



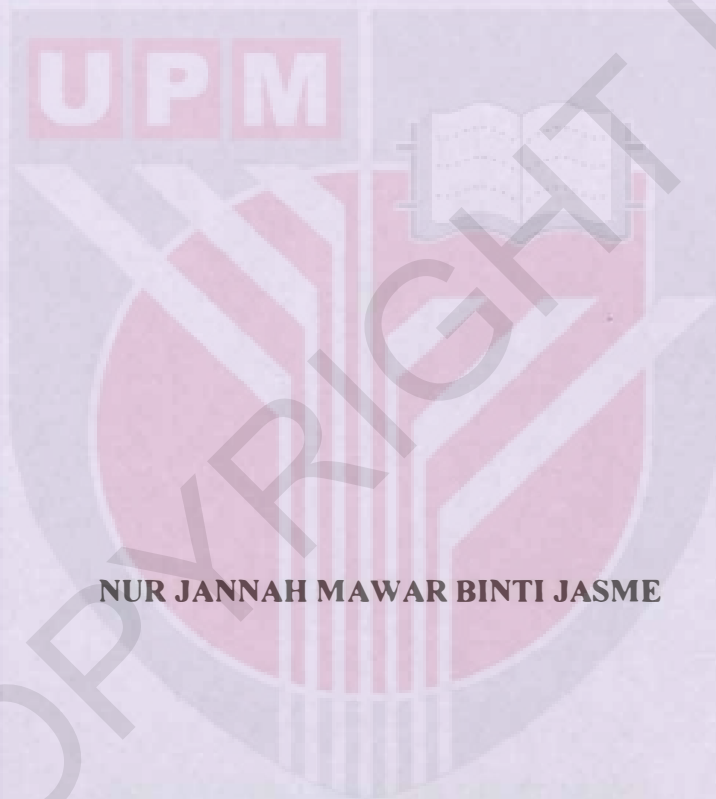
UNIVERSITI PUTRA MALAYSIA

EXPOSURE TO INDOOR PARTICULATE MATTER (PM_{2.5}), VOLATILE ORGANIC COMPOUNDS (VOCs) AND ITS ASSOCIATION WITH RESPIRATORY HEALTH AMONG PRESCHOOL CHILDREN IN AN INDUSTRIAL AREA IN PETALING JAYA, SELANGOR

NUR JANNAH MAWAR BINTI JASME

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HEALTH AMONG PRESCHOOL CHILDREN IN AN INDUSTRIAL AREA IN
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100051808

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IN PETALING JAYA, SELANGOR.**



BY

NUR JANNAH MAWAR BINTI JASME

**This thesis submitted in fulfillment of the requirement for the degree of
Bachelor Science (Environmental and Occupational Health) from the
Faculty of Medicine and Health Sciences, Universiti Putra Malaysia.**

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ABSTRACT

EXPOSURE TO INDOOR PARTICULATE MATTER (PM_{2.5}), VOLATILE ORGANIC COMPOUNDS (VOCS) AND ITS ASSOCIATION WITH RESPIRATORY HEALTH AMONG PRESCHOOL CHILDREN IN AN INDUSTRIAL AREA IN PETALING JAYA, SELANGOR.

NUR JANNAH MAWAR BINTI JASME

Introduction: Particulate Matter (PM_{2.5}) and Volatile Organic Compounds (VOCs), have links to respiratory related problems especially in children. Particulate Matter (PM_{2.5}) has been linked to the decrease in lung function growth among children. Meanwhile, VOCs exposure may increase the risk of childhood asthma. Children are more vulnerable to those diseases because they spend more time at home compared to working adults who spend most of their time working away from home. Besides, industrial area contributes to the increase in indoor pollutants which give adverse respiratory impact to children. **Objective:** To determine the exposure of PM_{2.5} and Volatile Organic Compounds (VOCs) and their association towards respiratory health among preschool children in industrial area. **Methodology:** 100 preschool children were involved in this cross sectional study with age between 5- 6 years old. The study group of 50 children are those who live near industrial area, while the comparative group of 50 children are those who lived far from industrial area. The questionnaires prepared were based on the American Thoracic Society questionnaire, which were filled out by their parents. Lung function test was done using Chest Graph H1-101 Spirometer. Gillian Air Pump and Pbbrae Portable VOC Monitor (Pbbrae 3000) was used to measure the amount of (PM_{2.5}) and Volatile Organic Compounds (VOCs) respectively. **Result:** There was a significant difference between studied group and comparative group for lung function test and lung function abnormality. Besides that, there was also a significant difference for prevalence of reported symptoms between studied and comparative groups for cough, phlegm and wheezing with 3 times more likelihood of getting cough for studied group (PR= 3.451, 95% CI =1.22-9.76). There was a correlation between PM_{2.5} with FEV₁/FVC of all respondents involved in this study. Indoor PM_{2.5} and VOCs concentration among studied group have inverse significant relationships for respiratory symptoms and reduction of lung function. **Conclusion:** The finding conclude that there was a significant difference between studied group and comparative group for lung function test and lung function abnormality. Furthermore, respondents living near an industrial area have a risk of getting lung function abnormality and respiratory problem.

Keyword: Indoor Air Pollutants, Particulate Matter (PM_{2.5}), VOCs, Respiratory Health, Industrial Area

ABSTRAK

PENDEDAHAN KEPADA PARTIKEL HALUS ($PM_{2.5}$), SEBATIAN ORGANIK MERUAP (VOCs) DAN KAITANNYA DENGAN KESIHATAN RESPIRATORI DALAM KALANGAN KANAK-KANAK PRASEKOLAH DI KAWASAN PERINDUSTRIAN DI PETALING JAYA, SELANGOR.

NUR JANNAH MAWAR BINTI JASME

Pengenalan: Partikel Halus Ternafas ($PM_{2.5}$) dan Sebatian Organik Meruap (VOCs), mempunyai hubungan dengan masalah pernafasan terutamanya kepada kanak-kanak. Di mana, Partikel Halus Ternafas ($PM_{2.5}$) telah dikaitkan dengan penurunan dalam perkembangan fungsi paru-paru di kalangan kanak-kanak. Sementara itu, pendedahan kepada Sebatian Organik Meruap (VOCs) boleh meningkatkan risiko asma kepada kanak-kanak. Kanak-kanak lebih terdedah kepada penyakit tersebut kerana mereka menghabiskan lebih banyak masa di rumah berbanding dengan orang dewasa yang menghabiskan sebahagian besar masa mereka bekerja di luar. Tambahan pula, kawasan perindustrian menyumbang kepada peningkatan pencemaran dalaman yang memberi kesan buruk kepada pernafasan kanak-kanak. **Objektif:** Untuk mengenal pasti pendedahan Partikel Halus Ternafas ($PM_{2.5}$) dan Sebatian Organik Meruap (VOC) serta kaitannya kepada kesihatan pernafasan dalam kalangan kanak-kanak prasekolah di kawasan perindustrian. **Kaedah kajian:** 100 kanak-kanak prasekolah yang berumur dalam lingkungan 5 hingga 6 tahun telah terlibat dalam kajian keratan rentas ini. 50 orang daripada keseluruhan kanak-kanak adalah mereka yang tinggal berhampiran dengan kawasan perindustrian, manakala 50 orang kanak-kanak yang lainnya tinggal jauh dari kawasan perindustrian. Borang kaji selidik yang diadaptasi dari *American Thoracic Society*, telah diedarkan dan diisi oleh ibu bapa kanak-kanak yang terlibat. Ujian fungsi paru-paru telah dijalankan dengan menggunakan *Chest Graph HI-101 Spirometer*, *Gillian Air Pump* dan *Pbbrae Portable VOC Monitor (Pbbrae 3000)* juga telah digunakan untuk mengukur jumlah $PM_{2.5}$ dan Sebatian Organik Meruap (VOCs) di dalam rumah kanak-kanak. **Hasil Kajian:** Terdapat perbezaan yang signifikan di antara kumpulan kanak-kanak yang tinggal di kawasan perindustrian dan kumpulan perbandingan untuk ujian fungsi paru-paru dan abnormaliti paru-paru. Selain itu, terdapat juga perbezaan yang signifikan bagi prevalen simptom yang dilaporkan antara kumpulan kajian dan perbandingan bagi batuk, kahak dan semput dengan kumpulan yang tinggal berhampiran kawasan perindustrian mempunyai 3 kali lebih kemungkinan mendapat batuk (PR=3.451, 95% CI=1.22-9.76). Terdapat hubungan antara Partikel Halus Ternafas ($PM_{2.5}$) dengan FEV_1/FVC bagi semua responden yang terlibat dalam kajian ini. Bagi kumpulan kajian, kepekatan Sebatian Organik Meruap (VOCs) dan Partikel Halus Ternafas ($PM_{2.5}$) telah meningkatkan risiko gejala pernafasan dan pengurangan fungsi paru-paru tetapi tidak signifikan dari segi statistik. **Kesimpulan:** Hasil kajian mendapati bahawa terdapat perbezaan yang signifikan di antara kumpulan kajian dan kumpulan perbandingan untuk ujian fungsi paru-paru dan abnormaliti paru-paru. Selain itu, responden yang tinggal berhampiran kawasan perindustrian mempunyai risiko mendapat fungsi paru-paru yang tidak normal dan masalah pernafasan.

Kata Kunci: Pencemaran Udara, Partikel Halus Ternafas ($PM_{2.5}$), Sebatian Organik Meruap (VOCs), Kesihatan Pernafasan, Kawasan Perindustrian

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LIST OF TERMS

ATS	American Thoracic Society
EPA	Environmental Protective Agency
WHO	World Health Organization
$\mu\text{g}/\text{m}^3$	Microgram per meter cubic
$\text{PM}_{2.5}$	Particulate Matter
VOCs	Volatile Organic Compounds

CHAPTER 1

INTRODUCTION

1.1 Background

Air pollution was identified as the world's single biggest environmental health risk. In 2012, air pollution had claim seven million deaths around the world which more than one-third of those deaths occurred in fast developing nations of Asia, said World Health Organization. They also said that about 3.3 million people had died as a result of indoor air pollution and 2.6 million deaths were related to outdoor air pollution, mainly in low- and middle-income countries in those regions. In Bombay, simply breathing is equivalent to smoking half a pack of cigarettes a day. While other country like U.S., air pollution causes as many as 50,000 deaths per year and costs as much as \$40 billion a year in health care and lost productivity. Like other country, Malaysians also face environmental health risk due to air pollution (Worldwatch Institute, 2013).

Death due to air pollution was linked with several critical diseases which largest part of the death occurs related to cardiovascular diseases. An assessment done by WHO by using satellite data, ground-level monitoring, modeling how pollutions drift in air and last but not

least is pollution-emissions data. The WHO assessment found that deaths related to outdoor air pollution 40% is due to heart disease and other 40% is due to stroke. Meanwhile, 11% of the deaths are due to chronic obstructive pulmonary diseases (COPD), whereas 6% of deaths caused by lung cancer. 3% of the deaths are related to acute lower respiratory infections in children which entirely cover quite large amount of victim. For deaths related to indoor pollution, it found that 34% of deaths are due to stroke, 26% of its die of heart diseases, 22% caused by chronic obstructive pulmonary diseases (COPD) and 6% due to lung cancer. Deaths involving children that exposed to indoor air pollution is slightly higher compare to outdoor air pollution which is 12%. This value showed that indoor air pollution influences the health of children greater than outdoor air pollution. This maybe because children spend more time inside building, unfortunately the causes are varying (WHO,2014).

Air pollution is a mixture of natural and man-made substances in the air we breathe such as fine particles produced by the burning of fossil fuels, ground-level ozone, which is a reactive form of oxygen that is a primary component of urban smog, and noxious gases such as sulfur dioxide, nitrogen oxides, carbon monoxide, and chemical vapors. The health effects of air pollution have been reported in research studies over the past 30 years. It is no surprise that air pollution causes deleterious damage to our respiratory tract. Simply by taking a deep breath of dirty air, we easily bring this air pollution inside our body. Air pollution can trigger new case asthma and provoke development of lung illnesses such as lung cancer and emphysema. Beside, air pollution can also interrupt the development of normal lung function, especially to younger age as they are exposed to these factors at earlier stage of body development.

Department of Environment Malaysia (2012), have listed the main air pollution sources in Malaysia is industries, development activities, motor vehicles, power generation, land clearing and open burning as well as open fires. These sources may contribute to both

indoor and outdoor pollution. While based on US EPA, there are many sources of indoor air pollution in any home. Categories of this pollutant including combustion sources, building materials and furnishings, products for household cleaning and maintenance, personal care or hobbies, central heating and cooling systems and humidification devices and also sources from outdoor air pollution that penetrate into buildings. Outdoor air can enter house with the outdoor pollutants and leaves a house by three ways. First is through infiltration whereas the outdoor air flows into the house openings, joints and also through tiny cracks around windows and doors, in walls, floors and ceiling. Second is through natural ventilation, air moves through opened windows and doors. Wind and air temperature differences between indoors and outdoors allow the infiltration and natural ventilation. Mechanical ventilation devices such as outdoor-vented fans and fans continuously remove indoor air and distribute filtered and conditioned outdoor air to strategic points throughout the house. Air exchange rate which is the rate where outdoor air replaces indoor air need to be high in order to decrease pollutants level in a building (United State Environmental Protective Agency, 2013).

There are few common indoor air pollutants that can aggregate the health of person staying inside the space. The pollutants include radon, biological contaminant, carbon monoxide, nitrogen oxide and sulphur dioxide, VOCs, Asbestos and also respirable suspended particles, PM_{2.5} and PM₁₀. Based on World Health Organizations, particulate matters 2.5 are particles that have aerodynamic diameter smaller than 2.5 μm (WHO, 2012). Particles in the size range of PM_{2.5} have a much greater probability of reaching the small airways and the alveoli of the lung than do larger particles. Numerous epidemiological studies have shown associations of acute and chronic exposures to airborne particles with risk for adverse effects on morbidity and mortality. In 1997, the US National Ambient Air Quality Standard for airborne particulate matter was revised, maintaining the previous indicator of particulate matter of less than or equal to 10 μm in aerodynamic diameter (PM₁₀) and

creating a new indicator for fine particulate matter of less than or equal to 2.5 μm in aerodynamic diameter ($\text{PM}_{2.5}$). Almost 10 years later there continues to be a lack of $\text{PM}_{2.5}$ health effects studies in the literature, particularly multi-year and multi-community based studies of its acute effect on specific causes of mortality (Francesca et. al., 2006).

VOCs include a variety of chemicals, some of which may have shorthand long-term adverse health effects. VOCs can originate from variety of household product including paints, paint strippers, and other solvents, wood preservatives, aerosol sprays, cleaners and disinfections, moth repellents as well as indoor combustion source (U.S EPA, 2012). Concentrations in new buildings were much greater, often by an order of magnitude or more, and appeared to arise from construction materials and building contents. It is generally believed that indoor air pollution, one way or another may cause indoor air complaints. However, any association between volatile organic compounds (VOCs) concentrations and increase of indoor climate complaints, like the sick-building syndrome symptoms, is not straightforward. The reported symptom rates of, in particular, eye and upper airway irritation cannot generally be explained by our present knowledge of common chemically non-reactive VOCs measured indoors (Wolkoff and Nielsen, 2001).

Children are more vulnerable to disease especially that related with indoor air pollutants at home because they spend more to at home compare to working adult that spend most of their days working outside. In addition, children have immature immune systems, greater food intake and inhaled breath per unit mass and rapid growth that making them more susceptible to develop symptom or disease due to indoor air quality (United State Environmental Protection Agency, 1995). United State Physician for Social Responsibility (PSR), state that children are particularly susceptible to the effects of air pollution because they breathe through their mouths, bypassing the filtering effects of the nasal passages and allowing pollutants to travel deeper into the lungs. And, children may ignore early symptoms

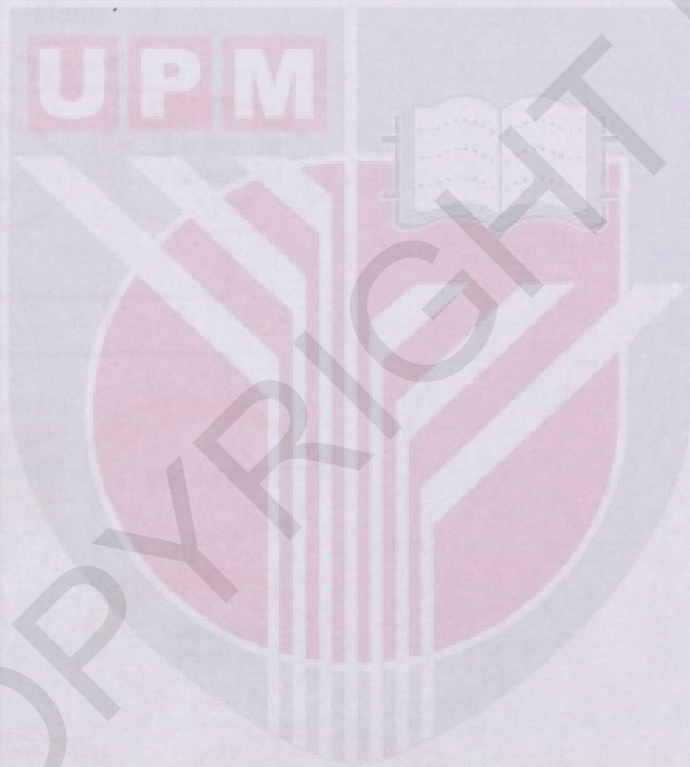
of air pollution effects, such as an asthma exacerbation, leading to attacks of increased severity.

1.2 Problem Statement

Exposure of $PM_{2.5}$ and VOCs to preschool children is a high concern because they are so vulnerable to develop disease especially respiratory related and the exposure took place at their own home. Children and infants are among the most susceptible to many of the air pollutants. In addition to associations between air pollution and respiratory symptoms, asthma exacerbations, and asthma hospitalizations, recent studies have found links between air pollution and preterm birth, infant mortality, deficits in lung growth, and possibly, development of asthma (Kim, 2004).

Studies regarding indoor air quality at home are quite limited, especially those which are focusing on preschool children who are exposed to indoor $PM_{2.5}$ and VOCs at home. A study on the spatial and temporal variation of particulate matter within the home of United Kingdom found out that continuous measurements of $PM_{2.5}$ and Total Suspended Particulates (TSP) showed large variability over the day as a result of activities such as cooking and smoking and the patterns were similar in the kitchen and the living room (Wiqzell E., Kendall M., And Neuwenhuijsen M. J. ,2000). It means that particulates from source originate from one part of the home can be transmitted to other part of house. Additionally, studies examining the association between $PM_{2.5}$ and daily deaths have been conducted in a limited number of locations not chosen to be representative of the general population, leaving considerable uncertainty as to the population average slope of the association (Meredith *et al* ,2006).

Malaysia is considered as developing country and industrial sector grown so fast in Malaysia so as the pollution they produced. This ambient air pollution can contribute to indoor air pollution to the buildings near them. A study to determine association of indoor and outdoor air pollutant level with respiratory problems among children in an industrial area of Delhi, India found that indoor SPM level was significantly higher in homes of children with a history of respiratory illness than homes of children having no history of respiratory illness. Results suggest that both indoor and outdoor particulate exposure may be important risk factors in the development of respiratory illness in children (Raja K.*et. al* ,2007).



1.3 Conceptual Framework

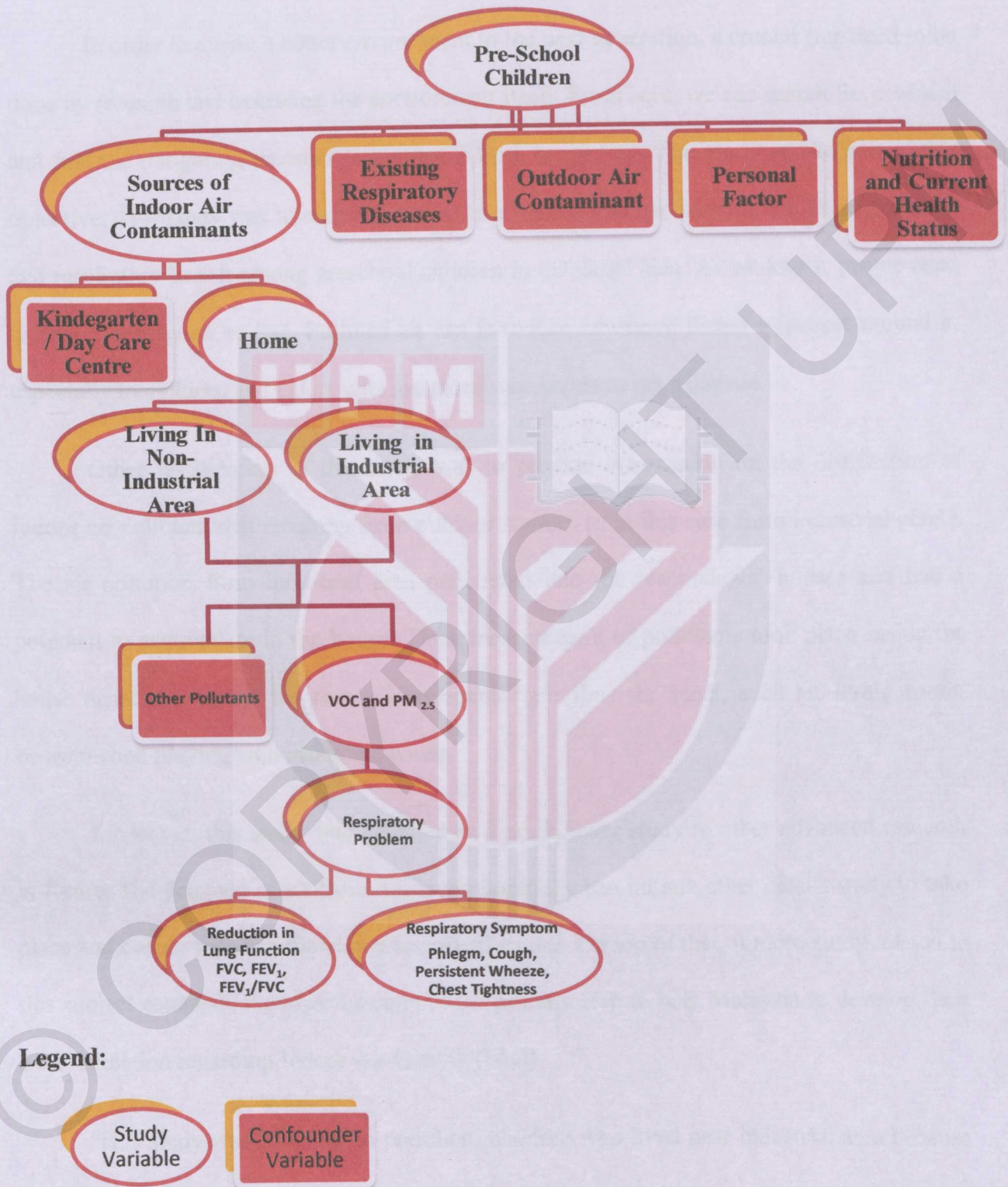


Figure 1.1 : Conceptual Framework

1.4 Study Justification

In order to create a better environment to the next generation, a crucial step need to be done by research and assessing the environment itself. From here, we can search the problem and find the mitigating measure to prevent it from happening. This study can be part of this objective. This study was intended to investigate the association between indoor air pollutant and respiratory health among preschool children in industrial area. As we know, people need to breath healthy air to live. Polluted air can introduce unwanted illness to people around it, especially to children and elders who are more susceptible to get a disease.

Other justification of this study was to provide information on the distribution of indoor air pollutant that resulting from outdoor sources as in this case from industrial plants. The air pollution from industrial area penetrated into the respondents' houses and had a potential to accumulate in the house. Thus, measurement of pollutants took place inside the house especially where the respondents spend their time the most, such as, living room, bedroom and playing area inside the house.

Moreover, this study was intended as a preliminary study to other advanced research in future. The data and result from this study hopefully can initiate other details study to take place and comes with beneficial and important values. On top of that, if more study related to this subject establish, it can acts as one of the primary step to help Malaysia to develop their own regulation regarding Indoor Air Quality (IAQ).

This study was focusing on preschool children who lived near industrial area because this area had a high potential of $PM_{2.5}$, VOCs and other air pollutants exposure to the people around them. A study done by C. Ehrlich (2006) had proved this. They study the emission from industrial plant include combustion (brown coal, heavy fuel oil, wood), cement

production, glass production, asphalt mixing, and processing plants for natural stones and sand, ceramics, metallurgy, chemical production, spray painting, wood processing or chip drying, poultry farming and waste treatment .

Last but not least, part of this study's objective was to create the awareness to the public on how important for us to prevent pollutants. All of us, not only parents that involved in his study, need to realize how pollutant can harm us. By right, we need to find ways to prevent pollutants around us especially inside of our house where we spend most of our time.

1.5 Definition

1.5.1 Conceptual Definition

a) Indoor Air Quality

Indoor Air Quality is a term referring to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupant. Indoor air quality can be disturbed by indoor pollution that release from its various sources. Whereas inadequate ventilation can increase indoor air pollutant levels by not bringing enough outdoor air to dilute pollutants inside a building. Indoor air quality also interfered by high temperature and humidity levels which can increase concentrations of some pollutants (U.S EPA, 2012).

b) Preschool

Early phase of education typically takes place between the age of four to six. It's a programme that exposes children to the learning experience within a year or more before entering year (The Malaysia Government's Official Page, 2012).

c) Particulate Matters (PM_{2.5})

Particulate matters 2.5 are particles that have aerodynamic diameter smaller than 2.5 μm (WHO, 2012). These particles were referred to as "fine" particles and source of fine particles include all type of combustion activities and certain industrial process (U.S EPA,2012).

d) Volatile Organic Compounds (VOCs)

VOCs include a variety of chemicals, some of which may have shorthand long-term adverse health effects. VOCs can originate from variety of household product including paints, paint strippers, and other solvents; wood preservatives; aerosol sprays; cleaners and disinfections; moth repellents as well as indoor combustion source (U.S EPA, 2012).

e) Forced Expiratory Volume in 1 second (FEV₁)

The FEV₁ is the maximum volume of air exhaled in the first second of a forced expiration from the position of full inspiration, expressed in liter of body temperature and pressure saturated. It interpret the reduction that occur in both obstructive and restrictive disease (BTPS) (ATS,2005).

f) Forced Vital Capacity (FVC)

Forced Vital Capacity (FVC) refer to the maximum volume of air exhaled with maximally forced effort from a maximum expiration for example vital capacity performed with the maximally forced expiratory effort, expressed in liters at body temperatures and ambient pressure saturated with water vapor (ATS, 2005).

g) Chronic Cough

Cough is a non-specific reaction to irritation anywhere from the pharynx to the lungs. Chronic cough for children is for at least 4 days in a week for 3 consecutive months in one year or more. Cough can be due to a lot of causes include virus infections, asthma, environmental agents and more (ATS,1978).

h) Chronic Phlegm

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

i) Wheezing

A wheeze is a high-pitched whistling sound made when air flows through narrowed airways in the lungs, usually when people breathe out. Sometimes, wheezes are only heard with the stethoscope, but other times they are heard with the naked ear. In this case is having wheezing or whistling sound in breathing associated with breathlessness on most days or night (ATS, 1978).

j) Chest Tightness

Chest tightness in children is an uncomfortable sensation of constriction, stiffness, or tension in a child's chest. In this case, it is a combination of cough or phlegm or increase of cough or phlegm in cases where the respondents cough or having problem continuously (ATS, 1978).

k) Industrial area

Industrial area include the built up factory, construction site, quarry, mining and other that can contribute to produce any product to support the daily life or demands. According to the increasing number of population, a basic life is needed including food supply, residency, and occupational. To fulfill the request, a lot of factory are built without concerning the kind of place (Department of Statistics Malaysia, 2011).

1.5.2 Operational Definition

a) Indoor Air Quality

Setting of study took place in respondent's house where are located in industrial area for studied group and non-industrial area for comparative group. Indoor air pollutants that were assessed in this study include $PM_{2.5}$ and indoor Volatile Organic Compounds (VOCs).

b) Preschoolers

Study involved preschool children in industrial area in Petaling Jaya, Selangor and children in non-industrial area in Hulu Langat, Selangor. All respondents are at aged of 5 to 6 years old. The exposed group was the preschool children that exposed to $PM_{2.5}$ and VOCs at their home.

c) Particulate Matters ($PM_{2.5}$)

Gillian air sampling pump with filter paper was used. Data measurement was based on gravimetric principle in mg/m^3 . The basic objective was to capture a sample of contaminants present within the air in the respondents' house. Sampling of $PM_{2.5}$ involved active sampling method which includes mechanical pumps, media filters and cyclones.

d) Volatile Organic Compound (VOCs)

PbbRAE Portable VOC Monitor was used to assess the presence of volatile organic compounds in respondent's house. Its monitored Volatile Organic Compounds (VOC) using a photoionization detector (PID) with a 9.8 eV, 10.6 eV, or 11.7 eV gas-discharge lamp. It can

monitor VOCs up to 16 hours for continuous monitoring.

e) Percentage of FEV₁%.

Value of FEV₁ from spirometry divided with predicted value FEV₁ of the respondents in percentage form. Predicted value of FEV₁ were adjusted based on Malaysian children normal value by Azizi (1994).

Expected value of FEV₁ % = $FEV_1 / (FEV_1 \text{ expected value}) \times 100$.

f) Percentage of FVC %

The value of FVC from spirometer divided with the predicted FVC of the respondents in percentage form. Predicted values of FVC were adjusted based on Malaysian children normal value by Azizi (1994).

Expected value of FVC = $FVC / (\text{predicted FVC}) \times 10$

g) Chronic Cough

In the questionnaire, the respondents' parent stated whether their child were having chronic cough or not. It's include the duration of last chronic cough took place. The questionnaire adapted from American Thoracic Society (ATS-DLD-78C, WHO).

h) Chronic Phlegm

Respondents' parent stated whether their child were having chronic phlegm or not. It's include the duration of last chronic phlegm took place. The questionnaire adapted from American Thoracic Society (ATS-DLD-78C, WHO).

i) Chest Tightness

The occurrences of chest tightness by the respondents were based on questionnaire filled by the respondents' parents. The questionnaire was adapted from American Thoracic Society (ATS-DLD-78C, WHO).

j) Wheezing

Respondents' parents stated in the questionnaire whether their child were having wheezing or not. It's include the duration from last wheezing occurrence. The questionnaire was adapted from American Thoracic Society (ATS-DLD-78C, WHO).

k) Industrial Area

The respondents selected were preschool children who live in 5 km radius from industrial area for exposed group and outside of 5km radius from industrial area for comparative group. The distance selected was according to Zone Of Impacts on Health Impact Assessment, given out by Department of Environmental, Malaysia (Guideline for Health Impacts Assessments, DOE)

1.6 Objective

1.6.1 General Objective

To determine the exposure of PM_{2.5} and Volatile Organic Compounds (VOCs) and its association towards respiratory health among preschool children in industrial area.

1.6.2 Specific Objective

1. To identify the socio-demographic data of the respondents.
2. To compare the concentration of indoor PM_{2.5} and Volatile Organic Compounds (VOCs) at the homes of studied and comparative group.
3. To compare the lung functions among studied group and comparative group.
4. To compare the respiratory symptoms among studied group and comparative group.
5. To determine the association between indoor PM_{2.5} and VOCs concentrations and lung functions among studied group living near the industrial area.
6. To determine the association between indoor PM_{2.5} and VOCs concentrations and the respiratory health symptoms among studied group living near the industrial area.

1.7 Study Hypothesis

1. There is significant difference between indoor $PM_{2.5}$ and indoor VOCs concentration at the home of studied group and comparative group.
2. There is significant difference between the lung function among studied group and comparative group.
3. There is significant difference between the respiratory symptoms among studied group and comparative group.
4. There is significant association between indoor $PM_{2.5}$ and VOCs concentrations and lung functions among studied group living near the industrial area.
5. There is significant association between indoor $PM_{2.5}$ and VOCs concentrations and the respiratory health symptoms among studied group living near the industrial area.

CHAPTER 2

LITERATURE REVIEW

2.1 Indoor Air Quality

What is Indoor Air Quality (IAQ) and why is it really important to maintain a good indoor air quality inside a space or building? American Lung Society (2014) stated that poor indoor air quality inside a building can contribute to harmful diseases and illnesses, especially to lung. Bad indoor air quality can cause to the development of infection, lung cancer, and chronic lung diseases, headaches, dry eyes, nasal congestion, nausea and fatigue. People who already have lung diseases are at greater risk. Alongside lung diseases, poor indoor air quality also result to other chronic disease, such as, stroke and ischemic heart disease which reported by World Health Organization (WHO). Whether at home, workplace or in any other buildings, individuals spend almost 80-90% of their time indoors. Especially in modernize populations. Indoor air quality is recognized as a significant environmental and health problem in most countries. Coupled with the common research finding that pollutants in indoor air occur more frequently and at higher concentrations than in outdoor air, it is clear that indoor air is the major source for environmental exposure to air pollutants. The result of such exposure is a spectrum of illnesses ranging from mild to severe effects. For example,

mild irritation or lethargy impaired respiratory development, asthma and cancer (Brown S.K., 1997).

Indoor air quality determined by complex set of interacting parameters, Philip J. Walsh state in his book, entitled *Indoor Air Quality* (1983), there are three aspects need to be understood in order to identify the nature of IAQ. First is by understanding their physical perspective which covered the quantitative relationship among parameters. Example for this type of perspective is by finding out interior sources of parameters and its relationship to temperature, pressure and other physical measurement. Other perspective need to be understood is the chemical perspective, which including measurement of chemicals' concentration in the space or building. Last but not least is biological perspective. Here concentration of chemicals measured must be evaluated for hazard potential. In other word, assessor need to predict the health effect of the chemical exposed to human inside the same building. In Malaysia, Department of Environment came out with simple guide for public to identify poor indoor air quality in a building, especially residence. In adjacent to identifying air quality problem, public must be aware such situation which is unusual and noticeable odor, stale or stuffy air, noticeable lack of air movement, frequent headaches, nausea or fatigue experienced within the indoor environment, excessive humidity, presence of mold or mildew and also noticing that one feels healthier when being outside of the indoor environment.

Indoor air pollutants are varying in different sources in difference areas of the world. It is closely related with different season (weather) and level of socioeconomic development. In *Air Quality Guidelines: Global update 2005* by World Health Organization (WHO), the major indoor air pollution worldwide include combustion of solid fuels indoors, tobacco smoking, outdoor air pollutants, emission from construction materials and furnishings, and improper maintenance of ventilation and air conditioning systems. The lists of pollutions' sources are in table below.

Table 2.1: Major Health-Damaging Pollutants Generated From Indoor Sources.

Pollutant	Major indoor sources
Fine particles	Fuel/tobacco combustion, cleaning operations, cooking
Carbon monoxide	Fuel/tobacco combustion
Polycyclic aromatic hydrocarbons	Fuel/tobacco combustion, cooking
Nitrogen oxides	Fuel/tobacco combustion
Sulfur oxides	Coal combustion
Arsenic and fluorine	Coal combustion
Volatile and semi-volatile organic compounds	Fuel/tobacco combustion, consumer products, furnishings, construction materials, cooking
Aldehydes	Furnishings, construction materials, cooking
Pesticides	Consumer products, dust from outside
Asbestos	Remodelling/demolition of construction materials
Biological pollutants	Damp materials/furnishings, components of climate control systems, occupants, outdoor air, pets
Radon	Soil under buildings, construction materials
Free radicals and other short-lived, highly reactive compounds	Indoor chemistry

Source: Indoor air Pollution: A Global Health Concern (Zhang and Smith,2003)

As one of the developing countries, indoor air quality is a really big problem that matter in a urban population, as well as, in rural population. Indoor air pollution is ubiquitous, and takes many forms, ranging from smoke emitted from solid fuel combustion, especially in households in developing countries, to complex mixtures of volatile and semi-volatile organic compounds present in modern buildings. Everyday exposure to multiple chemicals, most of which are present indoors, may contribute to increasing prevalence of asthma, autism, childhood cancer, medically unexplained symptoms, and perhaps other illnesses (Junfeng Z. and Kirk R. S.,2003).

A local study have done in Kuala Terengganu regarding Indoor Air Quality (IAQ).This study aims to investigate indoor air pollutants concentration in selected vernacular schools with different surrounding human activities. Parameters of indoor air quality which include temperature, relative humidity, air velocity, particulate matters , CO and CO₂ were measured in three different primary schools. This study conclude that surrounding human activities influences indoor concentrations of pollutants in selected schools. Human activities included outdoor combustion generated activities. For example automobiles exhaust from attached garages, nearby roads,or parking areas and construction which are believed to be the sources of CO concentration. Age of building, types of flooring, presence of curtains, shelf area, dust from blackboard and fans were found to be the determinants in the PM₁₀ classrooms (Marzuki Ismail *et. al.*, 2010).

2.2 Particulate Matters, PM_{2.5} and Its Effects to Respiratory Health.

Particulate matter in environments is a complex mixture with components having diverse chemical and physical characteristics. Different characteristics of particulate matter may be relevant to different health effects, it's due to its variation with size and other

physical characteristics, chemical composition and source. PM has been classified by aerodynamic diameter, because size is a critical determinant of the likelihood and site of deposition within the respiratory tract. PM can be generally be separated into three major fractions based on the particles size. There are coarse particles, fine particles and ultrafine particles. Coarse particles are larger than 2.5 μm in aerodynamic diameter, fine particles those smaller than smaller than 2.5 μm and the smallest scale is ultrafine particles which aerodynamic diameter that less than 0.1 μm . These size fractions differ in their overall contributions to airborne particle mass and in their physical characteristics, origins and chemical composition (WHO, 2005)

Particulate matter, both $\text{PM}_{2.5}$ and PM_{10} , have linked to decrease lung function growth among children. A study done by Horak *et. al.*, (2001) stated that an increase of 10 $\mu\text{g}/\text{m}^3$ in PM_{10} exposure was associated with a decrease in growth of forced expiratory volume in 1 second of 84 mL/year. The study was done in Austrian schoolchildren for 3 years by repeated measurements of spirometry. They also found that after adjustment for covariates, including initial lung function, lung function growth rates were associated with PM_{10} exposure. Similar study reported that chronic bronchitis and chest illness in children were associated with exposure to particulate air pollution (Dockery *et. al.*, 1989).

$\text{PM}_{2.5}$ accounts for a substantial impact on human health and environment with respect to airborne particle threat. Owing to their fine sizes, they pose health hazard due to their inhalation and deep penetration in the respiratory system during breathing. They are fine enough to surpass the anatomical screening mechanisms and enter the alveoli region of the respiratory tract. Due to their prolonged and cumulative deposition, crustatation and brittleness occurs in the alveoli. Significant problems as aggravated asthma, painful breathing,

wheezing, chronic bronchitis, decreased lung function and even premature death become pertinent (Dey, A., & Chakrabarty, S).

Kendall *et al.*, (2002) in his study explained the protective mechanism of lung on removal of foreign substances. The study entitled Lung Lining Liquid Modifies PM_{2.5} In Favour Of Particle Aggregation: A Protective Mechanism, assessed the physicochemical interactions of fine airborne particles (PM_{2.5}) and lung lining liquid using scanning electron microscopy, atomic force microscopy, and X-ray photon spectroscopy. The result shows the lung lining liquid modifies the chemistry and attract forces on the surface of PM_{2.5}, which leads to enhanced particle aggregation. They also find out that in susceptible subjects, the inability of PM_{2.5} to aggregate in lung lining liquid, which is possibly due to low opsonisation, reduces the chances of particle clearance by macrophages and enhances the possibility of epithelial cell uptake and transfer to the interstitium. In addition, particle adsorption and depletion of lung lining components, for example surfactant components such as proteins and antioxidants, may compromise lung defence mechanisms. This means that, for ultrafine particle, it can't be removed from the lung especially for susceptible person, adult and younger children.

Study on PM_{2.5} in Malaysia is little. One of the studies related to PM_{2.5} and lung function is by Nurul Anis S. F (2013). The aim of this study was to determine the exposure of indoor PM_{2.5} and lung function among children living near busy road, and comparative group of children living near less busy road in Cheras, Kuala Lumpur. Same methods of PM_{2.5} measurement and lung function test have been applied. The result came out with a significant difference of indoor PM_{2.5}, lung function abnormality and respiratory symptoms between exposed and comparative group. However, overall lung function status was weakly associated with indoor PM_{2.5}. This study also concludes that children living near busy road

have significantly higher indoor PM_{2.5} concentration than less busy road which makes them at higher risk of respiratory illnesses.

Hildemann *et al.*(1993) showed that industrial-scale boilers, fireplaces, cars with and without catalytic converters, diesel trucks and meat cooking operations all emit particles primarily in the range 0.1–0.2 µm. Petrol fuelled cars with catalytic converters emitted much lower particle masses than those without, while diesel trucks emitted about 100 times the particle mass, per kilometre driven, of a passenger car with a catalytic converter. Diesel particulate matter is almost pure carbon and exists as submicrometre-sized aggregates of ultrafine carbon spheroids with aerodynamic diameters of around 0.1 µm. This report also supported by Miller F. J. , whose in his study he found that combustion of fossil fuels in transportation, manufacturing and power generation are the one whose responsible to release fine particles(PM_{2.5}). This type of pollution typically contains a mixture of particles including acid condensates, soot, nitrate and sulfate particles. Fine particles are more likely to be toxic than larger particles and can be breathed more deeply into lungs, that is why these particles are thoughts to pose a great risk to health (Miller F.J., 1979).

Environmental Protection Agency also state that sources of fine particles are originate from all types of combustion activities, include emission from combustion of motor exhaust, power plants and wood burning. Certain industrial processes also a PM_{2.5} emitter. Beside combustion activities, fine particles may be formed in the air from the chemical change of gases. They are indirectly formed when gases from burning fuels react with sunlight and water vapour (EPA, 2013).

2.3 Volatile Organic Compounds (VOCs), Its Sources and Effects Towards Respiratory Health.

Oanh *et. al.*,(2002) stated in their study that indoor levels of about a dozen common organic pollutants were found to be two to five times higher than outdoor levels . VOCs form a subgroup of organic pollutants. VOCs are carbon-based organic chemicals that are present as vapors at room temperature. Hundreds of VOCs present indoors comprise a wide variety of hydrocarbons and hydrocarbon derivatives, including aliphatics, aromatics, alkylbenzenes, ketones, and chlorinated and polycyclic hydrocarbons. Based on sampling methods, VOCs are defined as organic compounds that have a lower boiling point limit between 50°C and 100°C and upper boiling limit between 240°C and 260°C. Organic compounds with boiling points above 400°C, are solids and compounds with the boiling points in the intermediate range are semi-VOCs. The semi-VOCs are presented indoor both in particles and in the gaseous phase.

A study stated that the strength of indoor sources emissions is a stronger influence than the infiltration of outdoor air for many of these pollutants, especially those associated with fragrances and other consumer products (Kim, 2001). Previous population-based studies in the United States also suggest that levels of many VOCs are typically higher inside residences than in matched outdoor concentrations (Sexton , 2004)

While there are other studies suggest that, indoor VOC concentrations are a function of both outdoor sources and indoor sources (John L.A., 2004). In an environmental tobacco smoke (ETS) free residential, VOC concentrations is dominated by compounds associated with indoor cleaning product. It is followed by compounds associated with traffic emissions from outside, long-range transport of pollutants and product emissions (Rufus D. E. , 2001).

Volatile organic compounds (VOCs) are an important class of outdoor air toxics because they are ubiquitous and associated with increased long-term health risks (Pratt C. G. *et. al.*, 2000). In a study to investigate the association between domestic exposure to volatile organic compounds (VOCs) and asthma in young children, domestic exposure to VOCs at levels below currently accepted recommendations may increase the risk of childhood asthma (Rumchev K. *et al* , 2004).

Minnesota Health Department distributed a sheet fact on 'Volatile Organic Compounds in Home' to their public in order to create awareness of their public on health effect of VOCs. Here the health authority mention that risk of health effects is from inhaling any chemical depends on how much is in the air, how long and how often a person breathes it in. the scientist look at short-term(acute) exposures as hours to days or long-term (chronic) exposures as years to even lifetime. Common symptoms of exposure to VOCs include:

Short-Term (acute):

- i. Eye, nose and throat irritation
- ii. Headaches
- iii. Nausea/ vomiting
- iv. Dizziness
- v. Worsening of asthma symptom

Long-Term (Chronic):

- i. Cancer
- ii. Liver damage
- iii. Kidney damage
- iv. Central nervous system damage

Here, they also explained the sources of VOCs in home. They simply divide the sources into three categories which are building materials, home and personal care products and behaviors. For building materials, the sources of VOCs may come from carpets and adhesives, composite wood products, paints, sealing caulks, solvents, upholstery fabrics, varnishes and also vinyl floors. Whereas for home and personal care products, the VOCs usually releases from air fresheners, air cleaners that produce ozone, cleaning and disinfecting chemicals, cosmetics, fuel oil, gasoline, moth balls, and also vehicle exhaust running a car in attached garage. As for behaviors such as cooking, dry cleaning, hobbies, newspaper, non-electric space heaters, photocopiers, smoking, stored paints and chemicals, and also wood burning stoves can increase amounts of VOCs inside a house.

Studies have shown that the level of VOCs indoors is generally two to five times higher than the level of VOC's outdoors. VOCs concentrations in indoor air depend on many factors, including the:

- i. Amount of VOCs in a product
- ii. Rate at which the VOCs are released
- iii. Volume of the air in the room/building
- iv. Ventilation rate or the area
- v. Outdoor concentrations of VOCs

2.4 Susceptibility of Children towards Pollutants and Its Complications.

Children immunity system is different when being compare to immunity system of an adult, as they are more far vulnerable to diseases. A workshop to identify critical windows of exposure for children's health have been held, result from collaboration of few universities

around USA. Here, they discuss the immune and respiratory systems of children. In the summary written by Rodney *et. al.* (2000) proved that there are differences in both the pharmacokinetics of the developing immune and respiratory systems as well as changes in target organ sensitivities to toxicants. They used animal model to identify differential windows of vulnerability during development of a child. The immune system undergoes a number of dynamic changes during the early stages of development in mammals. The changes include the maturation to immuno-competence.

As for respiratory system, differences in ventilation rates and in the upper respiratory tract structure and in size and branching patterns of lower respiratory system among different ages of people result in significantly different patterns of particle deposition and gas transport. There are also many physiologic differences in respiratory mechanisms between children and adults. Children have a more compliant trachea, larynx, and bronchi due to poor cartilaginous integrity as well as compliant chest wall which these factors increase the breathing work for children (Kache S., 2000).

As we all aware, air pollution has long been thought to cause minor acute illnesses to all age that susceptible to illness especially infants. Recent studies have suggested that air pollution, particularly traffic-related pollution, is associated with infant mortality and the development of asthma and atopy. There are also other studies that relate acute bronchitis and particulate air pollution and proved that rates of bronchitis and chronic cough declined in areas where particle concentrations have fallen. Overall, evidence for effects of air pollution on children have been growing, and effects are seen at concentrations that are common today. Children's exposure to air pollution is a special concern because their immune system and lungs are not fully developed when exposure begins, raising the possibility of different responses than seen in adults. Air pollution is not the leading cause of death or morbidity in children in the developed world. However, there is increasingly strong evidence that air

pollution is associated with nontrivial increases in the risk of death and chronic disease in children, worse pregnancy outcomes, and exacerbation of illnesses. Which pollutants are most responsible for the disease event is unclear, but particles and ozone have the strongest associations. For the incidence of asthma, traffic pollution, particularly from trucks, seems to be the key player (Schwartz J. , 2003).

In the late 1980s, another study by Schwartz examined the association between long-term exposure of children to air pollution and pulmonary function in the Second National Health and Nutrition Examination Survey. He found significant decrements in lung function associated with exposure. Jedrychowski *et. al.*, (1999) also reported that air pollution was associated with lower levels of lung function growth in children in Poland.

2.5 Industrial Air Emission and Its Effects to Surrounding Area.

As a developing country, industry plays an important role in the process of economic development in Malaysia. It increases the economic welfare of our citizens and supplies the material goods they consume. Unfortunately, benefit of industrial activities also came with their disadvantages. Industry is a major consumer of natural resources and a major contributor to the overall pollution event. Organization for Economic Cooperation and Development estimates that for about one-third of global energy consumption of their member states, and for about 10 percent of the total water withdrawal. Furthermore, the relative contribution to the total pollution load is obviously higher for industry-related pollutants.

Generally, the pollutants from industries are divided into three major categories which are gas, solid and water. Others such as noise and odour also included as pollutant.

Table 2.2: Table Shows Some Pollutant Types From Different Industries.

Industrial Sectors	Pollutants forms			
	Gas	Solid waste and soils	water	Others
Iron and Steel	SO _x , NO _x , HC, CO, H ₂ S Toxic Chemicals	Slag, wastes, sludge from effluent treatment	BOD, COD, oil, metals, acids, phenol, cyanide	Noise, particulate
Textiles and leather	SO _x , HC	Sludge (Chromium) from effluent treatment	BOD, solids, sulfates and chromium, dyes	Odor, noise, particulate
Pulp and paper	SO _x , NO _x	Sludge from effluent treatment	BOD, COD, solids, chlorinated organic compounds	Noise, odor, particulate
Petrochemicals, refineries	SO _x , NO _x , HC, CO, H ₂ S Toxic Chemicals	Spent catalysts, tars, sludge	BOD, COD, oil, phenols and chromium	Noise, odor, particulate
Chemicals	Organic chemicals	Sludge from pollution treatment and process waste	COD, organic chemicals, heavy metals, solids and cyanide	Odor, toxic chemicals

Source: Industrial Ecology (Manahan S. E. , 1999)

The major pollutants from industrial emission include gaseous emissions and particulate emissions. Gaseous emissions including SO₂, nitrogen oxides and chlorinated exhaust gas have the scale of health effects ranges from irritants to poisons. Epidemiological studies have concluded that chronic exposure to sulphur dioxide results in repeated occurrences of sinus infections, respiratory diseases, and breathlessness (Forstner U. , 1995).

One similar study has been done in Korea, where personal volatile organic compound (VOC) exposure of children attending elementary school adjacent to industrial complex. Result found that personal air concentrations of four VOCs, toluene, m, p-xylenes, and o-

xylene) were significantly higher for the children attending the school closest to the industrial complex compared to the children attending the school further away. The industrial complex was likely the primary cause for elevated personal air concentrations of the four VOCs in the children attending the school nearest them (Kun-Ho Park and Wan Kuen Jo, 2004).

VOCs in ambient air largely originated from mobile and industrial sources. The cumulative risk from exposure to multiple VOCs and other air pollutants is not known, and limited evidence suggested that the minority populations residing in inner-city neighbourhoods has disproportionately higher exposures (Kinney *et. al.*, 2002; Metzger *et. al.*, 1995).

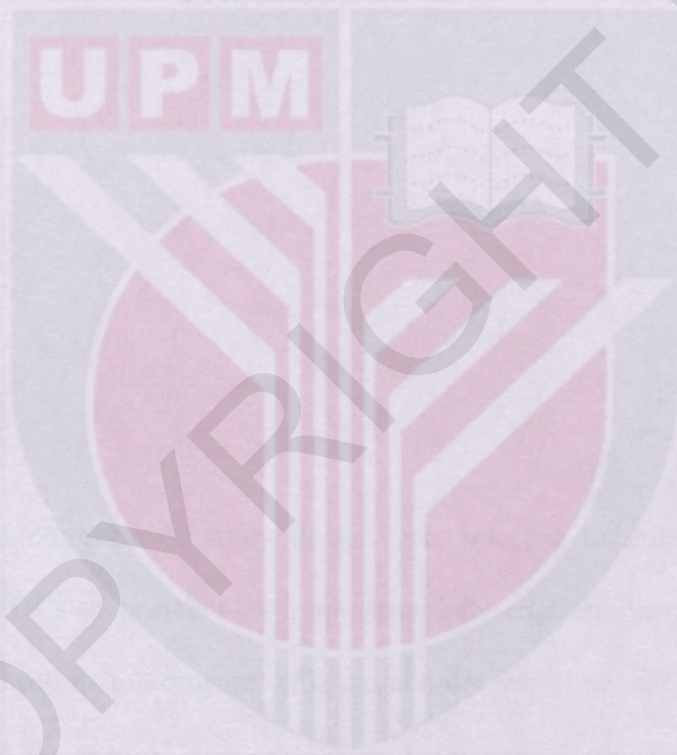
In the other hand, particulate emissions ranging from fine to coarser particle, not only pollute but also provide huge surface to absorb other pollutant such as heavy metals and toxic organic materials. Characterized by their mineralogy, chemical composition, concentration, particle size distribution and their morphological data, important particulate type and industrial emission sources listed as below.

Table 2.3: The Important Industrial Emission Sources and Particulate Type.

Source	Particulate types	Origin, occurrence
Fertilizer industry	Phosphates, urea, potassium chloride, anhydrate, and other sulfates	Pulverizing, processing, drying, sintering, granulating, gases
Carbo-chemistry	Coal + coke particulates, soot, condensed products	Degasifying, gasifying pulverizing
Electro- chemisrty	Metal + oxide particulates	Electrolysis in the dry method
Calcium- carbide	Coke, lime, calcium hydroxide	Coke pulverization + drying, lime sintering
Paint industry	ocher earth, + other particles, heavy metal compound	Pulverizing, dispersing
Biocide- industry	Insecticides, herbicides, carrier matter	Drying and mixing
Detergent industry	Sodium phosphate, soda, Na-borates	Mixing, dispersing, granulating
Rubber and plastics	Rubber + plastic particles, talcum, soot: other filter	Mechanical treatment, extracting, dispersing
Smelting	Ores, coke, metal-, metal oxide-, and slag particles	Pulverizing, sintering, throat gas
Metal processing	Metal and metal oxide	Converter and smelting furnace waste gas
Foundries	Metal and metal oxide dust, silicates	smelting furnace waste gas, moulding foundry sand treatment
Bonding agent and construction material	Raw meal and cement dust, rock and mineral dust	Raw material extracting, pulverizing, transporting, firing
Ceramics and glass industry	Quartz and silicates, metal and non-0metal oxides	Processing + treatment processes
Wood processing	Wood dust, sanding and	Grinding, sawing, milling,

Textile industry	polishing agents Cotton fiber and other textile fiber dust	size reduction Treatment (picking, combing), friction
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Source: Bass L. (1998).



CHAPTER 3

METHODOLOGY

3.1 Study Design

A cross sectional comparative study design was selected in order to study the exposure of PM_{2.5} and VOCs to preschooler living near industrial area and relate to their respiratory symptoms as well as to compare with preschooler who lives far from industrial area.

3.2 Study Location

The research was conducted in industrial area near Petaling Jaya as well as in non-industrial area near Hulu Langat. Both location located in Selangor. The data collections were taken among selective respondents of preschool children.

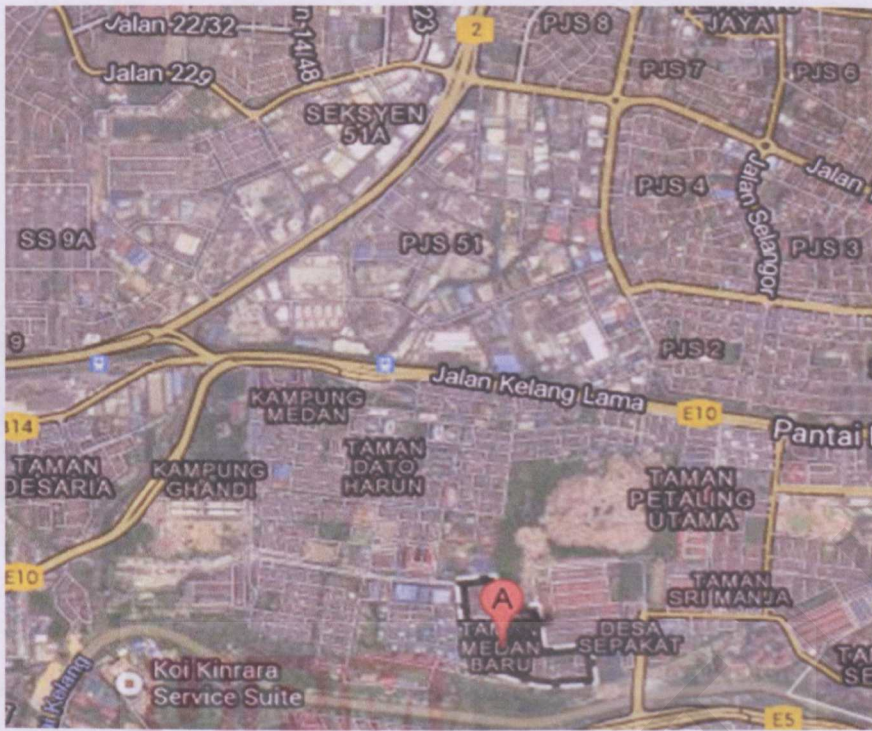


Figure 3.1 : Study Location Map (Industrial Area)

Source: Google Map

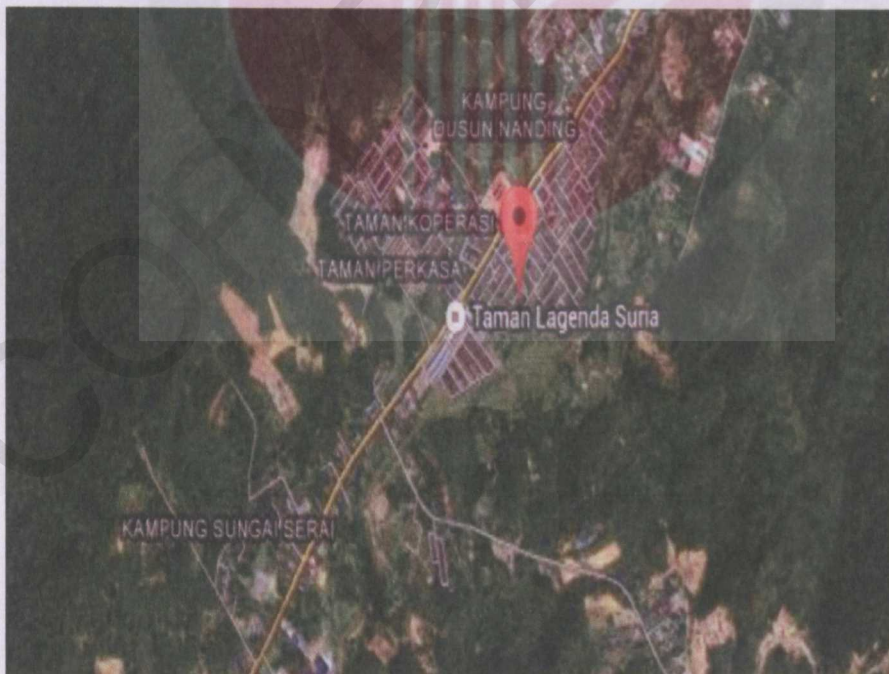


Figure 3.2: Study Location Map (Non-Industrial Area)

Source: Google Map

3.3 Study Population

Respondents of this study includes preschool children with age range of 5 to 6 years old who lives near industrial area who were exposed to PM_{2.5} and Volatile Organic Compounds (VOCs). The comparative group selected was preschoolers who live in non-industrial area.

3.4 Sample Frame

The Sample frame for this research was preschooler, aged between 5 to 6 years old. The respondents selected based on the list of students name given out by the preschool teacher for both exposed and comparative group. Preschooler with permission from their parents and fulfill the inclusion criteria was selected to be part of this study.

3.4.1 Inclusion and Exclusion Criteria

Several inclusion and exclusive criteria have been set up for the successfulness of this study as well as to avoid bias and other unwanted outcome. The inclusion criteria were:

1) Exposed group

- Preschool children at aged between 5 to 6 years old.
- Boys and girls.

- Respondents were Malaysian Nationality.
- Living within 5km from an industrial area.

2) Comparative group

- Preschool children at aged between 5 to 6 years old.
- Boys and girls.
- Respondents were Malaysian Nationality
- Living outside the 5km radius from an industrial area.

The exclusion criteria were children with existing respiratory illness to ensure that their current respiratory symptoms was due to the exposure of $PM_{2.5}$ and VOCs from nearby industries and not due to genetic factor or any other confounder. Furthermore, only respondent who stays in the same house since born will be chosen.

3.5 Sampling Method

The Purposive Sampling Method was used in this study. The respondents were selected based on inclusive criteria they fulfilled.

3.6 Sample Size

Sample size determination for this study is based on Lemeshow et al (1990) for group comparison study. It is confident that 95 percent (%) of the case sample estimates will fall within 1.96 standard errors ($Z_{1-\alpha}$) of the specified population value, if it was true value. The standard deviation of the two groups is combined (or pooled) standard deviation ($2\sigma^2$). Formula used is as follow:

$$n = \frac{2 \times 2(\sigma^2)[Z_{1-\alpha/2} + Z_{1-\beta}]^2}{(\mu_1 - \mu_2)^2}$$

Where,

σ^2 = Estimated standard deviation (assumed to be equal to each group)

μ_1 = Estimated mean (larger)

μ_2 = Estimated mean (smaller)

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

$Z_{1-\beta}$ = Standard error associated with power, 80% of power =0.84

Based on Prevalence of reported coughing among urban and rural groups:

$$n = \frac{2 \times 2(0.68)[1.96 + 0.84]^2}{(0.792 - 0.146)^2}$$

n=35 for each group (Arasyi et al, 2013)

The calculation of sample size for both groups was increased by 20%, where each group consist 42 samples. Therefore the total number of samples that will be selected was 84 samples. The increment of sample size is for the strength of analysis of the study.

3.7 Study Instrumentation

3.7.1 Collection of Respondents' Socio Demographic Data and Question Regarding Indoor Air Pollutants Sources by Distribution of Questionnaire Form.

Questionnaire used was adapted from American Thoracic Society Questionnaire ATS-DLD-78-C WHO (1982). Function of the distributed questionnaire was to gather all required information regarding respondents' demographic information, respiratory symptoms, home environment exposures as well as asthma and allergy information.

3.7.2 Assessment of Lung Function Test on Respondents by Using Spirometry.



Figure 3.3: Chest Graph H1-101

Source: Chest M.I., INC

Lung function was measured using Chest Graph H1-101. Spirometry measurements include forced expiratory volume in 1 second (FEV₁), forced vital capacity (FVC) and FEV₁/FVC%. Weight and height of each respondents were measured prior the lung function test. A demonstration and training was given to the respondents, which include the exact way to seal their lips around the mouthpiece tightly. It was also done to ensure the respondents exhaled as forcefully as possible and maintain their expiration until the indicator reached the end of the tracing. At least three spirometry tests were conducted whereby the best spirogram with the highest sum of FVC and FEV₁ were chosen for further analysis. Evaluation of the lung function test is based on ATS (1991) in Table 3.1 below, whereas the prediction values adjusted were based on the Malaysian children normal value by Azizi (1994) as in table 3.2.

Table 3.1: Evaluation of Lung Functions.

Obstructive disease	% predicted FEV ₁
Normal	≥ 80
Mild	70-79
Severe	60-69
Very Severe	<60
Restrictive disease	%Predicted FVC
Normal	≥ 80
Mild	70-79
Severe	60-69
Very severe	<60

Source: American Thoracic Society (1991)

Table 3.2: Normal Value of Lung Function Parameters among Children in Malaysia.

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

Source: Azizi and Henry (1994)

H= Height

FVC= Forced Vital Capacity

FEV₁= Forced Expiratory Capacity in 1 second

3.7.3 Measurement of Indoor PM_{2.5} in Respondents' House by Using Gillian Air Sampling Pump.

Air Sampling Pump was used to measure Particulate Matter 2.5 concentrations in the respondents' house. Fully charged sampling pumps were placed at common areas where the respondents spend most of their time within the house. Components of these devices are the portable air sampling pump, a cyclone, a cassette with specified filter membrane and rechargeable battery. The cyclone is the most important part as it was responsible in separating the PM_{2.5} from particulate matters of other sizes. The ambient air was collected at 1.7 liter/minute for 24 hours and fine particles were trapped in the filter membrane. Filter membrane used in this study was PVC with a diameter of 47mm and 5.0µm air pore size. Analysis on PM_{2.5} was done based on the NIOSH standard method 1994.



Figure 3.4: Gillian Air Sampling Pump

Source: Sensidyne Industry Health and Safety Instrument

3.7.4 Measurement of Indoor Volatile Organic Compounds (VOCs) In Respondent's House By PbbRAE Portable VOC Monitor (PbbRAE 3000).

PbbRAE Portable VOC Monitor (PbbRAE 3000) was used to assess the presence of Volatile Organic Compounds in the respondent's house. This device was placed at the same location as the Gillian Air Sampling Pump. Considerations regarding the placement were placing the device at least 1 meter away from the wall and 0.6 meters above the floor. The device was also placed away from the windows, doors and a minimum 0.5 meters away from bookshelves and other potentially stagnant areas. It is also crucial to ensure the device is located away from obvious sources of potential contaminants and is unreachable by children.



Figure 3.5: PbbRAE Portable VOC Monitor (pbbRAE 3000)

Source: RAE Systems.

3.8 Data Analysis

Statistical Packages for Social Science (SPSS) Version 22.0 was used in order to analyze statistical data gained from the questionnaire as well as the measurements of $PM_{2.5}$ and VOCs in the respondents' house. All the variables in this study were analyzed using both univariate and bivariate analysis. Univariate analysis is a descriptive analysis where it was conducted to analyze the mean, median, mode and standard deviation value of the data obtained from the study.

The value of $PM_{2.5}$ and VOCs concentration in the respondent's house were analyzed using bivariate analysis to compare both pollutants concentration for both groups. T-test was used for parametric data while Mann-Whitney test was used for non-parametric data.

Data analysis based on study objectives:

3.8.1 Objective 1: To identify the socio-demographic data of the respondents

Type of Data Analysis: Mean and standard deviation (SD) (Parametric equivalent), Median and interquartile range (IQR) (Non-parametric equivalent) and Frequency and percentage (%) (Categorical data).

3.8.2 Objective 2: To compare the concentration of indoor PM_{2.5} and Volatile Organic Compounds (VOCs) at the homes of studied and comparative group.

Type of Data Analysis: Independent T-Test (Parametric equivalent), Mann-Whitney Test (Non-Parametric equivalent) and Chi-Square (Nominal)

3.8.3 Objective 3: To compare the lung functions among studied group and comparative group.

Type of Data Analysis: Independent T-Test (Parametric equivalent), Mann-Whitney Test (Non-Parametric equivalent) and Chi-Square (Nominal)

3.8.4 Objective 4: To compare the respiratory symptoms among studied group and comparative group.

Type of Data Analysis: Independent T-Test (Parametric equivalent), Mann-Whitney Test (Non-Parametric equivalent) and Chi-Square (Nominal)

3.8.5 Objective 5: To determine the association between indoor PM_{2.5} and VOCs concentrations and lung functions among studied group living near the industrial area.

Type of Data Analysis: Pearson correlation (Parametric equivalent), Spearman Rho (Non-parametric equivalent).

3.8.6 Objective 6: To determine the association between indoor PM_{2.5} and VOCs concentrations and the respiratory health symptoms among studied group living near the industrial area.

Type of Data Analysis: Pearson correlation (Parametric equivalent), Spearman Rho (Non-parametric equivalent) and Logistic Correlation.

3.9 Quality Control

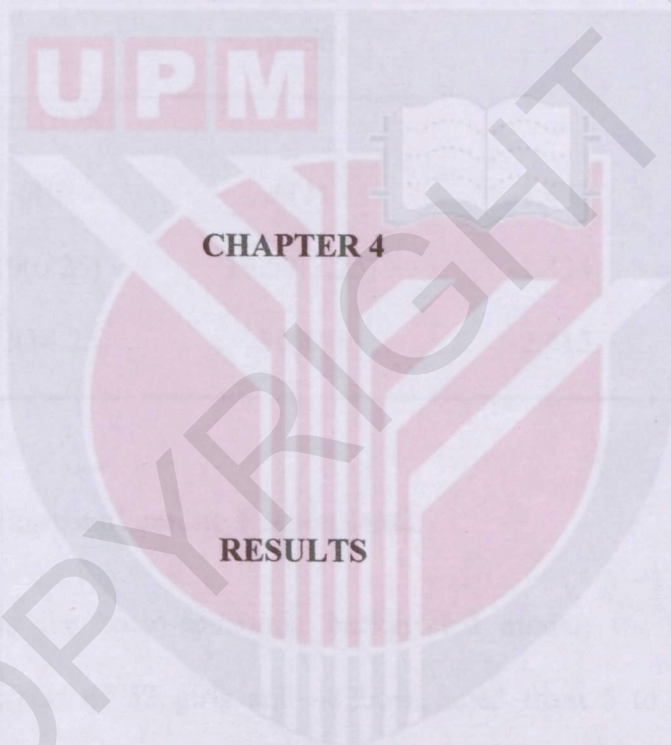
In order to ensure the validity and reliability of the data, quality control was done before, during and after data collection. Validity and reliability of the data is important as poor data collection will results in poor study achievement. The most important quality control is Pre-test Questionnaire and instruments calibration. For Pre-Test Questionnaire, the questionnaire needs to be tested by at least 10% of the actual sample size. This test is to detect any problems related to the questions, whether it is understandable or not. Meanwhile, instruments calibration is important to make sure that the equipments are at their best performance during data collection.

3.10 Ethical Approval

Ethical clearance has been obtained from ethical committee of Medicine and Health Science Faculty, Universiti Putra Malaysia. Prior to the selection of the respondents, permission letters were distributed to the parents in order to allow their children to be involved in this study. Any decision by the parents is highly respected. All the information regarding respondents is confidential.

3.11 Study Limitation

Limitation of this study was the results from the type of the study design itself. Since this study was a cross-sectional study, the exposure and the outcome were simultaneously assessed where although the data of the study shows some relationship between the exposure and the outcome, there was no evidence to prove it. Other limitation was not all preschoolers who attended the selected kindergarten live near the industrial area, whereas the type of industrial area was also influenced by the type of pollutant released. Moreover, probability of information bias to occur during filling out the questionnaire by parents was high.



CHAPTER 4

RESULTS

4.1 Socio-demographic data of the respondents

This study was conducted in an industrial area in Petaling Jaya, Selangor and a non-industrial area in Hulu Langat, Selangor. A total of 100 respondents were involved in this study, 50 respondents were from an industrial area and the other 50 respondents were from a

non-industrial area. Only 30 respondents from each group were selected for measurements of PM_{2.5} and VOCs in their house and for lung function test. There was no significant difference for age, body weight, height and gender between two study groups with $p > 0.05$.

Table 4.1: Comparison of Socio-Demographic Data among Respondent in Industrial and Non-Industrial Area.

Variables	Industrial(n=50)	Non-Industrial (n=50)	Z-Value	p value
	Median (IQR)			
Age	6(0)	6(1)	-1.441	0.150
Body Weight	19(0.25)	16.50(7.25)	-1.434	0.151
Height (cm)	92(14.25)	98(18)	-2.415	0.160

4.2 Socio-economic Background among Respondents.

Table 4.2 shows the socio-economic background among the respondents. The respondents were comprised of 52 girls and 48 boys, aged from 5 to 6 years old. The comparison between respondent's gender was not significantly different. Both groups have majority of respondents with total household income above RM3000. There were no significant differences between industrial and non-industrial group for total household income.

Table 4.2: Comparison of Socio-Economic Background among Respondents.

Variables	Industrial (n=50)	Non-Industrial (n=50)	χ^2	p value
	Number (%)			
Gender			0.000 ^a	1.000
Male	26(52)	26(52)		
Female	24(48)	24(48)		
Total				
Household				
Income			1.145 ^a	0.766
RM1501-	2(4)	2(4)		
RM2000				
RM2001-	4(8)	6(12)		
RM2500				
RM2501-	14(28)	17(34)		
RM3000				
>RM3000	30(60)	25(50)		
N=100				

a= Chi-square Test

*Significant level at $p < 0.01$

4.3 Parental Education Level among Respondents

Parental education levels were categorized based on primary level and secondary education. Primary school starts from standard 1 up to standard 6, while secondary education includes secondary school from form 1 up to form 5, and also includes STPM and diploma level. Tertiary level includes the degree level, master level as well as the doctorate level. Based on the data collected from the questionnaires, it is known that or parental majority of the children's parents for both areas had secondary education level. Less than 50% of them had higher education level. There were no significant differences between industrial and non-industrial area for parental education level.

Table 4. 3: Comparison of Parental Education Level of Respondents.

Variables	Industrial (n=50)	Non-Industrial (n=50)	χ^2	p value
	Number (%)			
Father				
Primary Education	0(0)	0(0)	0.271 ^a	0.795
Secondary Education	40(80)	42(84)		
Higher Education	10(20)	8(16)		

	Industrial	Non-Industrial	
Mother			2.216 ^a 0.330
Primary Education	0(0)	1(2)	
Secondary Education	35(70)	39(78)	
Higher Education	15(30)	10(20)	

N=100

a= Chi-square Test

*Significant level at $p < 0.01$

4.4 Distribution of Respondents Outdoor Information

As shown in table 4.4, majority of the respondents from the non-industrial area were living far away from the main roads (>1000m from road), whereas majority of the respondents from industrial area lives 100m to 500m from main roads. There was a significant difference among both groups at $p < 0.001$. On the other hand, majority of the respondents from industrial area were staying less than 500m away from factories. For non-industrial area, all of the respondents live more than 5km away from factories. There was also a significant difference at $p < 0.001$ for distance from factory for both areas.

Table 4.4: Distribution of the Exposed and Comparative Groups' Outdoor Information.

Variables	Industrial (n=50)	Non-Industrial (n=50)	χ^2	p value
	Number			
	(%)			
Distance From Main Road				
<100m From Road	3(6)	0(0)	96.078 ^a	0.001*
100-500m From Road	33(66)	0(0)		
500-1000m From Road	13(26)	0(0)		
>1000m From Road	1(2)	50(100)		

Distance From

Factory

<500 From 30(60) 0(0)

Factory

>1-2km From 17(34) 0(0)

Factory

100.00^a

0.001*

>2-5km From 3(6) 0(0)

Factory

>5km From 0(0) 50(100)

Factory

N=100

*Significant level at $p < 0.001$

4.5 Distribution of Exposure of Indoor Air Pollutant Sources.

Table 4.5 showed the exposure of indoor air pollutant sources for the respondents from an industrial and a non-industrial area. The findings indicate that majority of the respondent's family from industrial and non-industrial area used gas as fuel for cooking. There was a significant different in the type of fuel used for cooking.

Majority of the respondent's family from both area used fan as a method of indoor air cooling. There were only 3 families from industrial area and 1 family from non-industrial

area used air conditioner in their house. 4 families from industrial area and 2 families for non-industrial area used both indoor air cooling method. There were no significant differences in the type of indoor air cooling.

There were only 7 families from industrial area and 6 families from non-industrial area who have pets in their house. There was no significant different between industrial and non-industrial area for number of pets at home. Furthermore, majority of the respondent for both group have carpet in their house. There was also no significant different between industrial and non-industrial area for carpet usage.

Table 4.5: Distribution of Exposure of Indoor Air Pollution Sources .

Variables	Industrial (n=50)	Non-Industrial (n=50)	χ^2	p value
Fuel For				
Cooking				
Electric	3(6)	2(4)	6.921 ^a	0.031*
Gas	40(80)	33(88)		
Both	7(14)	4(8)		

Air Cooling

Air	3(6)	1(2)	1.844 ^a	0.398
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Conditioner

Fan	43(86)	47(94)
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Both	4(8)	2(4)
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Pet

Yes	7(14)	6(12)	0.88 ^a	0.766
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No	43(86)	44(88)
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Carpets

Yes	37(74)	42(84)	1.507 ^a	0.220
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No	13(26)	8(16)
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N=100

a= Chi-square Test

*Significant level at $p < 0.01$

There were 32(64%) of the families from the industrial area and 35(70%) of the families from non-industrial used aerosol spray as their mosquito repellent. Meanwhile, 14(28%) of the families from industrial area and 9(18%) of the families from non-industrial area choose electric as their mosquito repellents. There was no significant different between industrial and non-industrial group for the type of mosquito repellent used.

Majority of the respondent's family from both area were non-smoker which is 23(54%) for industrial area and 33(66%) for non-industrial area. None of the smokers were the respondent's mother. Most of the smokers in the respondent's families were their father, brother, uncle or grandfather. Based on the data obtained, there was no significant difference between industrial and non-industrial group for smokers.

Table 4.6: Distribution of Exposure to Indoor Air Pollutant Sources

Variables	Industrial (n=50)	Non-Industrial (n=50)	χ^2	p value
	Number (%)			
Mosquito				
Repellents				
Coil	4(8)	6(12)	1.621	0.445
Electric	14(28)	9(18)		
Aerosol Spray	32(64)	35(70)		

Smokers

Yes	23(46)	17(34)	1.500	0.307
No	27(54)	33(66)		

N=100

4.6 The Concentration of Indoor PM_{2.5} and Volatile Organic Compounds (VOCs) at the Homes of the Exposed and Comparative Group.

Normality test (Shapiro-Wilk) was performed in order to evaluate the data distribution of indoor pollutant concentrations. Result shows that all the data were normally distributed and parametric test was conducted to compare the indoor PM_{2.5} between industrial and non-industrial area. The mean and standard deviation of PM_{2.5} concentration for industrial area were (17.7453 ± 7.550) which was higher than non-industrial area which has the values of (15.3629± 5.354). The comparison between both groups was not statistically significant. The value for Indoor PM_{2.5} concentration inside respondent's house were not significantly difference (t=1.417, p=0.162) between study and comparative group. Table 4.7 shows the comparison of exposed and comparative group for indoor PM_{2.5} concentration.

Table 4.7: Comparison of Exposed and Comparative Group for Indoor PM_{2.5} Concentrations.

Variable	Industrial (n=30)		Non- Industrial (n = 30)		t-Value	p-value
	Mean ±SD	Range	Mean ±SD	Range		
PM _{2.5} (µg/m ³)	17.7453 ± 7.550	5.90 - 35.30	15.3629± 5.354	5.90 -23.80	1.417	0.162

N=60

Parametric analysis revealed that the distribution of VOCs concentrations were slightly higher (0.5163 ± 0.1726), in industrial area compared to non-industrial area (0.4739 ± 0.13805), but not statistically significant. There was no significant difference where by $p > 0.005$.

Table 4.8: The Comparison of Exposed and Comparative Group for Indoor VOCs Concentrations.

Variable	Industrial (n=30)		Non- Industrial (n = 30)		t-value	p-value
	Mean ±SD	Range	Mean ±SD	Range		
VOCs(ppm)	0.5163 ± 0.1726	0.23– 0.88	0.4739 ± 0.13805	0.18-0.65	1.063	0.292

N=60

4.7 The Lung Functions among the Exposed Group and Comparative Group

Lung function test was carried out among 30 respondents from each group. Comparison of lung function among both group was done to compare the values of FVC, FEV₁, FEV₁/FVC, FVC%, FEV₁% and FEV₁/FVC%. Mann-Whitney test was used and there were significant differences between the two groups for FVC, FEV₁, FEV₁% and FEV₁/FVC% at p= 0.001. However, there were no significant differences between groups for FEV₁/FVC and FVC%. Table 4.9 shows the comparison between both the exposed and comparative group based on lung function test.

Table 4.9: Comparison Between Exposed and Comparative Group Based on Lung Function Test.

Variables	Industrial (n=30)	Non-Industrial (n=30)	Z/t	P -value
	Mean(SD)/Median(IQR)			
FVC (liter) ^a	0.415(0.20)	0.695(0.10)	-5.629	0.001*
FEV ₁ (liter) ^a	0.400(0.144)	0.805(0.147)	-6.191	0.001*
FEV ₁ /FVC (liter) ^a	0.995(0.020)	0.974(0.130)	-0.775	0.438
FVC% ^a	69.19(12.09)	73.00(13.381)	-0.267	0.790
FEV ₁ % ^a	72.760(11.87)	104.3(15.59)	-5.914	0.001*
FEV ₁ /FVC% ^a	105.22(5.95)	138.5(28.39)	-5.757	0.001*

N=60

a= Mann-Whitney Test

*Significant level at p<0.01

Lung function test was conducted among children and it was based on American Thoracic Society (1991) to test the normality of lung function. Table 4.10 shows the comparison between the exposed and comparative group of lung function percentage of abnormality for FVC%, FEV₁% and FEV₁/FVC%. Result shows that 16(53.33%) children from industrial area were having lung function abnormality, whereas only 8(26.67%) children from non-industrial area were having an abnormality of lung function for FVC%. 13(43.33%) children from industrial area have lung function abnormality for FEV₁%, meanwhile none of the children from non-industrial area have such abnormality. There were significant differences for FVC% and FEV₁% between both groups. Furthermore, 1(3%) child from industrial area had a lung function abnormality for FEV₁/FVC% and 0(0%) from non-industrial area. FEV₁/FVC% between both groups was not significantly different with $p > 0.05$.

Table 4.10: Comparison between Exposed and Comparative Group for Lung Function Abnormality.

Lung Function	Industrial (n=30)		Non-Industrial (n=30)		χ^2	p-value	PR	95% CI	PR ^a
	Abnormal n(%)	Normal n(%)	Abnormal n(%)	Normal n(%)					
FVC%	16 (53.33)	14 (46.67)	8 (26.67)	22 (73.33)	4.44	0.035*	2	0.11-0.94	0.67
FEV ₁ %	13 (43.33)	17 (56.67)	0(0)	30 (100)	16.6	0.001*	0.5	0.41-0.78	0.28
FEV ₁ /FV	1(3)	29 (97)	0(0)	30 (100)	1.01	0.313	0.9	0.90-1.03	0.02
C%					7		7		

N=60

4.8 The Respiratory Symptoms among Exposed Group and Comparative Group.

Some of the respiratory symptoms studied were cough, phlegm, chest tightness and wheezing. The prevalence was obtained from the questionnaire given to the respondents. Referring to Table 4.11, it shows that 14(32%) and 6(12%) of the exposed group and comparative group respectively had cough, whereas, 34(68%) and 44(88%) did not. Furthermore, for phlegm, the number and percentage of exposed and comparative group having the symptoms were 29(58%) and 12(26%), while 21(42%) and 37(64%) of the respondents did not. Moreover, for chest tightness, the number and percentage of exposed and comparative group having the symptoms were 17(34%) and 9(18%), while 33(66%) and 41(82%) did not. Wheezing on the other hand, states 16(32%) and 5(10%) of the respondents of exposed and comparative group had the symptoms, while 34(68%) of exposed group and 45(90%) of the comparative group did not. With the observed prevalence ratio of 3.451(95%CI, 1.22-9.76), respondents who live in industrial area were more likely to get cough, phlegm and wheezing compared to the ones who live in non-industrial area. The prevalence ratio for cough increased to 3.545 after it has been adjusted for smoking and total household income.

Table 4.11: Comparison between Exposed Group and Comparative Group for Respondents' Respiratory Symptoms.

Variables	Industrial n(%)	Non- Industrial n(%)	χ^2	p-Value	PR	95% CI	PR ^a
Cough			5.828	0.016	3.451	1.22-	3.54
Yes	14(32)	6(12)				9.76*	
No	34(68)	44(88)					
Phlegm			10.509	0.001	3.930	1.69-	1.38
Yes	29(58)	12(26)				9.15*	
No	21(42)	37(64)					
Chest tightness			3.326 ^a	0.068	2.347	0.93-	2.85
Yes	17(34)	9(18)				5.49	
No	33(66)	41(82)					
Wheezing			7.294 ^a	0.007	4.235	1.41-	3.76
Yes	16(32)	5(10)				12.70*	
No	34(68)	45(90)					

N=100

*significant level at $p < 0.05$

^a= adjusted prevalence ratio for smoking and total household income.

4.9 The Association between Indoor PM_{2.5} and VOCs Concentrations and Lung

Functions among Exposed Group Living Near the Industrial Area

Table 4.12 shows result from Pearson and Spearman correlation that revealed that there were no correlation between FVC, FEV₁, FVC%, FEV₁% and FEV₁/FVC % with indoor PM_{2.5} concentration among children in both industrial and non-industrial area. There was a significant correlation between PM_{2.5} and Lung Function for all respondents in this study for FEV₁/FVC%.

Table 4.12: Correlation of Indoor PM_{2.5} Level and Lung Function among Exposed Group.

Variables	PM _{2.5}					
	Industrial		Non Industrial		All	
	r	p	r	p	r	p
FVC (liter) ^a	0.062	0.745	-0.313	0.092	-0.153	0.243
FEV ₁ (liter) ^a	0.060	0.751	0.225	0.233	-0.60	0.650
FEV ₁ /FVC (liter) ^b	-0.025	0.897	-0.036	0.851	-0.012	0.926
FVC% ^b	0.112	0.554	0.291	0.118	0.169	0.196
FEV ₁ % ^b	0.163	0.389	-0.015	0.937	-0.030	0.818
FEV ₁ /FVC% ^b	-0.210	0.265	-0.323	0.081	-0.272	0.036*

N=60

a= Pearson test

b= Spearman Rho test

*significant level at p<0.05

Table 4.13 shows result from Pearson and Spearman correlation that revealed that there were no correlation between FVC, FEV₁, FVC%, FEV₁% and FEV₁/FVC % with indoor VOCs concentration among children in both industrial and non-industrial area as well as for all respondent in this study.

Table 4.13: Correlation of Indoor VOCs Level and Lung Function among Exposed Group.

Variables	VOCs					
	Industrial		Non Industrial		All	
	r	p	r	p	r	p
FVC (liter) ^a	0.170	0.368	-0.143	0.450	-0.068	0.603
FEV ₁ (liter) ^a	0.181	0.339	0.110	0.563	-0.036	0.785
FEV ₁ /FVC (liter) ^b	0.213	0.258	0.090	0.635	0.128	0.328
FVC% ^b	-0.122	0.521	0.119	0.530	-0.038	0.771
FEV ₁ % ^b	-0.123	0.519	-0.129	0.495	-0.176	0.178
FEV ₁ /FVC% ^b	-0.97	0.610	-0.194	0.306	-0.222	0.088

N=60

a= Pearson test

b= Spearman Rho test

Table 4.14 shows the association of PM_{2.5} concentration and VOCs concentration with FVC% of exposed group. It revealed that they were not significant for both PM_{2.5} and VOCs concentrations with FVC% abnormality for respondents living in industrial area but

there were increased risk. The result is the same for FEV₁% abnormality for both concentrations as shown in table 4.15.

Table 4.14: Association of Indoor PM_{2.5} Concentration and VOCs Concentrations with FVC% Abnormality among Exposed Group.

Variables	Lung Function (FVC%)		χ^2	p value	PR	95% CI
	Abnormal Number(%)	Normal Number(%)				
PM _{2.5}						
High	8(27)	7(23)	0.000	1.000	1.00	0.24-4.2
Low	8(27)	7(23)				
VOCs			0.117	0.732	0.78	0.18-3.28
High	9(30)	7(23)				
Low	7(23)	7(23)				
N=60						

Table 4.15: Association of Indoor PM_{2.5} Concentration and VOCs Concentrations with FEV₁% Abnormality among Exposed Group.

Variables	Lung Function (FEV ₁ %)		χ^2	p value	PR	95% CI
	Abnormal	Normal				
	Number(%)	Number(%)				
PM _{2.5}						
High	9(30)	6(20)	0.136	0.713	1.31	0.30-5.58
Low	8(27)	7(23)				
VOCs			0.002	0.961	0.96	0.23-4.10
High	7(23)	9(30)				
Low	6(20)	8(27)				
N=60						

4.10 The Association between Indoor PM_{2.5} and VOCs Concentrations and The Respiratory Health Symptoms among Exposed Group Living Near The Industrial Area.

As shown in table 4.16, cough, phlegm, chest tightness and wheezing does not show any significance with a concentration of PM_{2.5} among exposed group. But the children who are exposed to high indoor PM_{2.5} concentration have increased risk to get cough and chest tightness, which not statistically significant. Whereas, in table 4.17, the respiratory symptoms also did not show any significant association with concentration of VOCs among exposed group but risk of getting phlegm and wheezing was high.

Table 4.16: The Association of Exposure between Indoor Air Pollutants, PM_{2.5} and Respiratory Symptoms among Preschool Children in Exposed Group.

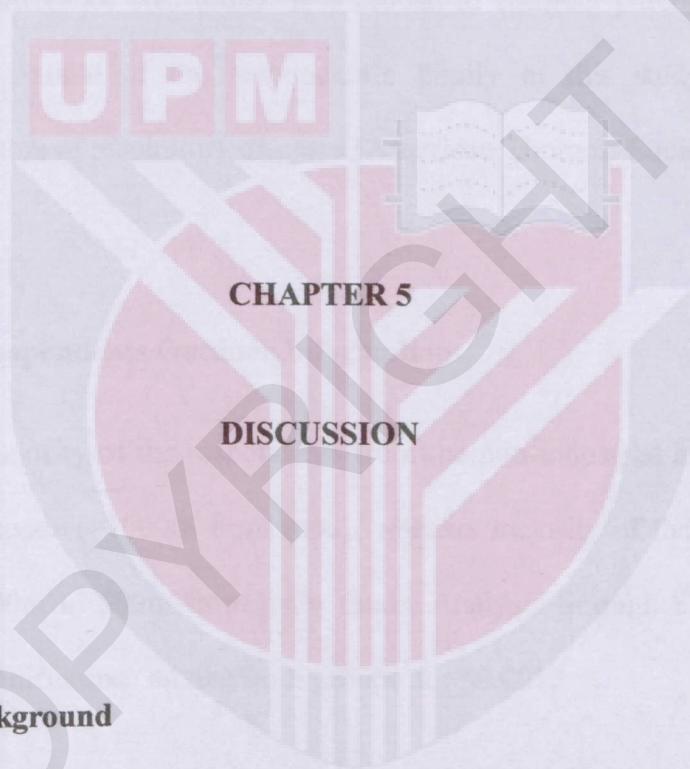
Variables	PM _{2.5}	PM _{2.5}	χ^2	p value	PR	95% CI
	(High)	(Low)				
Number (%)						
Cough						
Yes	7(46)	3(20)	2.400	0.121	3.50	0.69-17.71
No	8(54)	12(80)				
Phlegm						
Yes	7(46)	8(54)	0.133	0.715	0.77	0.18-2.24
No	8(54)	7(46)				
Wheezing						
Yes	4(27)	5(33)	0.159	0.690	0.73	0.15-3.49
No	11(73)	10(67)				
Chest tightness						
Yes	7(46)	3(20)	2.400	0.121	3.50	0.69-17.71
No	8(54)	12(80)				

N=60

Table 4.17: The Association of Exposure between Indoor Air Pollutants, VOCs and Respiratory Symptoms among Preschool Children in Exposed Group.

Variables	VOCs	VOCs	χ^2	p value	PR	95% CI
	(High)	(Low)				
		Number (%)				
Cough						
Yes	4(25)	6(43)	1.071	0.301	0.44	0.94-2.09
No	12(75)	8(57)				
Phlegm						
Yes	8(50)	7(50)	0.000	1.000	1.00	0.24-4.20
No	8(50)	7(50)				
Wheezing						
Yes	5(31)	4(29)	0.026	0.873	1.14	0.24-5.46
No	11(69)	10(71)				
Chest tightness						
Yes	4(25)	6(43)	1.071	0.301	0.44	0.09-2.09
No	12(75)	8(57)				

N=60



CHAPTER 5

DISCUSSION

5.1 Respondents Background

50 respondents from an industrial area and another 50 respondents from a non-industrial area were involved in this research to study the exposure of indoor particulate matter 2.5 ($PM_{2.5}$) and Volatile Organic Compounds (VOCs) among preschool children living in industrial area. The respondents were comprised of 52 girls and 48 boys, aged from 5 to 6 years old. As shown in table 4.1, age should be express in years, while height and weight should be express with the units use in the country, corresponding to the ones of the selected reference equation (American Thoracic Society, 2005).

5.2 Socio-economic Background among Respondents

Based on the data gained from the questionnaire (table 4.2 and 4.3), it was revealed that both groups have majority of respondents with total household income above RM3000. There was no significant different between industrial and non-industrial group for total household income. For parental education, majority of the children's parents for both areas had secondary education level. Less than 50% of them had higher education level. After being tested for comparison between industrial and non-industrial area for parental education level, no significant difference was found. It is crucial to consider parental education level and total household income of the respondent's family in this study because it was categorized as risk factors of respiratory diseases (American Thoracic Society, 1987).

5.3 Distribution of Respondents Outdoor Information

In table 4.4, majority of the respondents from the non-industrial area were living far away from the main roads (>1000m from road), whereas majority of the respondents from industrial area live 100m to 500m from main roads. Analysis through SPSS indicates that there was a significant difference among both groups at $p < 0.001$.

On the other hand, majority of the respondents from industrial area were staying less than 500m away from factories. For non-industrial area, all of the respondents live more than 5km away from factories. There was also a significant difference at $p < 0.001$ for distance from factory for both areas.

5.4 Distribution of Exposure of Indoor Air Pollutant Sources.

Table 4.5 shows the distribution of exposure to pollutant sources of fuel for cooking, air cooling, carpet usage and pets. The findings indicate that majority of the respondent's family from industrial and non-industrial area used gas as fuel for cooking. Only 6% used electric to cook for industrial area and 4% for non-industrial area. There was a significant different in the type of fuel used for cooking.

For type of indoor air cooling, 86% and 94% used fan for air cooling for family from industrial and non-industrial area respectively. Only 3 families from industrial area and 1 family from non-industrial area used air conditioner in their house. There were 4 families from industrial area and 2 families from non-industrial area used both indoor air cooling method. Result shows no significant different in the type of indoor air cooling.

For carpet usage, 74% of the families from industrial area have carpet in their house. The percentage was lower compared to families from non-industrial area where 84% of the families used carpet in their house. These families preferred carpet in their house eventhough some of them have already installed a proper flooring. There was also no significant different between industrial and non-industrial area for carpet usage.

As for mosquito repellent, aerosol type was easier to get and more user friendly (Azizi, 1990). That was the reasons why 32(64%) of the families from the industrial area and 35(70%) of the families from non-industrial respectively used aerosol spray as their mosquito repellent. There were very few families who used coil as their mosquito repellent as shown in table 4.6. Based on the interview with the respondent's family member, they were aware of the side effect of coil smoke to health which parallel with study done by Juliana (2004). Insecticides, scented mosquito-repellant and cosmetic may affect VOCs concentration in a house (B. Son, *et. al*, 2003)

Majority of the respondent's family from both area were non-smoker which was 23(54%) for industrial area and 33(66%) for non-industrial area. None of those smokers were the respondent's mother, where most of the smokers in the respondent's families were their father, brother, uncle or grandfather. Based on the data obtained, there was no significant difference between industrial and non-industrial group for smokers.

5.5 Comparison of the Concentration of Indoor PM_{2.5} and Volatile Organic Compounds (VOCs) at the Homes of the Study and Comparative Group.

Measurement of indoor PM_{2.5} was done by using portable air sampling pumps with cyclones and correct filters for 24 hours. Result shows that all the data were normally distributed and parametric test was conducted to compare the indoor PM_{2.5} between industrial and non-industrial area. The mean and standard deviation of PM_{2.5} concentration for industrial area were (17.7453 ± 7.550) which is higher than non-industrial area which were (15.3629 ± 5.354). The comparison for both groups was not statistically significant. Thus, indoor PM_{2.5} concentration inside respondent's house were not significantly difference between study and comparative group (t=1.417, p=0.162). The result was shown in table 4.7. The reading of PM_{2.5} for exposed groups reach the standard establish by EPA for 24 hours standard level of 35µg/m³. However, the concentrations of PM_{2.5} for comparative group were still below the standards. The comparison of exposed and comparative group of indoor PM_{2.5} concentration was not significant might be due to confounder. The main confounder is the type of study design itself. Cross-sectional study measure level of pollutants one time only and the result from this study only shows the temporary review of PM_{2.5} exposure and its health impact to respiratory systems. Plus, the sample size of this study is too small which decrease the probability of getting significant result.

Study by Kayrul H. M. (2006) agreed that children living near main road were exposed to higher level of indoor PM_{2.5} concentration compared to children who live far than main road. Based on the findings by Pope *et. al.* (2002), study also provides strong evidence that long-term exposure to fine particulate air pollution common to many metropolitan areas was an important risk factor for cardiopulmonary mortality. Study done by Nurul Anis S. F and Juliana J. (2013) also found significant differences in indoor PM_{2.5} concentration between residential near busy road than less busy road.

The concentration of VOCs was measured by using the PbbRAE VOC Monitor. In table 4.8, parametric analysis revealed that the distribution of VOCs concentrations were slightly higher (0.5163 ± 0.1726) in industrial area compared to non-industrial area (0.4739 ± 0.13805) but not statistically significant. There was no significant difference where by $p > 0.05$ which again due to confounder that rose from the study design and sample size. Referring to Code of Practice on Indoor Air Quality by DOSH (2010), the maximum limits of VOCs that can be exposed by occupants for 8 hour time is 3 ppm. Thus, the concentration in both industrial and non-industrial area does not exceed the limit. But still, domestic exposure to VOCs at levels below currently accepted recommendations may increase the risk of childhood asthma (Rumchev K. *et al.*, 2004).

Even there was no significant different between groups, the reading of indoor VOCs concentration for industrial still higher than the comparative group. This was supported by few studies including a study done by Lee *et. al.*, (2002) in crowded city of Hong Kong. The study revealed that the level of VOCs is high due to emission from automobile. Furthermore, other industrial sector where the organic compounds produced form an incomplete combustion of fossil fuels, especially from vehicle exhaust. One similar study has been done in Korea, where personal volatile organic compound (VOC) exposure of children attending elementary school adjacent to industrial complex. Result found that personal air

concentrations of four VOCs, toluene, m, p-xylenes, and o-xylene) were significantly higher for the children attending the school closest to the industrial complex compared to the children attending the school further away. The industrial complex was likely the primary cause for elevated personal air concentrations of the four VOCs in the children attending the school nearest them (Kun-Ho Park, Wan-Kuen Jo, 2004).

5.6 Comparison of Lung Functions among Exposed Group and Comparative Group

Lung function was measured using Chest Graph H1-101. The spirometry measurements included forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC) and $FEV_1/FVC\%$ among 30 respondents from each exposed and comparative groups. The procedure was based on American Thoracic Society (1991), whereas value for FVC% and $FEV_1\%$ was calculated based on Azizi (1994).

Comparison of lung function among both groups was done to compare the value of FVC, FEV_1 , FEV_1/FVC , FVC%, $FEV_1\%$ and $FEV_1/FVC\%$. Mann-Whitney test was used and there were significant differences between exposed and comparative groups for FVC, FEV_1 , $FEV_1\%$ and $FEV_1/FVC\%$ at $p= 0.001$. However, there were no significant differences between groups for FEV_1/FVC and FVC% (table 4.9).

In table 4.10, result also shows that 16(53.33%) children from industrial area had lung function abnormality, whereas only 8(26.67%) children from non-industrial area had an abnormality of lung function for FVC%. 13(43.33%) children from industrial area had lung function abnormality for $FEV_1\%$, meanwhile none of the children from non-industrial area were having such abnormality. There were significant differences for FVC% and $FEV_1\%$ between both groups. This result was supported by previous study done by Nurul Anis S. F.

(2013), where result showed significant lung function abnormality to children live near busy road in Cheras, compared to the comparative group. From here, we can conclude that respondents who lived in industrial area had poor lung function status than the ones who lived in non-industrial area where air pollution in the industrial areas is a risk factor in the prevalence of respiratory system symptoms and this is consistent with the results of other authors (Diapouli *et. al.*, 2007).

5.7 Comparison of Respiratory Symptoms among Exposed Group and Comparative Group.

Prevalence of the respiratory symptoms for all respondents was obtained from the questionnaire given. Some of the respiratory symptoms studied were cough, phlegm, chest tightness and wheezing. It showed that 14(32%) and 6(12%) children of the exposed group and comparative group respectively had cough, whereas, 34(68%) and 44(88%) did not. With an observed prevalence of 3.451(95% CI, 1.22-9.76), respondents that live in industrial area were 3 times more likely to get cough compared to the ones who live in non-industrial area. The prevalence ratio for cough increased to 3.545 after it is adjusted for smoking and total household income, as shown in table 4.11. The results obtained were similar with a study done by Abdul Mujid *et. al.*, (2003), where prevalence of respiratory symptoms among children from exposed group who lived near quarry significantly higher than the comparative group.

A study conducted among residents of a heavy-industry province also showed the same result where cough is one of respiratory symptoms with high prevalence ratio together with symptoms of phlegm and wheeze (Wilson, D., 2008). Other evidence that showed the same result was a study by Ritchie *et al.*, (2007) which showed that residing close to major

streets and highways increases the risk of developing adverse health effects, as does living near other potential sources, especially high-risk sources such as outdoor wood boilers, open burning of yard and household trash, and burning of agricultural and construction wastes.

5.8 The Association between Indoor PM_{2.5} and VOCs Concentrations and Lung Functions among Exposed Group Living Near the Industrial Area

A Pearson and Spearman correlation revealed that there were no correlation between FVC, FEV₁, FVC%, FEV₁% and FEV₁/FVC % with indoor PM_{2.5} concentration among children in both industrial and non-industrial area. However, there was a significant correlation between PM_{2.5} and lung function for FEV₁/FVC% when the respondents was not separately analyze into group, as shown in table 4.12. Meanwhile, Pearson and Spearman correlation revealed that there were no correlation between FVC, FEV₁, FVC%, FEV₁% and FEV₁/FVC % with indoor VOCs concentration among children in both industrial and non-industrial area as well as for all respondents in this study as shown in table 4.13. As a conclusion, PM_{2.5} has a potential to cause lung reduction among exposed children.

An analysis have been done to study the association between indoor PM_{2.5} and VOCs concentration and lung functions among exposed group living near the industrial area. It is to find out whether or not indoor PM_{2.5} and VOCs had caused a reduction of lung function among the respondents who live near the industrial area. Table 4.14 shows the association of PM_{2.5} concentration and VOCs concentration with FVC% of exposed group. It revealed that they were not significant for both PM_{2.5} and VOCs concentrations with FVC% abnormality for respondents living in industrial area but there were increased risk. The result is the same for FEV₁% abnormality for both concentrations as shown in table 4.15.

5.9 The Association between Indoor PM_{2.5} and VOCs Concentrations and The Respiratory Health Symptoms among Exposed Group Living Near The Industrial area.

In the table 4.16, cough, phlegm, chest tightness and wheezing does not show any significance with a concentration of PM_{2.5} among exposed group. But the children who are exposed to high indoor PM_{2.5} concentration have increased risk to get cough and chest tightness, which not statistically significant. A study done by Dockery *et. al.* (1999), reported that chronic bronchitis and chest illness in children were associated with exposure to particulate air pollution.

Meanwhile, in table 4.17, the respiratory symptoms also does not show any significant association with concentration of VOCs among exposed group but risk of getting phlegm and wheezing is high. This patterns was consistent with research by Arasyi Yahaya and Juliana J. (2014).

CONCLUSION

The study suggests that there was a significant difference between exposed group and comparative group for lung function test and lung function abnormality. Besides that, there was also a significant difference for prevalence of reported respiratory symptoms between groups for cough, phlegm and wheezing with the exposed group being 3 times more likely to get cough for exposed group.

This study also found that there was a significant correlation between $PM_{2.5}$ and Lung Function for all respondents in this study for $FEV_1/FVC\%$. Indoor $PM_{2.5}$ and VOCs concentration increases risk of reduction lung function and respiratory symptoms among respondent who live near an industrial area but it was not statistically significant.

RECOMMENDATIONS

Awareness on indoor $PM_{2.5}$ and VOCs and its impacts toward respiratory problems should be increased among the community especially the ones who live near the industrial area. Consciousness on how to prevent indoor $PM_{2.5}$ and VOCs exposure should be delivered, for instance, growing more plants around the house as a buffer between the house and the main road or factory. It is best to close any doors or windows during high pollution level to prevent them from entering the house.

Because of children have bigger susceptibility towards respiratory problems, parents own the responsibilities to ensure their children are safe from such exposure by being more cautious on the materials used inside and around the house. Furthermore, the effects of activities such as cooking should not be diminished.

Further research and studies regarding indoor $PM_{2.5}$ and VOCs concentrations and respiratory systems as well as other related pollutants should be conducted and exposed to the community. The researcher must consider other confounder that can interrupt the outcome of the study. Other pollutants, such as NO_2 and PM_{10} , can be included in the similar study because these pollutants are closely related and affect each other.

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BORANG B2: PENERANGAN DAN PERSETUJUAN IBUBAPA/PENJAGA

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

1. TAJUK KAJIAN

Pendedahan Terhadap $PM_{2.5}$ Dalam dan Sebatian Organik Meruap Serta Kaitannya Dengan Kesihatan Respiratori Antara Kanak-kanak Prasekolah Di Kawasan Perindustrian.

2. PENGENALAN

Kualiti udara dalaman merujuk kepada keseluruhan sifat—sifat udara dalaman yang menjejaskan kesihatan seseorang, termasuk kesejahteraan dan keselesaan. Secara puratanya, kita menghabiskan 80%- 90% atau lebih daripada masa kita setiap hari di dalam kediaman, sekolah atau tempat kerja. Udara dalaman selalunya lebih tercemar berbanding udara luaran, dimana kanak-kanak terutamanya mereka yang mempunyai alahan, asma atau lelah dan penyakit penafasan lain lebih mudah terdedah kepada masalah pencemaran udara dalaman. Antara sumber sumber pencemaran udara dalaman adalah seperti produk tembakau, organisma biologi, bahan-bahan mentah bangunan dan penyudah, bahan pencuci, pestisid, karpet, perabot, dan juga pencemaran yang disumbang oleh udara luaran.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Anda sebagai ibu/bapa/penjaga kepada responden dikehendaki:

1. Membaca dan memahami isi kandungan penerangan ini bagi menjawab semua soalan dalam borang kaji selidik yang telah disediakan.
2. Kajian ini bertujuan untuk menjalankan ujian fungsi paru- paru dalam kalangan responden. Alatan yang digunakan dalam kajian ini adalah spirometer. Semasa sesi ujian, responden dikehendaki menghembus nafas ke dalam pelekap mulut pakai buang (disposable mouthpiece) yang disertakan dengan alat spirometer. Bagi mendapatkan hasil yang terbaik, semua responden akan melakukan ujian fungsi paru- paru sebanyak 3 kali. Penilaian ujian paru- paru akan dijalankan berdasarkan keputusan pada alat spirometer. Jika ujian paru- paru anak anda di tahap yang tidak memuaskan. Pihak anda akan dimaklumkan agar membuat pemeriksaan khusus di hospital atau klinik berdekatan.
3. Penyelidik akan ke rumah responden bagi memasang "Air Sampling Pump" bagi mengira kuantiti PM 2.5 dan PbbRae 300 bagi mengira jumlah sebatian organik meruap di dalam rumah. Alat akan dipasang selama 24 jam.
4. Jika anda bersetuju untuk menyertai kajian ini, anda dikehendaki menandatangani borang penyertan responden dan hendaklah dikembalikan kepada pengkaji sebelum temubual dan ujian yang akan dijalankan.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Pelajar yang berumur di bawah lingkungan 6 tahun ke atas, bukan berbangsa Melayu dan menghadapi penyakit respiratori

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANAK/JAGAAN SAYA SEBAGAI PESERTA?

Kajian ini akan menjelaskan sama ada status kualiti udara dalaman boleh mengakibatkan masalah kepada fungsi paru- paru atau tidak kepada kanak- kanak prasekolah. Sekiranya kepekatan pencemar udara dalaman adalah tinggi dan memberi kesan kepada responden, tindakan selanjutnya boleh dilakukan berdasarkan hasil daripada maklumat kajian ini. Melalui kajian ini juga, anda akan dapat menentukan sama ada anak anda mengalami masalah dari segi sistem penafasan ataupun tidak tanpa dikenakan sebarang bayaran.

b) KEPADA PENYELIDIK?

Penyelidik dapat mengetahui cara- cara penggunaan alat pensampelan yang digunakan dalam kajian ini dengan cara yang betul. Selain itu, ia juga boleh meningkatkan kemahiran penyelidik dalam penggunaan alat yang terlibat dalam kajian tersebut. Tambahan, pengajaran pendidikan (health education) juga boleh disampaikan kepada ibu/bapa/penjaga dan responden agar mereka dapat memahami dengan lebih jelas tentang kajian yang dilakukan. Selain itu juga, data yang diperolehi daripada kajian yang dijalankan dapat digunakan bagi melengkapkan projek ilmiah tahun akhir.

6. ADAKAH IA BERISIKO?

Kajian ini tidak melibatkan sebarang risiko.

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

Semua maklumat yang diperolehi dari temubual dan ujian- ujian yang dijalankan oleh pengkaji adalah dijamin sulit. Maklumat ini hanya akan digunakan untuk tujuan kajian ini sahaja.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN

TAMBAHAN SEPANJANG PENYELIDIKAN INI?

Sekiranya anda mempunyai sebarang kemusykilan, pengkaji akan membantu anda untuk memberi maklumat yang selanjutnya. Terima kasih atas kerjasama dan bantuan anda.

NUR JANNAH MAWAR BINTI JASME ,Pelajar Tahun Akhir, Bacelor Sains Kesihatan Persekitaran dan Pekerjaan (019-3944136)



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

9. PERSETUJUAN

Saya..... No Kad Pengenalan.
beralamat.....

.....dengan ini secara sukarela bersetuju membenarkan *anak / jagaan saya
..... menyertai **penyelidikan tersebut di atas *(klinikal/percubaan ubat-
ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).**

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

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

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

*potong yang tidak berkenaan

Tandatangan Tandatangan
(Ibubapa/ Penjaga) (Saksi)

Tarikh : Nama :
No. K/P:

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

Tarikh Tandatangan
(Penyelidik)



JABATAN KESIHATAN PERSEKITARAN DAN PEKERJAAN
FAKULTI PERUBATAN DAN SAINS KESIHATAN
UNIVERSITI PUTRA MALAYSIA

BORANG SOAL SELIDIK

TAJUK:

EXPOSURE TO INDOOR PM_{2.5} AND VOLATILE ORGANIC COMPOUNDS (VOCS) AND ITS ASSOCIATIONS WITH RESPIRATORY HEALTH AMONG PRESCHOOL CHILDREN IN INDUSTRIAL AREA.

SOAL SELIDIK DILENGKAPKAN OLEH:

Ibu kanak-kanak

Bapa kanak-kanak

Ibu dan bapa kanak-kanak

Terima kasih atas kesudian anda menyertai penyelidikan saintifik ini. Kerjasama dari anda adalah sangat penting dalam menjayakan kajian ini. Jawapan yang jujur dan tepat amat diperlukan untuk melaksanakan projek ini.

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

BAHAGIAN I: MAKLUMAT PERIBADI KANAK-KANAK DAN KELUARGA

- 1. No. Responden:
- 2. Nama kanak-kanak: _____
- 3. Nama ibu/bapa/penjaga* kanak-kanak: _____
- 4. Alamat: _____

- 5. No. Telefon: _____ (pejabat) _____ (rumah)
- 6. Tinggi kanak-kanak: cm Berat kanak-kanak: kg
- 7. Umur: tahun
- 8. Tarikh lahir: hari bulan tahun
- 9. Bilangan adik-beradik: _____ (orang)
- 10. Tahun Persekolahan:
- 11. Nama sekolah: _____
- 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. Pendapatan isi rumah: RM _____ sebulan

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

22. Sudah berapa lama kanak-kanak tinggal di alamat sekarang: _____ tahun _____ bulan

23. Sila senaraikan tempat-tempat dimana kanak-kanak ini pernah tinggal selama enam bulan atau lebih sejak lahir hingga sekarang:

a) _____

b) _____

BAHAGIAN II :MAKLUMAT PERSEKITARAN DALAM RUMAH

1. Berapa buah bilik kah yang terdapat di dalam rumah ini? _____ buah

2. Berapa orang kah 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 _____ (silanyatakan)

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 TIADA, 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 kerap kah dalam seminggu anda membersihkan rumah anda ?

_____ kali seminggu

16. Adakah anda menggunakan karpit di kediaman anda ?

Ya

Tidak



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UPPM

BAHAGIAN III : MAKLUMAN 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 - 2 kilometer dari kilang
 > 2 - 5 kilometer dari kilang
 > 5 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 ke sekolah ?

Kereta

Basikal

Berjalan kaki

Bas

Motorsikal

Soalan-soalan berikut merupakan soalan-soalan mengenai taraf kesihatan di bahagian dada anak anda, sila berikan jawapan sama ada 'YA' atau 'TIDAK' jika anda tahu jawapannya.

Jika didapati soalan tersebut tidak merujuk pada anak tuan, sila tandakan pada bahagian tidak berkenaan. Sekiranya anda ragu-ragu sama ada jawapannya 'YA' atau 'TIDAK', sila tandakan 'TIDAK'.

BAHAGIAN IV : MAKLUMAT TARAF KESIHATAN KANAK-KANAK

BATUK / COUGH

	YA	TIDAK
1. Adakah anak anda selalu mengalami batuk beserta selsema?		
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)		
2b. 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 mengalami selsema?		
2. Adakah anak anda selalu mengalami kesesakan nafas dan 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)		
2b. Sudah berapa lamakah anak anda mengalami masalah batuk seperti ini? _____ bulan/tahun		
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 masalah ini berlaku? _____ bulan/tahun		

DADA BERBUNYI / WHEEZING

	YA	TIDAK
1. Adakah anak anda selalu mengalami masalah pernafasan berbunyi di bahagian 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 menghalang 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?		

A. 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 menghidap 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			

ALERGI / 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?		

B. SEJARAH KESIHATAN KELUARGA

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

	YA	TIDAK
1. Bronkitis kronik		
2. Emfisema		
3. Asma		
4. Barah paru-paru		
5. Lain-lain penyakit _____		

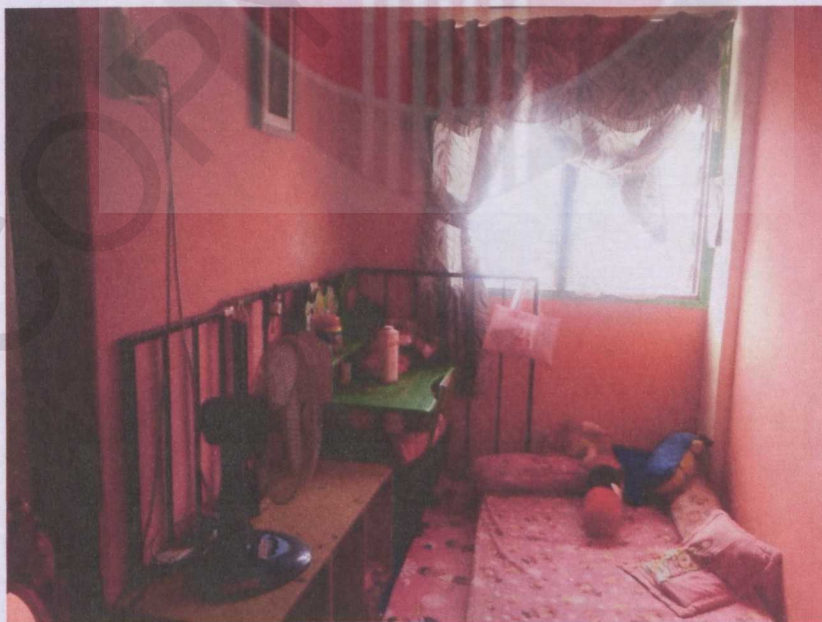


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Preschool children are doing the Lung Function Test.



Sampling Pump was positioned in playing area in one of the respondent's house



A factory nearby a respondent's house in Petaling Jaya



One of the respondent's house in Hulu Langat