartens was performed during school hours by using DustTrak Aerosol Monitor.

DustTrak (figure 3.2) were placed at the back of the classroom with the same level of children's breathing zone. That area was selected to avoid any disruption of sound from instrument during learning session and avoid attraction from children.

Figure 3.2 : DustTrak II Aerosol Monitor

b. Monitoring in Respondent's House

Air sampling pump was used to measure the quality of air in the house and in the kindergartens. In this study, the Gillian Air Pump model (figure 3.3) was used as a pump to suck up and filter put dust with aerodynamic diameter less than 1010 μm. The pump will operate up to 24 hours on a fully charged battery with a flow rate of 1.7 L/min. the fine particles will be trapped on the filter paper type Cellulose Nitrate Membrane with diameter 47 mm 0.45 μm air pore size.

Figure 3.3 : Gillian Air Pump Sampling model

3.6.3 Laboratory procedure

Procedure involve in the preparation of sampling instruments as follows :

a. Filter membran

Cellulose Nitrate Membrane Filter Membrane type filter paper was dried in an oven at 40°C for 2 hours, to remove the water vapor. Subsequently, the filter paper was cooled down in desiccators at room temperature. The filter papers were weighed with a microscale device that can measure up to the fifth decimal point. Initial weight of filter paper was measured using digital scales to five decimal places and the readings were

recorded. There were a few quality controls for filter papers. Each filter paper must be dry, weight and record the weight according to the procedure. Electrostatic discharger was used on the filter paper to eliminate electrostatic biases.

$$\text{Concentration } PM_{10} \ (\mu g/m^3) = \frac{\text{Final mass (g)} - \text{Initial massl (g)} \times 10^6 \ \mu g/g}{\text{Flow Rates (L/min)} \times \text{Time (minit)}} \quad 1000 \ (L/m^3)$$

b. Weighting procedure

This is an important procedure. Three times measurement was used to achieve the accurate data. The weighting machine should be calibarated first. The weighing procedure should be repeated three times. If there is a difference between the first and second reading (i.e more than 0.00004g) therefore, another reading should be taken. One controlled filter paper should represent as field blank.

c. Pump Calibration

Each pump was calibrated before use to maintain flow rate of the pump at 1.7 L/minute by using calibration jar to ensure quality of pump. Flow rate before sampling must be within the range of 2.5% of the 1.7L/minute.

3.6.5 Spirometer

Lung function test was perfomed on the selected children by using Spirolab II Model (figure 3.3). Spirolab makes FVC and FEV_1 and breathing pattern tests and calculates an index of test acceptability (test quality control) and a measure of reproducibility; and also gives functional interpretation with 11 possibile levels following the latest ATS (American Thoracic Society) classification.

Figure 3.3 : Spirolab II Model

a. Calibration

Before the spirometer used, it must be calibrated first. 3 litres of air will be injected in with a syringe into spirometer. The error allowed were 3% or 50 ml of air. Three parameters which can be obtained from this test were Forced Expired Volume in

one second (FEV_1% predicted), Forced Vital Capacity (FVC% predicted) and FEV_1/FVC% predicted.

b. Quality control of spirometric use

American Thoracic Society has recommended a number of quality control methods touse spirometer. These included the respondent should loosen tight clothing, are in place and stand erect and remove dentures if any before starting the test. Information testing procedures are to be carried out is given to the respondent. During the trial commenced, respondent was directed to draw breath after the maximum possible explanations and examples of how the technique of drawing breath right granted to it to facilitate the respondents' fullfil the criteria given by *American Thoracic Society* (1978).

c. Interpretation of spirometry test

Spirometer test intrepetation process will be made by comparing the observed and expected test scores to determine whether respondents who were tested had lung

function abnormalities. FVC and FVE 1 readings are directly aligned to the unit BPTS (*Temparature Body And Pressure Saturated*).

3.7 Data Collection

Data collections in this study were using several instrumentation such as personal air sampling pump, sampling pump and questioanaire. All the instruments were used to get the direct data from the site of research. This measurement data was important data in the study of the handling equipment is in accordance with standard operating procedures.

3.7.1 Mapping Data

Geographical Information System (GIS) is used for mapping, data for capturing, managing, analyzing, and displaying all forms of geographically referenced data. GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts. GIS technology can be integrated into any enterprise information system

framework. According to Matthias (2005), GIS has three major characteristic geographic, information and system. Geographic implies a concern with relating to geographi scales, information was the extraction of specific and meaningful information, and system was a data manager. GIS is powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatila data from the real world for a particular set of purposes. The GIS software was designed to manipulate spatial data with output in the form of maps and tabular reports, or as data files generated for interfacing with numerical models.

3.8 Data Analysis

All data obtained from this study were statistically analysed by "*statistical package for social sciences (*SPSS)" software verse 18. The analysis perfomed were at the univariate analysis and bivariate analysis. The level of significance in this study was set to at $p<0.05$. Univariate analysis was conducted to determine mean, range and standard deviation to illustatred the subjects' background, analysis of bivariate (t-test, chi-square) used to test the difference and correlation between the variables in this study.

3.9 Quality Control Data

Quality control is important in every measurement especially when using instruments. This is to avoid biases and error while doing the study. In this study, there were quality control for questionnaire, air sampling pump and spirometric test. Pre-test questionnaire based on questionnaire by American Thoracic Society (1978) was performed on 10% of the sample size. This is to ensure that all respondents understand the questions and reduce bias information. The questions were later edited to increase the understanding of the respondents. The quality controls for air pump sampling were based on the NIOSH (1998) procedures. Each recommendation and procedure by American Thoracic Society (1994) was followed by spirometric test.

4.0 STUDY LIMITATION

In this study, there were some limitations that were encountered. Among them are:

I. There were only few studies done among children exposed to indoor PM_{10} living near industrial area of Kajang

II. Due to the time constrains, only one measurement was taken per respondents

III. Researchers' concider the respondents answered all questions honestly and without bias memory (recall bias). Assumptions will be made for the answers given by parents are true.

5.0 ETHICAL ISSUES

Selection of the respondents needs to get permission from the respondents itself. They must agree to participate in this study. Agreement form needs to be signed by the respondents and give back to the researcher for conformation to participate in this study. All the information about the respondents were private and confidential .Ethical approval was approved by Ethic Committee, Faculty of Medicine and Health Sciences, University Putra Malaysia.

CHAPTER 4

RESULTS

4.1 Socio-Demographic Data of Respondent

The study was conducted at industrial area, Kajang, Selangor. A total of 69 respondents involved in this study. The respondents were chosen purposively based on several inclusion and exclusion criteria that has been stated in Chapter 3.

Table 4.1 show the socio demographic data of respondent. For the age, mean (SD) were 5±0.501, and ranges from were 5 and 6 years old. For the races, 69 (100%) respondents in this study were Malays. They were 30 (43.5%) for male respondents and 39 (56.5%) for female respondents.

Table 4.1 Socio-demographic data of respondent in Kajang Selangor

Variables	Mean ±SD (Years Old)	Median (Years Old)	Range (Years Old)
Age	5±0.501	5	5-6
variable	**Category**	**Number of Respondent (N)**	**Percentage (100%)**
Races	Malay	69	100
Gender	Boys	30	43.5
	Girls	39	56.5
Total Househol Income of parent	RM 1501-RM2000	1	1.4
	RM2001-RM2500	8	11.6
	RM2501-RM3000	31	44.9
	>RM3000	29	42.0

(N=69)

Results were obtained in sixty nine (69) Malay school children; comprised of 39 girls and 30 boys, age from 5 to 6 years old. Majority of the children comes from an intermediate family with household income range of RM 2501 to RM3000 (44.9%) (Table 4.1).

4.2 Parental Educational Level among Respondents

The parental educational levels were categorized from UPSR until degree / Master / PhD. Majority of respondents which was have educational level at STPM / Diploma 38 (55.1%). Followed by Degree/Master/ PhD level and SPM level which were 18 (26.1%) and 13 (18.8%) respectively. Based on table 4.2 below, educational level are divided into two which educational level of father and educational level of mother according to locations. Majority of respondent's father are in STPM/ Diploma level which were 21 (70%) living near factories. Then, follow educational level of father at construction site which were 11 (52.4%) also in level of STPM/ Diploma but living near construction site. Then, all level of educational which were 6 (33.3%) all respondents living near road for SPM, STPM/Diploma and Degree respectively.

Table 4.2: Distribution of educational level of father

Variables	Percentage of Respondents (%)		
	Factories (n=30)	Road (n=18)	Construction Site (n=21)
PMR	0 (0)	0 (0)	0 (0)
SPM	3 (10.0)	6 (33.3)	4 (19.0)
STPM/Diploma	21 (70.0)	6 (33.3)	11 (52.4)
Degree	6 (20.0)	6 (33.3)	6 (28.6)

N= 69,

Based on table 4.3 below, educational level are divided into educational level of mother according to locations. The parental educational levels were categorized from UPSR until degree/ Master / PhD. Majority of respondents which was have educational level at STPM/ Diploma 40 (57.9%). Then, follow by Degree/Master/ PhD level, SPM, PMR level which were 15 (21.7%), 13 (18.8%) and 1 (5.6%) respectively.

Table 4.3: Distribution of educational level of mother.

Variables	Percentage of Respondents (%)		
	Factories (n=30)	Road (n=18)	Construction Site (n=21)
PMR	0 (0)	1 (5.6)	0 (0)
SPM	4 (13.3)	3 (16.7)	6 (28.6)
STPM/Diploma	17 (56.7)	10 (55.6)	13 (61.9)
Degree	9 (30.0)	4 (22.2)	2 (9.5)

N=69,

4.3 Distribution Concentration of PM_{10} between Locations

The distribution concentration of PM_{10} among respondent based on three location in industrial area of Kajang are respondents who living near factories, near road and construction site. The highest concentration level of PM_{10} was in construction site which were 21 (30.4 %,) and the Mean (SD), 96.6 (2.54), min (89.2 $\mu g/m^3$), and max (98.3 $\mu g/m^3$). Then, follow the second highest of concentration level of PM_{10} was road

which were 30 (43.5 %), and the Mean (SD), 90.1 (17.23), min (49.2 μg/m³), and max (105.1 μg/m³). Lastly, the concentration level of PM_{10} who living near factories was 30 (43.5%) and the Mean (SD), 75.6 (23.23), min (48.9 μg/m³), and max (112.2 μg/m³). The chi-square test shows that there were significant difference of PM_{10} between locations ($x^2 = 6.969$, $p<0.001$).

Table 4.4: Comparison between locations and concentration level of PM_{10}.

Variable	Percentage (%)	Min (μg/m³)	Max (μg/m³)	Mean±SD (μg/m³)	x^2	p-value
Factories	30(43.5)	48.9	112.2	75.6±23.23		
Main Road	18(26.1)	49.2	105.1	90.1±17.23	6.959	<0.001
Construction Site	21(30.4)	89.2	98.3	96.6 ±2.54		

N=69,

4.3.1 Spatial Distribution of PM_{10} Concentration with Geographical Information System (GIS)

Figure 1 shows the distribution pattern of PM_{10} in the study area with the Inverse Distance Weight (IDW) interpolation technique of GIS. High concentration of PM_{10}, up to 112 ug/m^3 was detected in residence that located less than 2 km from the pollution sources such as construction site, industrial area and main road. In contrast, low concentration of PM_{10} was detected in residence that located more than 2 km away from these sources.

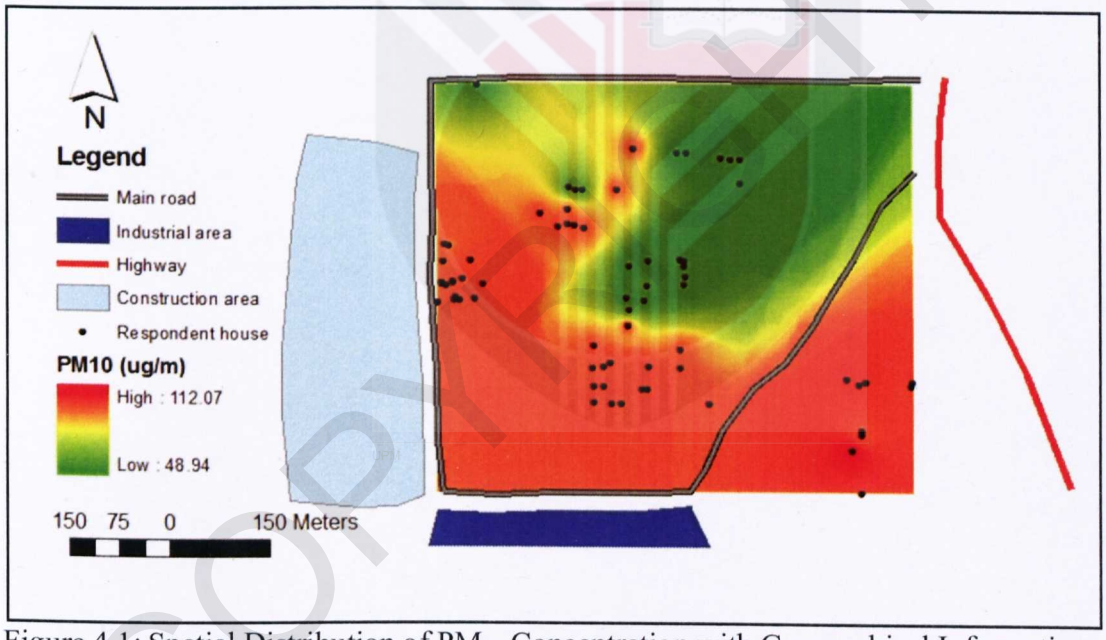

Figure 4.1: Spatial Distribution of PM_{10} Concentration with Geographical Information System (GIS)

Table 4.5 showed the concentration level of PM_{10} between two kindergartens. The first kindergarten was located about less than 100 meter from construction site was the highest concentration of PM_{10} compared to the second one with the value of average 91.3μg/m^3, and range between 46.6μg/m^3 to 161.0μg/m^3. Second kindergarten located >500 meter from the construction site has average the PM_{10} value of 65.9 μg/m^3, and range of 20.3 μg/m^3 to 122.7 μg/m^3.

Table 4.5: Concentration of PM_{10} between two kindergartens

variable	Maximum (μg/m3)	Minimum (μg/m3)	Average (μg/m3)
Kindergarten I	161.0	46.6	91.3
Kindergarten II	122.7	20.3	65.9

4.4 Distribution of Respondents Outdoor Information

Table 4.6 showed the background of respondents house. All of these home building materials were made from concrete. Majority of the children living in two-storey terrace houses (63), whereas only six of them living in a flat house. There were 18 children living in a proximity of the main road (less than 100 meter to 500 meter), 21 children living in a proximity of construction sites (less 100 meter to 500 meter) and 16 children living in a proximity of factories (<500 m).

Table 4. 6 : Information Background of Respondent's House.

Variables	Percentage (%) (n=69)
Home Building Material	
Cements	69 (100.0)
Type of Housing	
Flats	6 (8.7)
Two-storey Terraced	63 (91.3)
Location from main road	
<100 meter from road	8 (11.6)
>100-500 meter from road	9 (13.0)
>500-1000 meter from road	5 (7.2)
>1000 meter from road	47 (68.1)
Location from factories area	
<500 from factories	16 (23.2)
>1000-1500 meter from factories	14 (20.3)
>1500-3000 meter from factories	8 (11.6)
>3000 meter from factories	31 (44.9)
Location from construction site area	
<100 meter from site	15 (21.7)
>100-500 meter from site	6 (8.69)
>500-1000 meter from site	7 (10.1)
>1000 meter from site	40 (58.0)

N=69,

4.5 Distribution of Exposure Indoor Sources

Table 4.7 showed the exposure of indoor sources. Most of respondents who living near factories use fuel for cooking for both which are combine of electrical and gas, 25 (83.3%) then follow for construction site for both which were 17 (80.9 %).

The highest percentage of cooling air was fan usage which from who living near factories area 12 (40%) and only 7 (23.3%) used air-conditioner and the rest used fan 12 (40%). Most of respondents who stayed near road use air-conditioner 9 (50.0%) and the rest use fan and both. Most of respondents who stayed near construction site were used both for cooling air which were 10 (47.6%).

Most of respondent who stayed near construction site having pets which were 13 (43.3%), then followed by factories and road which were 8 (38.1%) and 7 (38.0%) respectively. For carpet usage still the construction site are highest usage of carpet which were 21 (70.0%) then followed by road and factories.

Table 4.7 : Exposure of indoor sources

Variables	Percentage of Respondents (%)		
	Factories (n=30)	Road (n=18)	Construction Site (n=21)
Fuel for cooking			
Gas	4 (13.3)	5 (27.7)	3 (14.3)
electric	1 (3.3)	0 (0.0)	1 (4.8)
Both	25 (83.3)	13 (72.2)	17(80.9)
Cooling air			
Air-conditioner	7 (23.2)	9 (50.0)	5 (23.8)
Fan	12 (40)	4 (22.2)	6 (28.5)
Both	11 (36.8)	5 (27.7)	10 (47.6)
Pets	8 (38.1)	7 (38.9)	13 (43.3)
Carpets usage	13 (61.9)	14 (77.8)	21 (70.0)

N=69,

Table 4.8 shows the electronic mosquito repellants were commonly used in the house of these children. The Chi-square test shows that that there was an association between mosquito repellants usage and the indoor PM_{10} concentration with x^2 value of 11.838 ($p<0.001$).

Table 4.8 : Exposure to Pollutants Sources among Respondents

Variables	High PM_{10} level (> 80µg/m³)	Low PM_{10} Level (< 80µg/m³)	x^2	p-value	Odd Ratio	95% CI
Mosquito Repellants						
Mosquito Coil	2 (6.3)	1 (2.7)				
Electric	24 (75.0)	20 (54.1)	11.838	*0.008		
Aerosol Spray	6 (18.8)	16 (43.2)				
Smoking						
Yes	11 (34.4)	19 (51.4)	-	0.120	2.015	0.761-5.335
No	21 (65.6)	18 (48.6)				

N=69 * p significant <0.001

4.6 Respiratory Health Symptoms among Respondents

Figure 4.2 shows the respiratory health symptoms among children in this study, includes coughing, phlegm, chest tightness and wheezing. Children who lived in a proximity to the main road were among the most having phlegm symptom (72.2 %) compared to children who lived in a proximity to construction sites (47.6%) and factories (43.3%). Meanwhile, coughing was another common symptom for children

who lived in a proximity to factories (56.3%) and road (55.6%), but not to children who lived in a proximity to construction site (23.8%). Other symptoms such as chest tightness and wheezing were not commonly occurred as reported by children parents in this study.

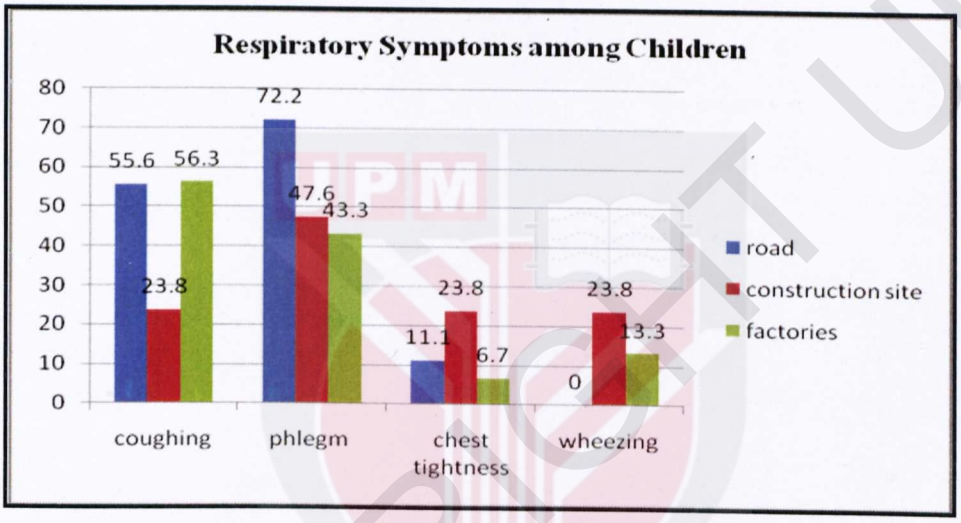

Figure 4.2 : Distribution of Respiratory Symptoms among Children between locations

4.6.1 Prevalence of Respiratory Health Symptom among Children

Table 4.9 shows that result the prevalence of respiratory health symptom among studied children who has been found from informed questionnaires by parents. Results shows that 33 (47.8%) of childrens were having coughing, In addition, about 37 (53.6%) of children were having phlegm whereas only 9 (13%) of children were having chest tightness and 11 (16%) of children were having wheezing.

Table 4.9: Prevalence of Respiratory Health Symptoms among Studied Children

Respiratory symptoms	Percentage	
	Yes	No
Cough	33 (47.8)	36 (52.2)
Phlegm	37 (53.6)	32 (46.4)
Chest Tightness	9 (13.0)	60 (87.0)
Wheezing	11 (16.0)	58 (84.0)

N=69

4.7 Lung Function among Respondents

Lung function among children in this studied was based on *American Thoracic Society* (1991) to determine whether the lung function among studied children was normal or not. Table 4.10 shows that the prevalence of lung function abnormalities which were FVC% predicted, FEV_1% predicted and FEV_1/FVC% predicted among studied children. The results shows that about 33 (47.8%) of children were having abnormal of lung function for FVC% predicted whereas about 36 (52.2%) of children were having normal for FVC% predicted. The result of indicator for FEV_1% predicted shows that about 38 (55.1%) of children were having abnormal of lung function whereas about 31 (44.9%) of children were having normal of lung function

abnormalities. About 69 (100%) of children were having normal of lung function for indicator of FEV_1/FVC% predicted.

Table 4.10 Prevalence of Lung Function Abnormalities among Respondents

Lung Function	Number of abnormal (%)	Number of normal (%)
FVC% predicted	33 (47.8)	36 (52.2)
FEV_1% predicted	38(55.1)	31 (44.9)
FEV_1/FVC% predicted	0 (0)	69 (100.0)

N=69

Table 4.11 shows that the prevalence of lung function abnormalities among groups of children with high concentration level of PM_{10} (> 80µg/m^3) and low concentration level of PM_{10} (< 80µg/m^3) which were FVC% predicted, FEV_1% predicted and FEV_1/FVC% predicted among studied children.

The results shows that about 28.6% of children were having abnormal of lung function for FVC% predicted in the group of high concentration level of PM_{10}. However, 43.8% of children were having abnormal for FVC% predicted in group of low concentration level of PM_{10}.

In addition, about 76.2% of children were having abnormal of lung function in group of high concentration level of PM_{10} whereas about 45.8% of children were having abnormal of lung function in group of low concentration level of PM_{10}. About 69 (100%) of children were having normal of lung function for indicator of $FEV_1/FVC\%$ predicted for both group either high or low concentration level of PM_{10}.

Table 4.10 and table 4.11 shows that the prevalence of lung function abnormalities for FVC% predicted, FEV_1% predicted and $FEV_1/FVC\%$ predicted indicators were based on Miller (1978).

Table 4.11 Prevalence of Lung Function Abnormalities among Groups of Children

	***Lung Function Abnormality**	
Lung function	**High PM10 level (> 80µg/m³)**	**Low PM10 Level (< 80µg/m³)**
FVC% Predicted	Abnormal (28.6 %) Normal (71.4 %)	Abnormal (43.8%) Normal (56.2 %)
FEV1% Predicted	Abnormal (76.2 %) Normal (23.8 %)	Abnormal (45.8 %) Normal (54.2%)
FEV1/FVC% Predicted	Normal (100%)	Normal (100%)

N= 69

4.8 Comparison of Lung Function among Studied Children

The result of Mann – Whitney U test was performed to compare the values of FVC, FEV_1, FVC% predicted, FEV_1% predicted and FEV_1/FVC% predicted between both groups which were high and low PM_{10} concentration. The statistical analysis proved there were significant difference of FVC% predicted, $FEV_{1\%}$ predicted, FVC and FEV_1 as shown in Table 4.12. However, the variable of FEV_1/ FVC % predicted has no significant difference between high level of PM_{10} concentration and low level of PM_{10} concentration group.

Table 4.12 : Comparison of Lung Function among studied children

Variables	High PM_{10} level ($\geq 80\mu g/m^3$) (n=32) Median (IQR)	Low PM_{10} level ($\leq 80\mu g/m^3$) (n =37) Median (IQR)	Z value	P value
FVC (liter)	2.20 (1.15)	2.37 (0.46)	-2.68	0.004*
FEV_1 (liter)	1.18 (0.99)	2.21 (0.44)	-2.63	0.012*
FVC % predicted	74.50 (11.80)	85.00 (17.00)	-2.91	0.791
FEV_1 % predicted	73.50 (11.00)	84.00 (16.00)	-2.50	0.008*
FEV_1 / FVC %	95.8 (2.70)	96.00 (2.9)	-0.26	0.007*

b= Mann U Whitney Test
*significant at p <0.05

4.9 Comparison of Respiratory Health Symptoms among Studied Children

As shown in Table 4.14, cough showed an increased risk of PM_{10} concentration, but the finding was not significant (OR = 1.3, 95% CI 0.46 - 3.63). However, phlegm was shown significant but not an increased risk (OR = 0.171, 95% CI 0.05-0.55). Chest tightness and wheezing were not having any significant difference between of two groups' level concentration of PM_{10}.

Table 4.14 Association between Respiratory Symptoms with PM_{10} Concentration

Variables	High PM_{10} level (> 80µg/m³)	Low PM_{10} Level (< 80µg/m³)	x^2	p-value	Odd Ratio	95% CI
Coughing			0.251	0.794	1.300	0.465-3.632
Yes	17 (53.1)	16 (43.2)				
No	15 (46.9)	21 (56.8)				
Phlegm			4.032	*0.03	0.171	0.053-0.550
Yes	18 (56.3)	22 (59.5)				
No	14 (43.7)	15(40.5)				
Chest tightness			1.825	0.177		
Yes	4 (12.5)	5 (13.5)				
No	28 (87.5)	32 (86.5)				
Wheezing			0.400	0.708		
Yes	3 (9.38)	5(13.5)				
No	29 (90.6)	32 (86.5)				

(N=69) , Fisher's Exact Test for Expected Value <5

4.10 Correlation of the Concentration Level of PM_{10} with Lung Function and Respiratory Health Symptoms

Result from Spearman correlation shows that there was an inverse correlation between FVC and FEV_1 which ($r = -0.388$, $p<0.001$) and ($r = -0.379$, $p<0.001$) respectively with concentration level of PM_{10}. Table 4.14 shows there were no significant different between FVC% predicted, FEV_1% predicted and concentration level of PM_{10} in this study.

Table 4.14 Correlation of PM_{10} concentration with lung function among studied children.

Variables	r- value	p- value
FVC (Liter)	-0.388	<0.001**
FEV_1 (Liter)	-0.379	<0.001**
FVC% Predicted	0.230	0.057
FEV_1% Predicted	0.194	0.110
FEV_1/FVC% Predicted	-0.100	0.412

N=69
***Significant at P<0.001*
r= spearman correlation

CHAPTER 5

DISCUSSION

5.1.1 : Socio demographic of respondents.

The study was conducted at industrial area, Kajang, Selangor. A total of 69 respondents involved in this study. The respondents were chosen purposively based on several inclusive and exclusive criteria that have been stated in Chapter 3. About 120 sets of concern letter were distributed to all parents for permission to do research against their children. Unfortunately, it just only 69 respondents are allowed be involved this kind of study according to their awareness about their children safety. Therefore, response rate for respondent was 57.5% after calculating. This occurred because possibility parents who does not know and not clearly understand what the

objectives of this research even though letter of explanations were distributed together with concern letter for parents.

All respondents were Malay 69 (100%) because of most of them were from the similar school which Islamic kindergartens. Therefore, all of them were Malaysia and easy for communicate among them.

Based on the result of parental education background, educational level were divided into two which educational level of father and educational level of father according to locations. Majority of respondent's father are in STPM/ Diploma level which were 21 (70%) living near factories. Then, follow educational level of father at construction site which were 11 (52.4%) also in level of STPM/ Diploma but living near construction site. Then, all level of educational which were 6 (33.3%) all respondents living near road for SPM, STPM/Diploma and Degree respectively.

Educational level was divided into two which educational level of mother and educational level of mother according to locations. There have a result on PMR level among respondent's mother which were 1 (5.6%) from mother who living near road. Majority of respondent's father are in STPM/ Diploma level which were 17 (56.7%)

living near factories. Then, follow educational level of mother at construction site which were 13 (61.9%) also in level of STPM/ Diploma but living near construction site. Level of education influences the type of jobs are usually entered into where the higher education level, the more good jobs available.

The monthly incomes of respondents have been categories into 4 categories. Results were obtained in sixty nine (69) Malay school children; comprised of 39 girls and 30 boys, age from 5 to 6 years old. Majority of the children comes from an intermediate family with household income range of RM 2501 to RM3000 (44.9%) Most of the salary scale also influences the level of education.

5.1.2 Distribution Concentration of PM_{10} between Locations

The distribution concentration of PM_{10} among respondent based on three location in industrial area of Kajang are respondents who living near factories, respondents who living near road and construction site. Based on the result, the highest concentration level of PM_{10} is construction site which were 21 (30.4 %,) and the Mean (SD), 96.6 (2.54). Then, followed by concentration level of PM_{10} was road which were

30 (43.5%) and the Mean (SD), 90.1 (17.23). Concentration level of PM_{10} who living near factories was 30 (43.5%) and the Mean (SD), 75.6 (23.23).

The highest concentration of PM_{10} level is construction site because there has a undergoing of construction third phase of new residential at Taman Sutera, Kajang. The distance from construction site and residential area are almost less than 100 meter. During collection, the environment really shows that it was really dusty. In addition, about one and two of kindergartens were opened in front of this construction site.

The second highest of PM_{10} concentration level was who living near road. It is because of there has a lot of car continuously use this kind of road to go to prime road. It is not because of only car use this road, but there has a lot of lorry also use the road. In addition, construction site were still under progressing, so that lorry will always use this road to complete their job. The third highest of concentration PM_{10} level was living near factories. PM_{10} level can be reduced by presence of trees that act as biological filters.

Hypothesis one was failed to be rejected because result from this study found that the exposure to indoor PM_{10} concentration among children living in industrial area

was significantly difference. It was suggested that the exposure to indoor PM_{10} to be harmful to health and even to lungs. Abdul Mujid (2001) found that there were significant higher mean of PM_{10} concentration in the exposed which children living near quarry compare to children living far from quarry. This is because of the small particles emitted from car smoke, all the factories and construction site activities caused ambient air pollutant, thus staining the house and increasing concentration level of indoor pollutant.

5.1.3 Distribution of Respondents Outdoor Information

All the home building material of respondents was made by cements which were 69 (100%). Most of respondents are stayed in two types of housing which were flats 6 (8.7%) and 63 (91.3 %) for two-storey terrace. Respondents who living near less 100 meter and more than 100 to 500 meter from the road were 9 (11.6%) and 9 (13%) respectively. The two distances are considered as really near to road. Respondents who living near less 100 meter and more than 100 to 500 meter from the construction site were 15 (21.7%) and 6 (8.69 %) respectively. The two distances are considered as really near to road.

Study done by Juliana (2002) found that there were significant difference home building material and type of housing between Kuala Lumpur and Terengganu which majority of houses in Kuala Lumpur near to main road which less than 100 meter whereas majority of children in Terengganu living more than 1000 meter from main road.

5.1.4 Distribution of Exposure Indoor Sources

The highest percentage of cooling air was fan usage which from who living near factories area 12 (40%) and only 7 (23.3%) used air-conditioner and the rest used fan 12 (40%). Most of respondents who stayed near road use air-conditioner 9 (50.0%) and the rest use fan and both. Most of respondents who stayed near construction site were used both for cooling air which were 10 (47.6%). Through the observation of researchers, the flow of air or ventilation in the closed condition of the house during the study was carried out. These practices to prevent dust entering into house, but it will reduce ventilation where dust or PM_{10} will be retaining in the house. Kildeso (1999) study found that there was an increase of 2 times the particulate level when the air conditioner of fan is not in use.

Mosquito repellant usage was common indoor residential among respondent which there association between mosquito repellant usage and PM_{10} concentration, (x^2 = 11.838, $p<0.05$). Strongly evidence through study of Azizi, there are many sources of indoor air pollution in any home. These include combustion sources such as oil, gas, coal, wood for cooking purpose, tobacco smoke and combustion of mosquito coil. Between the sources identified, these are several familiar activities among Malaysian that contribute to indoor air pollutant. It is include cooking activities, tobacco smoke and combustion of mosquito coil. (Azizi, 1990).

Strongly evidence support study done by Juliana, sources of exposure based on mosquito coil may cause increasing risk towards to respiratory health among children. Mostly, this exposure occurs continuously for 6-8 hours per night. Thus, children also breathe in air contaminated with smoke from mosquito coil as this material was usually placed near the bed or in the breathing zone of children while they sleep. (Juliana, 2004)

In addition, improper ventilation system at home makes them more badly. This condition cause the contaminants that have accumulated up until the result can be achieved to a level that can cause health problems and discomfort to the occupants in the house, especially to children. This condition occurs when all the doors and windows closed to prevent entry of mosquitoes into the house.

5.1.5 Exposure to Concentration level of PM_{10}

This study found that there has a significantly difference for exposure concentration level of PM_{10} measured between three location which are lives near at factories, road and construction site. These three location are assembles at a residential area which near to industrial area. Indoor level of PM_{10} near construction site is highest, followed by road and factories respectively. However, concentrations of PM_{10} levels in these areas are still below levels allowed by Department of Environment which is 150μg/m³. The differences of PM_{10} level between three locations are might be due to the emission of traffic pollutant, site pollutant and factories pollutants from outdoor activity. Most of industrial areas are growing up in urban areas that contribute of air pollutant in Malaysia (DOE,2010). As reported also by previous study, school children in urban were exposed to more particulate matter emitted by indoor activity (Chalaulakou et al.2003).

Monitoring results of PM_{10} concentration level in the respondent's house within 24 hours showed there are still lower levels of 150μg/m³ and monitoring carried out only once at each home during the study. If a continuous or daily monitoring carried out, the possibility of exceeding the PM_{10} level of 150μg/m³ will be found.

Based on previous study done Sofiah (2010), indoor particulate matter concentration was significantly higher in children living near busy road than comparative group which children living less busy road with (t=-2.496, p=0.014). The study of Mujid (2003) in Sungai Siput Utara, Perak also highlighted that the mean of PM_{10} concentration (76.66 $\mu g/m^3$) was higher in exposed area of the quarry compared to the non-exposed group, children who live far away from quarry but in the same district.

Main road was also the major contributors of PM_{10} exposure in this study mainly because of the heavy traffic. The study of Aminatul (2005) found that main road was the factor of exposure to indoor PM_{10} and effect on respiratory health among children at Kota Bahru, Kelantan. The concentrations of PM_{10} in residents near to factories were the lowest (75.6 $\mu g/m^3$) in this study. This is consistent with Abdul Mujid (2003) that determine 76.66 $\mu g/m^3$ of PM10 concentration in area near to quarry and cement factories of Sungai Siput, Perak.

The GIS's result shows that majority of respondent in high level of PM_{10} concentration in studied area. The highest concentration of PM_{10} (up to 112 $\mu g/m^3$) was detected among respondents that live near to construction site, industrial site and highway (less than 2 km). Meanwhile, PM_{10} concentration among respondents who live more than 1 km from these sources was low, indicated by green color in the map. In

spite of the fact that simulation of air pollutant distribution is carried out by standalone computer systems, the spatial database in the framework of the GIS is used to support decision-making processes in a more efficient way. Mostly, data are included in the map layers as attributes. Other map layers are carried out by the methods of spatial interpolation, raster algebra, and case oriented analysis. A series of extensions is built into the GIS to adapt its functionality. (Matejicek, 2003).

5.1.6 Comparison of Respiratory Health Symptoms among Studied Children

There were four parameters of chronic respiratory symptoms that were studied which were identified using the Questionnaire ATS-DLD-78-C WHO (1982). Coughing was the common symptoms among children (Table 4.14). Coughing was an important way to keep the throat and airways clear. However, excessive coughing may have an underlying disease or disorder. Cough without wheeze was associated with environmental factors including dampness in the home and air pollution, and was strongly related to socioeconomic status. (Jongste and Shields, 2003).

Alhtough, most of children grew up in same residential area, but presence of industrial activities such as transportation from factories or main road and construction site were contribute in high risk of develop respiratory symptoms among children in this

area. Study of school children in Hong Kong found a significant increase in respiratory symptoms in children living in contaminated areas, although some factors such as exposure to smoke controlled. This study also shows that there were significant different between concentration level of PM_{10} (OR: 2.015, 95% CI: 0.761-5.353) and indoor sources pollutans such as smoking habit among family members of respondents .

According to study done by Arividya (2000) found that the children who lives in smoking father's habit has significant with phlegm prevalence ($p<0.05$). In addition, the previous study done by Spengler and Sexton (1983) found that the exposure of smoke from parent smoking habit has significant with respiratory disease among children. This study was supported by Colley (1974) regarding the respiratory health in children and parental smoking and phlegm production done at Aylesbury, Buckinghamshire found that there has a significant (x^2 for trend 6865; 001 > P > 0005). The findings indicated an association between parental smoking habits and the prevalence of symptoms in their children.

5.1.7 Correlation of Lung Function between Studied Children

Lung function test was performed among children. By comparing of lung function among children (Table 6) shown the result of Mann – Whitney U test that have been run to all the value of lung function that been studied. From that, it have been found which the three variables of FVC % predicted, FEV_1 % predicted, FVC and FEV_1 shows have significant difference between the two group of study, high concentration level of PM_{10} and low concentration level of PM_{10}. Whereas, the variable of FEV_1/ FVC % predicted has no significant difference between high level of PM_{10} concentration and low level of PM_{10} concentration group.

Spearman correlation test has determined there was an inverse correlation between PM_{10} exposure level with the value of FVC (liter) , FEV_1 (liter), among studied locations. However, there has no signifficant relationship between PM_{10} exposure level with the value of FVC, FEV_1, FVC % predicted, FEV_1 % predicted, and FEV_1/FVC % among studied locations.

This shows that exposure of high level of PM_{10} may caused the decreasing level of lung function among studied children. This study was supported by study done among children at Sungai Siput which were the concentration level of PM_{10} has a

significant correlation with the FVC % predicted (r = -0.478, $p<0.05$) and FEV_1 % predicted (r = -0.482, $p < 0.05$) among studied children. (Mujid, 2001).

In addition, exposure of indoor PM_{10} can caused reduction of lung function especially to children and caused the tissue changes, lung stucture and respiratory system mechanism among children. (EPA, 2010).

This finding was supported by study done by Horak (2000) found that decresing lung function among children in range between 8 and 11 years old in Austria has a significant with increasing level of PM_{10}. However, the prolong effect of exposure among children will enhance the physiological effect especially on organ development when exposed to pollutant such as PM_{10} (WHO, 2010)

5.2 Conclusion

Result from this study found that children who live in industrial area as in Kajang were exposed in high air PM_{10} inside homes and school have the increasing level of PM_{10} concentration. Besides that, respiratory symptoms and children in industrial area are exposed to high risk getting respiratory health implication if the same exposure are still continue for a long time.

In term of respiratory symptoms, this study found that the highest concentration level of PM_{10} will contribute to highest prevalence of respiratory health problems among children. Most of children were having significant increase of respiratory health problems such as coughing, wheezing, phlegm and chest tightness.

The result of PM_{10} concentration level having association with lung function and respiratory symptom effect among studied children. Study shows that the continuous exposure of PM_{10} level emitted from factories, road and construction site will contribute to reduction of lung function and increasing of respiratory health symptoms.

5.3 Recommendation

Exposure to air pollution problems should be taken seriously by the public view, especially to parents because parents are really closed to children. Health program on the risk of exposure to air pollutant should be done so that they are more concerned and aware of the trends of exposure to health and thus creating a clean and comfortable environment of life for their children's development.

A further epidemiology study are planned and overall has to be done to monitor the long term effects of air pollution exposure on children, especially those living near industrial area by involving the wider community. It is not only involved the children alone, even the elderly, adults and people with chronic respiratory health problem.

The study of others sources of indoor air pollutants such as volatile organic compound (VOCs), nitrogen oxides (NO), and carbon monoxide (CO) should be carried out. This is intended to gather data to assess the impact and magnitude as a result of exposure to contaminants agent in their house environment of health and children development.

Otherwise, avoid the use of materials that can produce indoor air pollution such as mosquito coil. Use other alternative to replace the usage such as nets. However, if they had to use them, they can use in a short time and increase the air ventilation in the house so that; its impacts on health can be reduced. Smoking in the home environment should also be stopped as early preventive measures to increase the level of air pollution inside the home. A good ventilation and sufficient space is necessary to ensure a flow of impact on human health especially to children.

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APPENDICES

FAKULTI PERUBATAN DAN SAINS KESIHATAN
FACULTY OF MEDICINE AND HEALTH SCIENCES
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

BORANG PERSETUJUAN RESPONDEN

TAJUK PENYELIDIKAN :

PENILAIAN TAHAP KESIHATAN TERHADAP KANAK-KANAK DI KAWASAN PERINDUSTRIAN, KAJANG, SELANGOR TERHADAP PENDEDAHAN PARTIKEL TERNAFAS (PM10)

PENYELIDIK :

NUR FAZHILAH BINTI ABDUL RAZAK

Saya..... No Kad Pengenalan. .....)
beralamat.....
.....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam menyertai penyelidikan klinikal *(pengajian klinikal/ pengajian soal selidik/ percubaan ubat-ubatan) seperti yang disebut di atas.

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

*potong yang tidak berkenaan

Tandatangan .....
(*Responden*)

Tarikh :.....

Tandatangan .....
(*Saksi*)

Nama :.....

No. K/P: .....

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

Tarikh .....

Tandatangan .....
(*Penyelidik*)

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BORANG PERSETUJUAN PENYERTAAN (IBUBAPA/PENJAGA)

TAJUK PENYELIDIKAN :

PENILAIAN TAHAP KESIHATAN TERHADAP KANAK-KANAK DI KAWASAN PERINDUSTRIAN, KAJANG, SELANGOR TERHADAP PENDEDAHAN PARTIKEL TERNAFAS (PM10)

PENYELIDIK :

NUR FAZHILAH BINTI ABDUL RAZAK

Saya..... No Kad Pengenalan. .....)
beralamat.....
.....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam menyertai penyelidikan klinikal *(pengajian klinikal/ pengajian soal selidik/ percubaan ubat-ubatan) seperti yang disebut di atas.

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

Saya berminat / tidak berminat * untuk mengetahui keputusan kajian yang dijalankan ke atas sampel saudara saya.

*potong yang tidak berkenaan

Tandatangan .....
(*Responden*)

Tarikh :.....

Tandatangan .....
(*Saksi*)

Nama :.....

No. K/P: .....

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

Tarikh .....

Tandatangan .....
(*Penyelidik*)

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PENERANGAN KEPADA PESERTA

TAJUK KAJIAN : PENILAIAN TAHAP KESIHATAN TERHADAP KANAK-KANAK DI KAWASAN PERINDUSTRIAN, KAJANG, SELANGOR TERHADAP PENDEDAHAN PARTIKEL TERNAFAS (PM10)

Terima kasih kerana membantu kami di dalam kajian ini.

Apakah kajian ini?

Kanak-kanak adalah antara penduduk yang paling mudah terpengaruh dan terdedah kepda partikel ternafas (PM10). Hari ini pelbagai jenis penyakit akut dan kronik dilaporkan berlaku di kalangan kanak-kanak dan ia dikatakan akibat dedahan kepada agen-agen toksik di sekeliling mereka. Antara agen-agen toksik yang berbahaya adalah terdiri dari bahan kimia, biologikal dan partikel ternafas (PM10). Adalah jelas bahawa semua pihak yang terlibat mahupun kerajaan sendiri perlu menyedari dan menjalankan tanggungjawab mereka untuk memastikan bahawa kualiti udara di kawasan perumahan yang berdekatan dengan kawasan perindustrian adalah terkawal dan langkah-langkah keselamatan berkaitannya dipraktikkan. Pendedahan kepada partikel ternafas (PM10) berhubungkait dengan fungsi paru-paru di mana ia dapat menghalang paru-paru dari beroperasi dengan baik. Berdasarkan maklumat yang diperoleh dari kajian ini, beberapa usaha boleh dijalankan bagi mengawal pencemaran udara di kawasan perindustrian daripada terus berleluasa. Antaranya adalah kawalan pencemaran udara yang boleh dipraktikkan iaitu melalui undang-undang, pendidikan dan teknikal.

Apakah tujuan kajian ini?

Kajian ini dijalankan adalah bertujuan untuk mengenalpasti hubungan di antara pendedahan kepada partikel ternafas (PM10) dengan peningkatan masalah fungsi paru-paru di kanak-kanak di kawasan perindustrian.

Berapa ramai responden yang terpilih?

Responden akan dipilih dari kalangan kanak-kanak dan penduduk di sekitar kawasan perumahan yang berdekatan dengan kawasan perindustrian yang terdedah kepada partikel ternafas (PM10). Seramai 65 orang untuk kanak-kanak dan 35 orang untuk kumpulan penduduk berhampiran

kawasan perumahan yang berdekatan dengan kawasan kilang. Jumlah keseluruhan responden adalah 100 orang.

Apakah jenis ujian yang akan dilakukan?

Semua responden akan diberi borang soal selidik oleh penyelidik. Selain itu, kualiti udara di kawasan perumahan akan di ukur menggunakan *samppling pump* di dalam rumah dan tadika responden yang terpilih itu sendiri. Bagi mengukur tahap fungsi paru-paru bagi semua responden, mereka dikehendaki melakukan ujian respirator dengan menggunakan spirometer.

Adakah bayaran dikenakan?

Pengkaji akan menanggung segala pembiayaan ujian yang akan dijalankan dan tiada sebarang bayaran dikenakan terhadap setiap responden.

Adakah maklumat dijamin sulit?

Semua maklumat yang diberikan oleh responden di dalam borang kaji selidik adalah dijamin sulit. Tiada huraian individu akan dibuat pada mana-mana bahagian di dalam kajian atau penerbitan.

Apakah hak anda?

Kajian ini melibatkan anda secara sukarela. Oleh itu, peserta mempunyai hak untuk menarik diri dari penyertaan dalam kajian ini pada bila-bila masa sekiranya peserta merasa tidak selesa untuk memberikan maklumat kepada pengkaji.

Apakah yang anda akan dapati?

Kajian ini akan menjelaskan samada pendedahan kepada partikel ternafas (PM10) boleh mengakibatkan masalah kepada fungsi paru-paru atau tidak kepada kanak-kanak dan penduduk berhampiran yang terdedah. Andainya aras partikel ternafas (PM10) adalah tinggi dan memberi kesan kepada responden, maklumat kajian ini berguna untuk tindakan selanjutnya. Melalui hasil kajian tersebut, beberapa polisi boleh digubal atau dilaksanakan oleh pihak organisasi tertentu untuk meningkatkan taraf kesihatan penduduk. Melalui kajian ini juga, anda dapat menetukan samada anda mengalami masalah sistem pernafasan atau tidak tanpa dikenakan sebarang bayaran dan ianya berfaedah untuk anda.

Apakah yang harus anda lakukan?

Anda dikehendaki menandatangani borang penyertaan responden yang menyatakan minat anda untuk menyertai kajian ini. Ianya boleh dilakukan setelah anda membaca dan memahami isi kandungan penerangan ini. Borang penyertaan responden boleh dikembalikan kepada pengkaji sebelum temubual dan ujian yang akan dijalankan. Sekiranya anda mempunyai sebarang kemusykilan, penyelidik akan membantu untuk membei maklumat yang selanjutnya.

Terima kasih atas kerjasama dan bantuan anda.

NUR FAZHILAH BINTI ABDUL RAZAK
Penyelidik
Bs. Sc. Kesihatan Persekitaran dan Pekerjaan

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PENILAIAN TAHAP KESIHATAN TERHADAP KANAK-KANAK DI KAWASAN PERINDUSTRIAN, KAJANG, SELANGOR TERHADAP PENDEDAHAN PARTIKEL TERNAFAS (PM10)

Dengan ini, sukacita dimaklumkan bahawa pihak tuan telah disenaraikan sebagai salah seorang responden dalam satu kajian penyelidikan yang mengkaji hubungan antara pendedahan kepada partikel ternafas (PM10) dan hubungannya dengan fungsi paru-paru. Oleh yang demikian, saya memohon jasa baik pihak tuan untuk menjawab soalan-soalan yang terdapat dalam borang soal selidik ini secara tepat dan jujur. Segala maklumat kajian yang diterima akan dirahsiakan. Kerjasama dari pihak tuan amatlah dihargai.

No Responden: | | | | | | |

Tarikh: | | | | | | |

No Telefon: | | | - | | | | | | | | |

Tandatangan: _____

SULIT

BAHAGIAN A : MAKLUMAT PERIBADI KANAK-KANAK DAN KELUARGA

1. No. responden : ☐☐☐

2. Nama kanak-kanak : _____
3. Nama ibu kanak-kanak: _____
4. Alamat : _____
   _____
   _____

5. No. Telefon :_____ (pejabat) _____ (rumah)

6. Tinggi kanak-kanak:_____ (cm) Berat kanak-kanak:_____ (kg)

7. Umur : _____

8. Tarikh lahir : _____

9. Bilangan adik beradik : _____ (orang)

10. Tahun persekolahan ☐☐☐☐ :

12. Jantina : ☐ Lelaki ☐ Perempuan

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

14. Tahap Pendidikan Bapa :

    ☐ Sekolah rendah ☐ PMR/SRP ☐ SPM ☐ STPM / Diploma

    ☐ Ijazah / Master / PhD

15. Tahap Pendidikan Ibu :

    ☐ Sekolah rendah ☐ PMR/SRP ☐ SPM ☐ STPM / Diploma

    ☐ Ijazah / Master / PhD

16. Pekerjaan bapa :_____

17. Pekerjaan Ibu :_____

18. Pendapatan bapa : RM_____ - _____ (sebulan)

19.Pendapatan ibu : RM_____ - _____ (sebulan)

20. Jumlah pendapatan isi rumah : RM _____ -_____ (sebulan)

21. Sila senaraikan tempat-tempat dimana kanak-kanak ini pernah tinggal selama 6 bulan atau lebih sejak lahir hingga sekarang

a) _____

b) _____

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

☐ < 6-17 bulan ☐ 18-29 bulan ☐ 30 bulan dan < 5 tahun

☐ 5-9 tahun ☐ ≥ 10 tahun

BAHAGIAN B : MAKLUMAT PERSEKITARAN DALAM RUMAH

1. Berapa buah bilikkah yang terdapat di dalam rumah ini? _____ Bilik

2. Berapa orangkah yang tinggal di dalam rumah ini ? _____ orang

3. Kanak-kanak ini tidur/ tinggal di dalam bilik

☐ Sendiri ☐ Berkongsi dengan 2 orang

☐ Berkongsi dengan 3 orang ☐ Berkongsi dengan 4 orang

4. Apakah bahan api yang digunakan untuk memasak ?

☐ Elektrik ☐ Minyak tanah ☐ Arang

☐ Gas ☐ Kayu api

5. Berapa kali dalam sehari anda gunakan untuk memasak ? _____ kali

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

☐ Ya ☐ Tidak

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

☐ Penyaman udara ☐ Kipas

☐ Lain-lain_____ (nyatakan)

8. Adakah anda mempunyai haiwan peliharaan di dalam rumah ?

☐ Ya ☐ Tidak

9. Jika 'Ya', sila nyatakan : _____

10. 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 _____ (sila nyatakan)

10b. Berapa kerapkah anda menggunakannya dalam seminggu? _____ Kali seminggu

10c. Dimanakah ianya ditempatkan di dalam rumah ?

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

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

☐ Ya ☐ Tidak

12. Senaraikan individu yang merokok di dalam rumah

☐ Bapa ☐ Bapa saudara

☐ Abang ☐ Datuk ☐ Lain-lain

13. Berapa batang rokokkah yang dihisap oleh individu di atas (di persekitaran dalam rumah anda sahaja)? _____ Batang sehari

14. Apakah alat yang digunakan untuk membersihkan rumah anda ?

Sila nyatakan :_____

15. Berapa kerapkah dalam seminggu anda membersihkan rumah anda?

_____ Kali seminggu

16. 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 jalanraya

☐ < 100 meter dari jalanraya

☐ > 100-500 meter dari jalanraya

☐ >500-1000 meter dari jalanraya

☐ >1000 meter dari jalanraya

4. Lokasi rumah anda dari kawasan kilang

☐ <500 meter dari kilang

☐ > 1-1.5 kilometer dari kilang

☐ >1.5-3 kilometer dari kilang

☐ > 3 kilometer dari kilang

5. Apakah pendapat anda mengenai persekitaran rumah anda?

☐ Sangat berhabuk

☐ Sederhana berhabuk

☐ Kurang berhabuk

6. 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 **yang tidak berkenaan**. Jika sekiranya anda ragu-ragu samada jawapannya **ya atau tidak**, sila tandakan **tidak.**

BAHAGIAN D : MAKLUMAT TARAF KESIHATAN KANAK-KANAK

BATUK / *COUGH*

	YA	TIDAK
1. Adakah anak anda selalu mengalami batuk beserta selesema?		
2. Adakah anak anda mengalami batuk sahaja ?		
2a. Jika ya(soalan 1&2), adakah dia batuk pada keseluruhan hari (4 hari atau lebih dalam masa seminggu atau selama 3 bulan berturut-turut dalam masa setahun)		
3. Sudah berapa tahunkah anak anda mengalami batuk seperti ini? _____ Tahun		

KAHAK/ *PHLEGM*

	YA	TIDAK
1. Adakah anak anda selalu mengalami kesesakan nafas serta mengeluarkan kahak dan juga mengalami selsema ?		
2. Adakah anak anda selalu mengalami kesesakan nafas serta mengeluarkan kahak dan juga selsema ?		
2a. Jika ya (soalan 1 &2) , adakah anak anda mengalami kesesakan nafas dan mengeluarkan kahak pada keseluruhan hari (4 hari atau lebih dalam masa seminggu atau selama 3 bulan berturut-turut dalam masa setahun)		

3. Adakah anak anda pernah mengalami serangan batuk, kesesakan nafas atau berkahak dalam masa seminggu atau lebih dalam masa setahun?		
3a. Jika ya (soalan di atas), sudah berapa lamakah masa ini berlaku?	_____ Bulan/ tahun	

DADA BERBUNYI/ *WHEEZING*

	YA	TIDAK
1. Adakah anak anda selalu mengalami masalah pernafasan berbunyi di dada?		
1a. Adakah anak anda mengalami selsema?		
1b. Jika ya(soalan di atas) Sudah berapa lamakah anak anda mengalami masalah ini (dada berbunyi) _____ Bulan/ Tahun		
2. Adakah anak anda pernah mengalami serangan dada berbunyi yang menyebabkan anak anda mengalami masalah kesesakan nafas?		
3. Adakah anak anda mengalami masalah ini setelah anak anda melakukan aktiviti seperti senaman atau latihan?		

KESAKITAN DADA/ *CHEST PAIN*

	YA	TIDAK
1. Sejak 3 tahun lepas, adakah anak anda pernah mengalami kesesakan bahagian dada yang menhalang anak anda daripada melakukan aktiviti biasa selama 3 hari? ***Jika YA, sila jawab soalan seterusnya.***		
1a. Adakah anak anda mengeluarkan kahak atau mengalami kesesakan nafas lain daripada keadaan biasa selain dari mengalami penyakit ini?		
2 . Adakah anak anda pernah dimasukkan ke hospital kerana mengalami masalah jangkitan di dada yang serius sebelum berumur 2 tahun?		

BAHAGIAN E: PENYAKIT-PENYAKIT LAIN

	YA	TIDAK
1. Adakah doktor pernah mengatakan bahawa anak anda mengalami 'eczema'(gatal kulit) sebelum berumur 2 tahun?		
2. Adakah doktor pernah mengatakan bahawa anak anda mengidap asma?		

3. Adakah anak anda mempunyai penyakit-penyakit seperti berikut? Jika ***YA***, pada umur berapakah ia didiagnoskan mengalami penyakit berikut?

	YA	TIDAK	(umur didiagnoskan)
a) campak			
b) bronkitis			
c) Emfisema			
d) Asma (lelah)			
e) Pneumonia (Jangkitan paru-paru)			
f) Lain-lain			

ALLERGI/ALAHAN

	YA	TIDAK
1. Adakah doktor pernah mengatakan bahawa anak anda mengalami alahan kepada debu?		
2. Adakah doktor pernah mengatakan bahawa kulit anak anda mengalami alahan kepada detergen atau bahan kimia tertentu?		
3. Adakah ia mengambil suntikan untuk mengurangkan masalah alahan tersebut?		

BAHAGIAN F: SEJARAH KESIHATAN KELUARGA

Adakah ahli keluraga seperti ibu bapa, adik beradik atau keluarga mengalami masalah-masalah berikut:

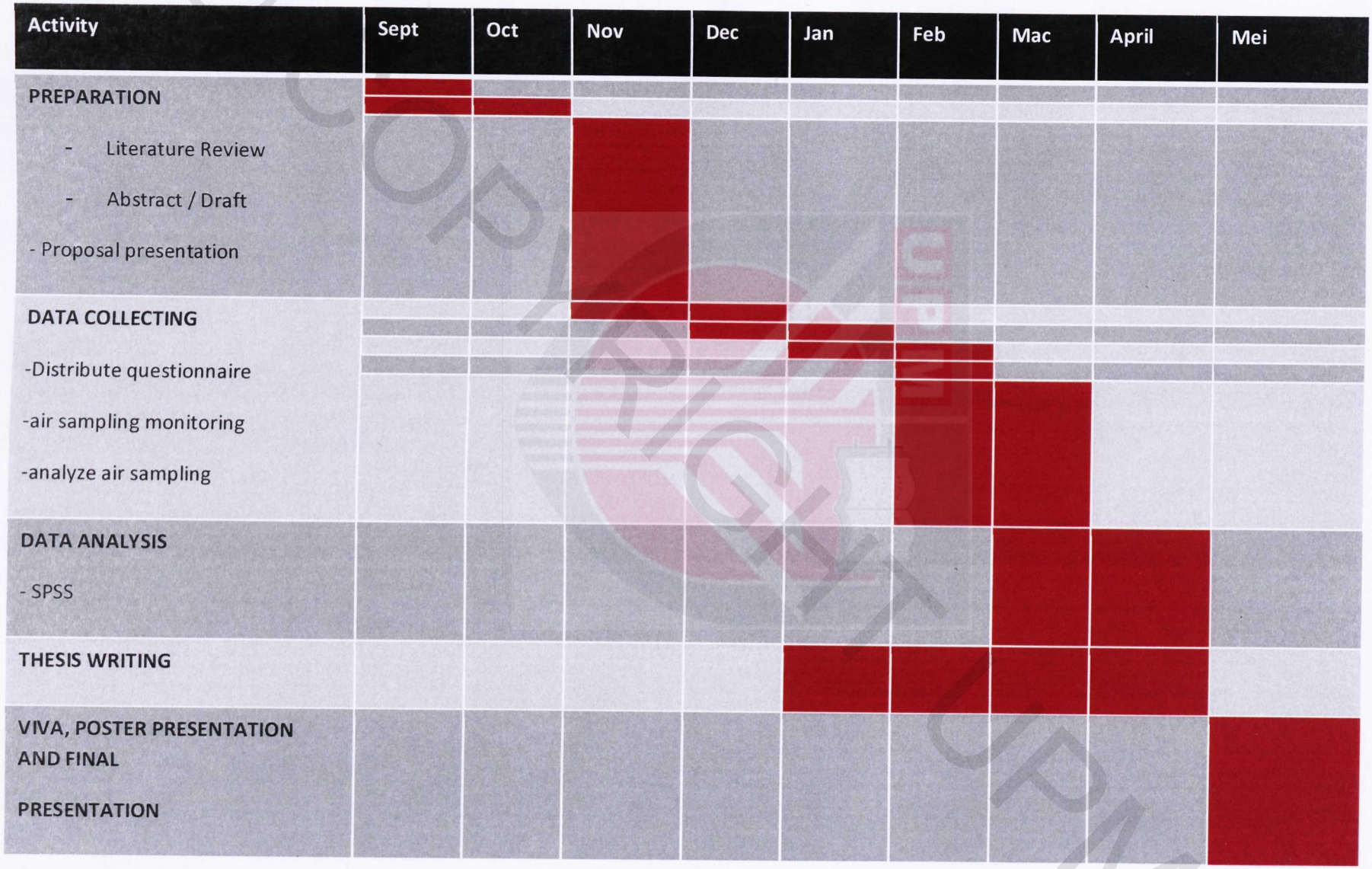
	YA	TIDAK
1. Bronchitis kronik		
2. Emfiseme		
3. Asma		
4. Barah paru-paru		
5. Lain-lain penyakit 6. _____		

SEKIAN TERIMA KASIH

Photo 1 : Lung Function Test

Photo 2 : Interviewing Parent by Using Questionnaire

FINAL YEAR PROJECT WORK TABLE



Activity	Sept	Oct	Nov	Dec	Jan	Feb	Mac	April	Mei
PREPARATION - Literature Review - Abstract / Draft - Proposal presentation									
DATA COLLECTING -Distribute questionnaire -air sampling monitoring -analyze air sampling									
DATA ANALYSIS - SPSS									
THESIS WRITING									
VIVA, POSTER PRESENTATION AND FINAL PRESENTATION									