UNIVERSITI PUTRA MALAYSIA

ASSOCIATION BETWEEN THE EXPOSURES TO INDUSTRIAL AIR POLLUTION WITH RESPIRATORY SYMPTOMS AMONG RESIDENTS IN PARIT RAJA, BATU PAHAT

NUR AFZA NATASHA BT MD.SOM

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BY

NUR AFZA NATASHA BT MD.SOM

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

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ABSTRACT

Introduction: The development of the manufacturing and industrial sectors in Parit Raja has resulted in rapid growth during the last 20 years. However, there is no disputing, that this industry has contributed greatly to the problem of air pollution in Parit Raja as a result of the industrial operations. Generally, air pollution has become a serious health concern, particularly for those who live in urban areas or near industrial facilities. Despite the fact that numerous studies have demonstrated a strong relationship between exposure to air pollution and the progression of myriad disease in nearly every organ system, their connection are yet difficult to explained. **Objective:** The objective of this study is to determine the association between the exposure to industrial air pollution with the respiratory symptoms among the adult residents in Parit Raja, Batu Pahat. **Methodology:** A cross-sectional comparative study was conducted among 110 adult residents in Parit Raja, Batu Pahat aged 19-65 years old. A self-administered, validated and pretested questionnaire adapted from American Thoracic Society was used to collect data on respiratory symptoms, history of exposure, and socio-demographic background of adult residents living within 5 km from the industrial area, which categorize as the exposed group, and adult residents living more than 5 km from industrial area, which categorize as the comparative group. **Result:** Significant differences in cough ($\chi 2 = 10.446$, $p=0.001$) and chest tightness ($\chi 2 = 6.643$, $p=0.010$) symptoms were found when the two groups were compared. Cough and chest tightness symptoms were shown to have higher association with the distance of residents' homes from industrial area ($p<0.05$, OR = 5.278) and ($p<0.05$, OR = 4.354) respectively . The length of time spent in the residential area on the other hand was significantly associated with the complaints of chest tightness ($p<0.05$, OR = 4.246). Result from Multiple Logistic Regression shows the most significant predictors of chest tightness symptoms after controlling all possible confounders is the distance of the residents' house from the industrial area. **Conclusion:** This study discovered that exposure to industrial air pollution causes not only respiratory symptoms but also acute respiratory infection, which includes runny nose/flu, sore or dry throat, headache, itching or eye irritation, and facial rashes, although the percentage was relatively low. Hence findings add to beneficial reference for better initiatives aimed at making the environment safer and cleaner for residents living near industrial facilities.

Keywords: Industrial air pollution; respiratory symptoms; distance from industry, staying duration.

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PERKAITAN ANTARA PENDEDAHAN TERHADAP PENCEMARAN UDARA INDUSTRI DENGAN GEJALA PERNAFASAN DI KALANGAN PENDUDUK DI PARIT RAJA, BATU PAHAT

NUR AFZA NATASHA BT MD.SOM

ABSTRAK

Pendahuluan: Perkembangan sektor pembuatan dan perindustrian di Parit Raja telah menunjukkan pertumbuhan pesat selama tempoh 20 tahun kebelakangan. Namun, tidak dapat dinafikan bahawa sektor ini juga telah memberikan sumbangan besar terhadap masalah pencemaran udara di Parit Raja akibat daripada kegiatan perindustrian tersebut. Amnya, pencemaran udara telah menjadi masalah kesihatan yang serius, terutama bagi mereka yang tinggal di kawasan bandar atau berdekatan dengan kemudahan industri. Walaupun banyak kajian menunjukkan hubungan yang kuat antara pendedahan pencemaran udara dan perkembangan pelbagai jenis penyakit di hampir setiap sistem organ, hubungannya adalah kompleks serta masih sukar dijelaskan. **Objektif:** Kajian ini bertujuan untuk menilai hubungan antara pendedahan kepada pencemaran udara industri dan gejala pernafasan di kalangan penduduk dewasa di Parit Raja, Batu Pahat. **Metodologi:** Satu kajian keratan rentas perbandingan dilakukan di kalangan 110 penduduk dewasa di Parit Raja, Batu Pahat berumur 19-65 tahun. Soal selidik yang dikendalikan sendiri, disahkan dan diuji yang diadaptasi dari American Thoracic Society digunakan untuk mengumpulkan data mengenai gejala pernafasan, sejarah pendedahan, dan latar belakang sosio-demografi penduduk dewasa yang tinggal dalam jarak 5 km dari kawasan perindustrian, yang dikategorikan sebagai kumpulan terdedah, dan penduduk dewasa yang tinggal lebih dari 5 km dari kawasan perindustrian, yang dikategorikan sebagai kumpulan perbandingan. **Keputusan:** Hasil kajian mendapati perbezaan ketara bagi gejala batuk ($\chi 2$= 10.446, p=0.001) dan sesak dada ($\chi 2$= 6.643, p=0.010) ketika kedua-dua kumpulan itu dibandingkan. Gejala batuk dan sesak dada terbukti mempunyai kaitan yang lebih tinggi dengan jarak rumah penduduk dari kawasan perindustrian masing-masing dengan ($p<0.05$, OR = 5.278) dan ($p<0.05$, OR = 4.354). Sebaliknya, masa yang dihabiskan di kawasan perumahan banyak dikaitkan dengan aduan sesak dada ($p<0.05$, OR = 4.246). Hasil dari Regresi Logistik Berganda menunjukkan faktor paling signifikan yang dikaitkan dengan simptom sesak dada setelah mengawal semua kemungkinan faktor lain adalah jarak rumah penduduk dari kawasan perindustrian. **Kesimpulan:** Kajian ini mendapati bahawa pendedahan kepada pencemaran udara industri tidak hanya menyebabkan gejala pernafasan tetapi juga jangkitan pernafasan akut, yang merangkumi hidung / selesema berair, sakit tekak atau kering, sakit kepala, gatal-gatal atau kerengsaan mata, dan ruam wajah, walaupun peratusannya adalah agak rendah. Oleh itu, dari aspek persekitaran, kajian ini menambahkan lagi rujukan yang berpotensi digunakan untuk inisiatif yang lebih baik bagi menyediakan persekitaran yang lebih selamat dan bersih bagi penduduk yang tinggal berdekatan dengan kemudahan industri.

Kata kunci: Pencemaran udara industri; gejala pernafasan; jarak dari industri, tempoh tinggal.

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LIST OF ABBREVIATIONS

<	Less Than
>	More Than
≥	At Least
ATS	American Thoracic Society
B	Regression Coefficient
CAA	Clean Air Act
CI	Confidence Interval
CO	Carbon Monoxide
COPD	Chronic Obstructive Pulmonary Disease
DALYs	Disability Adjusted Life Years
DOE	Department of Environment
EPA	Environmental Protection Agency
GBD	Global Burden Disease
HC	Hydrocarbon
IQR	Interquartile Range
km	Kilometer
m	Meter
MTPIE	Map Ta Phut Industrial Estate
NAAQS	National Ambient Air Quality Standards
NO_x	Nitrogen Oxides
O_3	Ozone
PM_{10}	Particulate Matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of 2.5 microns or less
PR	Prevalence Ratio
SE	Standard Error

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SPSS	Statistical Package for Social Science
SO_2	Sulphur Dioxide
Tg	Teragrams
UTHM	Universiti Tun Hussein Onn Malaysia
VOCs	Volatile Organic Compounds
WHO	World Health Organization

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CHAPTER 1

INTRODUCTION

1.0 Introduction

The air we breathe includes a combination of different gases, approximately 78% nitrogen, and 21% oxygen, along with a small number of other gases such as carbon dioxide, neon, and hydrogen. However, the air also holds plenty of tiny particles that we have been unintentionally exposed to from the air we breathe known as aerosol be it coming from natural sources or anthropogenic sources. According to the World Economic Forum (2015), the scientist has strongly agreed that the beginning of First Industrial Revolution is the specific point of time which remarked the broad and significant human impact on the environment that is just large enough to change the environment which was starting within the late 1780s to 1830s. It had been first beginning in Great Britain and quickly spread throughout the world.

Nature widespread of air, as well as the harmful side effect to humans and the environment, have made it a predominant issue to discuss among the various pollution produced (Leung & Drakaki, 2015). Besides, the outcomes from research have exhibited a solid connection between levels of airborne particles, Sulphur dioxide, and other petroleum derivative emission and risk of premature death from heart disease particularly for susceptible individuals with prior conditions, for example, hypertension, past heart disease, diabetes, respiratory disease and high cholesterol level (Marchwinska-Wyrwal et al., 2011).

Generally, air pollution refers to the contamination of the air, no matter indoors or outside. Air pollution can be divided into two categories are primarily air pollution, which is the type of pollutants that are brought about immediately or aftereffect of a process or a cycle such as Sulphur dioxide. Meanwhile, the secondary pollutant refers to the type of pollutants that are generated by the intermixing and responses of primary pollutants such as smog (University Of California Riverside, 2020). Air pollution is caused by either solid, liquid, or gas particles that are suspended in the air. Example of natural sources of pollution incorporates volcanic eruptions, gases

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release from respiration as well as methane gas release from cattle digestion. Additionally, the exhaust from industry and factories, motor vehicles, burning of fossil fuels, agricultural activities, waste in landfills, tobacco smoke, power generation, as well as mining operations are some of the examples of human activities that generate air pollutant (Rinkesh, 2016)

The health effects related to exposure to these gases and particles vary throughout the spectrum of their composition. For many pollutants, there are large uncertainties regarding the causal links between exposure and different health outcomes. US Environmental Protection Agency has established National Ambient Air Quality Standards (NAAQS) for six basic air pollutants (otherwise called "criteria air pollutants") following The Clean Air Act (CAA). These pollutants include particle matter, ground-level ozone, carbon monoxide, Sulphur dioxides, nitrogen oxides, and lead (US EPA, 2020).

Air pollution exposure has been implicated in myriad disease processes in almost every organ system and is currently the fifth highest risk factor for mortality worldwide (Adamkiewicz et al., 2020). Approximately 7 million deaths annually are attributable to air pollution worldwide. Plus, WHO information shows that 91% of the world's population, or roughly 9 out of 10 individuals inhales the air that surpasses WHO guideline limits containing significant levels of pollutant, with low- and middle-income countries experiencing the most elevated exposure (WHO, 2018). Moreover, according to WHO data, 4.2 million deaths each year due to stroke, heart disease, lung cancer as well as acute and chronic respiratory disease are associated with exposure to ambient air pollution (WHO, 2018). Over and above that, The Global Burden of Disease study appraises those 3.4 million premature deaths were ascribed to outdoor air pollution in 2017.

Proceeding onward to Malaysia research in this issue, these days, air pollution has become one of the major environmental concern in Malaysia and the reasons for this is that the pollutants in ambient air have substantially lessened the air quality level in the polluted area, encompassing regions in which it relies upon the wind speed and direction (Raffee et al., 2018). Malaysia has estimated the effect attributable to fossil fuel-related air pollution goes somewhere in the range of US$2.8 to US$6.7 billion (RM11. 7 billion to RM28 billion) a year, with around 10,000

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unexpected losses (Head Topics Malaysia, 2020). Also, air contamination is accountable for one out of each nine fatalities in Malaysia, making it one of the top reasons for death.

Malaysia aims to accomplish the status of being an industrial nation and having a rapid economic development by 2020 have subsequently begun to force cost not only to the environment, such as crops plantation, flora and fauna species, and eco-system but also to human wellbeing (Afroz et al., 2003). According to Global Burden of Disease data 2017, air pollution has been ranked sixth highest number of deaths among other risk factors for death in Malaysia. Figure 1 simplifies the number of deaths by risk factor in Malaysia in 2017, rating air pollution (indoor and outdoor) as a top-sixth leading risk factor of fatality in Malaysia.

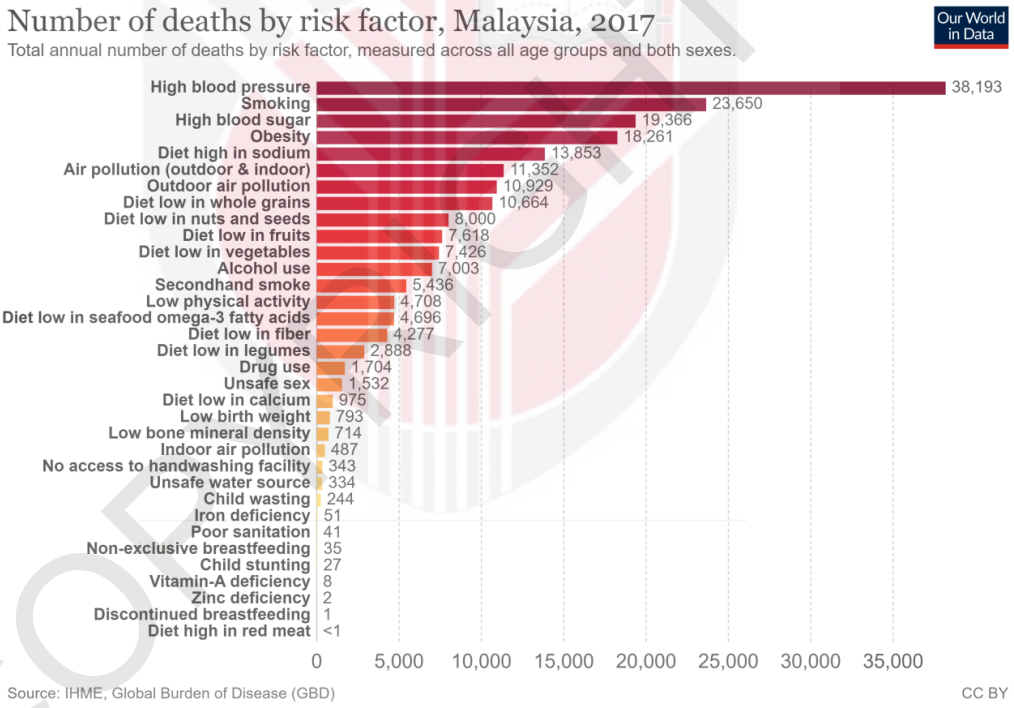

Figure 1.1: Number of deaths by risk factor in Malaysia, 2017 (Sources: Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2017 (GBD 2017) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2018)

Besides, air pollution appears to have different defame health impacts in early human existence, for example, respiratory, cardiovascular, mental, and perinatal problems, prompting infant mortality or chronic disease in adult (Kelishadi &

Poursafa, 2010). However, the estimated mortality rate associated with ambient air pollution based on general population studies may not be representative of the effects on certain subgroups.

According to the Department of Statistics Malaysia, the older age population in Malaysia is increasing each year leading Malaysia to an aging nation. The percentage of the population aged 15-64 years (working age) is making up 69.7 % of the total population of Malaysia in 2020 compared to 23.3 % for 0-14 years (young age) and 6.7 % for the population aged 65 years and over (old age). Thus, based on this data, it can conclude that there is a demand to assess the association between exposure to air pollution and respiratory symptoms among adults since this subgroup of the population is significantly make up the largest part of Malaysia's population. Figure 2 below describes the outdoor air pollution rates by age in Malaysia in 2017.

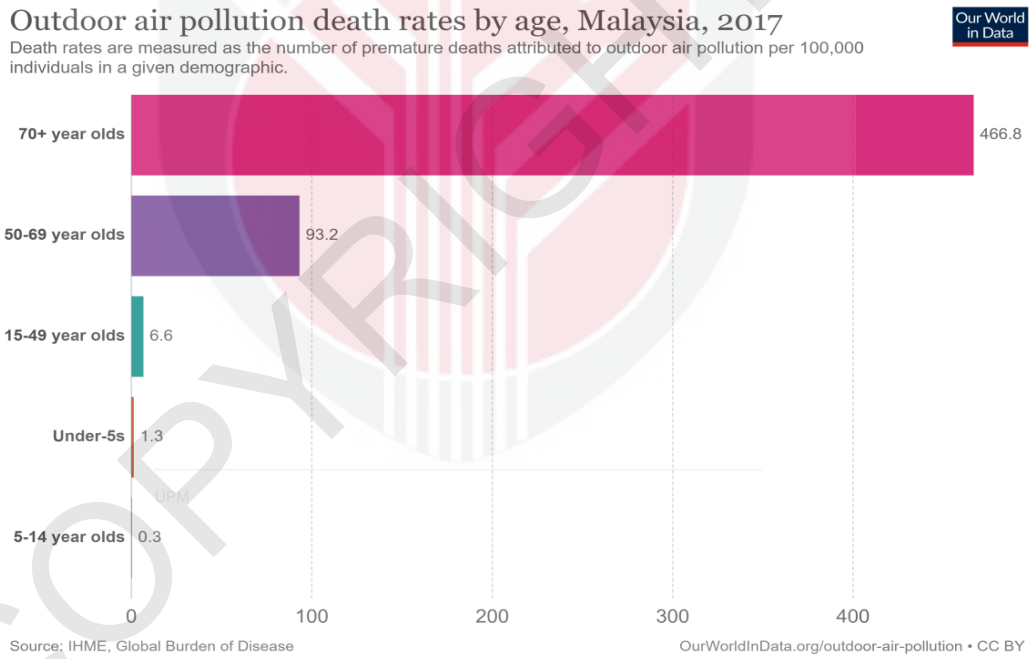

Figure 1.2 : Outdoor air pollution death rates by age, Malaysia, 2017 (Sources: Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2017 (GBD 2017) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2018)

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1.1 Background of Research

Being the quickest development state for an economic area in Malaysia particularly for as far back as four years, Johor's economy has created at a rate, in fact, quicker than that of Malaysia overall in 2016 (Takashi, 2017). Likewise, Johor is foreseen to turn into Malaysia's second-biggest economy behind Selangor (Takashi, 2017). The prompt advancement of the state including improvement of transportation infrastructure and vacation industry, symbolizing a contemporary metropolitan model, has resulted in more individuals moving to secure job opportunities in Johor.

Furthermore, Batu Pahat, one of the districts in the state of Johor is quickly arising to turning into a hub of education for the Southern Malaysia state and also a large industrial zone with heavy traffic congestion which contributes to the emission of air pollutant. The low air quality level can provoke detrimental impacts to human wellbeing particularly for the sensitive population including children, the elderly, and individuals with existing respiratory problems (Raffee et al., 2018).

One of the towns in Batu Pahat District is Parit Raja. Lately, the town has seen generous development because of its location containing industrial and education center. Figure 3 beneath is the guide of the industrial region in Parit Raja, Batu Pahat that is situated close to the residential area and a university, presenting the general population to the risk of industrial air pollution from both outdoor and indoor environment.

Figure 1.3 : Satellite image of Parit Raja Industrial Zone which is located near university and residential area (Source: Google Maps,2020)

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According to a study by (Miskam & Shafii, 2013), Parit Raja town was once in the past known as a small town that ran agricultural activities as its primary economic driver because of its geography of having low laying area. Notwithstanding, rapid development throughout the previous 20 years had influenced the changes in land use whereby extension of the residential area, shopping store, and social facility took place and consequently yielding negative result to the town in terms of air and water quality and also catastrophic event. This is occurred because of the impacts of rapid economic development yet poorly planned that eventually will be reflected in the environment. As a result of the substantial changes to the environment, the climate and health of the residents are at risk which rationalized the requirement for cautious consideration in the development perspective.

There has been an extreme utilization of motor vehicles because of the quick expansion of population in Parit Raja which likewise incorporates the students from Universiti Tun Hussein Onn Malaysia (UTHM). Based on data by the Department of Statistics Malaysia, the quantity of populace in Parit Raja is demonstrated to have expanded from 14901 individuals in 2000 to 18618 individuals in 2010 (exclude students of UTHM). Other than that, industrial activity, heat, and power generation plants, and also open burning are among the sources that contribute to the emission of PM_{10}.

Physical observation has indicated that the industrial activity in Parit Raja Industrial Area has the incessant generation of smog which possibly add to the elevated level of PM_{10}, and consequently imposing health effect to the population nearby (Raffee et al., 2018). Additional research was conducted to simplify the significant relationship between increase combustion and motor vehicle emission with the occurrence of air pollution which directly justifies that weather has an only low significant association to the air pollution episode as compared to both mention factors (Zakaria et al., 2018).

Over the past five years, emission from mobile sources such as motor vehicles have been the significant root cause of air pollution, adding to at any rate 70–75% of overall air pollution while emission from fixed sources particularly from industrial activity and open burning have accounted for roughly 20–25% and 3–5% of overall air pollution respectively (Afroz et al., 2003). Altogether, it can be concluded that

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individuals are adjusting and polluting the environment including the air by the reason of energy, food, water, and land utilization.

Initially, Parit Raja Industrial Zone is a designated industrial estate. However, due to the rapid expansion of population and perhaps the changes in land use and capacity, several residential areas have been built adjacent to the industrial area with merely small buffer distances. Hence, the sitting of the residential area near the industrial zone has been linked to several respiratory outcomes experience by the community. On top of that, there are approximately 11 manufacturing industries located in Parit Raja, Batu Pahat including wood supplier, electronic manufacturing, plastic manufacturing, textile industry, food processing, paper mill, adhesive and chemical manufacturing by which the emission from these industries is assumed to provoke respiratory symptoms to residential expose to the air pollutants. Figure 4 is the map view of Parit Raja Industrial.

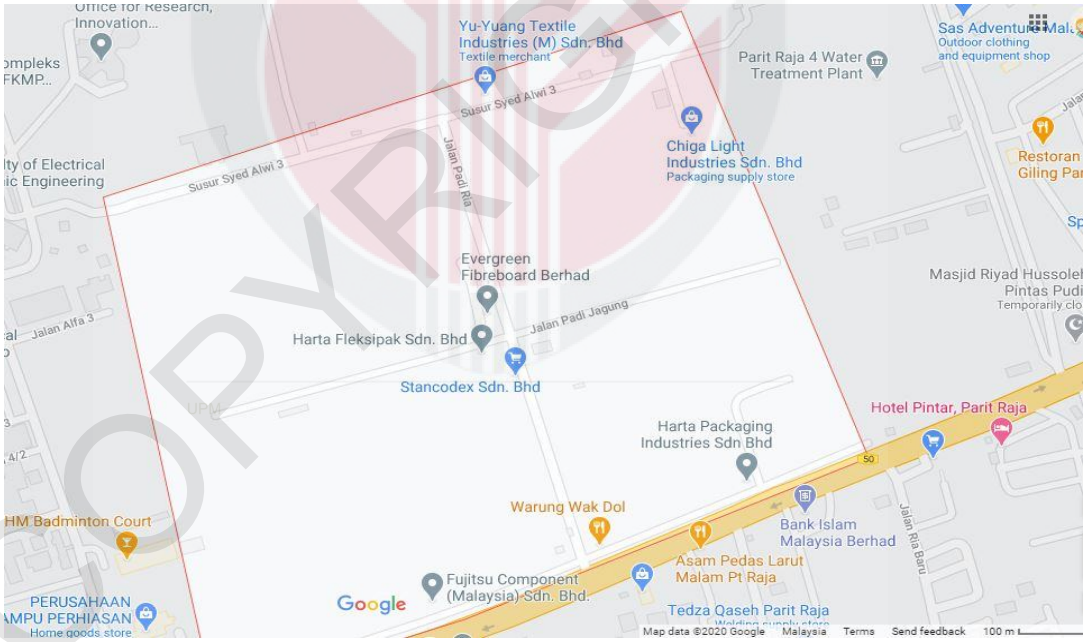

Figure 1.4 : The maps view of Parit Raja Industrial (Source: Google Maps, 2020)

1.2 Problem Statement

Batu Pahat Johor is one of Johor's industrial towns with several industrial zones situated inside this locale including Tongkang Pecah, Parit Raja, Sri Gading, Sri Sulong, Lian Aik, and Buditama, ranging from 20 acres (81,000 m2) to 200 acres

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(0.81 km2). A wide range of manufacturing businesses is located in this district such as wood supplier, electronic manufacturing, plastic manufacturing, textile industry, food processing, paper mill, adhesive and chemical manufacturing. Whilst Batu Pahat district is heavily industrialized, there are significant contributions made by these industries to the air pollution problem (Miskam & Shafii, 2013; Raffee et al., 2018). The majority of the residents residing within 5 km from Parit Raja Industrial Area and have stayed for quite some time have reported complaints on respiratory symptoms pertaining to the exposure to the industrial air pollution released by the industrial activity.

Moreover, air pollution is considered as the major environmental risk factor in the incidence and progression of respiratory symptoms ranging from acute exposure to long term health effect (Ghorani-Azam et al., 2016) making it highly important to identify which manufacturing activities are emitting the pollutant the most before planning for any preventive or mitigation measure to solve the issues. However, with no baseline data available specifically at the location of study, which is in Parit Raja Industrial Zone to determine the air pollution level mainly and the extent of exposure to residents living nearby, no scientific association can be made between the exposure to industrial air pollution with the respiratory symptoms among residents in Parit Raja Batu Pahat.

Additionally, the children and the elderly are consistently the effectively recognizable subgroups of interest for an air pollution study (Cakmak et al., 2007). Air pollution has been related to preterm birth, intrauterine growth impediment, sudden infant death syndrome, and newborn child mortality in the early period of life (Dales et al., 2004). Many research has been directed to decide the effect of industrial air pollution on children on the basis that they are susceptible and in danger of getting respiratory health problems mainly because their lungs still not completely grew at this point and low immunity resistance (Sopian et al., 2020). Among the older, negative impacts of air pollution have been accounted for in those > 65 years old (Kloog et al., 2013).

Nevertheless, a limited study is conducted to find the association between exposure to industrial air pollution and the health effect on the general population. The questions remain is that are the adult age whose define by WHO as the person

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who age between 19 years old to 64 years old is less impacted by industrial air pollution as compared to children and the elderly?

1.3 Study Justification

The purpose of this study is to determine the association between exposure to industrial air pollution with the respiratory symptoms among adult residents age (19 to 64 years old) of Parit Raja Batu Pahat. Since the effects of air pollutants on living organism especially human has been substantially known, this study might add up to provide an insight of how certain level of exposure to this industrial air pollutant might induce negative health impact towards the residents nearby industrial area of Parit Raja.

Moreover, numerous scientific data have demonstrated that fine particle pollutants can cause premature death in people with heart and/or lung disease including cardiac dysrhythmias, nonfatal heart attacks, aggravated asthma, and decreased lung functions (Kelishadi & Poursafa, 2010). Depending, on the degree and term of the exposure, particulate toxins may cause mild to severe illness to human wellbeing, for example, cough, dry mouth, wheezing, limitation to physical activity particularly involving outdoor activity because of breathing difficulty, chest tightness, and inflammation of the airways (Jiang et al., 2016). Therefore, through this study, an association between exposure to industrial air pollution and the respiratory symptoms among the resident leaving nearby industrial areas can be precisely understood perhaps contribute to the implementation of necessary preventive and mitigation measures.

Next, by conducting this research, an association can be made whether or not the adult residents comprising of a wide range of ages (19 years old to 64 years) are impacted by the industrial air pollution. By having this study, further research can be conducted to have a clear idea of the health impact of specific industrial air pollutants and the prevalence of respiratory health disease to the adult age group.

1.4 Research Questions

I. What is the association between the exposures to industrial air with the respiratory symptoms among the adult-age group residents (19-64 years old) in Parit Raja Batu Pahat?

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II. What is the prevalence of respiratory symptoms among adult residents living near Parit Raja Industrial Area and adult residents at comparative locality?

III. What is the main predictor of the respiratory symptoms of adult respondents after considering all the confounders?

1.5 Study Significance

The data collected through this project have the potential to be used to raise awareness of residents, industry, and relevant authorities who are concerned about the extent of the exposure to corresponding respiratory health effects. This awareness may lead to good effluent management of the industry. Plus, the information provided by this research can be utilized by organizations as well as authorities to construct an effort to create or improve prevention and control plans regarding exposure to industrial air pollution. The relevant authorities such as the Department of Environment (DOE) may consider taking extra steps to reduce and control the air pollution problem by inspecting to make certain that air pollution-controlled system is equipped and conduct performance monitoring as required by Regulation 7 and Regulation 9(b) of the Environmental Quality (Clean Air) Regulations 2014.

By identifying and pointing out the relationship between air pollutant exposure and the respiratory health of a person, a proper prevention or mitigation plan could be implemented into the industry to protect the residents. Evaluation of existing control and practices should be done not only to comply with occupational and environmental settings but to ensure the human health elements are considered thoroughly. As part of a precautionary approach, the findings of this study can be used to raise awareness and educate communities living near an industrial facility about the risks they face from regular exposure to industrial air pollution.

Furthermore, this research offers an overview of the effects of industrial air pollution on respiratory health and suggests measures that the community can take to ensure that they are living in a safe environment. There are indeed gaps in our understanding of the mechanisms of airway inflammation concerning air pollution exposure. As a result, the conclusions of this study should provide opportunities for improvement for other researchers.

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1.6 Study Objective

1.6.1 General Objective

To determine the association between the exposure to industrial air pollution with the respiratory symptoms among the adult-age group residents (19-64 years old) in Parit Raja, Batu Pahat.

1.6.2 Specific Objective

a) To determine the socio-demographic information of adult respondents in Parit Raja, Batu Pahat.
b) To compare the reported respiratory symptoms among the respondents in the exposed area and comparative area.
c) To determine the association between the exposure to industrial air pollution (duration of stay in the residential area and distance of residential area from the industrial area) with respiratory symptoms among adult residents living near the industrial area and adult residents who live in the comparative area.
d) To identify the main variables that influence respiratory symptoms among adult respondents after considering all the confounders.

1.7 Hypothesis

a) There is a significant difference between socio-demographic information of adult respondents in Parit Raja, Batu Pahat.
b) There is a significant difference between the reported respiratory symptoms among the respondents in the exposed area and the comparative area.
c) There is a significant association between the exposure to industrial air pollution (duration of stay in the residential area and distance of residential area from the industrial area) with the respiratory symptoms among adult resident Parit Raja, Batu Pahat.
d) The main variables that influence respiratory symptoms among adult respondents after considering all the cofounders are the distance of the residential area from the industrial area.

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1.8 Conceptual Framework

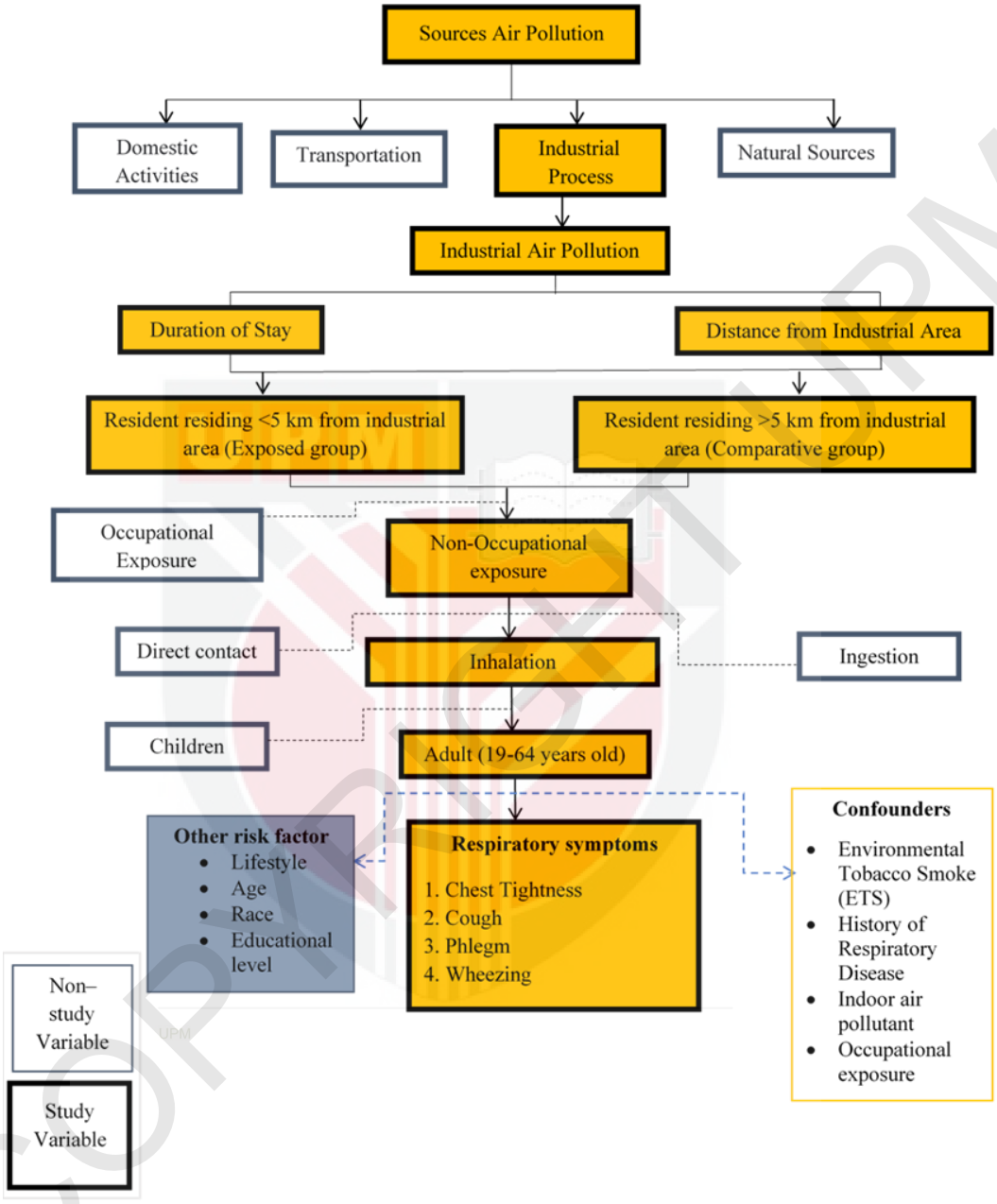

Figure 1.5 : Conceptual Framework of the study

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1.9 Definition

1.9.1 Conceptual Definition

i. Industrial Air Pollution

Industrial pollution can be straightforwardly referring to the pollution that is resulting from the production process or manufacturing activity. Industrial air pollution is also known as a stationary source of air pollution whereby it can be classified into the vast sector, for example, agriculture and food manufacturing, energy engine and combustion, electric and power generation, processing of foam, fiber, plastic, and rubber products, chemical production and so forth (US EPA, 2020)

ii. Industrial Area

Industrial areas are preferred as the designated and permitted industrial estates or areas designated for industrial use. In general, industrial areas should avoid areas where activity has a high probability of affecting environmentally sensitive areas downstream or in neighboring areas, either directly or indirectly (Guidelines for Siting Zoning of Industry and Residential Area, 2012). Furthermore, manufacturing areas are primarily served by decent road infrastructure, together with sufficient and suitable utility supplies that enable easy access to the site while avoiding direct passing through residential areas or sensitive receptors like hospitals and schools (Guidelines for Siting Zoning of Industry and Residential Area, 2012). To alleviate such environmental issues, the industrial area also requires a sufficient primary buffer (Guidelines for Siting Zoning of Industry and Residential Area, 2012).

iii. Residential Area

In contrast to industrial and commercial areas, a residential area is a land use where homes or households predominate (Guidelines for Siting Zoning of Industry and Residential Areas, 2012) Residential area may also be described as a planned community or cluster of separate or independent homes distinctly different or independent structures built on land that has been leased for ‘building' and is mainly occupied by private residences or used as a place of

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residence, according to the Guidelines for Siting Zoning of Industry and Residential Areas (2012). Besides, a cluster of houses, each of which is located on an individual lot of land classified as "agriculture," may also be called a "residential area" if the cluster is officially acknowledged as constituting "a village" or "kampong" (Guidelines for Siting Zoning of Industry and Residential Areas, 2012)

iv. Distance from Industrial Area

According to Oxford Dictionary, distance is defined as the amount of space between two places or things. In this study, distance is defined as the distance (in kilometers) of the residential area from the industrial area.

v. Duration of Stay

According to Oxford Dictionary, duration means the length of time that something lasts or continues, and stay means to continue to be in a particular place for a period of time without moving away. Therefore, in this research, duration of stay is defined as the length of time (in years) the respondent has been residing or staying in the residential area.

vi. Respiratory Symptoms

The respiratory symptom can be defined as a condition that resulted from a disturbance of the respiratory system. Many factors contributed to this condition which is either internally or externally. For instance, respiratory symptoms include cough, phlegm, wheezing, shortness of breath, and chest tightness (US EPA, 2017).

vii. Adult Resident

As per the World Health Organization (WHO), the adult is an individual older than 19 years old except if public law delimits a previous age, and an adolescent someone aged 10 to 19 years. In this research, the adult is defined as the residents aged 19 to 64 years old.

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1.9.2 Operational Definition

i. Distance from Industrial

The assessment of distance from the industrial area is conducted via questionnaire whereby the residential area that is located within 5 km of the industrial area is categorized as exposed area while the residential area that is located more than 5 km from the industrial area is categorized as comparative area.

ii. Duration of Stay

The assessment of the duration of stay in the residential area is carried out via questionnaire whereby only adult residents who have stayed in the residential area for at least one year will be chosen as respondents.

iii. Socio-demographic data

Socio-demographic data of respondents such as gender, age, marital status, and level of education are obtained from a modified and validated questionnaire ATS-DLD-78

iv. Respiratory symptoms

a. Cough

The assessment of coughing including coughing routine and frequency is identified through modified and validated questionnaire ATS-DLD-78

b. Phlegm

Phlegm is commonly related to conditions or diseases of the respiratory systems due to inflammation and is cough up from the lungs. The assessment of phlegm including phlegm routine and frequency is identified through modified and validated questionnaire ATS-DLD-78

c. Wheezing

Wheezing is identify as a high-pitched whistling sound made by the lung during exhale or in worst cases, it very well may be heard when a person

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breathes in due to the conditions of narrowed airways or airways inflammation (Kristeen Moore, 2020). The symptoms of wheezing are done through modified and validated questionnaire ATS-DLD-78

d. Chest Tightness

Chest pain causes discomfort to the patient in ways that are painful, the feeling of pressure and discomfort that are coming from the chest. The assessment of chest pain is assessed through modified and validated questionnaire ATS-DLD-78.

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CHAPTER 2

LITERATURE REVIEW

2.1 Air Pollution Exposures on Human Respiratory System

Everybody is exposed to outdoor air pollution each day, whereby the only difference is that the exposure may vary significantly from more to a lesser extent (Rückerl et al., 2011). People are exposed to a wide scope of air pollutants known to be related to numerous unfavorable consequences for human health (Jiang et al., 2016). As for today, an extensive study on different characteristics of air pollution is performed and conclusions have been made as such human health can be influenced by air pollution in all phases of life—from infant to elderly (Rückerl et al., 2011). The impact of air pollution on human health mainly respiratory health persists as the major public health concern around the world today (Jiang et al., 2016).

At this point, the respiratory health impacts due to the ambient air pollution have already been proven by the presence of a great deal of epidemiological study though there was an uncertainty that these outcomes presumably did not mirror a typical threat for everybody in the general population and thus a following large aim was towards attempting to recognize the most vulnerable populations (Berglind, 2017). Additional work by Olstrup (2019) noted that there is a significant relationship between the concentration of O_3 and $PM_{2.5-10}$ with the day-by-day mortality in Stockholm which reveals that behavioral factors are the factors that influencing the level of exposure to the pollutant rather than the type of pollutant itself. Hence, suggested that presenting a more reliable measurement technique for the assessment of particles would be advantageous in evaluating the impacts of exposure on respiratory health (Olstrup, 2019).

The first time the researcher assess the impact of air pollution on human wellbeing is after the Meuse Valley mist in 1930 (Firket, 1936) or the London smog in 1952 (Ministry of health, 1954), nobody might have understood what a diversified field of study they began, as cited in (Rückerl et al., 2011). Todays, universal

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epidemiological investigations show a constant increase of reported heart and respiratory disease associated with exposure to particulate matter (André Nel, 2005). World Health Organization estimated that 3.2 million deaths around the world are attributed to air pollution with 223,000 deaths due to lung cancer (The Global Burden of Non-Communicable Disease, 2020). Subsequently, $PM_{2.5}$ is assessed to be the sixth-highest factor for premature deaths worldwide as indicated by the Global Burden of Disease (GBD) in 2016, adding up to 4.1 million premature deaths due to coronary illness and stroke, chronic lung disease, lung cancer, and respiratory infections (Olstrup, 2019).

Plus, The International Agency for Research on Cancer (IARC) which is a part of the World Health Organization groups the primary pollutant of air pollution-particulate matters, as carcinogenic and produces a study to relate air pollution and lung cancer in 2013 (Clean Air Healthy Lungs-knoema, 2018). As a matter of fact, according to Global Burden of Disease (2019), COPD was ranked sixth among 25 of the leading causes of global DALYs and the percentage of total DALYs (1990-2019) across all age groups (Vos et al., 2020) with relatively no less than one-fourth of people all around the world is subjected to a harmful concentration of ambient air pollutants as accordance to statistical data from WHO in 2006 (Zhang et al., 2014).

In Malaysia, air pollution has become a huge concern for health especially for the populace who live in metropolitan regions or close to industrial regions besides the episode of haze Malaysian experience consistently (Suhaimi et al., 2015). These air pollutants are interfering with the lungs and respiratory system as well as can be taken up by the blood and circulated all around the body. From the outset, exposure to air pollution may at first induce irritation to the respiratory tract and breathing trouble and after a while develop to more severe medical conditions particularly for populaces at a higher risk, for example, children.

Extensive studies have proven air pollution levels in Malaysia will increase as a result of urbanization and also the expanding number of vehicles utilized by the population living in Malaysia (Raffee et al., 2018; Suhaimi et al., 2015). Reliable research conducted by Afroz et al. (2003), set up that the primary source of air pollution in Malaysia is from mobile sources (82%) and follow in order by power station (9%), industrial fuel consumption (5%), industrial manufacturing

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process(3%), open burning at solid waste dumping site (0.8%) and household emission and commercial furnace (0.2%)

2.2 Overview of Parit Raja Industrial Activity and Pollution

As previously mentioned in Chapter 1, Parit Raja town in Batu Pahat Johor has undergone major growth over the last 20 years (Miskam & Shafii, 2013). Parit Raja is a small town located in an industrial area and only 10 km from the North-South Highway. This area is said to be strategic because it is located on the main route of residents from Batu Pahat town to Ayer Itam, which is only 7 km from Ayer Itam and 23 km from Batu Pahat town. The strategic locations coupled with the upgrade of the main road to four lanes are believed to be the factor that contributes to the rapid development of Parit Raja town. Until now, Parit Raja town has become not only one of the main industrial areas in the state of Johor, but this town also contributes to the state of Johor in terms of agriculture as well as education through the development of a tertiary institution that is UTHM (Shafii et al., 2017).

At present, there are several mid and high-scale industries with a variety of business nature are located in Parit Raja town. Among them are Fujitsu Component (M) Sdn. Bhd which is a company producing electromagnetic goods, computers, and electrical; Harta Packaging Industry Sdn. Bhd., which is a paper packaging plant; Evergreen Fibreboard Sdn. Bhd., precisely a wood-based product trading; Chiga Light Industries Sdn. Bhd., specifically known for paper mill industry; EMI Embroidery Sdn Bhd, namely an industry producing vehicle and industry machinery; Yu-Yuang Textile Industries (M) Sdn. Bhd., which is a manufacturer and exporter of textile; and PCG Soon Lee Furniture Sdn. Bhd., that is Malaysia's leading furniture manufacturer.

Plus, the majority of the company are not just fulfilling the demand for domestic supplies but also exporting their products abroad. Roughly, this is enough to justify how massive these companies' production is. Significantly, the extensive economic activity in Parit Raja is assumed to be the culprit of poor air quality in Parit raja and is affecting the health of the population living nearby the industrial area (Raffee et al., 2018). Among all these huge industries, the wood-based industry is identified to be the major contributor to industrial air pollution in Parit Raja.

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As per Malaysia Investment Performance Report 2017 by the Malaysian Investment Development Authority, Malaysia was positioned as the eighth largest exporter of furniture worldwide, 80% of which is wood-based. Precisely, this industry remains on being a significant supporter of the Malaysian economy. Correspondingly, in 2017, Batu Pahat and Muar are the two main localities of which had recorded the production of more than 70% of Malaysia's furniture trades. Truth be told, Malaysia has been exporting RM23.2 billion worth of wood and wood products, around the globe including the USA, EU, Japan, Australia, South America, Africa, and the major distributor of office furniture in the Middle East nation. By 2020, the annual growth of timber exports is assessed to be worth RM53 billion (Malaysian Investment Development Authority, 2017).

Despite driving the Malaysian economy as a whole, the wood-based manufacturing industry is viewed as a contributing factor to increasing industrial emissions. Nevertheless, timber products may cause different sorts of environmental effects at various cycles of processing be it from harvesting to their dumping. A significant environmental consequence from the timber production process from crude materials to final products is the emission of greenhouse gases (GHG) (Adhikari & Ozarska, 2018). Besides, the sawmilling process which includes debarking and cutting of wood into smaller section, sawing of woods into sheets and oven drying leave a significant amount of wood residue or particulate matter (Adhikari & Ozarska, 2018). Furthermore, the organic solvent in coating chemicals used to preserve the wood product from environmental factors such as dampness, mechanical and chemical harm, and also natural decay can emit Volatile Organic Compounds (VOC) (Adhikari & Ozarska, 2018).

Apart from the wood industry, the paper industry in Parit Raja is also identified as a major contributor to greenhouse gases such as Carbon dioxide (CO_2), SO_2, and nitrogen oxide (NO) These greenhouse gases are known to cause acid rain and lead to environmental change (Deeba et al., 2018; Maureen Shisia, 2018). Plus, pulp and paper industry by-products emitted into air and water bodies present an adverse risk to human health and the climate. As studied by Deeba et al., (2018) the toxic chemicals produced from the paper plant have conceivable effects to devastate or reshape the surrounding environment of the paper mill industry. Additionally, the paper mill industry is associated with the emission of Sulphur oxides (SO_x), nitrogen

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oxides (NO_x), and Volatile Organic Compounds (VOCs) from the wood-chipping digestion and combustion process (Ince et al., 2011).

Furthermore, there is also a textile industry located in Parit Raja which is Yu-Yuang Textile Industries (M) Sdn. Bhd. For the most part, the impact of the textile industry on the environment has become a popular topic. However, the amount and type of pollutant release into the air from the textile industry are not promptly accessible. As demonstrated by specific investigations, the clothing business addresses 10% of overall carbon emission and is the second-greatest modern polluter (Parvin et al., 2020). Specifically, during the energy production stage, Sulphur dioxide and nitrous oxide are the pollutants that are produced from the textile industry. Besides, Volatile Organic Compounds (VOCs) are also generated during the coating, solidifying, drying, wastewater treatment, and chemical storage process (Parvin et al., 2020). Other than that, the utilization of dye and bleach in this industry is foreseen to discharge harmful gases into the climate (Parvin et al., 2020).

The poor air quality in Parit Raja may also due to no utilization or installation of pollution control equipment in the majority of small and mid-scale industries whereby this factor have caused the build-up of specific pollutant emission to the atmosphere particularly in the industrial area (Afroz et al., 2003). In addition, the location of the industrial region which is in close proximity with populated regions, making it more challenging to avoid the population being exposed to the industrial emission (Afroz et al., 2003).

2.3 Sources of Air Pollution

In addition to the advanced improvement and exponential growth of population, a sufficient amount of assets and supplies including energy, water, and food are needed for the public to sustain their living and subsequently generating various pollution to the environment along the way (Leung & Drakaki, 2015). Primarily, 14% of all asthma reported cases were identified to be related to the exposure to traffic-related pollutants based on an investigation of ten European urban communities (Perez et al., 2013). Following a study conducted by (Adamkiewicz et al., 2020) justify that a wide scope of human activities may be related to the generation of air pollutant, for instances the combustion of fossil fuels and traffic-

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related emissions (Guarnieri et al., 2014), industrial emission, farming activities, conflagration, together with various sources of pollutants that begin from indoor.

Moreover, Leung & Drakaki (2015), claimed that in a city, the air pollutant which chiefly comprises NO_x, SO_2, O_3, CO, HC, and various sizes of particulate matters (PM) are primarily produced from an on-road motor vehicle, railways trains, combustion process related to electricity production, industrial activities, incinerators, chemical plants, transportation emission including aviation and vessels, contingent upon the locations and current breezes. This is supported in a study conducted by Jiang et al. (2016), which emphasizes the significant contribution of seasons, times, and location with the impact of air pollution on health.

In similar research by Jiang et al. (2016) further mentioned the main cause of air pollution is largely from the burning of fossil fuels which explained the need for taking additional measures such as lessening the time outside or covering the mouth and nose with a face mask particularly for those with COPD or asthma to reduce the extent of exposure to this particular hazard (Jiang et al., 2016). A study by Zhang et al. (2014) also added that the outcome of research on air pollution can also be influenced by the population attributes in addition to the rate and duration of the assessment.

On the other hand, it is suggested that indeed, people predominantly are at risk of air pollution that sources from outside even when they are staying indoor owing to the reality that most people invest the vast majority of their time indoors and the fact that there is a significant association between the concentration of air pollutant from outdoor and indoor simply because of the interchange of air among inside and outside spaces (Adamkiewicz et al., 2020). In addition to this, a recent study by Leung & Drakaki (2015) found out that metropolitan air quality is exceptionally influenced by the city design whereby a compactly spread of tall building with huge structure tallness to street width ratios can impede and decrease wind flow, accordingly lessening the air ventilation rate.

Although not all air pollution originates from anthropogenic sources, for instances the naturally occurring phenomenon such as typhoon that works up dust all including 2.5 micro meters ($PM_{2.5}$) to 10 micro meters (PM_{10}) (Clean Air Healthy Lungs-knoema, 2018) and the aftereffect of unexpected changes in temperature,

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seasonal changes, or normal cycles (Matt Williams, 2016), in any case, the impacts of economic advancement especially industrial activities toward the generation of major pollutants in the environment have become a worry to the public authority and the general population (Hu et al., 2020) due to the serious health impact as well as huge healthcare expenditure related with industrial air pollution (Zeng & He, 2019). Pollutants can be conveniently classified into three groups which are pollutants essentially discharged into the outdoor environment, pollutants principally discharged into the indoor environment, as well as pollutants, discharged into both indoor and outdoor environments (Thurston, 2016).

In reference to the air quality monitoring report conducted in numerous cities in Malaysia, which cover various pollutant including Carbon monoxide (CO), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Ozone (O_3), and Suspended Particulate Matter (SPM), a conclusion can be made that Suspended Particulate Matter (SPM) and Nitrogen Dioxide (NO_2) are the two primary pollutants that contribute to the air pollution (Afroz et al., 2003). Inhalable coarse particles are the particle with the diameter ranging from 2.5μm to 10 μm and are mainly originating from motor vehicle emission as well as industrial emission, whereas fine particles are the particulate matter diameter lesser than 2.5 μm which are found in the haze and smoke, and are released to the atmosphere from the reaction of the gases radiated from energy generating plant, factories, and vehicles (Kelishadi & Poursafa, 2010).

Additionally, in 2011, the gross emission of industrial VOCs in East China was approximately 15.8 Tg, which in general originate from the production of VOCs, stockpiling and transport, and industrial process utilizing VOCs as base materials, and from the utilization of VOCs-containing items (Wu et al., 2015). Plus, industrial emissions of VOCs are considered to be the major contributor of VOCs emission accounting for 40% of total VOCs emission among the four sorts of sources including furniture producing, oil refining, machinery engineering, and printing industry which only took up 53.8% of total emission (Wu et al., 2015). In addition to that, VOCs also can be originated from indoor sources whereby a study conducted by J Jalaluddin & N Jannah Mawar (2015) , figured out that the concentration of VOCs in the new building turned up to be higher than normal and seemed to emerge from construction materials and building substance.

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2.4 Distance and Duration of Stay at Residential Area as Exposure Assessment

Air pollution is now a significant environmental public health problem, according to many epidemiological obervations. Subsequently, multiple studies have exhibited that exposure to outdoor air pollution is related to a variety of unfavorable results, for example, acute and chronic respiratory infections, asthma, lung cancer, and several other cardiovascular diseases (Marquès et al., 2020). In like manner, the findings summed up of several peer-reviewed studies have suggested that the prevalence of the examined adverse health effects is higher for the population including (kids, adults, and pregnant woman) living close to petrochemical facilities (Marquès et al., 2020).

Moreover, an examination led in one of the industrial estate in Thailand whereby the populations of communities surrounding the petrochemical industrial estates were selected has shown that individuals living close to industrial estates had experienced acute adverse health effects such as eye and nose irritation, shortness of breath, dizziness, nose clog, sore throat, phlegm, and fatigue as a result of their exposure to the pollutants. (Kongtip & Chantanakul, 2013). Exposure from industry was also related to self-announced hypertension among adults and respiratory symptoms among the kids (Bergstra et al., 2018)

Similarly, research to analyse the connection between the distance of the subject's home with the industrial area and the presence of the respiratory issues have been carried out at Map Ta Phut Municipality, one of Thailand's largest industrial park, involving the sum of 15,441 adults aged more than 13 years who lived in Map Ta Phut Municipality for a minimum of one year. The outcome from the research revealed that the study subjects who lived within a 5 km range distance to the MTPIE registered an odour complaint more often than those who lived further away.

Additionally, the investigation likewise demonstrated living nearer to the MTPIE was related to more intense respiratory problems than living farther from the MTPIE (Tanyanont & Vichit-Vadakan, 2012) On top of that, the respiratory symptoms and eye irritation was reported to bound to adults aged more than 40 as compared to adults aged below 40. Females were reported to have dyspnoea, wheezing and upper respiratory symptoms more frequently as compared to males. This study also

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indicates that living near the MTPIE for over 5 years was related to an expanded risk of wheezing and upper respiratory side effects (Tanyanont & Vichit-Vadakan, 2012).

Additionally, an exploration led on young people in Viadana region (Northern Italy) whereby exposure was characterized based on the distance from the kid's home and school to the wood industries due to the absence of accurate, separately gathered data on industrial emission levels and a lack of data on environmental air pollution demonstrate that by and large, the number of respiratory symptoms recorded lessen as the distance from the nearest industrial facilities increases (de Marco et al., 2010). This association was measurably remarkable for general respiratory symptoms including asthma, phlegm, cough, sore throat, and nose mouth, and eye irritation. The study likewise presumed that living near the wood industries was associated with a 3% prevalence increase of cough and phlegm, a 5% increase for the prevalence of having eye side effects, a 7% predominance of asthma-like symptoms, and also a 9% commonness in nose, throat or mouth symptoms in young people in long term(de Marco et al., 2010)

2.5 Exposure and Health Effect

Various studies in recent years have established the relationship between numerous health impacts with the exposure to air pollution (J Jalaluddin & N Jannah Mawar, 2015; Yorifuji et al., 2014; Tong & Colditz, 2004 ; Lee et al., 2007; Zhang et al., 2014; Kloog et al., 2013; Eljarrat et al., 2020; Ghorani-Azam et al., 2016; Adamkiewicz et al., 2020). Plus, many studies at present have already evaluated the relationship between day-by-day air pollution and day-by-day tallies of respiratory outcomes (Yorifuji et al., 2014). On top of that, the health outcome associated with the exposure to air pollutants may vary subject to both level of exposure and duration of exposure, and that long-term exposure has significantly detrimental effects as compared to short-term exposure (Pope, 2007).

Primarily, the research found that the exposure to a high concentration of air pollutant increase the risk of contracting respiratory symptoms and provoke inflammatory reactions (Suhaimi et al., 2015) including cause new asthma cases (Guarnieri & Balmes, 2014)(Guarnieri et al., n.d.) and stimulate the progression of the lung-related disease, for example, lung cancer and emphysema apart from interfering with normal development of lung function due to the exposure at early

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stages of body development particularly on children (J Jalaluddin & N Jannah Mawar, 2015).

Additional work by Sopian et al (2020) found out that an increased prevalence of respiratory manifestations and occurrence of asthma attacks as well as a decrease in lung function in a population are linked with the closeness to the industrial area as a comparison to the population in the non-industrial area. As studied by Sopian et al (2020), it can be concluded that exposure to industrial air pollutants greatly impacts the structure of micronuclei and increases the prevalence of respiratory complaints among children living closer to an industrial zone since every possible confounding factor has been ruled out. Some of the pollutants in the air might also a genetic toxicity compound giving that long-term exposure to high or low levels of this pollutant may subsequently increase the cancer risk (Sopian et al., 2020).

Air pollution has sway on the vast majority of the human body particularly the organ and system (Jiang et al., 2016; Guarnieri & Balmes, 2014). Air pollution can prompt and worsen respiratory disease such as cardio cerebral vascular disease, ischemic heart disease, chronic obstructive pulmonary disease (COPD), asthma, lung cancer, diminished lung function, increase prescription use, and escalate hospital emergency visit and even accounted for increasing all-cause mortality over long term exposure (Jiang et al., 2016; Zhang et al., 2014; Bahruddin et al., 2015). Moreover, respiratory system illness positioned the second (12.41%) among ten leading reasons for hospitalization in either government and private hospital in Malaysia, and also the second (21.70%) among the main ten chief reasons for mortality among the two healthcare facilities in Malaysia (Suhaimi et al., 2015).

Air pollution is known to cause multiple respiratory outcomes including provoking oxidative injury to the nose, throat, and lung causing irritation, remodeling, and high risk of sensitization (Guarnieri et al., 2014) especially to the sensitized and vulnerable population regardless during low air pollution episode (Eljarrat et al., 2020). Additional work by Hussin & Jalaludin (2016) demonstrates that children who are exposed to the elevated level of PM_{10} and $PM_{2.5}$ generated from palm oil mill both from home or school are more prone to decrease in lung function and have a higher risk of developing respiratory outcome including coughing, mucus, wheezing and difficulty in breathing contrasted with the children who not

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exposed to the pollutant. As studied by Yahaya & Jalaludin (2014), children in the urban region have most noteworthy whines on coughing(79.2 %) followed by phlegm(77.1 %), wheezing (75.0 %), and chest tightness (12.5 %) as compared to the children living in a rural setting, with only 14.6 % complaint of coughing and 14.6 % for phlegm.

Relatively, a portion of individuals who live nearby to industrial zone and profoundly expose to air pollution as a consequence of the economic development and urbanization that is circumventing the region may at first experience inflammation to the airways and chest tightness followed by severe respiratory conditions particularly for susceptible individual (Suhaimi et al., 2015) given that coughing was the main reported respiratory symptoms among the children (Sopian et al., 2020).

2.6 Local Study on the Exposure to Industrial Air Pollutants and Health Outcomes

The Department of Environment (DOE) Malaysia was the first in Malaysia to conduct air quality monitoring in 1977 (NA Mohd Zizi et al., 2018). Particularly, 52 air-monitoring stations are ideally located in both residential and industrial regions to identify any major change in air quality that could be harmful to human health and the environment. According to a study conducted by Tajudin et al. (2019), another solution to evaluate environmental air pollution would be to determine the relationship between air quality and public health to prevent health complications for the community, as major industries were emitting a variety of potentially hazardous pollutants into the air.

Nonetheless, only a few studies have been undertaken in Malaysia to look at the effects of industrial air pollution on the adult population's health (Tajudin et al., 2019). Research performed at three monitoring sites around a highly populated industrial zone in Nilai, Petaling Jaya, and Seberang Perai, on the other hand, observed that particulate matter (PM_{10}) was the main pollutant that caused a slightly moderate haze in Southeast Asia, mostly during the dry season (NA Mohd Zizi et al., 2018).

According to a local study conducted in Kuala Lumpur to estimate the risk associated with rapid urbanization on cardiovascular and respiratory

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hospitalizations, air pollution can cause both acute and chronic effects on cardiovascular and respiratory hospitalizations, although the RR value of PM_{10} was not significant in this study (Tajudin et al., 2019). Moreover, finding from the related study also revealed that most of the children living closer to an industrial area were having a higher prevalence of respiratory symptoms including cough (66%), phlegm (83.3%), wheezing (82.6%) and chest tightness (81.8%) compared to the comparative group (Hussin & Jalaludin, 2016)

In terms of occupational exposure and respiratory health symptoms in Malaysia, the numbers of reported respiratory symptoms were significantly higher among welders compared to the comparative society based on research conducted in Seri Kembangan, Selangor. Welding fumes were also identified as the significant risk factor for persistent cough, chronic phlegm, and chest tightness (Aida & Juliana, 2014). The findings are also consistent with a study conducted in one of the largest cement plants in Negeri Sembilan, which found that occupational exposure to respirable cement dust increases the risk of lung impairment by triggering respiratory symptoms, lowering lung function, and increasing airway inflammation in highly exposed workers (Kamaludin et al., 2018)

2.7 Mechanism of Particle Deposition

The information on the location as well as the magnitude of particles of various sizes deposited in the respiratory tract is required to comprehend and predict the health outcome concerning the exposure to the particles (Brown, 2015). Besides, a study conducted by Ghorani-Azam et al., (2016) revealed that the size of the particle is also important since it can be straightforwardly linked with the development of heart and lung diseases. This is based on the justification that the smaller the particle is, the greater its ability to arrive at the lower respiratory tract and therefore, having more noteworthy potential to cause lung and heart diseases. To further understand the mechanism of particle deposition, the structure of the human respiratory tract has to be identified in the first place. In short, the fundamental structure of the human respiratory tract is outlined in figure 6.

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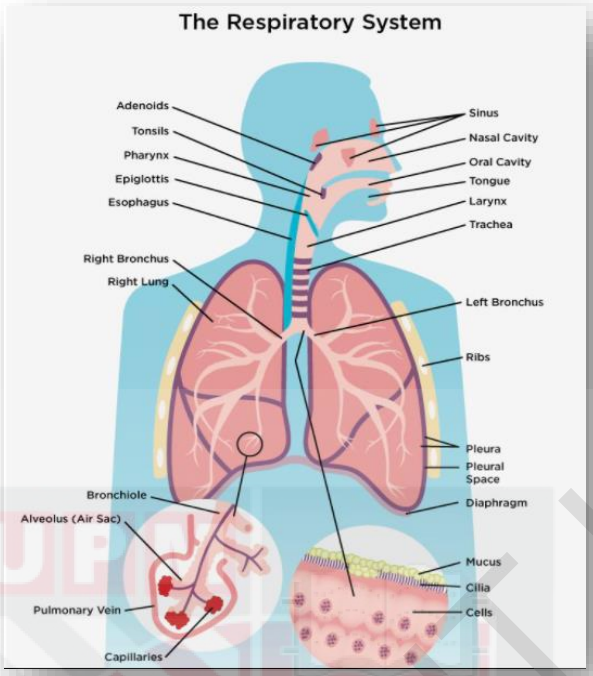

Figure 2.1: The basic structure of human respiratory system (Sources: Canadian Lung Association, 2017)

Generally, the respiratory system can be separated into upper and lower regions at the epiglottis, which is the structure that keeps off the lower respiratory system from the pharynx. The upper respiratory system which also known as the extra thoracic region includes the nose and mouth serve as the first and second opening respectively for direct contact with the outer environment. The nasal cavity is fixed with hairs that trap huge particles, such as pollen and dust to obstruct their deeper admittance into tissue.

Besides the mucous layer that lines the nasal cavity also helps to trap smaller particles and microorganisms for elimination. The lower respiratory system or the tracheobronchial region starts beneath the epiglottis in the larynx. The trachea branches into the left and right bronchi as it arrives at the lungs. These branches divide over and over to shape even smaller tubes known as bronchioles. The terminal bronchioles shaped in tree-like structure end in circular sacs called the alveoli. The alveolar region is encircled by a capillary network and serves as a gas exchange region in the respiratory system (*Anatomy and Normal Microbiota of the Urogenital Tract,* 2019).

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As a particle moves from the respiratory tract, it will be deposited to the wall of the airway. The deposition of the spherical particle in the respiratory happens primarily by three mechanisms which are diffusion, sedimentation, and impaction (Brown, 2015). Additionally, the capability of the particle to deposit in the respiratory tract is depending on several factors including the route of breathing which is divided into two categories, nose (nasal) or mouth and nose (oronasal), frequency of breathing (f), tidal volume (VT), and the respiratory tract morphology since different species (for instance human and animal) have different morphology. Plus, the morphology may also vary in humans according to their health status. However, among all these factors, deposition of the particle relies heavily upon the particle size and shape as being mentioned previously (Brown, 2015).

Diffusion is the random movement of particles just like the gas atoms in the atmosphere whereby the particle of size 0.5 µm and smaller is deposited in the bronchiole region generally by some coincidence (Canadian Centre for Occupational Health & Safety, 2010). Plus, the movement of the particle will significantly become stronger for smaller size particles. Diffusion is essential mechanism for the deposition of the particle with diameters of 0.1 mm or lesser in the alveoli. This mechanism of deposition is also known as Brownian diffusion whereby it is solely determined by the particle's diffusion coefficient, and the particle density does not influence the diffusion coefficient. The function of $(Dt)^{0.5}$ is used to calculate the efficiency of diffusion deposition in the respiratory tract where D is the diffusion coefficient and it is time in the region (Brown, 2015). Moreover, since $PM_{2.5}$ is able to arrive at the alveolar area by diffusion, this particle can harm different organs of the body through air exchange in the lungs (Xing et al., 2016).

The second mechanism for particle deposition is impaction. Particle tends to go along their original way when they are suspended in the air. In the beginning, a particle cannot keep up with the changes of direction when there is a curve in the respiratory track and hence depositing by the mechanism known as impaction (Canadian Centre for Occupational Health & Safety, 2010). Impaction is the primary mechanism of deposition of the particle at proximal airways(Brown, 2015). The probability of impaction relies upon the flow velocity and the particle mass. Commonly, most particles with an aerodynamic diameter bigger than 10 µm are

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deposited in the nose or throat and cannot enter the lower respiratory tract (Brown, 2015).

Nevertheless, increased prevalence of respiratory disease in adult have been associated with elevated levels of PM_{10} and coarse particulate although this particle might not directly penetrate the lower respiratory track (Xing et al., 2016). For the most part, the human tracheobronchial deposition of particles greater than 2-3 mm due to impaction increase with increment in flow rate during oral breathing, contrasted with nasal breathing because of the evacuation of particles >1 mm in the extra thoracic area (Brown, 2015).

The third mechanism of particle deposition is sedimentation which is brought about by the gravitational settling of the particle primarily in the distal airways and pulmonary region of the lung. The gravitational forces and air resistance will ultimately beat the particle buoyancy force as they move along in the air, causing the particles to deposit on the lung surface (Brown, 2015). Following sedimentation, particulate matter with an aerodynamic diameter of 2.5mm or lesser can disturb and erode the alveolar wall, causing free radical peroxidation and inflammatory, and consequently resulting in asthma, respiratory irritation, compromise lung function, and even stimulate cancer (Xing et al., 2016).

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CHAPTER 3

METHODOLOGY

3.1 Study Location

The location of this study is at Parit Raja, Batu Pahat, Johor. This town is located only 10 km away from Lebuh Raya Utara-Selatan, making it a strategic area for economic growth. Precisely, the study is conducted based on the proximity judgment between the residential area and Parit Raja Industrial zone. The residential area located ≤ 5km radius from Parit Raja Industrial zone is categorized as an exposed group. Simultaneously, the residential area located ≥ 5km radius from Parit Raja Industrial zone is chosen as the comparative group (non-exposed). Besides, the location of the study was selected following a previous study regarding wind characteristics at Parit Raja that indicates the wind speed and wind direction. Following the wind rose diagram, it is known that the air pollutants dispersed downwind that is toward the east and southeast from the source of air emissions. Therefore, it can be justified that the wind is mainly dispersed towards UTHM and nearby residential areas. Figure 7 shows the locality maps of the exposed locality.

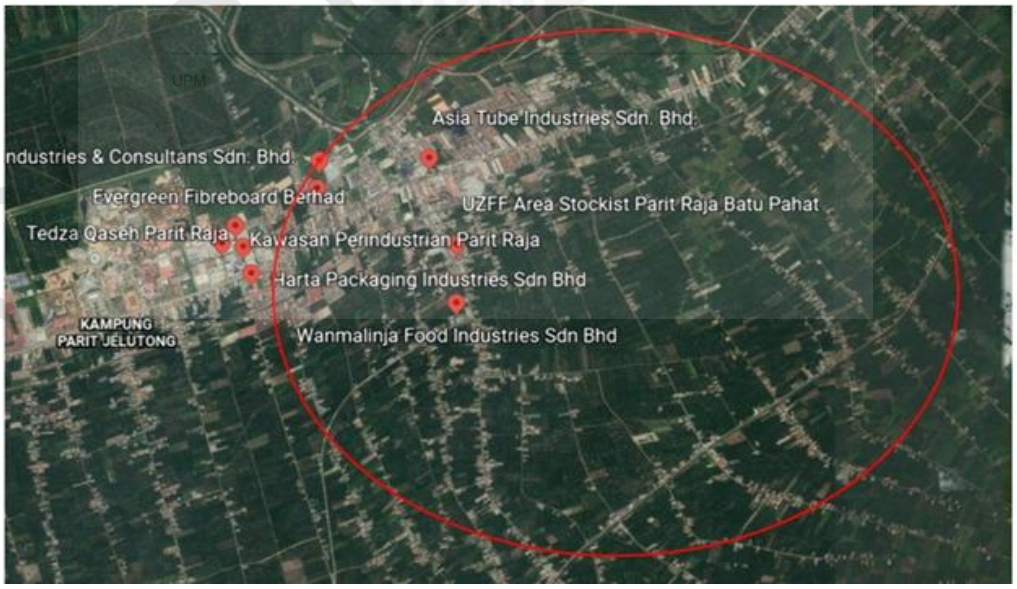

Figure 3.1 : Satellite image of surrounding area which covers 5 km radius from the closest boundary of Parit Raja Industrial Area (Image generated by Google Maps,2020)

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3.2 Study Design

This study will be carried out by using a cross-sectional comparative study to determine and compare the exposure to industrial air pollution (duration of stay in residential area and distance from the industrial area) with the respiratory symptoms among adult residents in Parit Raja, Batu Pahat with the non-exposed group. This study will be focusing on the respiratory symptoms regarding the exposure to industrial air pollution towards adult residents that live near an industrial area and adult residents that live far away from the industrial area. The respiratory symptoms which are coughing, wheezing, chest tightness, and phlegm will be assessed to determine the exposure.

3.2 Study Duration

The planned study will take place from January 2021 to June 2021. The timeline for performing this research is ideal for collecting data.

3.3 Sampling

3.3.1 Sampling Population

The study population will be male and female adult residents age 19-64 years old living in close proximity with Parit Raja Industrial Area. The same age group of residents living away from industrial areas will be chosen as the comparative group. The respondent for this study will be selected using purposive sampling based on inclusive and exclusive criteria. Individual who meets the inclusion criteria will be randomly selected as the respondent

Inclusive criteria for selection of respondents:

1. Male and female adult aged between 19-64 years old
2. Have resided in the residential area for at least one year.
3. Only Malaysian citizen will be recruited as respondent

Exclusive criteria for selection of respondents:

1. Individuals with a doctor-diagnosed history of respiratory diseases such as cardio cerebral vascular disease, ischemic heart disease, chronic obstructive pulmonary disease (COPD), asthma, and lung cancer.

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2. Smokers

3.3.2 Sampling Frame

The target population is adult residents aged 19-64 years old in 2021. Therefore, the sampling frame included all male and female adults aged 19-64 years old who were residing in the residential area in Parit Raja in the year 2021. These residents must at least have stayed in the residential area for a minimum of one year.

3.3.3 Sampling Method

Based on the purposive sampling method, the adult resident living near Parit raja Industrial Area (less than 5 km from the closest boundary of an industrial site) and in the comparative area (more than 5 km from the closest boundary of an industrial site with less traffic) Batu Pahat was selected following the wind rose pattern obtained from previous research. The selection of the residential area was based on their distances from the point of sources, which was believed to contribute to the emission of industrial air pollutants. Those who fulfilled the inclusion criteria were recruited through purposive sampling. A clear explanation of this sampling method is shown in Figure 8.

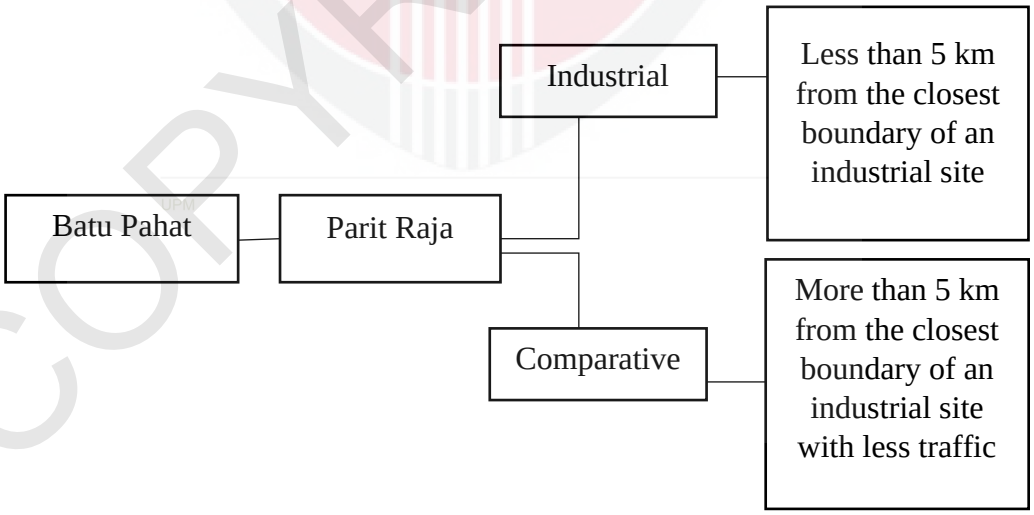

Figure 3.2 : Flowchart of Residential Area sampling

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3.3.4 Sample Size

This study will use the formula from Lemeshow (1990) for group comparison by using the pooled standard deviation between the exposed and comparative groups. This formula will determine the number of respondents that will be chosen for the study.

Formula;

$$n = \frac{\left(z_{1-\frac{\alpha}{2}}\sqrt{2\bar{P}(1-\bar{P})} + z_{1-\beta}\sqrt{P_1(1-P_1)+P_2(1-P_2)}\right)^2}{(P_1-P_2)^2}$$

Where,k

n = Sample size

$Z_{1-\alpha/2}$ = Standard error associated with confidence interval (CI), 99% CI = 2.58

$Z_{1-\beta}$ = Standard error associated with power, 84.2% of power=0.84

P_1 = Prevalence of adult with cough from the exposed area; 46.3% = 0.463 (Nkhama et al., 2017)

P_2 = Prevalence of adult with cough from comparative group; 13.8% = 0.138 (Nkhama et al., 2017)

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

$\bar{P}$ = $(0.46 + 0.14) / 2$

$\bar{P}$ = 0.30

Then, the $\bar{P}$ value needs to be substitute into the formula to find n, the sample size.

$$\frac{\left(2.58\sqrt{2(0.30)(1-0.30)} + 0.84\sqrt{0.46(1-0.46)+0.14(1-0.14)}\right)^2}{(0.46-0.14)^2}$$

n = 46.48

n = 46

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Therefore, 46 respondents will be recruited for each exposed and comparative group. The sample size is increased to 20% for attrition bias and due to purposive sampling.

$$
\begin{aligned}
n &= 20/100 \times 46 \\
n &= 9.2 \\
n &= 46 + 9.2 \\
n &= 55.2 \text{ respondents} \\
n &= 55 \text{ respondents}
\end{aligned}
$$

A sample size of 55 respondents would be needed from each group, exposed group which is adult residents residing less than 5 km from the closest boundary of an industrial site of Parit Raja, and also for the comparative group, which is the adult residents living more than 5 km from the closest boundary of an industrial site and less traffic of Parit Raja. A total sample size (N) summing up the exposed and comparative group will be 110 respondents.

3.4 Instrumentation

3.4.1 Questionnaire

The questionnaire used is adopted from American Thoracic Society "ATS-DLD-78" that has been validated and translated from previous research to obtain background information and respiratory symptoms of the respondents. The questionnaire is modified according to the setting of this study and is available in the Malay language to ensure respondent understanding and to ease some respondents who lack literacy skills in English.

Two types of information were obtained from the respondents. The first part is regarding the sociodemographic background of the respondents, while the second part provides information on the indoor and outdoor environment, respondent's employment, respondent's lifestyle, respondents' respiratory health , other related diseases and also family health history. This questionnaire consists of 7 sections as follow:

a) Part A: Respondent's Personal Information
b) Part B: Respondent's Employment Information

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c) Part C: Lifestyle Information
d) Part D: Respondent's Residence Background:
    i. Outdoor Residential Background
    ii. Residential Building Characteristics
    iii. Staying Duration and Inhabitant
    iv. Indoor Air Pollutant Sources in Homes
e) Part E: Respiratory Symptom Information
f) Part F: Other Current Health Symptoms and Diseases
g) Part G: Family Health History

3.4.2 Method of Data Collection

The secondary data on environmental air pollution is fully used for this research. A study on wind characteristics that indicates the wind speed and wind direction in Parit Raja is utilizing to map and categorized the locality into the exposed and comparative group. Following the wind rose pattern, a low speed of the wind that could cause a higher probability of air pollutants dispersed was observed at direction downwind that is toward the east and southeast from the source of industrial emissions. Therefore, it was largely fair to assume that the wind is dispersed towards UTHM and the residential area nearby. Hence, the result from this data was used to identify the selected residential areas that need to be sampled. In addition, the duration of stay in the residential area, as well as the distance of the residential area from Parit Raja Industrial Area, was assessed in the questionnaire to determine the respondent's exposure to industrial air pollution.

The questionnaire was distributed in two distinct ways in order to achieve the required sample size. Mainly, the questionnaire was distributed by the researcher to public places such as mosques and kindergarten. Adult respondents were highly encouraged to fill up the questionnaire. Besides, the questionnaire was also administered by publishing a Google form URL in the social media platform of Facebook and telegram. The respondent was contacted personally through social media and was given a brief explanation regarding the study as well as the inclusive and exclusive criteria needed to be fulfilled by the respondent before they could proceed with completing the questionnaire. The eligible respondent was selected from several community groups of Parit Raja obtained from Facebook and telegram.

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Plus, the questionnaire was self-administered by the selected respondents. The questionnaire was prepared in the Malay Language to ensure respondent understanding and to ease respondents who lack literacy skills in English. Each questionnaire was also attached with a consent letter to obtain permission and to explain the methodology used in this study. The questionnaire would have taken about 15-20 minutes to complete. Once the questionnaire was completed, the data were recorded on the computer. For those subjects who did not meet the criteria, they were excluded from this study.

3.4.3 Flow Chart of Data Collection

The workflow of data collection with the number of respondents recruited is as shown below in Figure 9.

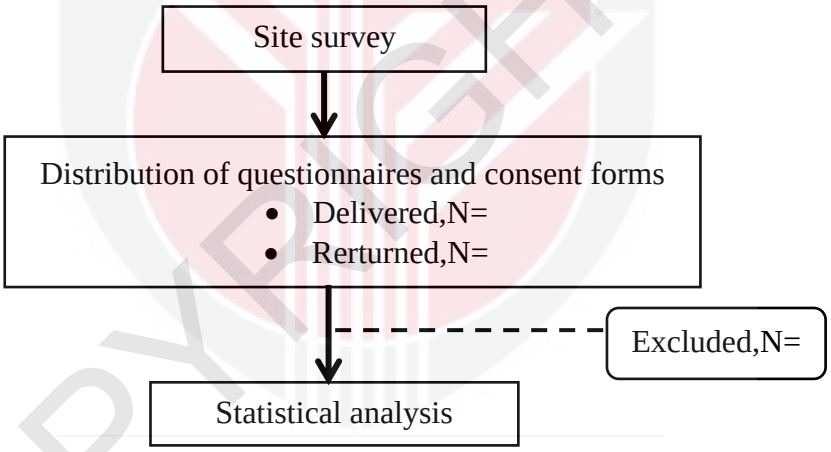

Figure 3.3 : Data Collection Flowchart

3.5 Statistical Analyses

The questionnaire data were analyzed using IBM's Statistical Package for the Social Sciences (SPSS) Version 26.0. Shapiro Wilks was used to determining the normality of continuous variables. When the p-value of Shapiro Wilks is greater than 0.05, the data is normally distributed. Then, for further investigation, an appropriate test was determined. Parametric tests were used to analyze data that were normally distributed, while non-parametric tests were used to analyze data that was not

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normally distributed. Finally, each of the objectives in this study was examined using univariate, bivariate, and multivariate testing.

3.6 Quality Control of Questionnaire

A pilot testing of the questionnaire was conducted before data collection. The pilot testing was carried out among representatives of the residents from the exposed locality. Approximately 10% of the total sample size have tested the questionnaire to assess whether they are able to understand the questionnaire and to avoid any unfamiliar terms to them. Plus, the questionnaire was also labeled with a special respondent code for confidentiality concerns.

3.7 Study Ethics

Before the study which involves human subjects could take place, the proposed study was presented to the ethical committee from Universiti Putra Malaysia. Once the study was approved, the study proceeded. All respondents were given a brief explanation about the purpose of the study. The respondents were asked to participate in the study voluntarily. Consent forms were given to be read and signed by the respondent. All respondents were given choices to continue participating in the study or to pull out at any time when they choose to do so. The information about respondents involved in this research remains confidential.

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CHAPTER 4

RESULTS

4.1 Response Rate

The study aimed to determine the association between industrial air pollution exposure and respiratory health symptoms among adults in Parit Raja, Batu Pahat. Individuals who lived < 5 km from Parit Raja Industrial Area were classified as the exposed group, whereas those who lived > 5 km away were classified as the comparative group. The residents' exposure to industrial air pollution was determined by the distance between their homes and the industrial area, as well as the number of years they lived there. A total of 55 respondents were selected from each group. Purposive sampling of residents who satisfied the inclusion criteria outlined in Chapter 3 was used to select respondents.

Figure 4.1 explains how the respondents for this study were selected. 200 copies of the questionnaires and consent form were distributed to the targeted group, and only 50 copies were returned, accounting for around 25% of the total. The remaining sample size is obtained by the use of an online questionnaire distribution approach. The questionnaire received 118 replies through its online distribution. However, 58 respondents (49.1%) were excluded because they did not meet the requisite inclusive and exclusive criteria. As a result, only 60 respondents (50.8%) were obtained through the online questionnaire distribution. The number of respondents gathered from both the exposed and comparative groups is equal, with 55 respondents for each group.

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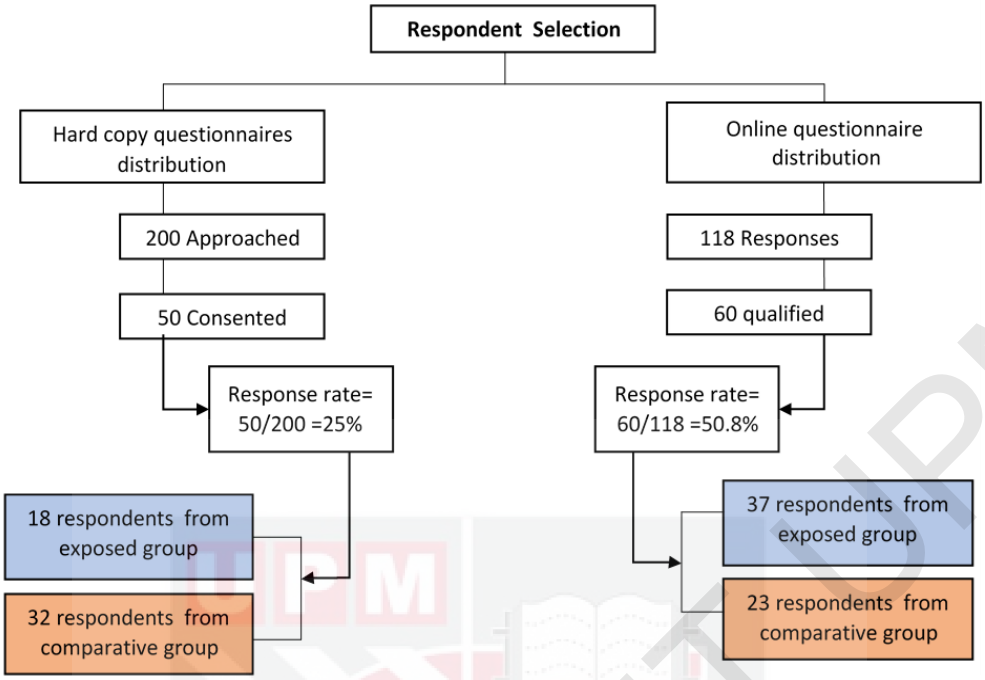

Figure 4.1: Flow Chart of Respondents Recruitment and response rate

4.2 Background of Respondents

4.2.1 Sociodemographic and Socioeconomic Characteristics

Table 4.1 summarizes the gender and location distribution of respondents. There was a total of 39 (35.5%) males and 71 (64.5%) females among the 110 responses. Meanwhile, the gender distribution by location is 23 (41.8%) males and 32 (58.2%) females in the exposed area, whereas 16 (29.1%) males and 39 (70.9%) female respondents were from the comparative group. In both areas, the gender distribution is nearly identical, with females accounting for the majority of respondents.

Table 4.1: Gender distribution across the locality

Gender	Exposed (N=55)	Comparative (N=55)	χ^2	p-value
	N (%)			
Male	23 (41.8)	16 (29.1)	1.947	0.163
Female	32 (58.2)	39 (70.9)		

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Table 4.2, 4.3 and 4.4 compare the sociodemographic background information collected from respondents. For instance, both groups have a median age of 33 years. Additionally, for the race comparison, both the exposed and comparative groups have a similar race distribution, with 54 Malay respondents (98.2%) and only 1 respondent (1.8%) is accounted for others. The median height of respondents in the exposed and comparison groups in this study was 161.0 cm and 160.0 cm, respectively, with a total mean height of 162.66 cm. The median weight of respondents in the exposed group was 64.0 kg, while those in the comparative group weighed 65.0 kg, and the total mean of weight was 66.06 kg. The majority of those in the exposed group 20 (36.4%) were obese, and a median BMI of 23.68. This seems to be similar to the comparative group, where the majority of the respondents 28 (50.9 %) were also obese and had a median BMI of 24.67.

Apart from that, 27 respondents (49.1%) in the exposed group were single, 27 respondents (49.1%) were married, and 1 respondent (1.8%) was separated. In the comparative group, 18 respondents (32.7 %) were single, 35 respondents (63.6 %) were married, and 2 respondents (3.6 %) were separated.

Following that, the education level of both groups revealed that the majority of respondents finished their tertiary education comprising of diploma/degree/Master degree and Ph.D. Among the exposed group, 51 respondents (92.7%) have pursued their tertiary education while the remaining 4 respondents (7.3%) have completed secondary education. In the comparative group, 45 respondents (81.8%) had pursued tertiary education and another 10 respondents (18.2 %) had completed secondary education.

Furthermore, 14 respondents (25.5 %) from the exposed group were currently employed, whereas the remaining 41 respondents (74.5 %) were not currently employed. A total of 10 respondents (18.2 %) were employed from the comparative group, while the remaining 45 respondents (81.8%) were unemployed. For the employment specification, 16 respondents (14.5%) that were employed from both groups were working in the government sector, whereas 7 respondents (6.4%) were working in the private sector and only 1 respondent (0.9%) was self-employed. None of the respondents from both groups were having health problems related to their occupation (100.0%). When it comes to household income, the majority of the

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respondents fall into the low-income category, with 29 respondents (52.7%) from exposed groups and 33 respondents (60.0%) from comparative groups.

Additionally, for lifestyle comparison in the exposed group, 40 respondents (72.7%) were involved in any physical activity whereas the remaining 15 respondents (27.3%) were not involved in any physical activity. On the other hand, 42 respondents (76.4%) from the comparative group were involved in physical activity and 13 respondents (23.6%) were not involved in any physical activity. Independent t-test and Chi-Square test were performed to evaluate whether the difference in sociodemographic characteristics and lifestyle characteristics has a relationship with the respondents. It is shown that there is no significant difference in the sociodemographic characteristics for the study group.

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Table 4.2: Sociodemographic Characteristics of Respondents

Variables	Exposed (N=55)		Comparative (N=55)		Total (N=110)		χ^2 /Z	p-value
	N(%)	Median±IQR	N(%)	Median±IQR	N(%)	Median±IQR		
Age (years)								
19-25	23 (41.8)		14(25.5)		37(33.6)			
26-35	11 (20.0)		18 (32.7)		29 (26.4)			
36-45	16 (29.1)	34 ±17.0	21 (38.2)	33 ±15	37(33.6)	33±17	6.221	0.156
46-55	4 (7.3)		2 (3.6)		6(5.5)			
56-65	1(1.8)		Na		1(0.9)			
Race								
Malay	54 (98.2)		54 (98.2)				Na	1.000
Others	1(1.8)		1(1.8)					
Height	55 (100)	161.0±13.0	55 (100)	160.0±12.0	110(100)	160.0±12.0	-0.276	0.783
Weight	55 (100)	64.0±23.0	55 (100)	65.0±26.0	110(100)	65.0±23.0	-0.619	0.536
BMI								
Underweight	4 (7.3)		2 (3.6)		6 (5.5)			
Normal	17 (30.9)	23.68±5.36	18 (32.7)	24.67±6.15	35 (31.8)	24.29±6.0	4.362	0.227
Overweight	14 (25.5)		7 (12.7)		21 (19.1)			

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Obese	20 (36.4)	28 (50.9)	48 (43.6)		
Marital Status					
Single	27 (49.1)	18 (32.7)			
Married	27 (49.1)	35 (63.6)		3.166	0.295
Separated	1 (1.8)	2 (3.6)			
Education level					
Primary	0	0			
Secondary	4 (7.3)	10 (18.2)		2.946	0.086
Tertiary	51 (92.7)	45 (81.8)			
Employment Status					
Yes	14 (25.5)	10 (18.2)		0.853	0.356
No	41 (74.5)	45 (81.8)			
Household Income					
Low	29 (52.7)	33 (60.0)			
Medium	24 (43.6)	19 (34.5)		1.039	0.636
High	2 (3.6)	3 (5.5)			

Na= Not available

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Table 4.3: Employment Specification and Health Problem Related to Employment

Variables	Exposed (N=55)	Comparative (N=55)	χ^2	p-value
	N (%)			
Employment Specification				
Government Sector	9 (16.4)	7 (12.7)		
Private Sector	4 (7.3)	3(5.5)	1.579	0.721
Self-Employed	1 (1.8)	0		
Not Employed	41 (74.5)	45 (81.8)		
Health Problem Related to Employment				
Yes	0	0	Na	Na
No	55 (100)	55 (100)		

Na= Not available

Table 4.4: Lifestyle characteristics of the subjects

Variables	Exposed (N=55)	Comparative (N=55)	χ^2	p-value
	N (%)			
Physical activity				
Yes	40 (72.7)	42 (76.4)	0.192	0.662
No	15 (27.3)	13 (23.6)		

4.3 Background of Respondents' Residence

4.3.1 Outdoor Residential Background

According to Table 4.5, the majority of respondents' homes are located within 100-500 meters of the main road, with 23 respondents (41.8%) belong to the exposed group and 22 respondents (40.0%) belong to the comparative group. Besides, almost majority of respondents from the exposed group (45.5 %) lived between 1.1km and

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5km from the industrial area followed by 21 respondents (38.2%) for a distance of 500-1000 meters and 9 respondents (16.4%) from the distance of < 500 meters. On the other hand, most comparative group houses were located further which is > 10 km from the industrial area (56.4%), and the remaining 24 respondents' houses (43.6%) were located within 5km to 10 km from the industrial area. Furthermore, it is notable that more than half of the respondents from the exposed group had moderate or high exposure to industrial air pollution, with proportions of 26 (47.3%) and 8 (14.5%), respectively. In contrast, 44 respondents (80.0 %) in the comparative group have had low exposure to industrial air pollution. Chi-square result shows that there was a significant difference between the respondent groups with distance of the house from the main road (p=0.019), distance of the house from the industrial area (p<0.001), and exposure to pollutant from the industrial area (p<0.001).

Table 4.5: Comparison of Outdoor Residential Background

Variables	**Exposed (N=55)**	**Comparative (N=55)**	χ^2	**p-value**
	N (%)			
Distance from Main Road				
< 100 meters	22 (40)	15 (27.3)		
100 – 500 meters	23(41.8)	22 (40.0)	9.930	**0.019***
501 – 1000 meters	9 (16.4)	7 (12.7)		
> 1000 meters	1 (1.8)	11 (20.0)		
Distance from Industrial Area				
<500 meters	9 (16.4)	Na	110.000	**<0.001****
500 – 1000 meters	21 (38.2)	Na		
1.1–5 kilometres	25 (45.5)	Na		
5.1–10 kilometres	Na	24 (43.6)		
>10 kilometres	Na	31 (56.4)		

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Exposure to Pollutant from Industrial Area				
Low Exposure	21 (38.2)	44 (80.0)	19.996	**<0.001****
Moderate Exposure	26 (47.3)	9 (16.4)		
High Exposure	8 (14.5)	2 (3.6)		

**Significant at p<0.001; *significant at p<0.05; Na= Not available

4.3.2 Residential Building Characteristics

The residential building characteristics of respondents are shown in Table 4.6. In the exposed group, 35 respondents (63.6%) reside in a single-story Terrace, whilst 35 respondents (63.6%) from the comparative group reside in a village type. Bricks and concrete were the most frequent building materials for both groups (85.5%). Both groups used the same type of ventilation system, with the residents relying heavily on fans (86.4%). Furthermore, only a small percentage of respondents in the exposed and comparative groups own an air purifier or air filter, with around 8 respondents (14.5%) and 15 respondents (27.3%), respectively, using one. The majority of the exposed group's respondents claimed their houses were moderately dusty (63.6%). The majority of respondents in the comparative group, on the other hand, described their home environment as less dusty (65.5%). Plus, 49.1% of respondents in the exposed group live in a three-bedroom house, while 56.4% of respondents in the comparative group live in a house with more than three bedrooms. Chi-square comparison shows that there was a significant difference between respondent groups with the type of houses (p<0.001), building materials (p=0.005), and house environment (p<0.001).

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Table 4.6 : Comparison of Residential Building Characteristics

Variables	Exposed (N=55)	Comparative (N=55)	χ^2	p-value
	N(%)			
Types of Residences				
Single-Storey Terrace	35 (63.6)	8 (14.5)	38.617	**<0.001****
Double-Storey Terrace	5 (9.1)	6 (10.9)		
Bungalow	2 (3.6)	5 (9.1)		
Apartment	2 (3.6)	Na		
Flat	1 (1.8)	Na		
Village Type	8 (14.5)	35 (63.6)		
Semi-detached house	2 (3.6)	1 (1.8)		
Building Materials				
Bricks & concrete	53 (96.4)	41 (74.5)	10.548	**0.005***
Boards	1 (1.8)	6 (10.9)		
Bricks & concrete and Boards	1 (1.8)	8 (14.5)		
Type of ventilation system				
Fan	48 (87.3)	47 (85.5)	1.011	1.000
Air Conditioner	Na	1 (1.8)		
Fan & Air Conditioner	7 (12.7)	7 (12.7)		
Availability of Air Purifier/Air Filter				
Yes	8 (14.5)	15 (27.3)	2.694	0.101
No	47 (85.5)	40 (72.7)		
House Environment				
Less Dusty	13 (23.6)	36 (65.5)	20.749	**<0.001****
Moderate Dusty	35 (63.6)	18 (32.7)		
Very Dusty	7 (12.7)	1 (1.8)		
Number of Rooms				
< 3 rooms	5 (9.1)	4 (7.3)	2.339	0.350
3 rooms	27 (49.1)	20 (36.4)		
> 3 rooms	23 (41.8)	31 (56.4)		

**Significant at p<0.001; *significant at p<0.05

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4.3.3 Staying Duration and Inhabitants

Table 4.7 presents the responses for the years of living in the residential area and the total number of household members. The median duration of staying in the residential area is 14 ± 18.25. The majority of respondents in the exposed group had lived in the residential area for 10-20 years (43.6%), whereas most of the respondents in the comparative group have lived in the residential area for no more than 10 years (34.5%). Furthermore, nearly every family for both the exposed and comparative groups had a total household member count of more than 5, with 56.4 % in each group. None of these factors were significantly associated with respondents' groups, according to chi-square analysis.

Table 4.7: Comparison of Staying Duration and Inhabitants

Variables	Exposed (N=55)	Comparative (N=55)	Total (N=110)	χ^2	p-value
	N(%)		Median ±IQR		
Duration Residents Stay in Residential Area					
<10 years	21 (38.2)	19 (34.5)	14.0 ±18.25	9.177	0.054
10-20 years	24 (43.6)	15 (27.3)			
21-30 years	6 (10.9)	9 (16.4)			
31-40 years	1 (1.8)	9 (16.4)			
>41 years	3 (5.5)	3 (5.5)			
Total Household Members					
1-2 people	2 (3.6)	2 (3.6)	5.0 ±2	0.139	1.000
3-4 people	22 (40.0)	22 (40.0)			
≥5 people	31 (56.4)	31 (56.4)			

4.3.4 Indoor Air Pollutant Sources in Homes

Table 4.8 compares respondents' exposure to indoor pollution sources in their homes based on responses from the questionnaire. Only 12 respondents (21.8%) from the exposed group and 17 respondents (30.9%) from the comparative group performed indoor painting in the previous 12 months. Meanwhile, just 2 exposed group respondents (3.6%) and 9 comparative group respondents (16.4%) have had

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their home flooring changed in the last 12 months. Furthermore, the carpet was used by 42 (76.4%) and 40 (72.7%) respondents in the exposed and comparative groups, respectively.

The majority of respondents (74.5 %) in both groups did not have a furry pet at home. 7 respondents (12.7 %) in the exposed group had smokers in their homes, while the remaining 48 respondents (87.3 %) had no smokers in their homes. In the comparative group, 13 respondents (23.6 %) have smokers in their homes, while 42 others (76.4 %) do not. According to the results of the chi-square analysis, there were significant difference between respondents' groups with the change of flooring in the previous 12 months (p=0.026).

Table 4.8: Indoor Conditions at Homes

Variables	Exposed (N=55)	Comparative (N=55)	χ^2	p-value
	N(%)			
Indoor Painting within the past 12 months				
Yes	12 (21.8)	17 (30.9)	1.171	0.279
No	43 (78.2)	38 (69.1)		
Change Flooring within the past 12 months				
Yes	2 (3.6)	9 (16.4)	4.949	**0.026***
No	53 (96.4)	46 (83.6)		
Carpet Usage				
Yes	42 (76.4)	40 (72.7)	0.192	0.662
No	13 (23.6)	15 (27.3)		
Furry Pets				
Yes	13 (23.6)	15 (27.3)	0.192	0.662
No	42 (76.4)	40 (72.7)		

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Indoor Smoking				
Yes	7 (12.7)	13 (23.6)	2.200	0.138

*Significant at p<0.05

The results for sources of indoor air pollution from activities inside the home are shown in Table 4.9. Cooking, cleaning, and using a mosquito repellent agent were all included in the activities.

Both groups used gas as a source of fuel for the majority of their cooking activities, accounting for 69.1% of the total. In the meantime, 30 people (27.3%) from both categories use both gas and electricity as a source of energy. Furthermore, more than half of all respondents (70.9%) cooked one to three times every day. Almost all respondents agreed that ventilation is important when cooking whereby 97.3% of respondents allow ventilation either natural or mechanical during cooking.

Following that, cleaning was largely done using brooms and mops, and also a vacuum cleaner. The majority of respondents also cleaned their homes more than five times each week, with proportions of 38.2% for the exposed group and 47.3 % for the comparable group, respectively.

Mosquito repellent was utilized by two-thirds of the respondents. Spray type mosquito repellent was the most commonly utilized by both groups, with 55.6 % using only spray type, 16.7% using both spray and electric type, 6.9% using spray and coil type, and 1.4% using the spray, electric, and coil type. The majority of those respondents clarified that they used mosquito repellent two to three times a week (38.9%). The most common placement for mosquito repellent chemicals was in the bedroom. The result from the Chi-square test shows that the respondent's group was significantly associated with the use of mosquito repellent (p=0.005), type of mosquito repellent agent used (p<0.001), and also the frequency of mosquito repellent usage (p=0.020).

Table 4.9: Comparison of Indoor Pollution Sources from Activities Inside Home

Variables		**Exposed (N=55)**	**Comparative (N=55)**	χ^2	**p-value**
		N (%)			
Cooking	**Types of Fuel**				
	Gas	37 (67.3)	39 (70.9)	1.053	0.725

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	Electricity	3 (5.5)	1 (1.8)		
	Gas and electricity	15 (27.3)	15 (27.3)		
	Frequency of Fuel Usage				
	Less than 1/day	5 (9.1)	3 (5.5)		
	1-3 times/day	36 (65.5)	39 (70.9)	0.657	0.742
	3 times and above/day	14 (25.5)	13 (23.6)		
	Ventilation				
	Yes	53 (96.4)	54 (98.2)	0.343	1.000
	No	2 (3.6)	1 (1.8)		
Cleaning	**Tools**				
	Broom & mops	20 (36.4)	26 (47.3)		
	Vacuum cleaner	6(10.9)	8 (14.5)	2.348	0.309
	Broom & mops and vacuum	29 (52.7)	21 (38.2)		
	Frequency of Cleaning				
	Once/week	10 (18.2)	3 (5.5)		
	2-3 times/week	20 (36.4)	21 (38.2)	4.437	0.225
	4-5 times/week	4 (7.3)	5 (9.1)		
	>5 times/week	21 (38.2)	26 (47.3)		
Use of mosquito repellent	Yes	29 (52.7)	43 (78.2)	7.880	**0.005***
	No	26 (47.3)	12 (21.8)		
	Types of Agents				
	Coil	1 (3.4)	-		
	Spray	9 (31.0)	31 (72.1)		
	Electrical	7 (24.1)	6 (14.0)		
	Spray and Electrical	10 (34.5)	2 (4.7)	19.318	**<0.001****
	Coil and spray	1 (3.4)	4 (9.3)		
	Coil, spray, and electric	1 (3.4)	-		
	Frequency of Usage				
	Once/week	4 (13.8)	10 (23.3)		
	2-3 times/week	11 (37.9)	17 (39.5)	11.388	**0.020***
	4-5 times/week	5 (17.2)	2 (4.7)		

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>5 times/week	9 (37.5)	14 (32.6)		
Placement in House				
Living Room	3 (10.3)	9 (20.9)		
Bedroom	15 (51.7)	21 (48.8)	1.501	0.501
Bedrooms and Living Rooms	11 (37.9)	13 (30.2)		

**Significant at p<0.001; *significant at p<0.05

4.5 Respiratory Health Symptoms

Respondents' respiratory symptoms were assessed using a standardized and validated questionnaire developed by the American Thoracic Society. The presence of respiratory health symptoms and a family history of respiratory illness were used to make the assessment. Cough, phlegm, wheezing, and chest tightness was assessed as the respiratory symptoms.

4.5.1 Comparison of Respiratory Health Symptoms Among Study Respondents

Adult respondents' respiratory symptoms were assessed using a standardized questionnaire derived from the American Thoracic Society. The residents completed the questionnaire themselves. Cough, phlegm, wheeze, and chest tightness were among the respiratory symptoms reported in this study.

Table 4.10 shows the prevalence of respiratory symptoms. Cough was reported by 19 respondents (34.5 %) in the exposed group and 5 respondents (9.1%) in the comparative group. Meanwhile, 14 respondents (25.5%) and 4 respondents (7.3%) reported chest tightness in both the exposed and comparative groups, respectively. Furthermore, a small proportion of respondents reported phlegm symptoms, with approximately 10.9% of respondents in the exposed group and 7.3% of respondents in the comparative group. Besides that, 9.1% of respondents in the exposed group and 5.5% of respondents in the comparative group have reported experiencing wheezing. The Chi-square test shows that there is a significant association between respondents' group with coughing (p=0.001) and chest tightness (p=0.010) symptoms.

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Table 4.10: Comparison of Respiratory Symptoms

Variables	Exposed (N=55)	Comparative (N=55)	χ^2	p-value
	N (%)			
Cough				
Yes	19 (34.5)	5 (9.1)	10.446	**0.001***
No	36 (65.5)	50 (90.9)		
Phlegm				
Yes	6 (10.9)	4 (7.3)	0.440	0.507
No	49 (89.1)	51 (97.2)		
Wheezing§				
Yes	5 (9.1)	3 (5.5)	0.539	0.716
No	50 (90.9)	52 (94.5)		
Chest Tightness§				
Yes	14 (25.5)	4 (7.3)	6.643	**0.010***
No	41 (74.5)	51 (92.7)		

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

4.5.2 Other Current Health Symptoms

Figure 4.2 represents the frequency of other reported current health symptoms in the exposed and comparative groups. A total of 10 health symptoms were evaluated based on two distinct frequencies of occurrences: seldom and weekly. These current health symptoms evaluated include fatigue, difficulty concentrating, itching or eye inflammation, a runny nose, a sore or dry throat, a headache, difficulty breathing, face rashes, hand rashes, and also scalp or ears crusty or itchy.

The most commonly reported current health symptoms in both the exposed and comparative groups were indeed fatigue and difficulty to concentrate, with 53% respondents in the exposed group and 47% respondents in the comparative group reporting for fatigue symptoms. Whereas, 40% of respondents in the exposed group and 31% of respondents in the comparative group reporting difficulty concentrating symptoms. The most uncommon other symptoms reported from both the exposed and comparative groups, on the other hand, were difficulty breathing and scalp or

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ears crusty/itchy, with a total of 91% respondents in the exposed group and 96% respondents in the comparative group reporting seldom frequency of occurrence for difficulty breathing symptoms. Meanwhile, more than half of the respondents in the exposed group and the comparative group have reported seldom frequency for symptoms scalp or ears crusty/itchy.

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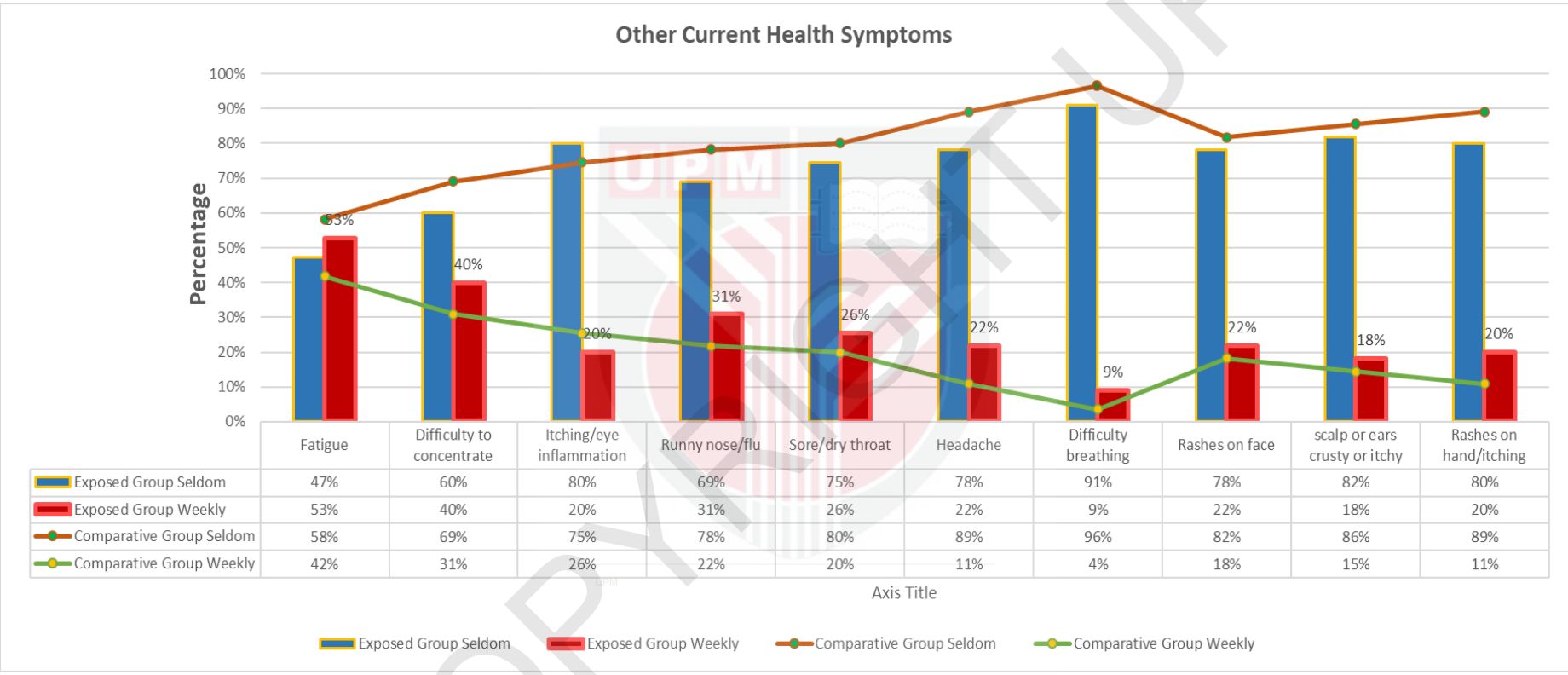

	Fatigue	Difficulty to concentrate	Itching/eye inflammation	Runny nose/flu	Sore/dry throat	Headache	Difficulty breathing	Rashes on face	scalp or ears crusty or itchy	Rashes on hand/itching
Exposed Group Seldom	47%	60%	80%	69%	75%	78%	91%	78%	82%	80%
Exposed Group Weekly	53%	40%	20%	31%	26%	22%	9%	22%	18%	20%
Comparative Group Seldom	58%	69%	75%	78%	80%	89%	96%	82%	86%	89%
Comparative Group Weekly	42%	31%	26%	22%	20%	11%	4%	18%	15%	11%

Figure 4.2: Reported Frequency of Occurrence of Other Current Health Symptoms

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4.6 Association between Duration of Stay in Residential Area with Respiratory Health Symptoms

Duration of stay in the residential area for both locations was cross-tabulated with the prevalence of respiratory symptoms. The duration of living in the residential area was classified into <14 years and ≥ 14 years using the median duration of stay in the residential area since the data is not normally distributed.

Table 4.11 shows that the association between the duration of stay in the residential area with respiratory symptoms among adult residents. Chi-square tests were performed to find out whether there is a relationship between years of living in the residential area according to the location with respiratory symptoms reported. The result from the test showed that there is no significant relationship between duration of stay in the residential according to location with reported respiratory symptoms except for chest tightness in the exposed locations at $p=0.037$, $p<0.05$, OR = 4.246 (95% CI = 1.03-17.50).

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Table 4.11: Association between Duration of Stay in Residential Area with Respiratory Symptoms

Variables	Location		<14 years	≥14 years	χ^2	p-value	OR	95% CI
			N (%)					
Cough	Exposed	Yes	7 (23.3)	12 (48.0)	3.669	0.055	0.330	0.10-1.05
		No	23 (76.7)	13 (52.0)				
	Comparative§	Yes	1 (4.0)	4 (13.3)	0.530	0.467	0.271	0.03-2.60
		No	24 (96.0)	26 (86.7)				
Phlegm	Exposed§	Yes	4 (13.3)	2 (8.0)	0.408	0.523	1.769	0.30-10.57
		No	26 (86.7)	23 (92.0)				
	Comparative§	Yes	2 (8.0)	2 (6.7)	0.36	1.000	1.217	0.16-9.33
		No	23 (92.0)	28 (93.3)				
Wheezing	Exposed§	Yes	5 (16.7)	0	2.789	0.095	2.000	1.52-2.64
		No	25 (83.3)	25 (100)				
	Comparative§	Yes	1 (4.0)	2 (6.7)	0.188	1.000	0.583	0.05-6.84
		No	24 (96.0)	28 (93.3)				
Chest Tightness	Exposed	Yes	11 (36.7)	3 (12.0)	4.373	**0.037***	4.246	1.03-17.50
		No	19 (63.3)	22 (88.0)				
	Comparative§	Yes	3 (12.0)	1 (3.3)	0.506	0.477	3.955	0.39-40.65
		No	22 (88.0)	29 (96.7)				

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

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4.7 Association between Distance of Residence from Industrial Area with Respiratory Health Symptoms

The prevalence of respiratory symptoms was compared to the distance of a residence from an industrial area. The distance between the house and the industrial area was divided into two categories: 5 km, which represents the exposed locality, and 5 km, which represents the comparative locality.

Table 4.12 shows that the association between the distance of residence from the industrial area with respiratory symptoms among adult residents. A Chi-square test was performed to find out whether there is a relationship between the distance of residence with respiratory symptoms reported. There was a significant association between reported respiratory symptoms with the distance of residence from the industrial area except for wheezing and phlegm. Cough was significantly associated at p=0.001, p<0.05, OR = 5.278, (95% CI = 1.80-15.45). Meanwhile, chest tightness was significantly associated at p=0.019, p<0.05, OR = 4.354, (95% CI = 1.33-14.24).

Table 4.12: Association between Distance of Residence from Industrial Area with Respiratory Symptoms

Variables	N (%) (N=110)		χ^2	p-value	OR	95% CI
	< 5 km	≥ 5 km				
Cough						
Yes	19 (34.5)	5 (9.1)	10.446	**0.001***	5.278	1.80-15.45
No	36 (65.5)	50 (90.9)				
Phlegm §						
Yes	6 (10.9)	4 (7.3)	0.440	0.507	1.561	0.42-5.87
No	49 (89.1)	51 (92.7)				
Wheezing §						
Yes	5 (9.1)	3 (5.5)	0.539	0.716	1.733	0.39-7.64
No	50 (90.9)	52 (94.5)				
Chest Tightness §						
Yes	14 (25.5)	4 (7.3)	6.643	**0.019***	4.354	1.33-14.24
No	41 (74.5)	51 (92.7)				

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

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4.8 Factors that Influences the Respiratory Symptoms after controlling all confounders

After all of the confounders in this study were taken into account, logistic regression was used to find the significant factors that influenced respiratory symptoms (chest tightness) among research respondents. Logistics regression was used to assess chest tightness symptoms since only this variable demonstrated an increase in risk with duration of stay and distance from industrial areas.

The distance between respondents' houses and industrial areas, as well as the duration of stay in the industrial area, were taken into account as independent variables. Meanwhile, outside residential background (distance from the main road) and indoor residential background (housing environment and house type) indoor air pollution sources in households, ventilation during cooking, frequency of cleaning, frequency of cleaning, usage, and frequency of mosquito repellent agent), gender, employment status, and socio-demographic characteristics were assessed as the covariates that may possibly influence the outcomes based on univariate analysis conducted.

4.8.1 Factors that Influence the Respiratory Symptom (Chest Tightness) among Study Respondents after controlling all Confounders

Table 4.13 shows significant factors that influenced chest tightness symptoms among the respondents after all confounders in this study have been controlled. The risk of getting chest tightness was significantly increased among respondents who were living within a distance <5 km from the industrial area (B=2.361, p=0.012, AOR= 10.606, 95% CI=1.69-66.68). The result shows that 56.3 % (Nagelkerke R^2= 0.563) of chest tightness symptoms was influenced by the distance of the house from the industrial area.

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Table 4.13: Factors that Influence the Respiratory Symptom (Chest Tightness) among Study Respondents after controlling all Confounders

Independent Variables	B	S.E	p-Value	AOR	95% CI
Constant	1.631	0.258	0.000	5.111	-
Distance of Residence from Industrial Area					
<5 km ≥ 5 km	2.361	0.938	**0.012***	10.606	1.69-66.68
Duration of Stay					
<14 years ≥14 years	-1.570	0.856	0.067	0.208	0.04-1.11
Distance from Main Road					
< 100 meters 100 – 500 meters 501 – 1000 meters > 1000 meters	1.509	1.367	0.270	4.521	0.31-65.92
Age	0.032	0.053	0.550	1.032	0.93-1.15
Employment Specification	-2.202	1.607	0.171	0.111	0.01-2.58
Mosquito Repellent Usage	2.080	1.084	0.055	8.005	0.96-67.02
Exposure to Pollutant from Industrial Area	0.682	1.589	0.668	1.978	0.09-44.58

N=110

Adjusted for Study group, Gender, Employment Status, Indoor smoking, BMI, Cooking activity, Ventilation during Cooking, Frequency of Cleaning and House environment; *p-value significant at <0.05; AOR = Adjusted Odds Ration; B=regression coefficient; SE=Standard Error, Nagelkerke R^2 = 0.563

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CHAPTER 5

DISCUSSION

5.1 Respondent Background

This study aimed to find out if there was a link between exposure to industrial air pollution and respiratory symptoms reported by adults in Parit Raja. Before performing this study, the Ethics Committee of Universiti Putra Malaysia was consulted. A total of 110 respondents ranging in age from 19 to 65 years old took part in this study. This study was conducted in Parit Raja, having respondents living less than 5 kilometers from the industrial area as the exposed group and respondents living more than 5 kilometers from the industrial area as the comparative group.

Following the needed sample size, the sample size included in this study is adequate. A total of 110 respondents were successfully recruited from both areas, with 55 people from each location. Since the pandemic Covid-19 and the Mobility Control Order implemented in Malaysia, more than half of the respondents were approached more conveniently through the online method than through the hardcopy distribution. Respondents were selected among those who completed the entire questionnaire, whether it was distributed online or in hard copy. Because the majority of respondents are Malay, the sampling does not fully represent the Parit Raja community. Furthermore, only adult residents who are free from doctor-diagnosed respiratory illness, non-smokers, and have lived in the residential area for at least one year were chosen to participate in this study.

The sociodemographic background, employment specification, and lifestyle characteristics of the respondents were shown in Table 4.2, Table 4.3, and Table 4.4, respectively. The respondents were mostly female accounting for 64.5% of the total respondents. Most of the respondents involved in this study were Malay and only 2 respondents were Others with aged range 19-65 years old and median ages of 33 years old. Additionally, 78.2% of the respondents have completed tertiary education meanwhile 21.8% remaining respondents have completed secondary education. The education levels of the respondents are essential to ensure that they comprehended

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the questions in the questionnaire. In this study, the median height of the respondents was 160.0 cm and the median weight was 65 kg. The majority of the respondents were also classified as either overweight or obese with a median BMI of 24.29.

Besides, more than half of the respondents were currently not employed. Whereas, among the employed respondents, the majority of them worked in government sectors with none of the respondents from the employed group have reported any health problems related to their occupations. Despite various age and employment status of the respondents, 82(74.5%) of them manage to be involved in any form of physical activities during their ample time. Approximately, 62(56.4%) of the respondents were from a low-income household, whilst 43(39.1%) and 5(4.5%) of the respondents were from medium and high-income households, respectively.

There are no significant differences in all variables measured (socio-demographic characteristics, employment specifications, lifestyle characteristics) when compared to the study groups. Hence, it is fair to assume that both exposed and comparative groups had a relatively similar sociodemographic background, employment status, and specifications, and physical activity history.

5.2 Background of Respondents' Residence

Table 4.5 exhibits the background characteristics of the respondents' residences. This information is required as it helps to indicates how much the respondents were being exposed to industrial air pollution. The respondents are evenly divided into two categories which were either residing <5km from an industrial area or ≥ 5 km from the industrial area with both groups accounting for 55 respondents each.

Under <5 km categories, the respondents were separated into three subgroups based on their distance from the industrial area: 500 meters, 501-1000 meters, or 1.1-5 kilometers. It's worth noting that the majority of the respondents in the exposed group lived between 1.1 and 5 kilometers from the industrial area 25(45.5%). Meanwhile, the comparative groups were classified into two distance categories: 5.1-10km and >10 km from the industrial area. The majority of the respondents from the comparative group live >10 km away from the industrial area 31(56.4). There is a

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significant difference observed between the study groups with the distance from the industrial area, ($\chi 2$= 110.000,$p<0.001$).

The distance of residence from the main road was also assessed in the questionnaire to better understand the source of outdoor pollution exposure to residences. A total of 45(40.9%) of all respondents were residing between 100-500 meters of the main road with approximately 23(41.8%) of respondents from the exposed group and 22(40%) respondents from the comparative group respectively. The Chi-square result shows that there is a significant difference between the distance of the house from the main road with the study groups, ($\chi 2$= 9.930, p=0.019). Pollutants along main roads are responsible for the high occurrence of deteriorating asthma in urban areas, with such air pollutants accounting for 15% of all scenes of asthma symptoms in communities living near roadway traffic(Perez et al., 2013). Perez et al. (2013) also indicate that the distribution pattern of near-road traffic-related pollution is linked to the distribution of several health impacts.

In terms of industrial air pollution exposure, 26(47.3%) respondents in the exposed group claimed moderate pollution exposure. On the other hand, 44(80.0%) of the comparative group's respondents characterize their frequency of exposure to pollution as low. It is comprehensible that the respondent's frequency of exposure is influenced by their residence's proximity to an industrial area and a busy road. The result of Chi-square tests shows the significant difference in exposure to pollution and study groups ($\chi 2$= 19.996, $p<0.001$). The finding is consistent with the study conducted by de Marco et al. (2010) which suggests that the frequency of exposure to industrial pollution is most likely linked to the residential area's vicinity to the industry.

The exposed group had the majority of 35(63.6%) of respondents living in a single-story terrace house, whereas the comparative group with the same percentage residing in a village settlement. In general, neighborhoods surrounding industries are unfavorable to most people. However, the community may opt for residence nearer to the industrial area because it takes less time for them to commute to town daily for working purposes or daily business. Finding from the previous study support the idea of urbanization may be attributed to the rising of outdoor air pollution. This is because many urban areas are experiencing rapid population expansion as well as

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rising outdoor air pollution, which eventually led to the increased global burden of asthma (Guarnieri & Balmes, 2014). Plus, the result was significant between the type of house with the study groups ($\chi 2$= 38.617, p<0.001). Approximately 94(85.5%) of the respondents in both groups lived in a house composed of bricks and concrete. The result from Chi-square also shows significant differences between the building materials and the study groups ($\chi 2$= 10.548, p=0.005). The utilization of fan for ventilation system in the house was also higher in both groups with 48 (87.3%) from the exposed group and 47 (85.5%) from comparative group use fan as their main ventilation systems.

Only in a comparative group, the number of respondents who live in a less dusty environment was higher, 36(65.5 %). In contrast, 35(63.6 %) of respondents in the exposed group reported living in a moderately dusty environment, while 8 (14.5%) reported living in an extremely dusty house environment. The result was significant between the house environment and the study groups at ($\chi 2$= 20.846, p<0.001). According to Sopian et al. (2020), the higher amounts of pollutants found in the exposed group's homes possibly reflect a greater penetration of pollutants from outdoor air into respondents' houses through windows and doors, which were generally left open during the day for improved ventilation. Additionally, 47(85.5%) of respondents in the exposed group and 40(72.7%) of respondents in the comparative group did not utilize an air purifier or air filter. The majority of respondents in the exposed group have three rooms in their home 27(49.1%), while the majority of respondents in the comparative group 31(56.4 %) live in a home with more than three bedrooms.

5.3 Duration of Stay and Inhabitants

Table 4.7 provides the duration spent in the residential area as well as the total number of household members. The majority of the respondents in the exposed group, 24(43.6%) had lived in the residential area for 10-20 years, and 21(38.2%) of respondents in the exposed group have lived in the residential area for less than10 years. There seems to be little difference in the comparative group, where it is observed that the majority of respondents 19 (34.5%) have been living in the residential area for less than 10 years while staying durations of 10-20 years was account for the second-largest proportion 15(27.3%). Generally, the majority of

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respondents, 62(56.4%) from both groups had more than 5 total household members. The results from chi-square show no significant difference between these variables and the study groups.

5.4 Indoor air pollutant sources in homes

Indoor air exposure in homes was assessed using the questionnaire and the result was shown in Table 4.8 and Table 4.9. Indoor air pollution sources from home include indoor painting, floor renovation, presence of pets, carpet usage, indoor smoking, cooking activity, cleaning activity as well as mosquito repellent usage. The result was shown in Table 4.8 and Table 4.9.

The study found that the majority of the respondents from both groups 81(73.6%) were not having their walls painted for the past 12 months. 2(3.6%) of respondents from the exposed group and 9(16.4%) respondents from the comparative group had floor construction for the past 12 months. The result of the Chi-square test shows the significant difference between the study group and floor construction ($\chi 2$= 4.949, p=0.026). A higher percentage of respondents used carpet with exactly 42(76.4%) of respondents from the exposed group and 40(72.7%) respondents from the comparative group. The majority of the respondents reported not having pets at home 42(76.4%) for the exposed group and 40(72.7%) from the comparative group. This study also found out that the majority of the respondents from both groups were not exposed to indoor smoke from active smokers in their homes, 48(87.3%) from the exposed group and 42(76.4%) from the comparative group.

In both the exposed and comparative groups, the majority of respondents (37(67.3%) and 39(70.9%) used gas for cooking. The frequency of use is practically comparable in both groups, with 36(65.5%) respondents in the exposed group and 39(70.9%) respondents in the comparative group were cooking 1 to 3 times each day. The majority of respondents from both groups, 107(97.3%), allow for ventilation during the cooking process. The findings are comparable to those of a previous study by Oluchi (2017), which found no significant differences between study groups in terms of cooking activity, frequency of cooking activity, and availability of ventilation throughout the cooking process.

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With regards to cleaning activities, the group of respondents who used both a vacuum and brooms and mops had the highest percentage among the exposed group 29 respondents (52.7%). Meanwhile, in the comparative group, the majority of respondents 26(47.3%) only use brooms and mops. Both vacuums and brooms & mops were chosen by respondents in the exposed group because they provide an effective approach to clean the floor while reducing the chance of an allergic reaction. Nonetheless, both groups were found to be comparable in aspects of house cleaning frequency, with 21 (38.2 %) in the exposed group and 26 (47.3 %) in the comparative group cleaning their homes more than 5 times per week.

The study found a significant difference between mosquito repellent use and study groups ($\chi 2$= 7.880, p=0.005). In the comparative group, 43 (78.2%) of respondents use mosquito repellent, compared to 29 respondents (52.7%) in the exposed group. There was also a significant difference between the type of mosquito repellent agents regarding the study groups ($\chi 2$= 19.318 p<0.001). The comparative group's respondents are more likely to utilize spray type 31(72.1%), whereas the exposed group prefers spray and electrical type 10 (34.5%). The majority of respondents in the exposed group 11(37.9%) used mosquito repellent 2 to 3 times per week, but a larger number of respondents in the comparable group 28(38.9%) used mosquito repellent on a similar frequency.

The result from the Chi-square analysis shows that there was a significant difference between the frequency of usage of mosquito repellent with the study groups. According to Islam et al., (2020), since these mosquito repellents are high in toxic chemicals and spraying or burning them releases a large amount of toxic particulate matter that mixes with indoor air, and, as a result, causes indoor air pollution, the community is affected by various respiratory diseases such as eye, nose and throat irritation, cough and asthma due to the usage.

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5.5 Comparison of Respiratory Health Symptoms between Exposed and Comparative Group

The respiratory symptoms of adult residents in both groups were assessed using a standardized questionnaire derived from the American Thoracic Society. Respondents completed the questionnaires themselves. The result of the respiratory symptoms of residents which include coughing, phlegm, wheezing, and chest tightness was shown in Table 4.10. The adult residents living in the exposed community reported more cases of cough, phlegm, wheezing, and chest tightness. Plus, the result was also statistically significant for symptoms of cough ($\chi 2$= 10.446, p=0.001) and chest tightness ($\chi 2$= 6.643, p=0.010) with regards to the study group.

Adult residents in the exposed group were exposed to higher levels of air pollution. Thus, they were more likely to develop respiratory symptoms than those in the comparative group. These findings are consistent with the findings of various epidemiological studies that reveal a higher frequency of respiratory symptoms reported among adults in highly exposed communities (Nkhama et al., 2017; Paolocci et al., 2020; Tanyanont & Vichit-Vadakan, 2012; Pascal et al., 2013).

Nkhama et al. (2017) have conducted a cross-sectional study in Chilanga, Zambia, to explore seasonal fluctuations in airborne $PM_{2.5}$ and PM_{10} concentrations and their impact on respiratory health in a community near a cement factory. For the study, 63 people from a community within 1 kilometer of the factory and 55 people from the control community 18 km away from the factory aged 21 to 59 years old were selected respectively. In each of the three climatic seasons, the respondents filled their symptom diary questionnaires and lung function tests every day for 14 days. Study results indicated that the incidence of reported respiratory symptoms was higher in the exposed group than in the control group, with 46.3 % of exposed people reporting cough symptoms compared to 13.8% in the control group. The prevalence of phlegm symptoms is also higher in the exposed group compared to the control group, at 41.2% vs. 9.6 %. As for wheezing symptoms, the exposed group is at 13.9% prevalence meanwhile the control group had just a 3.9% prevalence. In addition, in the exposed community, the risk of persons without a cough shifting to experiencing cough over time was thrice higher than in the control group.

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Tanyanont & Vichit-Vadakan, (2012) conducted a cross-sectional study to analyze the reported respiratory problems associated with exposure to industrial air pollution in a community residing near the Map Ta Phut Industrial Estate in Thailand. A standardized questionnaire was developed to gather information on respiratory problems among adult residents of Map Ta Phut Municipality. The research comprised 15,441 adults aged 13 and above who had lived in Map Ta Phut Municipality for at least one year. According to the study, adults over 40 years old were found to be more likely than those under 40 years old to experience respiratory symptoms and eye irritation. Furthermore, living nearer to the MTPIE was linked to an increased risk of wheezing and upper respiratory symptoms, with females having a higher risk of dyspnea, wheezing, and upper respiratory symptoms than males. Residents who lived closer to the MTPIE also had a higher prevalence of chronic cough and phlegm than those that lived further away.

5.6 Other Current Health Symptoms Reported

Apart from coughing, wheezing, phlegm, and chest tightness, Figure 4.2 displays the percentage of residents who have other current health problems. Fatigue, difficulty concentrating, eye inflammation/itching, sore or dry throat, difficulty breathing, face rashes, hand rashes/itching, and crusty or itchy scalp or ears were among the ten present symptoms evaluated. Out of 10 health symptoms, fatigue, difficulty breathing, runny nose, and sore throat symptoms were reported by 53%, 40 %, 31%, and 26% of adult residents in the exposed group every week, respectively. Additionally, those four symptoms were likewise the most commonly reported in the comparative group, and that the pattern did not differ significantly from that of the exposed group. Despite this, difficulty breathing is the least frequently reported symptom in both groups, with % in the exposed group and % in the comparative group reporting the symptoms relatively seldom. In this investigation, there were no significant differences between any of these symptoms with the study group.

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5.7 Associations between Exposure to Industrial Air Pollution and Respiratory Symptoms

5.7.1 Duration of Living in Residential Area and Chest Tightness

While there is abundant literature on the short-term consequences of air pollution over the last decade, evidence on the long-term impacts of air pollution, particularly for respiratory symptoms in adults, has remained relatively limited. A relationship between the duration of living in the residential area according to location with the chest tightness respiratory symptoms are displayed in Table 4.11. The duration of living in the residential area was classified into <14 years and ≥ 14 years using the median duration of stay of the residents in the residential area. There is a significant association between the years of living in the residential area with chest tightness symptoms among the exposed group at ($p=0.037$, $p<0.05$, OR = 4.246, 95% CI = 1.03-17.50).

The finding of this study is generally similar to a finding of a study in Map Ta Phut Municipality Industrial Estate whereby the residents who stayed longer in the residential area, (more than 5 years) had an elevated risk of upper respiratory problems, (OR 1.24; 95%CI 1.12-1.36) and was more likely to have chronic respiratory difficulties as well as lower respiratory symptoms, especially among the elderly who aged above 40 years old (Tanyanont & Vichit-Vadakan, 2012).

Exposure to air pollution can result in a chronic condition of respiratory health, hence chest tightness symptoms reported by the exposed group residents who have lived in the residence for <14 years are presumed to be a manifestation of a common sign of an acute or chronic respiratory infection in this study location. This is because the overall epidemiological studies imply that detrimental health effects are reliant on both exposure concentrations and exposure duration, with long-term exposures are largely associated with more persistent cumulative effects compared to short-term exposures (Pope, 2007).

People's responses to air pollution, on the other hand, vary widely which reflects why some people experience some respiratory symptoms while others do not (American Family Physician, 2001). Additionally, residents in the neighborhoods, who have stayed even longer than ≥14 years in the on the contrary, may have experienced fewer respiratory symptoms as a consequence of being adapted to or

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developing a tolerance for industrial air pollutants after living in this vicinity for so long (Kongtip & Chantanakul, 2013). Furthermore, an air monitoring research done in Parit Raja from July to September 2019 has confirmed that increasing concentrations of industrial pollutants, notably $PM_{2.5}$ and SO_2, were identified over a period of time (Nur-Nabilah et al., 2021). Due to the larger extent of exposure to these contaminants, it is unsurprising that the exposed group in Parit Raja exhibited chest tightness symptoms even after only 14 years living in the residence.

5.7.2 Distance of residences from Industrial Area with Cough and Chest Tightness Symptoms

The result of the association between the distance of residence from the industrial area and the respiratory symptom is shown in Table 4.12. Since there were limited data on ambient levels of air pollutants and no independently gathered data on industrial emission levels at the location of study, exposure was determined based on the distance between the residential and industrial areas. The distances were divided into two categories: <5 km and >5 km.

The 5 km cut-off point was determined based on the findings of an earlier study, a wind speed study (unpublished report) performed at three sampling stations in UTHM to evaluate the movement and distribution of air pollutants indicated the area at risk of industrial emission are at the east and southeast from the source of air pollution, with air modelling results indicating that the community living within 5 km of the industry was significantly associated with higher exposure to air pollutants and also reporting more unpleasant odour complaint than those further living away. Moreover, many environmental epidemiology studies applied the proximity approach as an exposure assessment for assessing health impacts around industrial facilities since it is simple, efficient, and less expensive (Alwahaibi & Zeka, 2016).

According to the findings from this study, the incidence of respiratory problems cough, and chest tightness is higher in the community living less than 5 kilometres from the industrial area, ($\chi2$= 10.446, p=0.001, PR = 5.278, CI = 1.80-15.45) and ($\chi2$= 6.643 p=0.019, PR = 4.354, CI = 1.33-14.24) respectively. Coughing and chest tightness are two prominent signs of bronchial spasms, which induce spasms to the lung airways. When pollutants reach the respiratory tract, the human body needs coughing as a defense mechanism to expel pollutants from the lungs and bronchi.

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Meanwhile, chest tightness caused by irritation of the respiratory system as a result of prolonged exposure to polluted air can make breathing more difficult than usual. Hence, the rise in cough and chest tightness symptoms suggests that residents living near industrial regions are more exposed to pollutants than those in the comparative region.

Tanyanont & Vichit-Vadakan (2012) reporting a similar finding whereby chronic cough was found to be more prevalent among individuals residing within 5 kilometres of the MTPIE than among those living further away, although the differences were not significant (p=0.052). Besides, there is a significant association between increased risks for adverse respiratory outcomes among adults living within 5 km of the MTPIE compared with those living farther away from the industrial with odd ratios:1.6 for throat irritation (95%CI= 1.27-2.05) and 1.7 for sore throat (95% CI=1.28-1.7).

Research by Kongtip & Chantanakul (2013) revealed that industrial air pollutants are detrimental to people living near industrial estates, with coughing being one of the most commonly reported symptoms in the community. The adjusted odds ratios for cough rise 7.71 when CO levels are raised 1 ppm (Kongtip & Chantanakul, 2013). Additionally, research done among locals living near industrial areas in India discovered several conditions including difficulty breathing, cough, chest tightness, and an irregular heartbeat that might be linked to exposure to the industrial pollutants (Mehraj et al., 2013). The study also discovered a 96% rate of cough in the cement-affected neighborhood compared to a 15% rate in the control area as well as a 49% rate of chest pains in the exposed area and only 11% rate in the control area (Mehraj et al., 2013).

Similar findings were reported by Nkhama et al. (2017) whereby the incidence rate of cough in the exposed group varied from 12.4% to 15.9% in Bauleni and 10.4% to 75.1 percent in Freedom, which was a wider variation than in the control group. In addition to that, even after controlling for potential confounding variables, a study of residents living near national industrial complexes in Korea found that the risk of cough was significantly higher for residents living near industrial area than those in the control areas with an odds ratio: 1.18 and 95% confidence interval 1.06 to 1.31 (Sang et al., 2018)

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5.8 Factor that Influences the Chest Tightness Symptoms after controlling confounders

The fourth objective in this study was to identify the factors that influence the respiratory symptoms after all the confounders have been controlled using Multiple logistics regression. The independent variables were taken into consideration for the chest tightness symptoms meanwhile the confounders include sociodemographic characteristic (age), employment specification, outdoor residential (distance from main road and frequency of exposure), and indoor residential background (house environment, indoor pollutant sources in homes, indoor smoking, mosquito repellent usage, and frequency).

Table 4.13 shows factors that influenced the chest tightness symptoms among exposed respondents after all confounders were controlled. Statistical analysis showed that the risk of chest tightness symptoms increases significantly among residents living <5km from the industrial area (p=0.012, AOR 10.6). Meanwhile, the decrease in the duration of stay in the residential area will reduce the likelihood of exhibiting chest tightness symptoms (AOR 0.2), although the association is not significant (p=0.067). The model explained about 56.3 % of the variance in chest tightness symptoms and correctly classified 90% of cases.

Previous research in a Korean industrial complex revealed a similar finding that there is an insignificant positive association between dyspnea and proximity to an industrial region. (OR=1.08; 95% CI=0.98-1.18; p =0.4) (Sang et al., 2018). Even though this study states the association using different terminology, the findings are nonetheless related. This is because dyspnea may also be described as chest tightness, quick shallow breathing, or lack of oxygen.

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CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study found a higher prevalence of respiratory symptoms among adult residents in the exposed group resulting from exposure to industrial air pollution. The occurrence of the respiratory symptoms depends on both distances from the industrial area and durations of living in the residential area (years). In this study, cough and chest tightness were reported higher among the adult residents in the exposed group. Duration of living in the residential area significantly increase the risk of getting chest tightness, whereas the distance of residence from the industrial area significantly increases the risk of getting respiratory symptoms. Nonetheless, determining the exact causative agents is challenging due to various limitations in the study's design that will be discussed further in the limitations section. This study also found that exposure to industrial air pollution is not only causing respiratory symptoms but also inducing acute respiratory infection which includes runny nose/flue, sore or dry throat, headache, itching or eye inflammation, and faces rashes upon exposure, although the percentage was relatively low.

Different statistical analysis was used to test the hypothesis in this study and the results showed that:

1. There is a significant difference between the outdoor residential background and residential building area in the exposed and comparative group.
2. There is a significant difference between indoor conditions in homes and the indoor pollution sources from activities inside the home in exposed and comparative groups.
3. There is a significant difference between the reported respiratory symptoms among the respondents in the exposed area and the comparative area.
4. There is a significant association between the exposure to industrial air pollution (duration of stay in residential area and distance of residence from industrial area) with the respiratory symptoms among the exposed resident in Parit Raja, Batu Pahat.

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5. The main variables that influence respiratory symptoms among adult respondents after considering all the cofounders are the distance of the residential area from the industrial area.

6.2 Study Limitations

Since this study was cross-sectional conducted in one single period, it provides no sign of the series of events occurring, making causality difficult to prove because we could not precisely determine whether the respiratory symptoms have happened before, during, or after the onset of exposure. Next, this research includes a fraction of the adult population in the study location. Yet, the only way to get an exact estimate of association is to include all of the adults in the study area.

Furthermore, while a set of criteria including adult residents who had lived in the locality for at least one year, had no history of respiratory illness, and none smokers, must be met by the respondent in order to be eligible for the study, the findings of this study certainly may not apply to the adults who were excluded from this study.

To minimize information bias, the questionnaire utilized in this study was designed in a close-response style. However, because the questionnaire was self-reported by the respondent and different respondents may have interpreted the questions differently, there is a possibility of recall and information bias.

The environmental exposure was measured using the distance from Parit Raja Industrial Area as an indicator. One of the disadvantages of this approach would be the potential for inaccurate characterization of exposure, since the categorization based on respondents' addresses may inadequately describe the exposure. Also, individuals may not spend all of their time at home, and we lack thorough information on their everyday activities.

6.3 Recommendations

The first and only solution to overcome this issue is through public awareness, as well as for regulatory authorities, industry, residents, and researchers to take a multidisciplinary approach to evaluate the problem and to develop long-term solutions.

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The authorities such as the District Health Office or the Ministry of Health can work with the community to create a campaign aim to educate and to raise awareness about air pollution problems. The campaign should be focused on the health risks associated with exposure to air pollution and the measures that should be done by the community to protect themselves and their family. This might serve as a wake-up call to the community to not take air pollution problems for granted, especially when they have not yet experienced the worst-case scenario, as air pollution is indeed a silent killer.

Furthermore, DOE may install advertisement boards presenting the area's daily Air Pollution Index reading at strategic spots nearby industrial sites to keep the public informed of the air pollution update. Even though DOE has posted the readings on their websites, certain communities have poor computer literacy.

Even though some of the residents aware of the risk of living near an industrial region, still, they have no option but to survive in the residence because the industrial facilities provide them with a source of income. Thus, authorities may develop a strategy to ensure that both economic and environmental goals are met. The enforcement of regulations should be stricter whereby Batu Pahat Municipal Council should periodically review air pollution emissions of the industries and take necessary action towards the factories if it is found to be violating or failing to comply with the provisions set up.

Industries

The owners of factories must take all necessary steps to comply with the opacity and limit values outlined in Regulations 12 and 13 of the Environmental Quality (Clean Air) Regulation 2014, to ensure that hazardous waste generated by their operations is properly disposed of and does not pollute the environment. Furthermore, the industry should have an air pollution control system or hire a competent engineer to develop and manage the construction of an air pollution control system for managing and decreasing air pollutants emissions from the factories.

In addition, industries should undertake continuous emissions monitoring to assess the performance of their pollution control system and ensure its efficacy. Furthermore, industry managers may engage with communities to adequately

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communicate their type of business and related hazards so that the community is aware of the risk and takes the necessary precautions.

Communities

The absence of sufficient ventilation within the house has been related to an increase in respiratory complaints. To avoid respiratory issues, people should adequately ventilate and clean their homes regularly. If there isn't enough ventilation within the house, respiratory symptoms like cough and flu can quickly spread. Additionally, those communities that develop respiratory problems should seek medical attention and get appropriate therapy. The community may also consider using air purifiers to clean indoor air that has been contaminated by air contaminants however this might cause them some money.

The community also can protect themselves and their families from the impacts of air pollution by spending as much time as possible indoors throughout the day because many pollutants have lower levels indoors compared to outdoors. The community must also remain relaxed, and refrain from exerting oneself, because the faster people breathe, the more pollution they inhale.

6.4 Future Research

This study might be enhanced with several changes, as stated in the limitations section. To further understand the complex association between air pollution and respiratory inflammation, more study should be done on larger adult respondents with varied ethnicities and varied industrial areas. The statistics produced of these modifications will be representatives of the whole diversity of Malaysian population. Future study in the Parit Raja Industrial Area should look at how pollutants are dispersed and how they influence the population in terms of chronic health impacts from prolonged exposure. Since evidence on the link between the health effects of environmental air pollution on the community, particularly on adults, is scarce in Malaysia, hence more research may be required to determine the extent of air pollution exposure and its influence on adult overall health.

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APPENDIX 1
GANTT CHART

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Year	2020			2021						
Project (Activities)	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**
1. Proposal writing										
2. Proposal Presentation and Ethical Approval										
3. Pre-Study										
4. Execution of Exposure to Industrial Air Pollutions and Outcomes Assessment (Questionnaire)										
5. Data Analysis										
6. Thesis Writing										
7. VIVA. Thesis Review, and Thesis Submission										

Year	2020			2021						
Project (Milestone)	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**
1. Complete Proposal writing			*							
2. Complete Presentation and Ethical Clearance					*					
3. Complete Pre study					*					

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4. Complete Execution of Exposure to Industrial Air Pollutions and Outcomes Assessment (Questionnaire)								*		
5. Complete Data analysis									*	
6. Complete VIVA,Thesis review and Thesis Submission										*

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APPENDIX 2
ETHICAL APPROVAL LETTERS

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

Research title	:	**Association Between the Exposures to Industrial Air Pollution (VOCs, $PM_{2.5}$, PM_{10}) with Respiratory Symptoms among Residents in Parit Raja, Batu Pahat.**
Study Site	:	**Parit Raja, Batu Pahat, Johor**
JKEUPM Ref No.	:	**JKEUPM-2021-004**
Researcher	:	**Nur Afza Natasha Md. Som**
Supervisor	:	**Prof. Dr. Juliana Jalaludin**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 5/1/2021
2. Respondent Information Sheet & Consent (Malay), Version 2 dated 17/3/2021
3. Respondent Information Sheet & Consent (English), Version 2 dated 17/3/2021
4. Proposal (English), Version 1 dated 5/1/2021
5. Questionnaire/Interview (Malay), Version 1 dated 5/1/2021
6. Curriculum Vitae of:
    a. Prof. Dr. Juliana Jalaludin
    b. Prof. Madya Ts. Dr. Nor Haslina Hashim

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

[X] Approved

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

[ ] Disapproved

Please note that the approval is **VALID UNTIL 24 MARCH 2022**

Researchers should comply with the following:

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

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

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

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APPENDIX 3
EXPLANATION LETTER AND CONSENT FORM

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

RESPONDENT'S INFORMATION SHEET AND INFORMED CONSENT FORM

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

1. STUDY TITLE :

Association Between The Exposures To Industrial Air Pollution With Respiratory Symptoms Among Residents In Parit Raja, Batu Pahat.

2. INTRODUCTION:

Parit Raja has grown rapidly over the past 20 years as a result of the development of the manufacturing and industrial sectors in the town. However, there is no denying that there are many contributions that have been given by this industry to the problem of air pollution in Parit Raja as a result of industrial activities carried out. The purpose of this study was to evaluate the relationship between exposure to industrial air pollution and respiratory symptoms among the adult population living near the Parit Raja Industrial Area. Meanwhile the adult population living far from industrial areas will be the comparison group. This study consists of two methods of data collection, namely using a questionnaire to assess the background information of respondents and respiratory symptoms experienced as well as environmental air monitoring using instruments to measure the concentration of industrial air pollutants in outdoor areas. For the information of respondents, this study has been approved by the Ethics Committee of Universiti Putra Malaysia for Research Involving Human Subjects.

3. WHAT WILL YOU HAVE TO DO?

Briefly, the researcher will approach potential respondents to be involved in the study from house to house and provide general details about the purpose of the visit. Then, the Respondent's Consent Notification Letter with details of the research project will be submitted if it is found that the respondent has met the inclusive criteria of male and female adults aged 19-64 years, has lived in the residential area for at least one year and is a Malaysian citizen. In addition, questions on validation of meeting the characteristics of these inclusive criteria are included at the beginning of the questionnaire for the purpose of screening the eligible respondents. Respondents need to sign the Respondent Consent Notification Letter if they agree to follow this study. After the agreement was made, the respondent will be given a questionnaire in Malay Language, which must be completed to assess demographic variables and respiratory symptoms experienced before returning the questionnaires back to the researchers.

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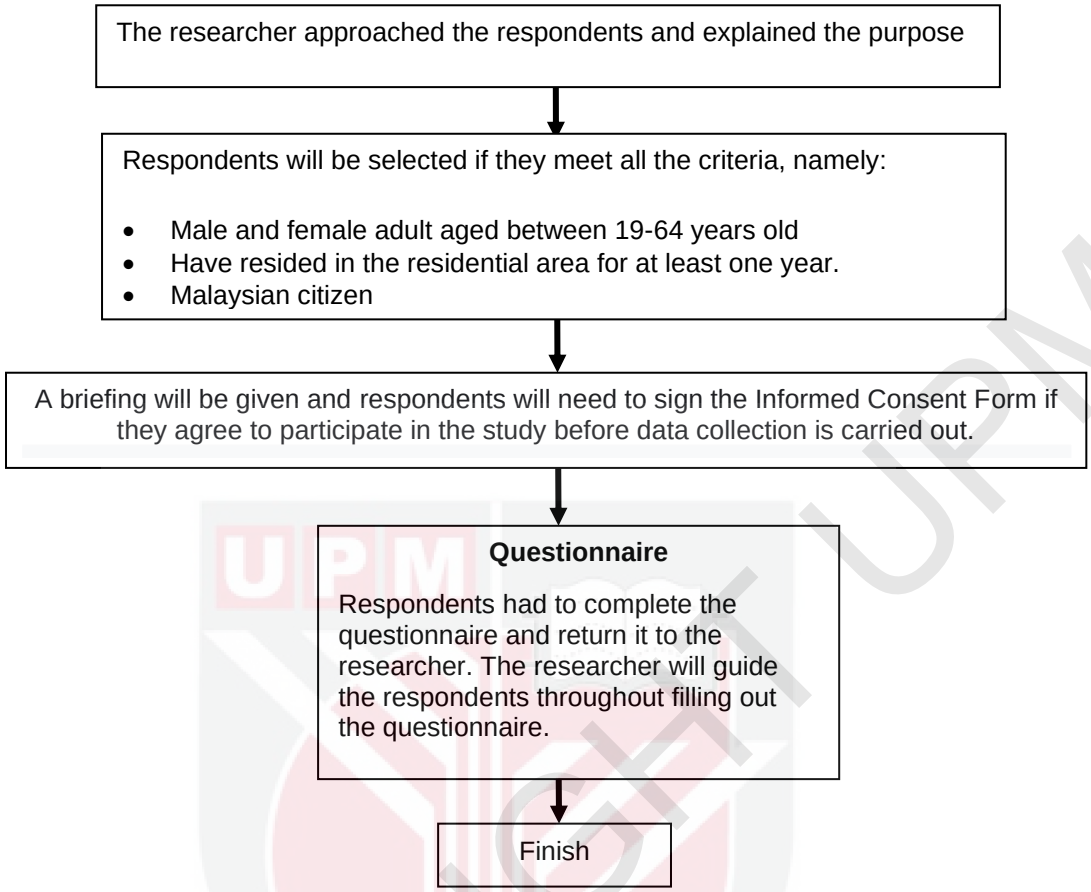

Figure 4: Flowchart of Data Collection for Questionnaire and Environmental Air Monitoring

4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

Respondent should not participate in the study if they have previous history of respiratory disease or an active smoker.

5. WHAT WILL BE THE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

In general, this study will provide input to respondents specifically on the effects of exposure to industrial air pollutants on the respiratory health of respondents. If the level of air pollutants is high, early preventive measures should be taken. Respondents will be informed of any abnormal results so that appropriate action and precautions can be taken against health.

(b) TO THE INVESTIGATOR?

The results of this study have the potential to contribute to early steps to reduce health risks of exposure to air pollutants from industrial areas. Government agencies can use the data provided from this research to prepare action plans such as awareness programs related to industrial air pollution and health programs in residential areas to increase awareness and health status of the population exposed to industrial air pollution.

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6. WHAT ARE THE POSSIBLE RISKS?

There was no risk involved in this study as the only data collected from the respondents was through questionnaires. Thus, there is no compensation in any form provided by the researcher to the respondents.

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

Yes. All data collected during the study on the respondents were confidential and were only used for the purpose of this study. All information obtained through the questionnaire is confidential and will not be disclosed to any third party. Questionnaires can only be accessed by researchers and research assistants only. The personal information of each individual involved in this study will not be disclosed in any future research and publication. Furthermore, answering the questionnaire is voluntary and respondents had the right to withdraw at any time without any reason.

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

For any inquiries during the course of research, please contact;
Research student: Nur Afza Natasha Bt Md.Som (019-3471958) or
email @: afzanatasha98@gmail.com

Research Supervisor: Prof.Dr.Juliana Jalaluddin (017-6834103) or
email @ : juliana@upm.edu.my

Research CoSupervisor: Prof.Madya.Ts.Dr. Nor Haslina Binti Hashim (019-2016792) or
email @: haslina@uthm.edu.my

*Please initial here if you have read and understood the contents of this page*_____

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9. CONSENT

I …… Identity Card No. …… address…… ….. ……..hereby voluntarily agree to take part in the research stated above *(questionnaire-based).

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

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

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

* delete where necessary

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

Date :…….. Name :……..…..

I/C No. :……..…..

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

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

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

PENERANGAN DAN PERSETUJUAN RESPONDEN

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

1.TAJUK KAJIAN

Perkaitan Antara Pendedahan Terhadap Pencemaran Udara Industri Dengan Gejala Pernafasan Di Kalangan Penduduk Di Parit Raja, Batu Pahat.

2. PENGENALAN

Parit Raja telah berkembang dengan pesat sejak 20 tahun kebelakangan hasil daripada pembangunan dari sektor perusahaan pembuatan dan perindustrian di pekan ini. Akan tetapi,tidak dapat dinafikan bahawa terdapat banyak sumbangan yang telah diberikan oleh industri ini terhadap masalah pencemaran udara di Parit Raja hasil daripada kegiatan perindustrian yang dijalankan. Tujuan kajian ini adalah untuk menilai hubungan antara pendedahan kepada pencemaran udara industri dengan gejala pernafasan di kalangan penduduk dewasa yang tinggal berdekatan dengan Kawasan Perindustrian Parit Raja. Manakala penduduk dewasa yang tinggal jauh dari kawasan perindustrian akan menjadi kumpulan perbandingan. Kajian ini terdiri daripada dua kaedah pengumpulan data iaitu menggunakan soal selidik untuk menilai latar belakang maklumat responden dan gejala pernafasan yang dialami serta pemantauan udara persekitaran menggunakan instrumen untuk mengukur kepekatan pencemar udara industri di kawasan luar dan persekitaran rumah responden. Untuk makluman responden, kajian ini telah diluluskan oleh Jawatankuasa Etika Universiti Putra Malaysia untuk Penyelidikan yang Melibatkan Subjek Manusia.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Secara ringkas, penyelidik akan mendekati responden yang berpotensi untuk terlibat di dalam kajian ini dari rumah ke rumah dan memberikan butiran umum mengenai tujuan lawatan. Selanjutnya, Surat Pemakluman Persetujuan Responden dengan perincian projek penyelidikan akan dikemukakan sekiranya didapati bahawa responden telah memenuhi kriteria inklusif iaitu penduduk dewasa lelaki dan wanita berumur 19-64 tahun, telah tinggal di kawasan perumahan sekurang-kurangnya satu tahun dan merupakan warganegara Malaysia. Tambahan lagi, soalan tentang pengesahan memenuhi ciri-ciri kriteria inklusif ini ada disertakan di awal borang soal selidik untuk tujuan saringan responden. Responden perlu menandatangani Surat Pemakluman Persetujuan Responden sekiranya bersetuju untuk mengikuti kajian ini. Setelah persetujuan dibuat, responden akan diberikan satu set soal selidik dalam Bahasa Melayu yang perlu diisi dengan lengkap untuk menilai maklumat latar belakang responden dan gejala pernafasan yang dialami sebelum mengembalikan borang soal selidik tersebut semula kepada penyelidik.

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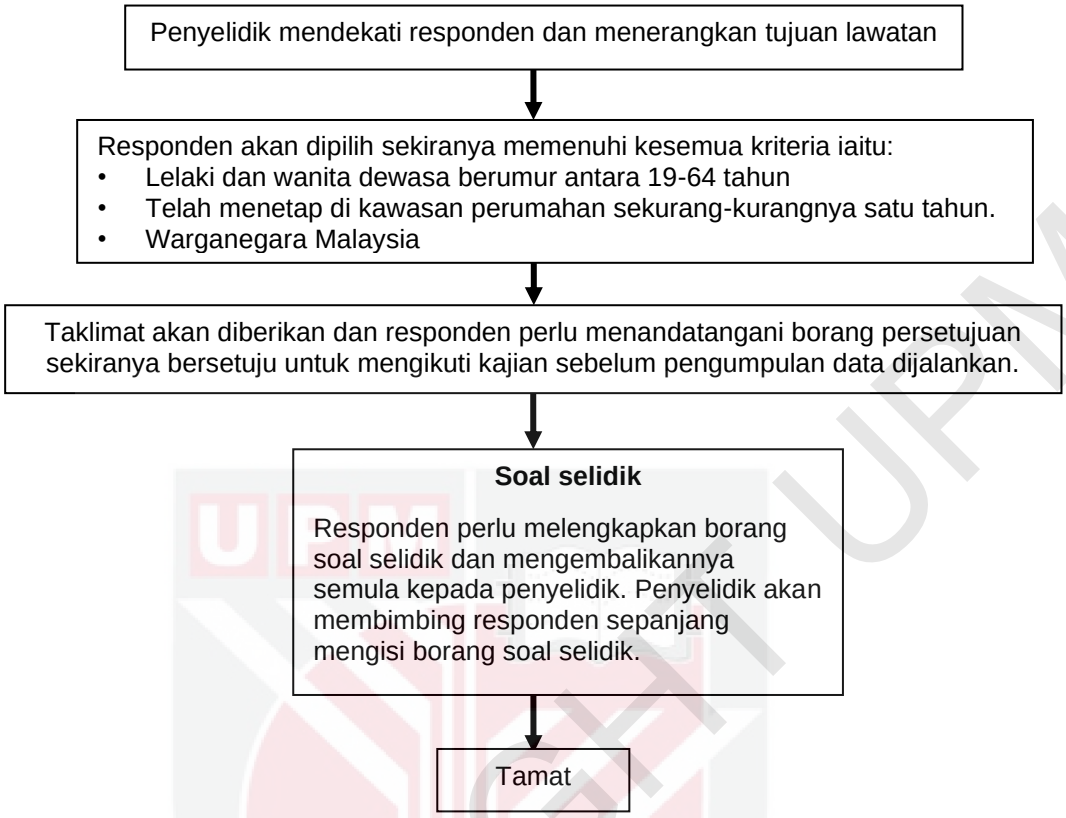

Rajah 4: Carta Alir Pengumpulan Data untuk Soal Selidik dan Pemantauan

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Responden tidak boleh mengambil bahagian dalam kajian ini sekiranya mereka mempunyai sejarah penyakit pernafasan sejak lahir atau seorang perokok aktif.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Secara amnya, kajian ini akan memberikan input kepada responden khususnya tentang kesan pendedahan kepada bahan pencemar udara industri terhadap kesihatan respiratori responden. Sekiranya tahap bahan pencemar udara adalah tinggi, langkah pencegahan awal perlu diambil. Responden akan dimaklumkan tentang apa-apa keputusan yang tidak normal supaya tindakan yang sesuai dan langkah berjaga-jaga dapat diambil terhadap kesihatan.

b) KEPADA PENYELIDIK?

Hasil kajian ini berpotensi menyumbang kepada langkah awal untuk mengurangkan risiko kesihatan terhadap pendedahan kepada bahan pencemar udara dari kawasan perindustrian. Agensi-agensi kerajaan boleh menggunakan data yang disediakan daripada penyelidikan ini untuk menyediakan pelan tindakan seperti program kesedaran berkaitan pencemaran udara industri dan program kesihatan di kawasan perumahan bagi meningkatkan kesedaran dan status kesihatan penduduk yang terdedah kepada pencemaran udara industri.

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6. ADAKAH IA BERISIKO?

Tidak ada risiko yang terlibat dalam kajian ini kerana satu-satunya data yang dikumpulkan dari responden adalah melalui soal selidik. Justeru, tidak ada sebarang pampasan atau ganti rugi dalam apa apa bentuk yang disediakan oleh pihak penyelidik kepada responden.

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Semua data yang dikumpulkan semasa kajian mengenai responden adalah sulit dan hanya digunakan untuk tujuan kajian ini. Segala maklumat yang diperoleh melalui borang soal selidik adalah sulit dan tidak akan didedahkan kepada mana-mana pihak ketiga. Borang soal selidik hanya boleh di akses oleh penyelidik dan pembantu penyelidik sahaja. Maklumat peribadi setiap individu yang terlibat di dalam kajian ini tidak akan didedahkan di dalam mana-mana bahagian penyelidikan dan penerbitan kelak. Tambahan pula, menjawab soal selidik ini adalah sukarela dan responden berhak menarik diri pada bila-bila masa tanpa sebarang alasan.

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

Untuk sebarang pertanyaan semasa penyelidikan, sila hubungi;

Pelajar Penyelidikan: Nur Afza Natasha Bt Md.Som (019-3471958) atau
e-mel @: afzanatasha98@gmail.com

Penyelia Penyelidikan: Prof.Dr.Juliana Jalaludin (017-6834103) atau
e-mel @: juliana@upm.edu.my

Penyelia Penyelidikan: Prof.Madya.Ts.Dr. Nor Haslina Binti Hashim (019-2016792) atau
e-mel @: haslina@uthm.edu.my

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

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9. PERSETUJUAN

Saya…… No Kad Pengenalan. …… beralamat…… ……..dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(soal selidik).

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

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

Saya setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan ……..…… Tandatangan ……..……
(*Responden*) (*Saksi*)

Tarikh :…….….. Nama :…….…..

No. K/P: ……..

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

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

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APPENDIX 4
ADAPTED QUESTIONNAIRE

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ID NO:	
TARIKH:	

JABATAN SAINS KESIHATAN PERSEKITARAN DAN PEKERJAAN, FAKULTI PERUBATAN DAN SAINS KESIHATAN, UNIVERSITI PUTRA MALAYSIA. 43400 UPM SERDANG.

BORANG SOAL SELIDIK

TAJUK KAJIAN	PERKAITAN ANTARA PENDEDAHAN TERHADAP PENCEMARAN UDARA INDUSTRI DENGAN GEJALA PERNAFASAN DI KALANGAN PENDUDUK DI PARIT RAJA, BATU PAHAT
NAMA PENYELIDIK	NUR AFZA NATASHABT MD.SOM

ARAHAN

Borang kaji selidik ini mengandungi 8 bahagian:
Bahagian A: Maklumat Peribadi Responden
Bahagian B: Maklumat Pekerjaan Responden
Bahagian C: Maklumat Persekitaran Dalam Rumah
Bahagian D: Maklumat Persekitaran Luar Rumah
Bahagian E: Maklumat Gaya Hidup (Lifestyle)
Bahagian F: Maklumat Gejala Respiratori
Bahagian G: Penyakit-Penyakit Lain
Bahagian H: Sejarah Kesihatan Keluarga

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

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

Soalan boleh dijawab dengan menanda jawapan terbaik atau dengan mengisi tempat kosong dengan (/) atau perkataan.
Anda akan dibantu dengan soalan-soalan ini semasa sedang mengisi soal selidik ini.

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Bahagian A: Maklumat Peribadi Responden

1. No Responden	
2. Nama	
3. Alamat	
4. Umur	19-25 tahun 26 -35 tahun 36-45 tahun 46-55 tahun 56-65 tahun
5. Tarikh Lahir	Hari Bulan Tahun
6. Tempat Lahir	Negeri Bandar
7. Tinggi (cm)	
8. Berat (kg)	
9. Jantina	Perempuan Lelaki
12. Bangsa	Melayu Cina India Lain-lain
Status Perkahwinan	Bujang Berkahwin Duda/Janda/Balu
14. Taraf Pendidikan	Tidak bersekolah Sekolah Rendah Sekolah Menengah Sijil/Diploma/Ijazah/PhD
Kategori isi rumah	B40 M40 T20
14. Sudah berapa tahunkah menetap di alamat sekarang? tahun bulan	

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Bahagian B: Maklumat Pekerjaan Responden

A) Maklumat pekerjaan sekarang	
1. Apakah status pekerjaan anda	☐ Sektor kerajaan ☐ Sektor swasta ☐ Bekerja sendiri ☐ Tidak bekerja ☐ Pelajar
2. Nyatakan pekerjaan	
3. Nyatakan tempat kerja	
4. Berapa lamakah anda telah bekerja?	☐☐ Tahun ☐☐ Bulan
5. Secara purata, tempoh masa bekerja dalam sehari	☐☐ Jam/sehari
6. Sepanjang bekerja (pekerjaan sekarang), Adakah anda terdedah kepada sebarang hazad berikut?	☐ Bahan kimia ☐ Panas melampau ☐ Habuk ☐ Bunyi bising ☐ Binatang berbisa ☐ Lain-lain. Nyatakan:
7. Adakah pekerjaan sekarang menyebabkan anda mengalami masalah kesihatan?	☐ Ya , Nyatakan masalah kesihatan yang dihadapi: _____ ☐ Tidak
B) Sejarah pekerjaan dahulu	
8. Pernahkah anda bekerja di syarikat lain sebelum pekerjaan sekarang?	☐ Ya ☐ Tidak **Jika Tidak, teruskan ke Bahagian C**
9. Nyatakan pekerjaan dahulu	
10. Berapa lamakah anda telah bekerja?	☐☐ Tahun ☐☐ Bulan
11. Secara purata, tempoh masa bekerja dalam sehari	☐☐ Jam/sehari

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12. Sepanjang bekerja (pekerjaan dahulu), Adakah anda terdedah kepada sebarang hazad berikut?	☐ Bahan kimia ☐ Panas melampau ☐ Habuk ☐ Bunyi bising ☐ Binatang berbisa ☐ Lain-lain. Nyatakan:
13. Adakah pekerjaan sekarang menyebabkan anda mengalami masalah kesihatan?	☐ Ya , Nyatakan masalah kesihatan yang dihadapi: _____ ☐ Tidak

Bahagian C: Maklumat Gaya Hidup Responden

A) Aktiviti Fizikal		
1. Adakah anda melakukan sebarang aktiviti fizikal?	☐ Ya	☐ Tidak
2. Nyatakan aktiviti fizikal yang dilakukan		
B) Kualiti Tidur		
3. Adakah anda mengalami kesukaran untuk tidur?	☐ Ya	☐ Tidak
4. Adakah anda mengalami gangguan ketika tidur?	☐ Ya	☐ Tidak

Bahagian D: Maklumat Kediaman Responden

Maklumat Persekitaran Dalam Rumah
1. Berapa orangkah yang tinggal di dalam rumah ini? _____ orang
2. Berapa buah bilikkah yang terdapat di dalam rumah ini? _____ bilik
3. Adakah bahagian dalam rumah anda dicat dalam tempoh 12 bulan lepas? ☐ Ya ☐ Tidak
4. Adakah lantai rumah anda ada ditukar dalam tempoh 12 bulan lepas? ☐ Ya ☐ Tidak
5. Apakah bahan api yang digunakan untuk memasak? ☐ Elektrik ☐ Minyak tanah ☐ Arang ☐ Gas ☐ Kayu Api
5. Berapa kali dalam sehari anda gunakan untuk memasak ? _____ kali sehari

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

☐ Ya ☐ Tidak

Alat apakah yang digunakan untuk membenarkan pengaliran udara di dalam rumah semasa memasak dan secara umum?

☐ Penyaman udara
☐ Kipas
☐ Membuka tingkap dan pintu rumah
☐ Penyedut asap atau hood dapur (cooker hood)
☐ Lain-lain(Nyatakan) _____

Adakah rumah anda menggunakan sebarang jenis alat pembersih udara atau penapis udara seperti Coway,Cuckoo dan lain-lain?

☐ Ya ☐ ak

Berapa kerapkah anda menggunakan alat pembersih udara/penapis udara tersebut?

☐ Sekali seminggu
☐ 2-3 kali seminggu
☐ 4-5 kali seminggu
☐ Setiap hari
☐ Tidak berkenaan

Berapa kerapkah anda menukar/servis alat penapis udara anda dalam masa setahun
Sila nyatakan :_____

Berapa kerapkah anda membuka pintu dan tingkap bagi tujuan pengaliran udara secara semulajadi dalam masa seminggu?

☐ Sekali seminggu
☐ 2-3 kali seminggu
☐ 4-5 kali seminggu
☐ Setiap hari
☐ Tidak berkenaan

Apakah alat yang anda gunakan untuk membersihkan rumah
Sila nyatakan :_____

Berapa kerapkah anda membersihkan rumah anda dalam masa seminggu?

☐ Sekali seminggu
☐ 2-3 kali seminggu
☐ 4-5 kali seminggu
☐ Setiap hari

8. Adakah anda mempunyai binatang peliharaan di dalam rumah?

☐ Ya ☐ Tidak

9. Adakah anda menggunakan karpet di kediaman anda

☐ Ya ☐ Tidak

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9. **Jika ' Ya' untuk soalan nombor 8,**

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(nyatakan) _____

10b. Berapa kalikah anda menggunakannya dalam seminggu?

_____ kali seminggu

10c. Dimanakah ianya ditempatkan di dalam rumah?

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

11. Adakah terdapat sesiapa/ahli keluarga yang merokok di persekitaran dalam rumah? (bermaksud sekurang kurangnya 1 batang rokok sehari atau 1 aun tembakau dalam masa satu bulan).

Jika Tidak, teruskan ke no. 14

☐ Ya ☐ Tidak

12. Senaraikan individu yang merokok di dalam rumah

☐ Bapa ☐ saudara ☐ Lain-lain Sila nyatakan :_____
☐ Abang ☐ Datuk

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

_____ batang sehari

Secara keseluruhannya, apakah pendapat anda tentang kualiti udara didalam rumah anda?

☐ Sangat teruk
☐ Teruk
☐ Sederhana
☐ Baik
☐ Sangat baik

Maklumat Persekitaran Luar Rumah	
1. Bahan binaan rumah kanak-kanak	☐ Batu/simen ☐ Kayu/Papan ☐ -lain _____ (sila nyatakan)

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2. Jenis kawasan perumahan:	☐ Kampung ☐ Rumah Teres Setingkat ☐ Rumah Teres Dua tingkat ☐ Flat ☐ Banglo
3. Lokasi rumah dari jalan raya:	☐ < 100 meter dari jalanraya ☐ 100- 500 meter dari jalanraya ☐ 501 – 1 kilometer dari jalanraya ☐ > 1 kilometer dari jalanraya
4. Lokasi rumah anda dari kawasan industri	☐ < 500 meter dari kawasan industri ☐ 501 – 1 kilometer dari kawasan industri ☐ 1.1- 5 kilometer dari kawasan industri ☐ 5.1- 10 kilometer dari kawasan industri ☐ Lebih dari 10 kilometer dari Kawasan industri
5. Apakah pendapat anda mengenai persekitaran rumah anda	☐ Sangat berhabuk ☐ Sederhana berhabuk ☐ Kurang berhabuk
Berapa kerapkah anda terdedah kepada asap/debu berbahaya serta bahan kimia dari awasan industri?	☐ Sedikit ☐ Sederhana ☐ Banyak
Pada pendapat anda, apakah kualiti udara di Parit Raja secara keseluruhannya?	☐ Sangat teruk ☐ Teruk ☐ Sederhana ☐ Baik ☐ Sangat baik
Pada pendapat anda, adakah kualiti udara di Parit Raja memberikan kesan yang ketara pada tahap kesihatan anda?	☐ Langsung tiada kaitan ☐ Tidak memberi kesan ☐ Sedikit memberi kesan ☐ Amat memberi kesan ☐ Tidak pasti

Bahagian E: Maklumat Gejala Respiratori

BATUK	
Adakah anda selalu mengalami batuk (batuk dibuat untuk berkahak tidak dikira sebagai batuk)?	☐ Ya ☐ Tidak
Adakah anda sering batuk 4 hingga 6 kali sehari atau berlarutan selama 4 hari seminggu?	☐ Ya ☐ Tidak
Adakah anda batuk semasa bangun daripada tidur atau pada waktu pagi?	☐ Ya ☐ Tidak

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Adakah anda batuk pada waktu siang atau malam?	☐ Ya ☐ Tidak
Adakah anda batuk selama 3 bulan berturut-turut dalam setahun?	☐ Ya ☐ Tidak
6. Sudah berapa hari/ bulan/ tahunkah anda mengalami batuk seperti ini? **Jika tidak berkenaan, tulis "tidak berkenaan"** _____hari/tahun	
KAHAK	
1. Adakah anda sering berkahak berpunca daripada bahagian dada anda? (termasuk kahak yang ditelan)	☐ Ya ☐ Tidak
Adakah anda berkahak lebih daripada 2 kali sehari dan berlarutan selama lebih 4 hari dalam seminggu?	☐ Ya ☐ Tidak
Adakah anda batuk berkahak semasa bangun dari tidur atau pada waktu pagi?	☐ Ya ☐ Tidak
Adakah anda berkahak pada waktu siang atau malam?	☐ Ya ☐ Tidak
Adakah anda berkahak untuk selama 3 bulan berturut-turut dalam setahun?	☐ Ya ☐ Tidak
6. Sudah berapa hari/ bulan/ tahunkah anda mengalami kahak seperti ini? **Jika tidak berkenaan, tulis "tidak berkenaan"** _____hari/tahun	
DADA BERBUNYI /WHEEZING	
1. Adakah anda mengalami masalah pernafasan berbunyi di dada?	☐ Ya ☐ Tidak
Jika YA, untuk soalan 1 diatas, sila jawab soalan-soalan berikut:	
1a. Apabila anda mengalami selsema?	☐ Ya ☐ Tidak
1b. Kadang kala walaupun tidak mengalami selsema	☐ Ya ☐ Tidak
1c. Hampir setiap hari (waktu siang dan juga malam)	☐ Ya ☐ Tidak
1d. Sudah berapa lamakah anda mengalami masalah ini(dada berbunyi) _____ tahun	

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Adakah anda pernah mengalami masalah dada berbunyi yang menyebabkan anda mengalami sesak nafas?	☐ Ya ☐ Tidak
Jika Ya bagi soalan 2 di atas sila jawab soalan berikut:	
2a. Apakah umur anda ketika pertama kali mendapat serangan seperti itu? _____ tahun	
2b. Adakah anda pernah memerlukan ubat atau rawatan untuk serangan?	☐ Ya ☐ Tidak
KESAKITAN DADA	
Sejak 3 tahun lepas, adakah anda pernah mengalami kesesakan di bahagian dada yang menghalang anda bekerja,dirumah atau dibilik tidur selama seminggu?	☐ Ya ☐ Tidak
Jika Ya bagi soalan 1 sila jawab soalan-soalan berikut	
1a. Berapa kali anda mengalami penyakit seperti berikut dalam 3 tahun lepas? ☐ Kurang daripada sekali dalam setahun ☐ Sekali dalam setahun ☐ 2-5 kali dalam masa setahun ☐ >5 kali dalam setahun	
1b. Berapa kalikah penyakit seperti ini berlaku sekurang-kurangnya selama 7 hari? _____kali ☐ Tidak berkenaan	

Bahagian F: Maklumat Penyakit-Penyakit atau Gejala Respiratori Lain

1. Adakah anda mengalami symptom-simptom lain seperti dibawah dalam masa tiga bulan lepas?

	Tidak pernah	Jarang sekali	Sekali seminggu	Lebih sekali seminggu
a) Keletihan				
Sukar menumpukan perhatian				
Gatal,rasa terbakar atau radang mata				
Radang, tersumbat atau hidung berair				
Tekak serak dan kering				
Merasa 'berat kepala'/sakit kepala/loya				
Sesak nafas/ lebih sukar bernafas				
Kulit muka kering atau kemerahan				
Kulit kepala atau telinga berkerak/gatal				
Tangan kering,gatal, kemerahan				

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Adakah anda mengalami penyakit-penyakit seperti berikut? Jika **Ya**, pada umur berapakah anda didiagnoskan mengalami penyakit berikut?			
	Ya	Tidak	Umur didiagnoskan (Sila Nyatakan)
a. Radang hidung (sinusitis)			
b. Radang telinga (otitis)			
c. Radang tonsil (tonsilitis)			
Adakah anda mengalami gangguan atau sakit paru-paru sebelum berumur 16 tahun			
Asma (Lelah)			
Emfisema (paru-paru mengembang dan rosak)			
Bronkitis			
Pneumonia (jangkitan paru- paru)			
Masalah kesihatan lain melbatkan paru-paru			
Sakit jantung			
Darah tinggi			
Penyakit berkaitan jantung			
Lain-lain nyatakan_____			
Jika jawapan anda Ya bagi soalan 2 sila jawab soalan-soalan berikut			
Adakah penyakit-penyakit respiratori yang disenaraikan di atas disahkan oleh doktor?	☐ Ya ☐ Tidak		
Adakah anda mendapatkan rawatan untuk penyakit-penyakit respiratori tersebut?	☐ Ya ☐ Tidak		
Masih mendapat rawatan?	☐ Ya ☐ Tidak		

Bahagian G: Sejarah Kesihatan Keluarga

IBU			
Penyakit keluarga berkaitan keluarga sebelah ibu			
	Ya	Tidak	Tidak tahu
a. Asma			
b. Barah paru-paru			
c. Paru-paru berair			
d. Bronkitis kronik			
e. Lain-lain masalah paru-paru			

BAPA			
Penyakit keluarga berkaitan keluarga sebelah bapa			
	Ya	Tidak	Tidak tahu
a. Asma			
b. Barah paru-paru			
c. Paru-paru berair			
d. Bronkitis kronik			
e. Lain-lain masalah paru-paru			

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