RELATIONSHIP BETWEEN AIR QUALITY STATUS AND RESPIRATORY HEALTH AMONG PRESCHOOLERS AT JOHAN SETIA AND KUALA SELANGOR

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RELATIONSHIP BETWEEN AIR QUALITY STATUS AND RESPIRATORY HEALTH AMONG PRESCHOOLERS AT JOHAN SETIA AND KUALA SELANGOR

ABSTRACT

Poor air quality in Johan Setia can be unhealthy and negatively affect sensitive groups like children and elderly. Long-term and short-term exposure towards sensitive groups could decline lung function and steer to chronic lung diseases. The aim of this research is to address the baseline of respiratory health status of pre-schoolers in relationship to the exposure to relatively concentrated air pollutant within specified duration. The study location was carried out at Johan Setia, where it surrounded by large scale industrial sectors. Collected information were later compared to the data collected from the District of Kuala Selangor where it represents the control site. The objectives of the research are to determine the correlation between preschoolers' respiratory health and changes in the core index value of PM_{10} and $PM_{2.5}$ in the ambience. The duration of air quality data from the year 2018, 2019 and 2020 were collected from DOE AQ Monitoring Station as the independent variable meanwhile the health status of preschoolers was used as dependent variable. Information was collected using survey instrument, with guided questionnaires. Beside health status, the survey also included parent's knowledge, attitudes and practises (KAP) towards air quality. Data analysis for PM_{10} and $PM_{2.5}$ in Johan Setia shown exceeding the standard annual range. While other pollutants such as ozone (O_3), carbon monoxide (CO), sulphur dioxide (SO_2), and nitrogen dioxide (NO_2) remained within standard range. This study has revealed that there is relationship between children exposed to high PM reading with the occurrence of symptomatic respiratory health. Analysis of KAP is to be disclosed at the end of this study.

Keywords: Industrialized area; respiratory health symptoms amongst children. Johan Setia; Kuala Selangor: KAP

HUBUNGAN ANTARA STATUS KUALITI UDARA DENGAN KESIHATAN PERNAFASAN DALAM KALANGAN WARGA PRASEKOLAH DI JOHAN SETIA DAN KUALA SELANGOR

ABSTRAK

Kualiti udara yang buruk di Johan Setia memberi kesan negatif kepada kumpulan sensitif seperti kanak-kanak dan warga emas. Pendedahan jangka panjang dan jangka pendek terhadap kumpulan sensitif boleh merosot fungsi paru-paru. Matlamat penyelidikan ini adalah untuk menangani garis asas status kesihatan pernafasan kanak-kanak prasekolah berhubung dengan pendedahan kepada bahan pencemar udara yang agak tertumpu dalam tempoh yang ditetapkan. Lokasi kajian dijalankan di Johan Setia, dikelilingi oleh sektor industri berskala besar. Maklumat yang di kumpul kemudiannya dibandingkan dengan data yang di kumpul dari Daerah Kuala Selangor di mana ia mewakili tapak kawalan. Objektif penyelidikan adalah untuk menentukan korelasi antara kesihatan pernafasan kanak-kanak prasekolah dan perubahan dalam nilai indeks teras PM_{10} dan $PM_{2.5}$. Tempoh data kualiti udara dari tahun 2018, 2019 dan 2020 di kumpul dari stesen pemantauan JAS sebagai pemboleh ubah bebas manakala status kesihatan kanak-kanak prasekolah digunakan sebagai pemboleh ubah bersandar. Maklumat di kumpul menggunakan instrumen tinjauan, soal selidik berpandu. Selain status kesihatan, tinjauan itu juga merangkumi pengetahuan, sikap dan amalan (KAP) ibu bapa terhadap kualiti udara. Analisis data untuk PM_{10} dan $PM_{2.5}$ di Johan Setia ditunjukkan melebihi julat tahunan standard. Manakala bahan pencemar lain seperti ozon (O_3), karbon monoksida (CO), sulfur dioksida (SO_2) dan nitrogen dioksida (NO_2) kekal dalam julat piawai. Kajian ini telah mendedahkan bahawa terdapat hubungan antara kanak-kanak yang terdedah kepada bacaan PM yang tinggi dengan kejadian kesihatan pernafasan simptom. Analisis KAP akan didedahkan pada akhir kajian ini.

Kata kunci: Kawasan perindustrian; gejala kesihatan pernafasan di kalangan kanak-kanak. Johan Setia; Kuala Selangor: KAP

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LIST OF SYMBOLS AND ABBREVIATIONS

μm	:	Micrometres
AQG	:	Air Quality Guidelines
CO	:	Carbon Monoxide
COHb	:	Carboxyhaemoglobin
COPD	:	Chronic Obstructive Pulmonary Disease
DOE	:	Department of Environmental
FEV_1	:	Forced expiratory volume in 1 second
FVC	:	Coerced vital capacity
GHG	:	Greenhouse gas
GLO	:	Ground level ozone
GOLD	:	Global Initiative for Chronic Obstructive Lung Disease
AQGs	:	Global air quality guidelines
Hb	:	Haemoglobin
IARC	:	The International Agency for Research on Cancer
KAP	:	Knowledge, Attitudes and Practises
MAAQG	:	Malaysia Ambient Air Quality Guidelines
MoE	:	Ministry of Environment
MCO	:	Movement Control Order
NEA	:	National Environment Agency
NO_2	:	Nitrogen Dioxide

NO	:	Nitrogen Monoxide
NOx	:	Nitrogen Oxide
O_3	:	Ozone
$PM_{2.5}$	:	Particulate matter size less than 2.5 microns
PM_{10}	:	Particulate matter size less than 10 microns
Pb	:	Lead
SO_2	:	Sulphur Dioxide
WHO	:	World Health Organization

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CHAPTER 1: INTRODUCTION

1.1 General Introduction

Annual air concentration being above recommended levels by World Health Organisation (WHO) is believed to be threat to human health especially children under the age of 10 (Hissamuddin et al, 2020). WHO declared air pollution as environmental threat to human health in 2019 as air pollution has consequential mortality impacts (Kuerban et al., 2020). Condition like asthma and severe heart problems like cardiovascular disease and permanent damage to the lung could reduce the quality of life of any average person. Children, people with lung condition and elderly are susceptible to the pollution deeply affected to the effects of the pollutants present in the polluted air in daily basis (Hao et al, 2020). Both long-term and short-term revelation to sensitive groups could steer to decreased lung function and chronic pulmonary disease (WHO, 2020). The International Agency for Research on Cancer revealed maternal exposure to the polluted ambient air could lead to premature deaths where it causes about 400,000 premature deaths per year globally (IARC, 2020).

Up to the minute, the main sources of air pollution in Malaysia are from illegal open burning activities, emissions from industries and transportation (Abdul Shakor et al., 2020). Motor vehicle emission alone contributes up to 75% of air contamination in the nation, while trade activities such as industrial along with power stations contributes up to 25% (Abdul Shakor et al., 2020). Illegal open burning and forest fires contributing 5% of the air pollution. Hinge on World Health Organization (WHO) findings, between 2013 along with 2018, the level of particulate matter (PM) has primitively rose to 5% in Southeast Asia countries as almost 50% of the cities has escalating PM trend levels yearly which exceeding the existing WHO Air Quality Guidelines (AQG) (WHO, 2018).

Air pollutants can be categorised as predominant pollutants and subordinate pollutants. Predominant pollutants like particulate matter (PM), sulphur dioxides (SO_2), nitrogen oxides (NO_x) mostly are emitted directly into the atmosphere whereas subordinate pollutants like ozone (O_3) are cast in the ambience from the predecessor pollutants through vicious circle in latency of sunlight following the emission gases like nitrogen monoxides (NO) and nitrogen dioxides (NO_2) (Dong et al, 2020). One of the substantial reasons of hospital admission was due to respiratory disease and one of the foremost founts of demise in 2018 was chronic lower respiratory diseases with an average death of 50 person per day (Weaver, 2020). Globally respiratory disease is prime ground of demise where around 334 million individuals agonize from bronchospasm respiratory disorder or well known as asthma and known as the prevailing amicable illness of childhood take hold of nearly 14% children's population. Overall, there is over and above 1 billion people agonize from one or the other acute or chronic respiratory system (Kitagawa et al., 2022).

As stated by the World Health Organization (WHO), disturbing figure of demise annually is related to respiratory diseases. This estimation was believed to be due to industrial bloom and imbalance of urbanization over the years (WHO, 2021). Increasing number of vehicles is also directly contributing to below par air quality and disastrous effects to public well-being. Burning of fossil fuels and release of pollutants like carbon monoxide (CO) from motor transportation carries major effect on the ambient air status. Owing to rapid suburbanization and industrialization, the air quality in Johan Setia, Klang is almost reaching unhealthy level at certain peak time on hourly basis. The current moderate air quality index can be life threating for sensitive groups like children, senior citizen and including those with heart and lung disease are at the most endanger as it could lead to breathing difficulties (Suhaimi et al, 2022).

1.2 Research Background

The levels of particle pollutants and ground level ozone pollutants are considerably lower than in past, still there is areas in Klang Valley like Johan Setia with rapid urbanization and industrial bloom that needs new tool and information on air quality managing to protect the air we breathe (Tran et al, 2020). It is vital to appraise the air status shifts and latent fount emission in Johan Setia, Klang as the current ambient air quality is almost reaching to unhealthy level and children who is being unveil to these air pollutants perchance at greater risk in developing acute respiratory disease and worst-case scenario is chronic cardiovascular disease. According to WHO report on air pollution and child health, it was stated that poor air quality will also take toll on poor neurodevelopment and cognitive ability on triggering asthma and childhood cancer (WHO, 2021). The current moderate air quality index can be life threating for sensitive groups like children and those with heart and lung disease at the most risk as it could led to breathing difficulty. Nevertheless, disturbing figure of demise annually is related to respiratory diseases. This estimation was believed due to industrial bloom and imbalance of urbanization over the years. Increasing number of vehicles is also directly contributing to bad air quality and hostile to the public well-being (WHO, 2018).

1.3 Problem Statement

The ambience is directly associated to the industrial growth along with urbanization. The pollution caused by vehicular emission and industrial production in an urbanized area such as release of high amount of fine dust and tiny particles that could lead to detrimental effects to both human health and atmosphere (Song et al., 2018). Dust released from anthropogenic sources could deteriorate respiratory health in a healthy person as the pollutant present in the ambient air will be inhaled during respiration

(Wang et al., 2022). Augment figure of premature demise attributers to the poor air quality. The correlation connecting the current air quality status in Johan Setia and the respiratory health among pre-schoolers has not been well studied or established. Studies on social aspects on public's perception, awareness and attitude towards environmental issues and understanding citizens perceptions on current air pollution, their awareness level on their ambient air and attitudes towards the environmental protection and policies are very infrequent. Comprehensible evidence on the untoward health effects caused by poor air pollution was addressed as basal global air quality guidelines (AQGs) in 2021 as the recommended annual mean concentration of pollutants not exceeding recommended concentration level (Huang et al., 2022).

1.4 Research Objectives

Objectives of this research are as follows:

I. To investigate the relationship between current Air Polution Index (API) and preschool children's respiratory health.

II. To determine the level of awareness on the current air quality based on API in Johan Setia, Klang.

III. To study the trend of pollutants in the air by studying the API of year 2018, 2019 and 2020.

1.5 Scope of Work

This research will discuss on the annual mean concentration of pollutant based on the Malaysia Ambient Air Quality Guidelines (MAAQS) in comparison with the availability of current API data from DOE for the year 2018, 2019, 2020. Four preschools have been selected as locations to conduct the research based on its air quality status, survey on the respondent's social aspects, attitudes towards environmental protection and poor air quality effects on their children was included as part of the questionnaire. The type of pollutants evaluated in the study are primary pollutants like particulate matter (PM), sulphur dioxides (SO_2) and secondary pollutants like ozone (O_3), nitrogen dioxides (NO_2) and carbon monoxide (CO).

1.6 Dissertation Structure

The dissertation contains with mainly six chapters namely introduction, literature review, methodology, result and discussion and conclusion and recommendation.

The introductory chapter provides general introductory part about the dissertation including background of the research, reviews from previous studies, aim and objectives of the study and the scope of work.

The second chapter consists of literature review which focuses on the background of ambience pollution and ambience quality and the measure taken by government to improve the air quality through Malaysia's existing law and legislations. This chapter also reviewed characteristic of poor air quality and its adverse health effects on children and the sources contributing to poor air quality in Klang valley.

The third chapter provides information on the population density on the selected site in Johan Setia and Kuala Selangor and explains the size of sample and number of respondents chosen for each site. Types of data collection process and data analysis used for retrieving secondary data from DOE and findings from the survey were explained. In addition, chapter four represents all the obtained result from the survey and the analysis of API reading, and the fifth chapter presents discussion over the results.

Lastly, the sixth chapter consist of the conclusion of the study which summarizes the findings of the study and considerable recommendations for prospective and upcoming work.

CHAPTER 2: LITERATURE REVIEW

2.1 Stunting Air Pollution Issues

DNA damaging, chromosomal mutation effects, reduce in lung function, preterm delivery for expecting mothers, and cardiopulmonary disease are examples of toxicity out-turn correlated with exposure of poor air quality (Othman et al, 2021). Gases present in excess amount in the ambient air are considered as air pollutants like carbon monoxide, nitrogen dioxide, ground level ozone and sulphur dioxide. Interaction between our physical surroundings has been compromised due to ongoing human activities to achieve urbanization and rapid development (Manisalidiset al. 2020). Although industrial revolution happens as part of development it takes toll on our environment as it releases a substantial number of contaminants into the ambient air that are detrimental to our well-being especially sensitive groups like toddlers, elderly and pregnant mothers (Othman et al, 2021). Air pollution is characterized when there is any modification in the natural characteristics of the atmosphere due to any chemical or agent contamination in the environment (Ragguett et al., 2017). This includes any combination of gasses such as Ozone (O_3), particulate matter sized between 2.5µm to 10µm, nitrogen dioxide (NO_2) and sulphur dioxide (SO_2). The pollutants have potential in creating adverse health effects in sensitive groups of people such as increasing risk of cardiovascular diseases in older adults, impaired lung functions in young adults due to increase in exposure throughout their childhood which led to wheezing and asthma conditions (Bergstra et al., 2018). Children are more prone and susceptive to air pollution since their immune responses along with vital organ such as lungs are not fully developed yet (Abdullah, 2020). Air pollution is also associated in reducing life expectancy of a population and have been identified contributing negative health effects upon prolong exposures (Odo et al., 2022).

2.1.1 Public Complaints on Ambient Air Quality

In the year 2019, DOE received almost 11,127 numbers of environmental pollution complaints from the public. Selangor received the highest number of complains compared to other states which was 3,286 (29.5%) and the least was Federal Territory of Putrajaya which was only 11 (0.1%) of the complains. Most of the complaints were related to air pollution 9,085 (81.0%) whereas lowest was on land and oil spill pollution 158 (1%) as shown in the figure below (DOE Annual Report, 2019).

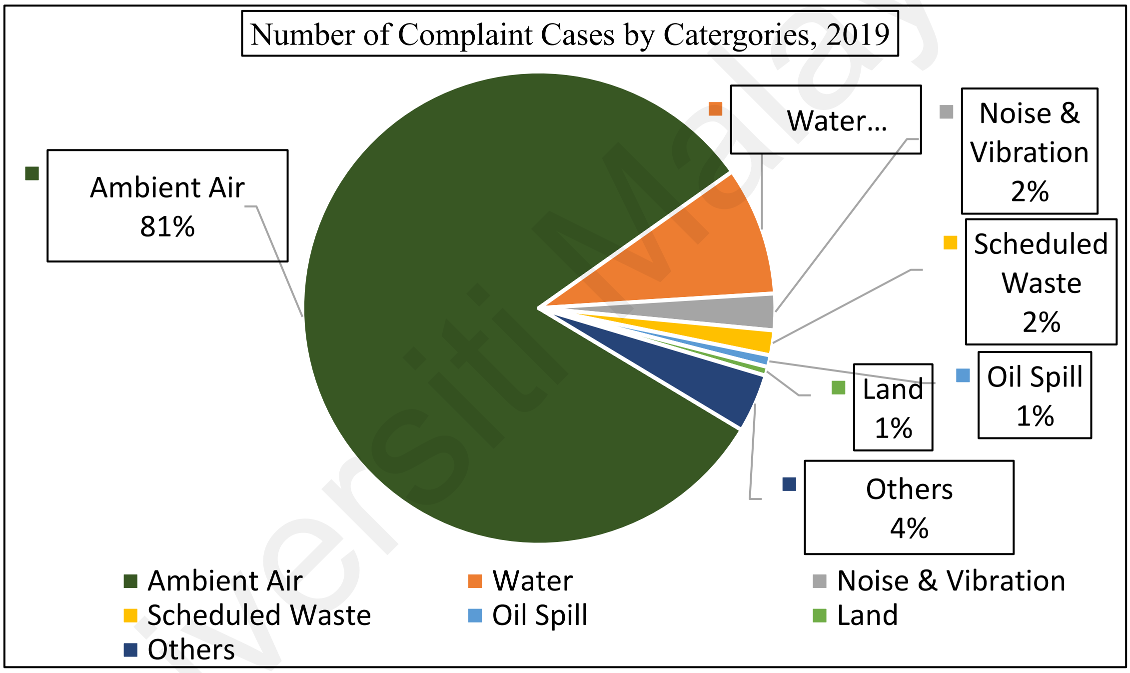

Figure 2.1: Types of complaint received in 2019 (DOE Annual Report, 2019)

2.1.2 Air Quality Status in Klang Valley in 2020-2021

In 2020, Klang recorded the highest number of moderate days where the API readings where above 51 for 365 days and recorded only one days with API below 50. Followed by Shah Alam, with 347 number of moderate days where the API was also above 51 with only 1 day with API below 51. Whereas Kuala Selangor recorded the least number of moderate days which is 298 days, about 10 months followed by the maximal number of good ambiance days which is 68 days, about 2 months 1-week. (DOE Compendium Book, 2022).

In 2021, the concentration of PM_{10} spiked about 4% in comparison to the previous year where the concentration of the pollutant was 32% lower from the previous year whereas for $PM_{2.5}$ the average concentration plunged to 6.7% followed with CO easing up to 9.7%. (DOE, 2022). Industrial activities restriction and movement control led to reduction in vehicular emissions. Controlled number of road users during implementation of movement control order (MCO) shifted the API reading to 'good' and 'moderate' ambiance status especially within Klang Valley. Monitoring station at Klang recorded the highest 'moderate' air quality days about 363 days compared to 365 days in 2020 (Compendium of Environment Statistics, 2022). The air pollutants that impart to moderate ambiance in Klang Valley are mainly PM_{10}, O_3, NO_2 and SO_2. The pollutants are believed to be trapped owing to the features of the valley land. Klang had 50 days of prominent harmful air pollution level with API surpassing 100 and one of the air pollutant benchmarks were exceeding the MAAQG levels (Yang et al, 2020). Research suggests that continues exposure to these pollutants could increase the mortality rate by compromising other organs such as kidney, heart and lungs and make people more vulnerable to respiratory diseases (Yang et al, 2021).

2.2 Framework for Air Pollution Control

2.2.1 Malaysia's Existing Law and Legislation

In Malaysian air pollution is controlled by Department of Environment (DOE) through 65 monitoring station throughout Malaysia. Various policies and laws from the environmental regulatory framework, such as the Environmental Quality Act formulated as early as in 1974, with supplemental policies known as Malaysian Ambient Air Quality Standard 2013, followed by Environmental Quality (Clean Air) Regulation 2014 (Ezani et al., 2021). These policies serve primary approaches in mitigation measures and supervise the range readings in the pollutant parameters such as particulates, nitrogen oxide and ozone emitted from industrial and vehicular emissions.

The Malaysian Air Pollutant Index (API) is adopted from the U.S EPA Ambient Air Quality Index. Both has the same criteria which includes six main pollutants known as PM_{10} and $PM_{2.5}$, ozone (O_3), carbon monoxide (CO), sulphur dioxide (SO_2), and nitrogen dioxide (NO_2). A subfix is deliberated on recurring basis for each contaminant and the largest reading on sub-index merit influence the indicative of API for that time. In Malaysia, Department of Environment (DOE) records the API data by calculating and records them in the official portal for public view. This help the public to be aware for their surrounding ambient air and air pollution levels. The latest air pollution levels are categorised into 6 breakpoints whereas previous version had only 5 breakpoints comparatively as 0-50 (good), 51-100 (moderate), 101-200 (unhealthy), 201-300 (very unhealthy) and 301-500 (hazardous), and additional exceeding 500 is announced exigency where prevailing population will be counsel to act in accordance with orders from National Security Council and must follow instruction through mass media (Compendium of Environment Statistics, 2022). The immense the API reading the further the ambient air is polluted and it poses preeminent risk on human well-being especially sensitive groups as it will aggravate respiratory health symptoms and endangers health. The description for each API and the air quality degree is shown in table below (Suki et al., 2022).

Table 2.1: Air Pollutant Index (API)

API	AIR QUALITY STATUS
0-50	Good
51-100	Moderate
101-200	Unhealthy
201-300	Very Unhealthy
301-500	Hazardous
Above 500	Emergency

Source: DOE Compendium Book, 2022

2.2.2 Interim Target of API in Malaysia

The latest Malaysia Ambient Air Quality Guidelines (MAAQG) has stipulated and improved as interim target to be achieved by 2020 with the addition of extra ambient specification for 6 types of air pollutants that comprises the 5 existing air pollutants from the older guideline which is been used since 1989. These are ground level ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO) and particulate matter with size less than 10 micron (PM_{10}) with additional parameter which is the particulate matter with size less than 2.5 microns ($PM_{2.5}$) as shown in Table 2.2 (DOE, 2019). However, the minimum annual mean concentration of pollutants is still yet to be achieved as per the standard target suggested by DOE for 2020.

Table 2.2: Malaysia Ambient Air Quality Guidelines.

Pollutants	Averaging Time	Ambient Air Quality Standard		
		IT-1 (2015)	IT-2 (2018)	Standard (2020)
		µg/m³	µg/m³	µg/m³
PM_{10}	1 Year	50	45	40
	24 Hour	150	120	100
$PM_{2.5}$	1 Year	35	25	15
	24 Hour	75	50	35
SO_2	1 Hour	350	300	250
	24 Hour	105	90	80
NO_2	1 Hour	320	300	280
	24 Hours	75	75	70
O_3	1 Hour	200	200	180

	8 Hour	120	120	100
CO	1 Hour	35	35	30
	8 Hour	10	10	10

Source: DOE 2019

2.2.3 Decarbonized Development Path and Copenhagen Effort

Air pollutants that are being released from fuel combustion in the form of fuel oil, gasoline, natural gas, and coal in generating energy are the leading fount of air pollutants which contributes to ambience contamination in Malaysia (Dong et al, 2021). For instance, recent economic expansion and urban development contributes to industrial pollution (Kuerban et al, 2020). These generate particulate emissions like greenhouse gases which are mainly categorized into several types like carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) (Hao et al, 2020). Former Prime Minister set forth that Malaysia would practice and achieve a 40% depletion in its carbon exhalation to address climate change and Malaysia could attain a carbon emission easing of 33% by 2020 and made commitment that it would be possible to reduce 45% by 2030 (Susskind et al. 2020). The Green Technology Master Plan is an effort taken by our government to bring down greenhouse gas (GHG) at 45% before 2030 by adapting green technology such as implementing green building certificates plans, improving waste management method, all newly registered automobiles are encouraged to be either hybrid or electric vehicles, promoting public transportation while limiting private vehicle ownership (Susskind et al. 2020).

2.2.4 Strength and Weakness of Pollutant Database

Previous studies reveal strength of pollutant databases on ambient air quality including measurements on urban development, residential areas, and hotspot areas such as urban sites. In 2018, WHO reviewed evidence based on research to review annual mean concentration of PM with abiding being exposure to ambient air deterioration and provided global recapitulation on PM pollution (Schwela & Haq, 2020). However, other research also revealed limitation in pollutant database on ambient air quality such as API on emission source area like urban roadsides and highways were not included due to limitation location comparability although a certain population might lay bare to exhalation from industrial facilities as actual placement of station could vary from less polluted residential areas to busy roads on high polluted city (Schwela & Haq, 2020).

2.2.5 Current Control of Practice by Neighboring Countries

Singapore is an exemplary country that uses WHO AQGs as international quality benchmark in integrating industrial planning and development control in minimizing the ambience contamination as the primal root of air pollution in Singapore arise from vehicular and industrial emission. Singapore has strict enforcement program and air quality monitoring system, where the air quality in Singapore prevailed 'good' despite being heavy in metropolitan landscape and has substantial industrial pedestal. National Environment Agency (NEA) in Singapore works closely with various stakeholders and institution of higher education to ensure the guidelines are constantly reviewed. For instance, from 2019, power stations and industries were mandated to switch use cleaner fuels to reduce release of $PM_{2.5}$ in their ambient air and industries are monitored regularly to meet the prescribed air emission standards (National Environment Agency, 2021). In 2020, Japan introduced 'Green diet' as first waves of environmental policymaking strengthening their environmental policies and regulations. These regulations were constantly updated to respond to new concerns and emerging challenges. In 2005, Ministry of Environment (MoE) in Japan established seven Regional Environmental Offices mainly to focus on activities related to development of environmental awareness and education initiatives. Japan's government takes vehicle emission standards seriously and any violations is considered civil crime. In 2017, the road transport safety act was amended where the authorities can suspend any designation approval for vehicles manufacturer if not compiled with the policy stated by the government for vehicular emission in line with European standard (MoE, 2018).

2.3 Urbanization impact

Among the states in Malaysia, Selangor has the greatest composition of population by citizenship in 2021 with (20.1%) which is almost 6.56 million population residing in this state with 0.5% annual population growth rate. Selangor is also in the top 5 densely populated state with 824 people per square kilometre (Current Population Estimates, Malaysia 2021) (Department of Statistics, Malaysia). Population growth is stimulated by increase in economic actives especially in a rapid urbanization centre like Klang Valley (Mohd Shafie et al. 2022). Industrial manufacturing and activities contribute half of the total CO emission and followed by motor vehicles exhaust. This resentfully, affects the general health of the population as pollutants exposure prone to rise in areas with excessive population density and hefty traffic (Ezani et al. 2022).

2.4 Air Quality in Klang Valley in the past

Highly industrialized areas like Klang Valley, observation for long term trends on major air pollution on both local and transboundary emission were done and were outlined as haze and non-haze period (Rahman et al., 2022). Vehicular emission or mobile transportation emission were considered as 70% of the overall exhalation in the non-rural areas. The forenoon peak hours were mostly due to vehicular emission and after-hours peak was due to meteorological setting for instance wind speed and stability of atmospheric (Suhaimi et al. 2022).

Six crucial haze incidences were disclosed in Malaysia since 1980 and the worst episode were in 1997 where it was found that during that stretch, airborne particle (PM_{10}) prevailed to be the root of haze and transboundary from a short-term observation using continuous monitoring system (Chin et al. 2019). PM_{10} is responsible in influencing the API values reading in Klang as it serves as the most significant pollutant and increases every year. In 2011, Klang has the highest number of days with PM_{10} concentration with 41 days (Mabahwi et al., 2018). Satellite image were used as an evident during the haze period caused by the large forest fire that took place in part of Sumatran and Kalimantan, Indonesia (Nadzir et al., 2020). The smog was widespread covering the Southeast Asia and the amount of economic cost suffered by Malaysia on the recovery process on this environmental disaster were enormous as it affected several important sectors like agriculture-based industries, shipping, construction, and tourism (Chin et al. 2019).

2.5 Health Impacts due to Poor Air Quality

Non-rural air quality and personage health consequences in Selangor begin to scrutinize when the air quality starts deteriorating due to brisk industrialization. The premature death was surpassing 4.2 million worldwide annually and exposure during pregnancy were related in the company of poor birthing wight and early childbirth and increases risk of developing chronic diseases (Bai et al., 2022). According to WHO (2020), respiratory affliction and lung carcinoma are notably rising in individuals who draw breath unhealthy or moderate ambiance setting compared with individuals in cleaner ambience. The inducement of poor air quality was related to open fires and poorly maintained motor vehicles and air pollutants were apt to unfurl far away owing to prolonged atmospheric lifespan (Chung et al., 2022). Well-being risk analysis and assessment became crucial as it helps in re-reviewing the current air quality status as disease borne and poor general health of a population is directly related to substandard air quality (Bai et al., 2022).

Deaths from poor air quality occur mainly in elderly and younger kids. Almost 4.2 million toddlers aged below 5 lose their life each year from acute respiratory disease aggravated by air tainting worldwide in 2018 (Chatkin & Santos, 2022). Inhalation and direct absorption through skin damages the delicate tissue in the cornea and respiratory passages, for instance air pollutants like SO_2, NO_2, and O_3 act as very strong oxidizing agent and destroys sensitive tissues in human body and impair respiratory functions (Zhang et al., 2022)

One of the substantial reasons of hospital admission was due to respiratory disease and one of the foremost founts of demise in 2018 was chronic lower respiratory diseases with an average death of 50 person per day (Department of Statistics, 2019). Globally respiratory disease is prime ground of demise where around 334 million individuals agonize from bronchospasm respiratory disorder or well known as asthma and known as the prevailing amicable illness of childhood take hold of nearly 14% children's population. Overall, there is over and above 1 billion people agonize from one or the other acute or chronic respiratory system (Odo et al., 2022).

2.5.1 Chronic Obstructive Pulmonary Disease (COPD)

COPD draw breath inarguable as the ternary foremost root of fatalities globally with the surging air deterioration (Gentile et al., 2022). Disturbingly the prevalence in younger populations is more common. This disease has high incidence rate as the diagnosed patients will not show any symptoms even if diagnosed early and lose about half of their lung capacity compared to a healthy adult (Yang et al. 2021). COPD is caused when there's abnormalities in a person's airway and alveolar and obstruction in airway wall (Bush, 2021). By 2030, COPD is reckoned to be the prime root of mortality and common chronic disease among younger populations as they are prone to childhood risk facet such as adolescence respiratory contagion along with asthma (Chen & Pan, 2021). Studies associated air pollution and fine particulate matter as a risk factor of COPD (Yang et al. 2021). COPD is also directly associated with under development of lung in a fetus, exposure to pollution and smoking in womb causes adverse effects such as prematurity, compromised immunological responses, decline in birth wight and early wheezing in a child (Gentry & Gentry, 2017). Prolonged exposure to the pollutants could induce respiratory symptoms, abnormalities in the pulmonary function and repulse within the forced expiratory volume in 1 second (FEV_1). FEV_1 acts like marker in look for severity of COPD and progression of the disease in the patients (Cardoso et al., 2018). COPD has dominant symptoms like growing short of breath and pertussis in patients in the company of continuing subjection to smoking and air deterioration (Odonkor & Mahami, 2020). Lung functions can be tracked from preschool such as air flow obstruction, wheezing, pertussis, and vomiting, all the symptoms can be detected early till late middle age as the child will be showing onset signs of asthmatic in their childhood (Bush, 2021).

2.5.2 Assessment of COPD

Crucial features of COPD are limitations in the post bronchodilator limitations to expiratory airflow in the company of respiratory capacity (Hoffmann et al. 2022). Exhalation whiff is known as coerced expiratory volume in 1 second (FEV_1) along with respiratory capacity as the coerced vital capacity (FVC). These physiological parameters can be assessed to address lung function in an individual using a spirometer. Ratio of FEV_1: FVC lower than 0.7 is set as criteria of healthy range to diagnose airflow limitation in COPD clinically (Grant & Wood, 2022). Severity and prevalence of the disease can be easily established by using spirometry to diagnose early COPD and progression of the disease as the test is well understood to identify rates of loss in pulmonary function (Hansel et al., 2021).

2.5.3 Severity of COPD

Global Initiative for Chronic Obstructive Lung Disease (GOLD) specification bring forth direction to understand the complexity behind COPD by further grasping the idea of development of the disease and classifying them into 4 categories (Bourbeau et al., 2022). This helps physicians to group their patients based on their symptoms to provide treatment regimen in relation to their patients' disease progression. Grade 1 is mild COPD or early COPD, has no primary symptoms as the lung function begin to decline but not noticeable (Evangelopoulos et al., 2021). Airflow limitation becomes mild with persistent coughing. Grade 2 is moderate COPD, where an affected individual's airflow begins to constraint and symptoms becomes more prominent and patients start seeking treatment. Symptoms that will be experienced will be increasing in phlegm production and shortness of breath. Grade 3 is severe COPD, severity in breathing increases as airway of the individuals starts to get obstructed leading to chest discomfort. Lower tolerance in carrying out daily and physical activities due to fatigue (Wang et al., 2022). Grade 4 is very severe COPD or end stage of COPD; the symptoms could be life-threating and fatal. High risk of respiratory failure and requires hospitalization. High chances for lung infection or pneumonia and shortness of breath even while resting (Hurst et al., 2021).

2.6 Occurrence of Asthma in Children

Asthmatic or bronchial asthma is one of the apparent long-standing diseases in toddlers. The burden of these disease is corelated with diminished quality of life of a child including major cause appertaining to acute visits and hospitalizations globally (Radhakrishnan et al., 2021). During infant stage and early childhood, exposure to harmful pollutants like SO_2, NO_2 and PM could increase the risk of developing asthma condition as a long-term effect and asthma morbidity. Fine and ultrafine particulates are found in air pollutants that are being released from diesel engine exhaust, industrial sites and factories, open burnings, and wildfires (Grant & Wood, 2022). Traffic related pollutants could also worsen asthmatic like symptoms in a healthy child. A child's lung development occurs in the first 4 years of their life, newborn stage till an adolescence, only then the lung is fully developed (Garcia et al., 2021). Children's lung surface area ratio is greater compared to an adult as children have higher air intake per minute during respiration process. Due to these children have greater tendency to be energetic than an average adult and occupy most of their time outdoor carrying out activities while being exposed to the poor air quality (Grant & Wood, 2022). Studies show that good mitigation measures for controlling the level of exposure of traffic and industrial related air pollutants could improve respiratory health in a child overall and directly reduces the new onset of asthma occurrences on toddlers (Radhakrishnan et al., 2021).

2.7 Threshold Values of Ambient Air Pollutant

2.7.1 Respirable Particulate Matter (PM)

Particulate matter is categorized according to their aerodynamic diameters. These pollutants are created from a chemical reaction between different pollutants and the penetration of these particles are linked with the size of these particles (Manisalidis et al. 2020). The finer the particles the hazardous it is to human health. There are two types of PM, particles that has diameter lesser than 10 micrometers (µm) in diameter is known as PM_{10} and particles that are extremely fine which is around 2.5 micrometers (µm) and smaller is known as $PM_{2.5}$. These particles are hazardous to human health once inhaled as it can enter the lungs and absorb into bloodstream as the particulate carries' liquid and solid droplets (Abd Wahil et al., 2020).

PM_{10} is known as the extremely small, suspended particles of solid or liquid droplets restraining acids, organic chemicals and soot fragments in the atmosphere that are attain from natural and human activities such as agricultural dust, emission from vehicle tires, during mining operations and construction demolition process. Wildfires and windblown dust are part of PM_{10} natural sources (Maung et al., 2022). Continuous vulnerability to the contaminant could contribute in developing cardiovascular and respiring diseases and the worst-case scenario is lung cancer. In Malaysia, exposure to these pollutants in and around a neighborhood further increases the chances of developing air pollution-related health condition and disease due to usage of traditional stove at home and open burning activities (Kitagawa et al., 2022).

$PM_{2.5}$ mainly arises from anthropogenic activities such as ignition of fuels from generating stations, construction work, burning of biomass fuel and vehicular emissions during traffic (Rahman et al., 2022). $PM_{2.5}$ is smaller in size and has an immense area besides the perforation capability and prolonged continuance in ambiance. This pollutant easily penetrates the human respiratory tract and becomes greatly hazardous once associated with prolonged exposures (Stephen, 2020). This makes this pollutant more hazardous to humans compared to other pollutants. According to WHO (2020), this pollutant has been recognized as group 1 carcinogen as it is able to absorb into blood stream and attack the organs directly. $PM_{2.5}$ has array of poor health illness such as acute respiratory symptoms from short-term exposure and chronic respiratory symptoms because of continuous exposure (McCarron et al., 2022). Continuing revelation to pregnant mothers could as well led to disabilities in fetus's neurocognitive function and development along with long-standing disease in adults including diabetes. $PM_{2.5}$ also carries an essential component known as bioaerosol (Abdul Shakor et al., 2020). Bioaerosols can be carrying living organisms from biological sources like fungi, bacteria and pollens that are present in the atmosphere and are bind to PM by means of dust and water particles. Bioaerosol that are attached to PM can trigger asthma attacks, allergies, rhinitis and wheezing in toddlers and grown-ups (Maung et al., 2022). Grievous lung damage and chronic obstructive pulmonary disease (COPD) were also linked alongside impairment of lung function in humans as the size is smaller compared to PM_{10}, this pollutant able to reach the pulmonary epithelium effortlessly (Gehring et al., 2020). During respiration process, particulates that enter a human lung can slow down the exchange process of oxygen and carbon dioxide which led to shortness of breath as the heart will try to compensate for the oxygen loss (Alias et al, 2020). PM contributes nearly 800,000 premature deaths annually and classified as 13^{th} in causing mortality worldwide (Zaini et al, 2022). Exposure to PM also causes direct and indirect coagulation activation, respiratory mortality, worsening respiratory symptoms leading to long-term respiratory complications. Pulmonary oxidative stress and inflammation are activated by PM, the activation of damaging oxidation is correlated in the company of bronchial asthma occurrence and chronic obstructive pulmonary disease (COPD) along with chronic inflammation (Burbank, 2018).

Table 2.3: Permeability in accordance to particle size

Particle size (micrometer)	Permeable degree in human respiratory system
>11 µm	Passage into nostrils and upper respiratory tract
7-11 µm	Passage into nasal cavity
4.7-7 µm	Passage into larynx
3.3-4.7 µm	Passage into trachea-bronchial area
2.1-3.3 µm	Secondary bronchial area passage
1.1-2.1 µm	Terminal bronchial area passage
0.65-1.1 µm	Bronchiole's penetrability
0.43-0.65 µm	Alveolar penetrability

Source: Frontiers in Public Health (2020)

2.7.2 Sulfur Dioxide (SO_2)

Sulfur dioxide (SO_2) known as reactive fumes with a strong odor, produced through anthropogenic sources including burning of fossil fuels, vehicular combustions, industrial activities like releasing of industrial waste and residues, various types of constructions and open fires (Cao & Cai, 2022). It has direct impacts on sensitive groups such as children, elderly, and asthmatic patients as SO_2 is responsible for various respiratory problems (Lestari & Haryanto, 2022). Exposures to high concentration of

SO_2 could led to breathing disablement in both adults and sensitive groups, especially asthmatic kids who are more active outdoor compared to indoor as it could aggregate existing cardiovascular disease (Kan, 2022). Short term exposure to the abnormal level of SO_2 can minimize the normal lung function accompanied by health indication like out of breath, panting for air and band-like tightness on chest (Miller, 2017).

2.7.3 Nitrogen Dioxide (NO_2)

Nitrogen dioxide is formed when nitric oxide is oxidized in air, its mostly colorless to brown with strong pungent smell and has poor solubility in water as it reacts with water and only soluble in sulfuric and nitric acid (Huang et al., 2022). In ambient condition nitric oxide undergoes oxidation to form nitrogen dioxide with oxygen and ozone. Nitrogen dioxide is mostly produced anthropogenically such as traffic and combustion of fuels (Meng et al., 2021). Exposure at as two hours could change the pulmonary function in asthmatic patients as they gall at threat of untoward health out-turn similarly to wheezing and coughing. Being vulnerable to this pollutant is also associated with respiratory illness and impairment in lung function growth in toddlers followed by development of chronic respiratory illness (Johnson et al., 2021).

2.7.4 Ozone (O_3)

Ozone known as triplet oxygen formed when the regular oxygen molecule (O_2) reacts with singlet oxygen atom (O) to absorb the heat of reaction during ionization of O_2 (Zhang et al. 2019). Ground level ozone (GLO) is usually in gaseous state under atmospheric conditions and the common health effects are breathing problems such as shortness of breath, triggering asthma in both adult and children, chest pain reducing lung function in an effected person and increasing the chances of respiratory disease (Ji et al., 2022). Inhaled ozone has potential to infiltrate deeply into the respiratory as ozone uptake occurs by inhalation as its widely known as respiratory tract irritants. Long-term exposure to ozone can increase chances of bronchitis, give rise to scarring living cells, organs and living organisms including person, fauna as well as flora (Zhang et al. 2019). Ozone brings down vegetative crop's yields and growth as it affects the microflora of the plants directly due to its antimicrobial capacity (Manisalidis et al. 2020). Ozone is also capable in affecting the outer layer of skin as it can form malondialdehyde in the epidermis and result in vitamin C and E depletion leading to skin diseases and tear ducts. Capable of causing damage to biological macromolecules as ozone can affect lung functions, especially in individuals with chronic health symptoms such as asthma (Ji et al., 2021).

2.7.5 Carbon Monoxide (CO)

Carbon monoxides are widely known as colorless and odorless gas that are created during incomplete process of combustion mostly substances that contain carbon (Weaver, 2020). Indelible revelation to small extent of the pollutant may well led to untoward health hazard such as headache along with nausea, prominent exposure could also be deadly while causing disorientation and unconsciousness as it impacts the neurobehavioral process. Sources of CO are mostly from combustion fumes from our vehicle and human daily activities such as cooking using a gas stove and smoking tobacco (Tran et al, 2020). CO can bind with hemoglobin (Hb) carrying oxygen in our blood forming carboxyhemoglobin (COHb), this reduces the oxygen carrying capacity in a Hb and further decreasing oxygen delivery and release leading to damaging the cells and tissue in human body. CO poisoning could also cause severe headaches, nausea, chest pain and shortness of breath (Rose at al. 2017).

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Study description

The study area selected for this study was focused within states of Selangor. There are 9 districts in Selangor, Kampung Johan Setia (3° 1.1563'N, 101° 28.0825') was selected as study site in Klang district and a control site near Bukit Melawati in Kuala Selangor (3° 20.411'N, 101° 14.9857'). Both sites are surrounded by large- and small-scale industrial sectors, commercial and residential areas and has been operating for more than 10 years. The selected sites were ideal for the study as it has moderate-air quality throughout the year with lowest good-air quality days (Johan Setia) as there are surrounded by extreme busy motorways and in comparison, with highest good-air quality days (Kuala Selangor).

3.1.1 Site selected for questionnaire distribution

The selected site, which is in Johan Setia, Klang as shown in table 3.1 below is surrounded by many large, scaled industries and approximately 3km away from Taman Perindustrian Air Hitam Phase 1 & 2. The selected site was ideal to measure the air quality as the mentioned site is in continuous development resulting in increasing socioeconomic growth, industrialization and urbanization. The increase in the vehicle population has contributed with the low air quality in these areas as the carbon emission is higher in ambient air and these pollutants are mainly contributed from mobile exhaust, dust, factories, open burning and wildfires.

Urbanization and industrial activities are also causing the increase of PM_{10} in the air as the factories and industrial activities releases chemical vapours and smoke out to the atmosphere through vents and smokestack besides than incinerating and burning waste in open dumps. As for control site, as presented in Table 3.1 below, the air quality in

Kuala Selangor seems ideal and has highest number of healthy days in 2020 compared in Klang. According to DOE, gleaned from the Air Pollutant Index the current average API in Kuala Selangor were below 50 as the 24 hours running average of the most dominant pollutants which includes $PM_{2.5}$, PM_{10} and Ozone. The API status varies everyday but remains mostly at healthy rate.

Table 3.1: Site location in Johan Setia and Kuala Selangor

Name of Site	Latitude	Longitude	Description of Site
Tadika ABC Bestari, Klang	2.974787216812373	101.48172469683446	25 participants selected (Study site)
Tadika Mutiara Al- Fikh, Klang	2.979765260080704	101.48228786513874	25 participants selected (Study site)
Pasti As-Sakinah, Klang	2.9773749014411823	101.48207556426193	25 participants selected (Study site)
Genius Aulad, Kuala Selangor	3.3306675339452734	101.25588421349332	25 participants selected (Control site)

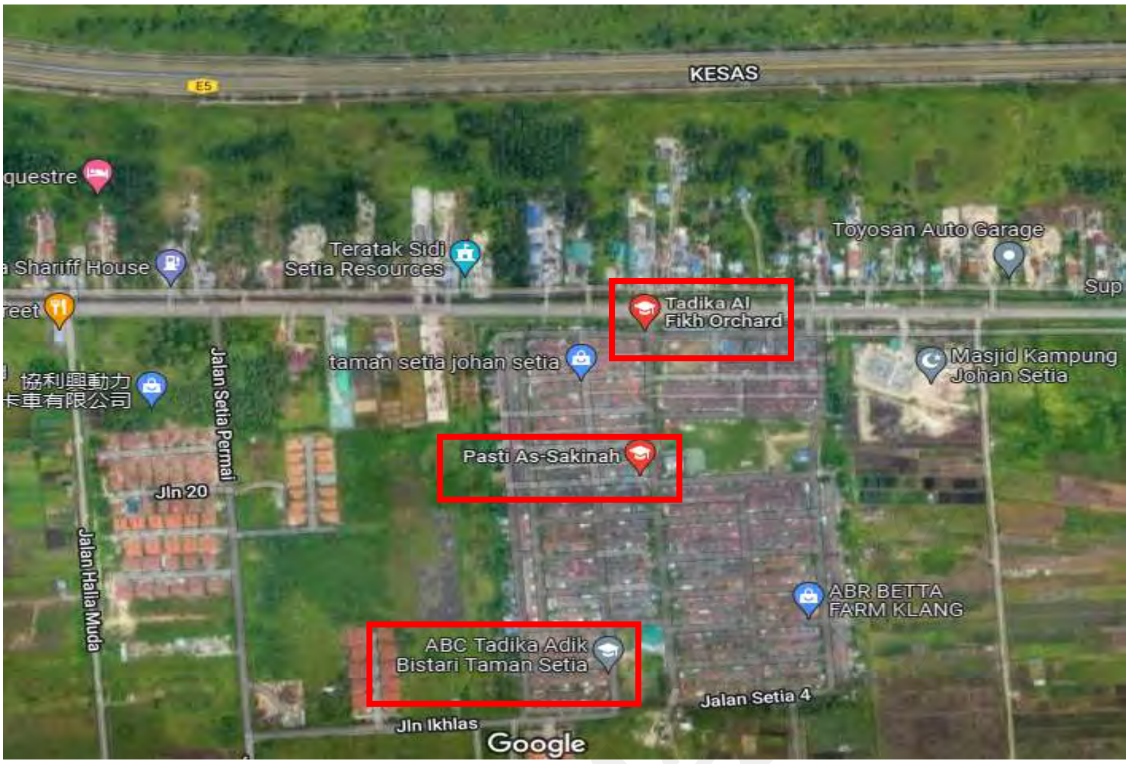

Figure 3.1: Location of selected preschool on study site in Johan Setia (Source Google Map 2022)

Figure 3.2: Location of selected preschool as control site in Kuala Selangor (Source Google Map 2022)

3.2 Study Population and Sampling Technique

25 preschool children from each preschool located in Kampung Johan Setia and a preschool in Kuala Selangor with a total number of sampling size of 100 were recruited for this study. Random sampling method was used to select the respondents with several criteria; children aged between 4-6 only, free from chronic respiratory illness and only children residing in Kampung Johan Setia area and Kuala Selangor. The list of names of the preschool children was obtained from preschool manager. Screening of respiratory health symptoms was done by using an online constructed questionnaire, where the questionnaire was sent through online, and the parents were able to fill in the information from their respective homes. The questions in the questionnaire were directed only to the parents or guardian this is because the parents or guardians is spending longer time with the children and will be more aware of the children's health symptoms.

3.3 Questionnaire development

The study was designed to gather quantitative data by using a constructed online questionnaire to assess the parent's knowledge, attitudes and practises on their current air quality status and their children's health symptoms. The online questionnaire was created using Google Form and were paraphrased into both Malay and English language, to ensure the respondents are comfortable in answering the questions in their preferred language. The validity and content of the questionnaire was cross checked several times by piloting to highlight questions that could lead to biased answer. Continuous improvement on the questionnaire design and layout was made before distributing the actual questionnaire. The online constructed questionnaire was titled *'Survey on Respiratory Health Symptoms Among Preschool Children at Johan Setia.'*

3.4 Data collection Process

'Survey on Respiratory Health Symptoms Among Preschool Children at Johan Setia,' questionnaire was filled in by the guardians or parents of the children from their respective homes. Survey participants responded to the questions using a Multiple choice. The feedback of the questionnaire was completed and sent through Google Form from all the survey participants within given timeframe. The questionnaire helped to acquire information and help the public to understand and scope the issue from answering the structured questionnaire. It also focused to converge inputs on the symptoms or illness associated to air pollution to discover the interrelation between the human well-being and the current air status and simultaneously study the correlation encounter and experienced by younger generations on air quality.

This study took place between 1 January 2022 and 30 May 2022. The questions in the questionnaire were built to meet the objective of the study during data collection. The questionnaire used the KAP Survey Model (Knowledge, Attitudes and Practises), the questions were compromised into 4 major sections with total 23 questions overall; sociodemographic section with 7 questions, awareness on current atmospheric condition with 4 questions, attitudes towards environmental protection with 3 questions, poor air quality effects on the toddler with 9 questions. 30 minutes were taken approximately to complete the survey.

3.5 Respondent's Consent

During the data collection, respondents of the survey were informed on the nature of study and the purpose of the questionnaire. The respondents were understanding as involvement was non-mandatory and can be refused to engage or cooperate anytime throughout the study with no punitive action imposed. The participants were also given assurance that the data obtained is only for study purposes and is protected in terms of confidentiality. Ethical clearance with reference number (UM. TNC2/UMREC_1997) was also acquired from University of Malaya Research Ethics Committee (UMREC) as it involved human participation and wellbeing.

3.6 Retrieval of secondary data from DOE

Data on ambient air quality in this study were obtained from subsidiary source on condition by Department of Environment Malaysia (DOE) specifically is the hourly API particulars for three consecutive years 2018, 2019 and 2020. From the hourly data received in Johan Setia and Kuala Selangor, the level of pollutant in the atmosphere was observed for a three-year time. The constructed annual mean concentration from the data was then compared with the findings from the survey. Pollutants that were monitored was the main types of air pollutants presence in the atmosphere such as ground level Ozone (O_3), Carbon Dioxide (CO), Nitrogen Dioxide (NO_2), Sulphur Dioxide (SO_2) and particulate matter known as PM_{10} with diameter less than 10 microns and $PM_{2.5}$ with diameter less than 2.5 microns, all these pollutants determined the Air Pollution Index (API) reading in index. The average daily concentration of air pollutants was calculated as the sub-index that determined the presence of highest concentration of air pollutant as the dominant pollutant in the API reading.

3.7 Type of Data Analysis

3.7.1 The Questionnaire survey

Data collected from the survey were used to study the trends and behavior of respondents as the open-ended questions were able to convey the respondents' feelings as the information is converted in terms of language than numerical value. Most of the responses were on descriptive and interpretation based. The questions are constructed to allow the respondent to explore the depth of the questions as it approaches a non-statistical form of data. Qualitative research method suits the questionnaire's design.

3.7.2 Statistical Analysis

Sets of data from DOE for the years 2018, 2019 and 2020 were used to study using IBM 'Statistical Package for Science (SPSS) version 28.0.0.0 for descriptive analysis, trend, and quantitative analysis. Descriptive analysis was used to elucidate on the tables and figures attributes to study the correlation between air quality data and the responses from the questionnaire survey on health symptoms shown in the preschoolers. One-way analysis of variance (ANOVA) was applied to analyze the distinction between other air quality parameters (PM_{10}, $PM_{2.5}$, O_3, CO, NO_2, SO_2). Independent sample test to compare the means of PM by measuring how difference are the means of both Johan Setia and Kuala Selangor relative to the variability. Assumption in *t*-test is that the difference and expected values do not make any presuppositions about which way the difference might be as the criteria to reject a null hypothesis in two-tailed distribution has to be less than 5%. Therefore, if sample mean is different from expected mean, then it is considered significantly different. Only limitation in *t*-test, is the variation in the set of data's sample mean can never be certain to reflect differences in the population mean.

CHAPTER 4: RESULT

4.1 Introduction

This research directs on the relationship of air quality status and the respiratory healthy among pre-schoolers in Johan Setia and Kuala Selangor. Findings from questionnaire was used to assess and acquire information from the parents/ guardian as they answer the structured questionnaire. It also focused to collect data on the symptoms associated to air pollution in pursuance of finding the interrelation between the human health and the current air status and at the same time study the correlation shared by younger generations on air quality. Consent form was included in the survey form where participant was required to give consent before proceeding to the next question as shown in Figure 4.1 below for Johan Setia and Kuala Selangor. All hundred respondents agree to participate in the survey.

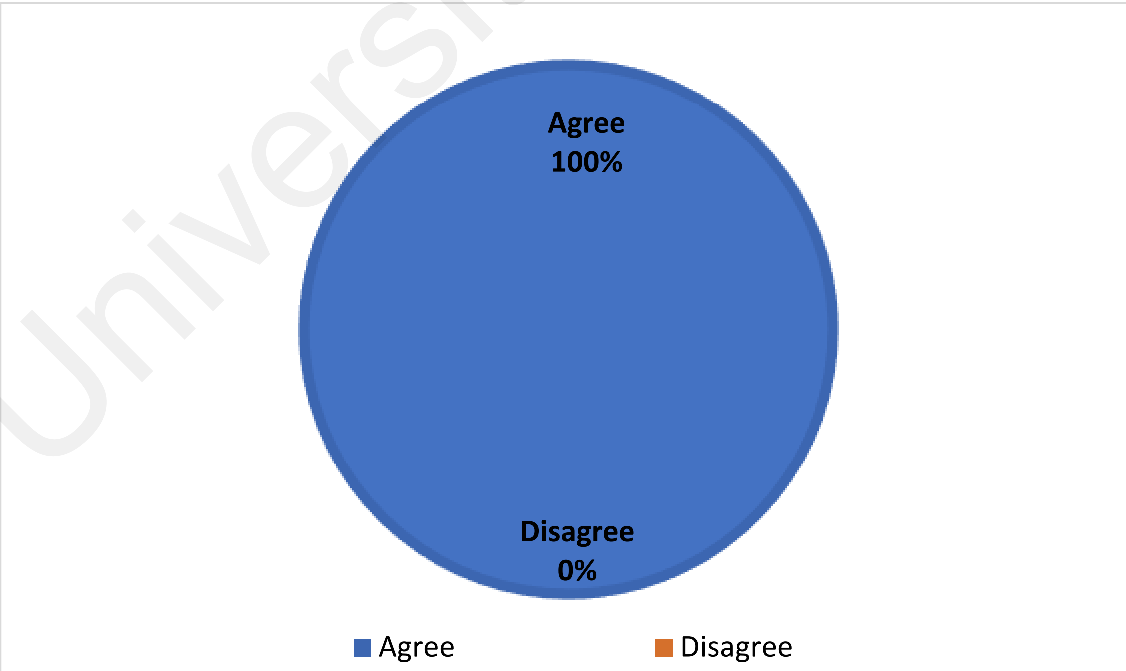

Figure 4.1: Consent from participants in Johan Setia and Kuala Selangor

4.1.1 Section A: Respondent's Demographic Information

This section consists of seven questions, these included education levels, employment status, monthly household income, regard payment for their child's healthcare services, distance of residence area from the study site and duration of their stay in Johan Setia and Kuala Selangor neighbourhood.

Figure 4.2 below shows the level of education of the respondents in Johan Setia. This indicates 55 (73.7%) of the respondents out of 75 respondents had secondary education whereas the remaining 20 (26.7%) had tertiary education. Figure 4.3 below shows the respondent in Kuala Selangor with 18 (72%) of the respondent out of 25 respondents with tertiary education and remaining 7 (28%) with secondary education.

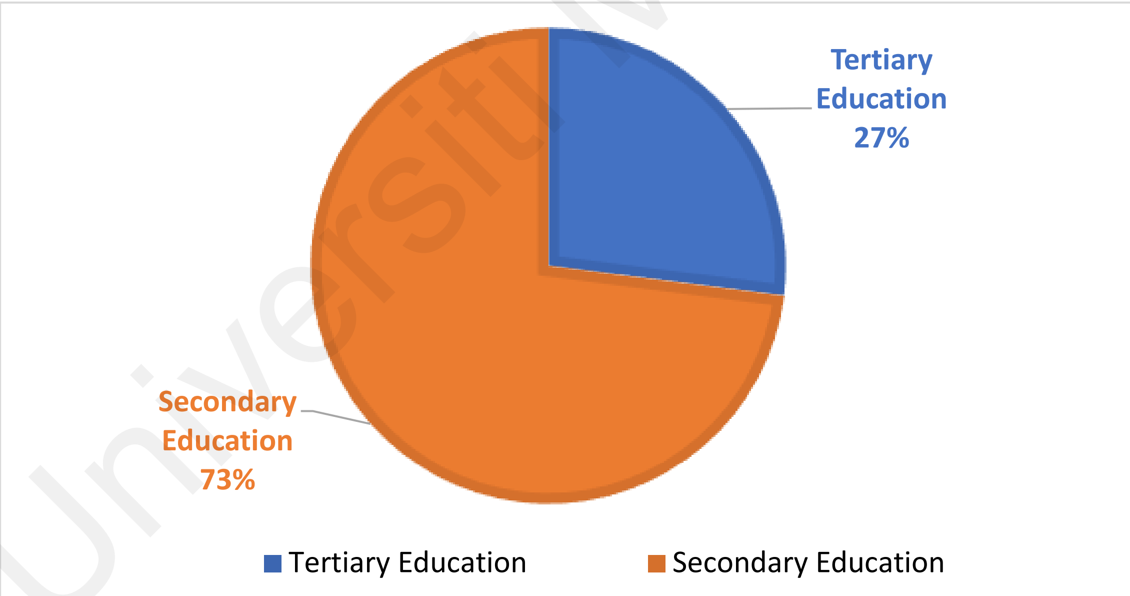

Figure 4.2: Level of education of the respondents in Johan Setia

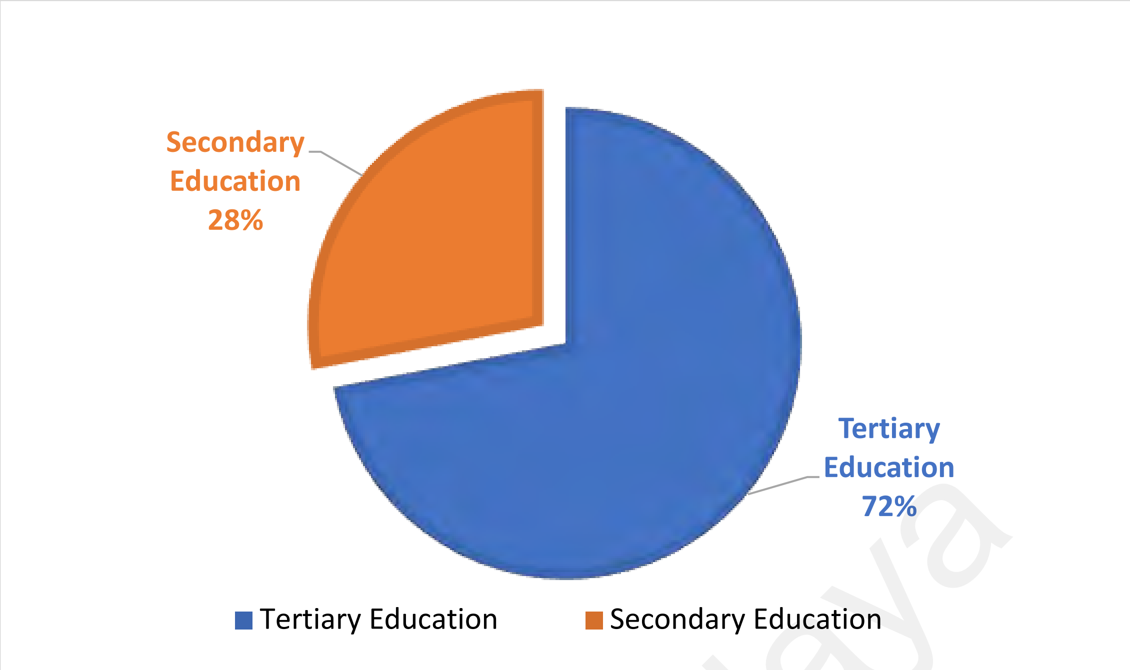

Figure 4.3: Level of education of the respondents in Kuala Selangor

Figure 4.4 below indicate the employment status of respondents in Johan Setia, about 23 (30.7%) were self-employed, 25 (33.3%) were employed and remaining 27 (36%) were housewives whereas Figure 4.5 shows the employment status of respondents in Kuala Selangor, 12 (48%) of the respondents were self-employed and the remaining 13 (52%) were employed.

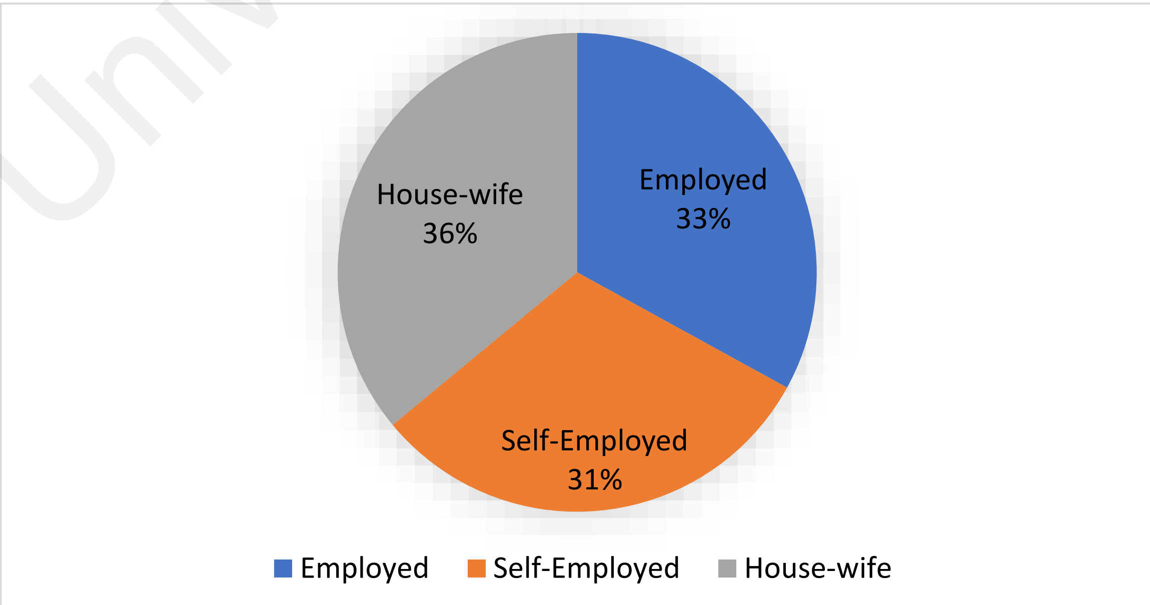

Figure 4.4: Employment status of respondents in Johan Setia

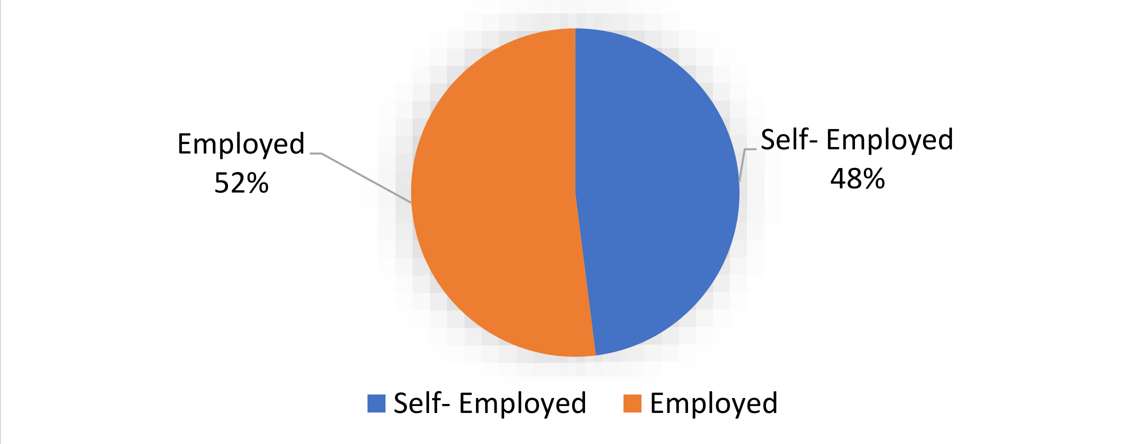

Figure 4.5: Employment status of respondents in Kuala Selangor

Figure 4.6 shows the monthly household income of respondent in Johan Setia, about 36 (48%) had monthly income less than RM4, 360 (B40), 36 (48%) more than RM4, 360 (M40), 2 (2.7%) less than RM2500 (B1) and only two respondents with monthly income above RM9, 619 (T20). Figure 4.7 shows the monthly income of respondents in Kuala Selangor, about 14 (56%) has income more than RM4, 360 (M40) whereas 11 (44%) has income more than RM 9, 619 (T20).

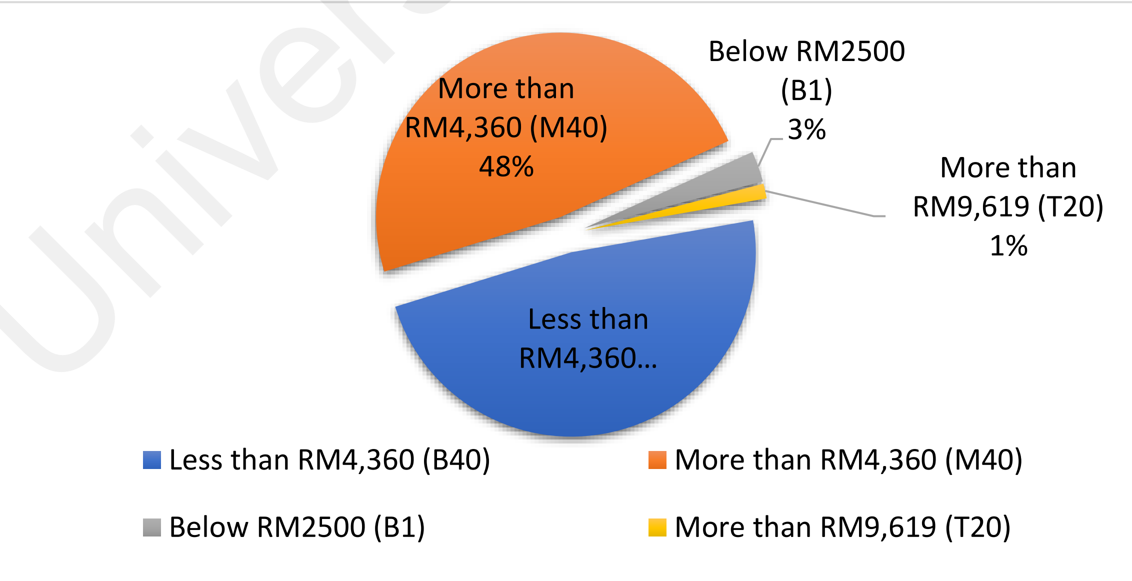

Figure 4.6: The monthly household income of respondent in Johan Setia

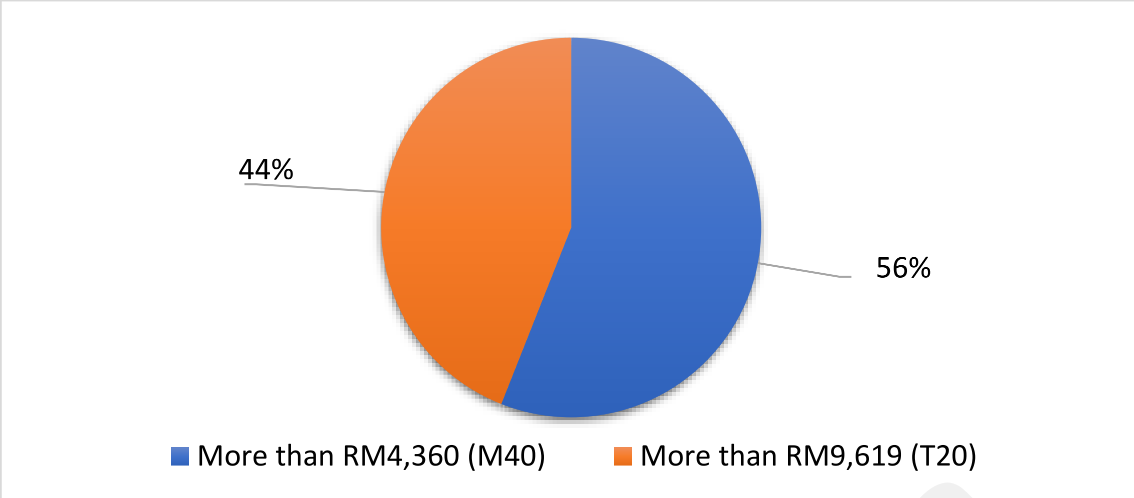

Figure 4:7: The monthly household income of respondent in Kuala Selangor

Figure 4.8 below shows the payment method of parents supporting their children healthcare service in Johan Setia, Klang. About 49 (65.3%) of parents were depending on government healthcare services, 13 (17.3%) has their own private medical insurance, 12 (16%) depends on employer's medical insurance and the remaining 1 (1.3%) were self-funding. Figure 4.9 below shows the payment method in supporting children's healthcare services in Kuala Selangor, about 22 (88%) of the respondent has own private medical insurance whereas remaining 3 (12%) has employers' medical coverage.

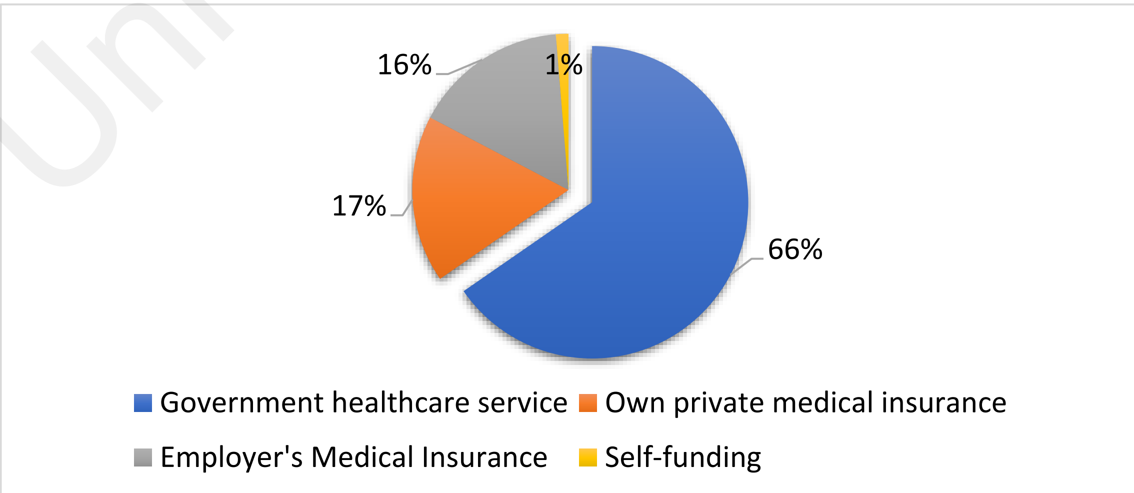

Figure 4.8: Payment method for children's healthcare service in Johan Setia

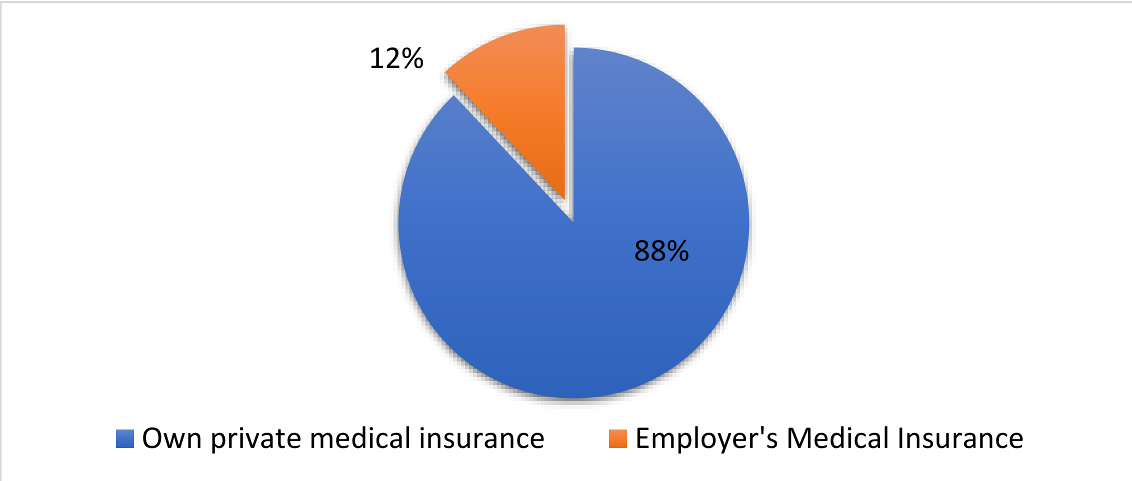

Figure 4.9: Payment method for children's healthcare service in Kuala Selangor

Figure 4.10 below shows the distance of the respondent residential area with their children's preschool for respondents from Johan Setia, Klang. About 68 (90.7%) answered 'Yes' (within 5km radius) and the remaining 7 (9.3%) answered 'No' (more than 5km radius). Whereas for respondent in Kuala Selangor was 22 (88%) answered 'Yes" (within 5km radius) and remaining 3 (12%) were staying away, more than 5km radius from their children's preschool as shown in Figure 4.11 below.

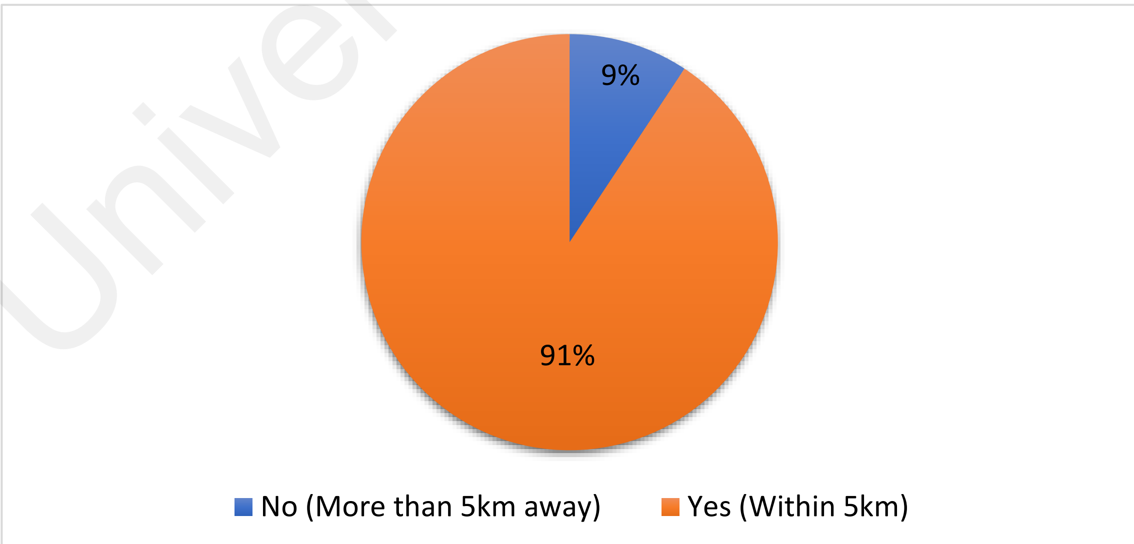

Figure 4.10: Distance of the respondent's residence with the children's preschool for Johan Setia

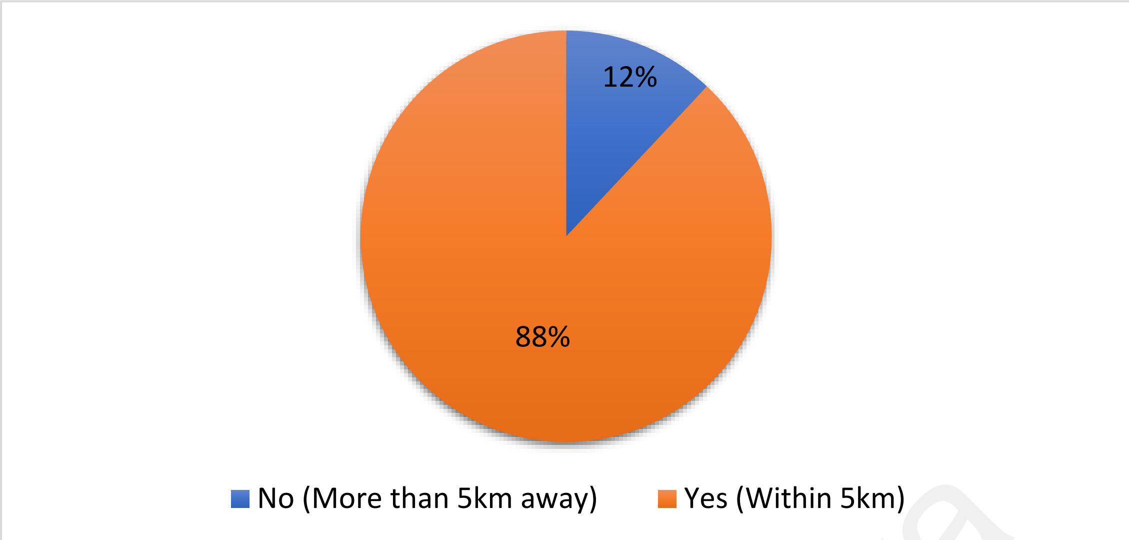

Figure 4.11: Distance of the respondent's residence with the children's preschool for Kuala Selangor

Figure 4.12 below shows the stretch of the respondent's stay in Johan Setia neighbourhood, about 58 (77.3%) of respondents were staying in Johan Setia for more than 10 years, 14 (18.7%) more than 5 years and remaining 3 (4%) less than 3 years. Figure 4.13 shows the duration of respondent stay in Kuala Selangor neighbourhood. 15 (60%) were more than 10 years, 9 (36%) were more than 5 years and remaining 1 (4%) were more than 3 years.

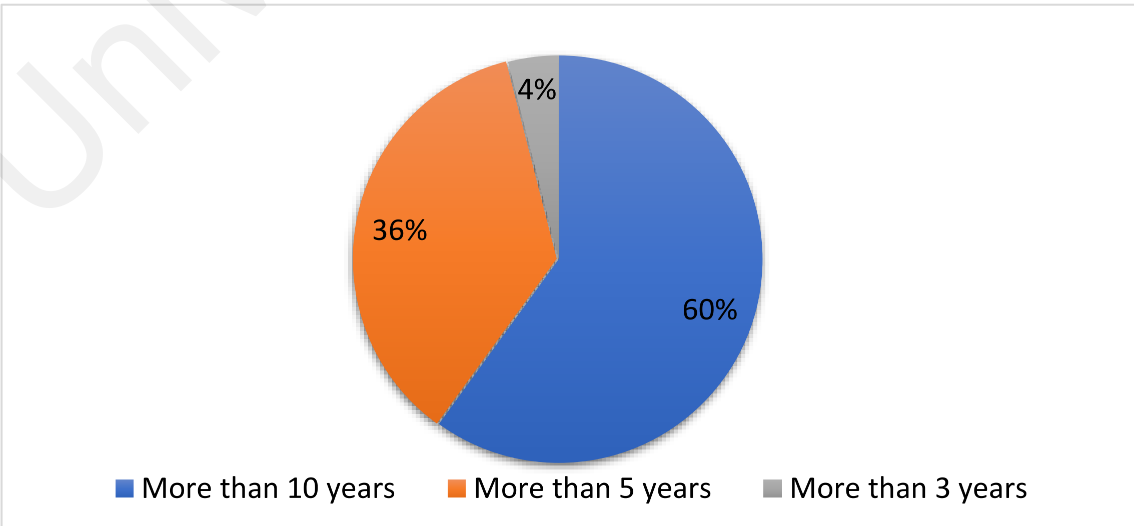

Figure 4.12: Duration of the respondent's stay in Johan Setia neighbourhood

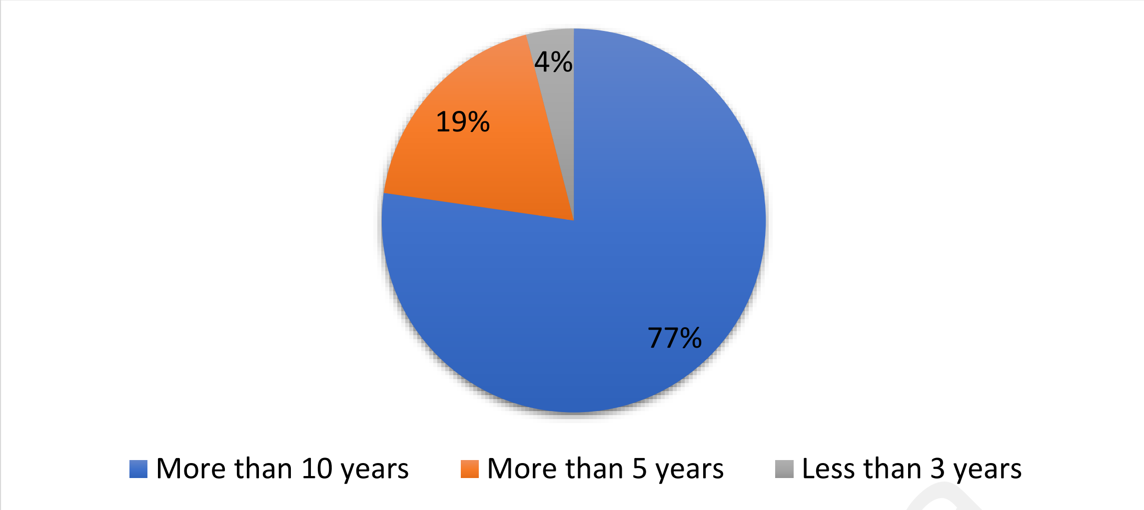

Figure 4.13: Duration of the respondent's stay in Kuala Selangor neighbourhood

Last question in the demographic section is the age of the respondent's child. In figure 4.14 it shows about 29 (38.7%) of children in Johan Setia were about 6 years old, 25 (33.3%) of children were 5 years old and remaining 21 (28%) was 4 years old. Whereas in Kuala Selangor, 14 (56%) of children were 6 years old, 6 (24%) are 4 years old and 5 (20%) was 5 years old as depicted in Figure 4.15 below.

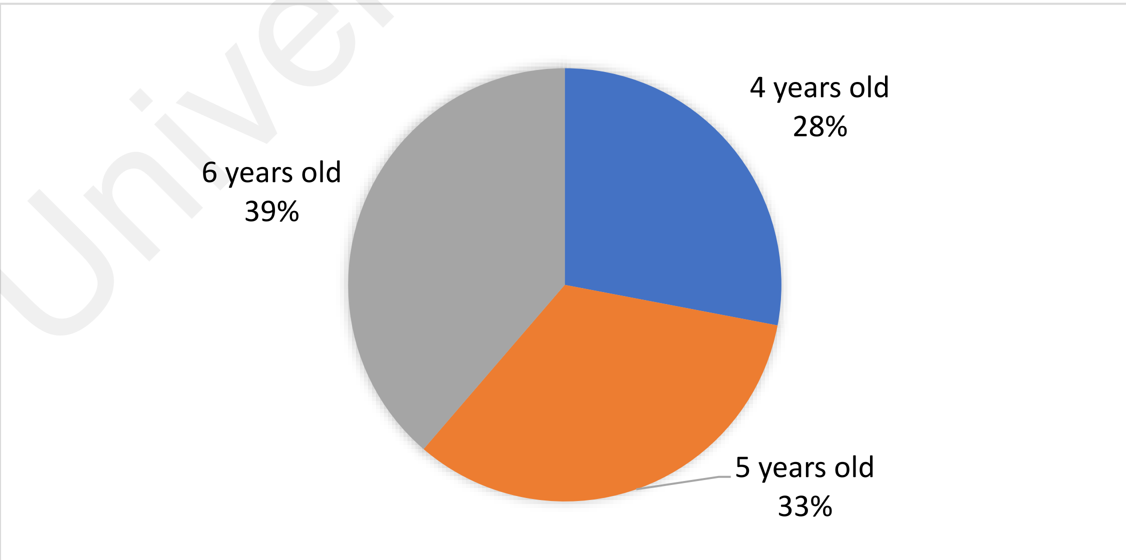

Figure 4.14: Age of children in Johan Setia

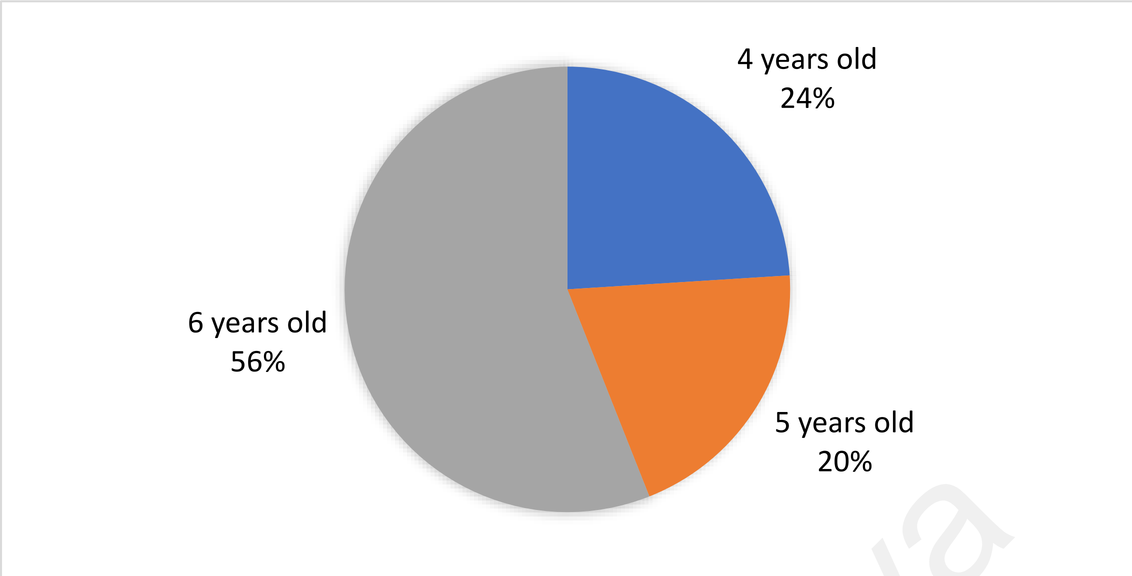

Figure 4.15: Age of children in Kuala Selangor

4.1.2 Section B: Awareness on Current Atmospheric Condition

This section consists of four questions to study the level of awareness of the respondents on their ambient air as following, “What is the overall air quality compared to last year,” “Has there been any changes in air quality in their neighbourhood since 2018, 2019 and 2020”, ‘’To what extent is the air pollution affecting them’’, and “How frequent the respondent’s witness open burning in their neighbourhood’’.

Figure 4.16 shows the responses from the respondents in Johan Setia on the rating of the on the whole air quality in their housing area compared to last year. 39 (52%) of respondent said, ‘A little better’, 30 (40%) said ‘About the same’, 5 (6.7%) said ‘A little worse’, and only 1 (1.3%) said ‘Much better’. As for responses in Kuala Selangor were more positive as 14 (56%) said ‘Much better’ and remaining 11 (44%) said ‘A little better’ as depicted in Figure 4.17 below.

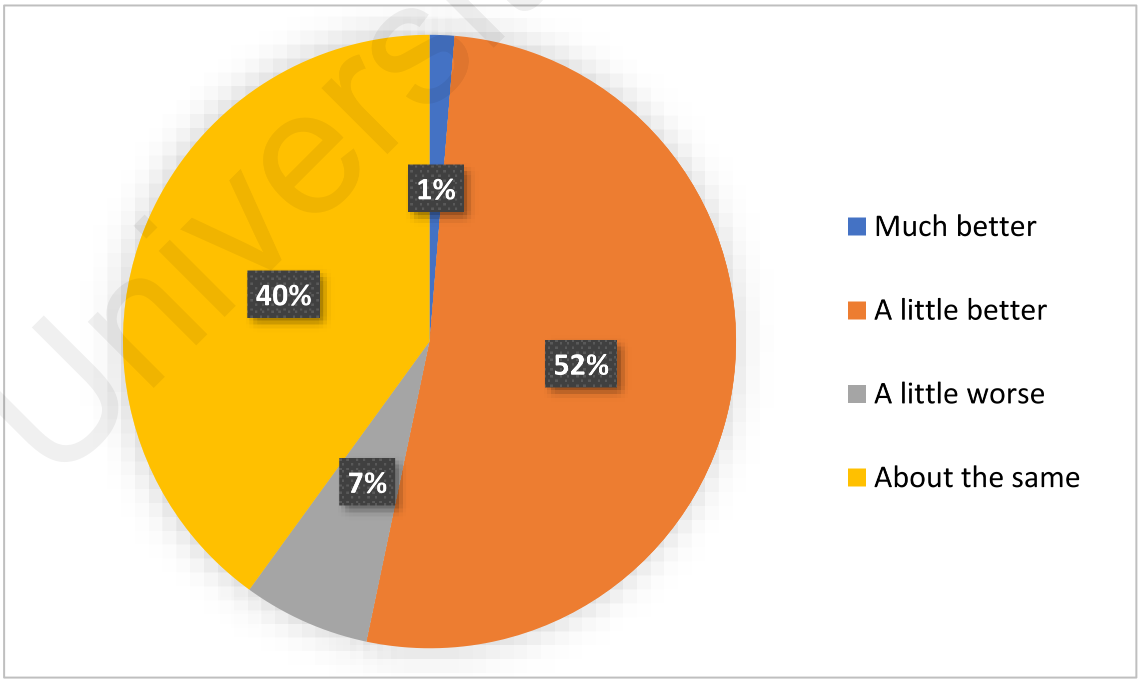

Figure 4.16: Rating of the oervall air quality in Johan Setia neighbourhood compared to last year

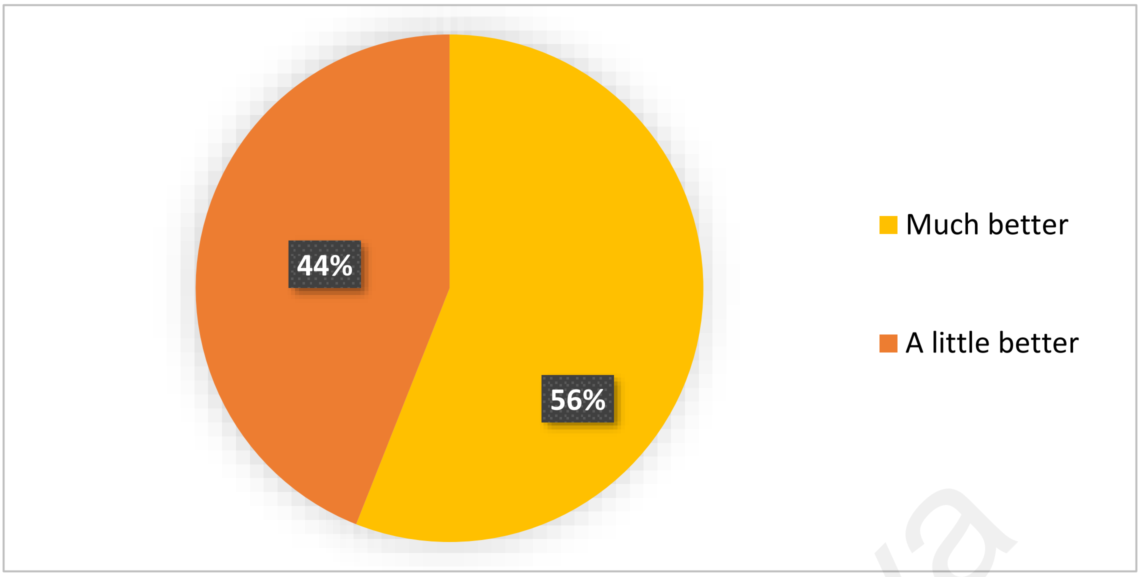

Figure 4.17: Rating of the overall air quality in Kuala Selangor neighbourhood compared to last year

Figure 4.18 below shows the responses on the opinion of the respondents in Johan Setia on the changes of air quality in their neighbourhood since 2018, 2019, 2020 and now. 39 (52%) said ‘A little better’, 29 (38.7%) said ‘About the same’, 6 (8%) said ‘A little worse’, and only 1 (1.3%) of the respondent said ‘Much better’. Whereas in Kuala Selangor it was more positive as 14 (56%) of the respondent said ‘Much better’ and 11 (44%) said ‘A little better’ as shown in Figure 4.19.

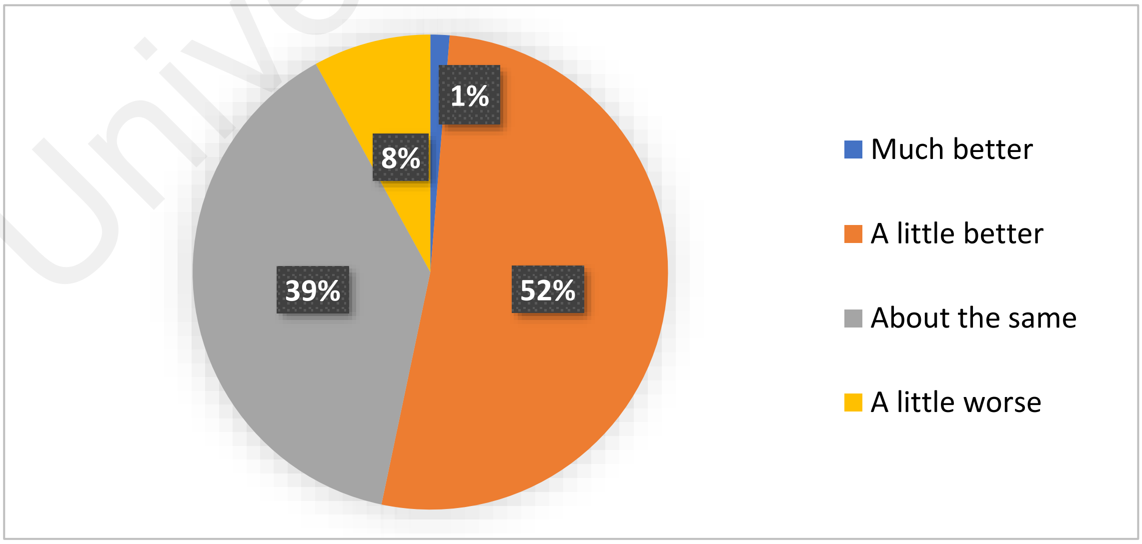

Figure 4.18: Opinion of the respondents in Johan Setia on the changes of air quality in their neighbourhood since 2018, 2019, 2020 and now

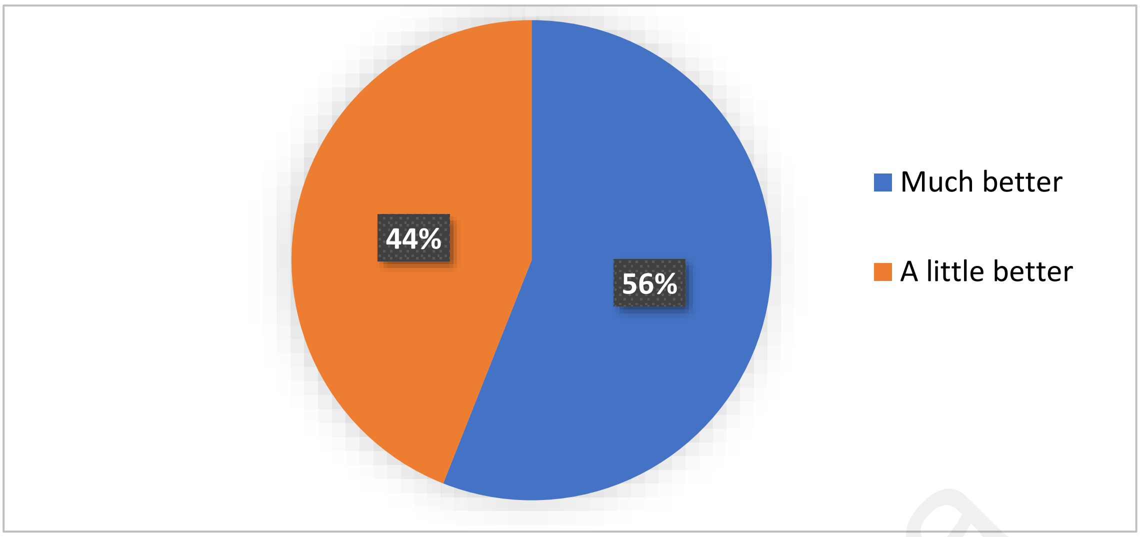

Figure 4.19: Opinion of the respondents in Kuala Selangor on the changes of air quality in their neighbourhood since 2018, 2019, 2020 and now

Figure 4.20 shows the responses on the extent of air pollution affecting them in Johan Setia. 71 (94.7%) has responded 'Slightly affected' (not needing medical attention), 3 (4%) responded 'Affected' (visiting the hospital as outpatient), and 1 (1.3%) 'Not affected'. In Kuala Selangor the responses was positive as 23 (92%) of respondents said 'Not affected' and only 2 (8%) said 'Slightly affected' (not needing medical attention) as shown in Figure 4.21 below.

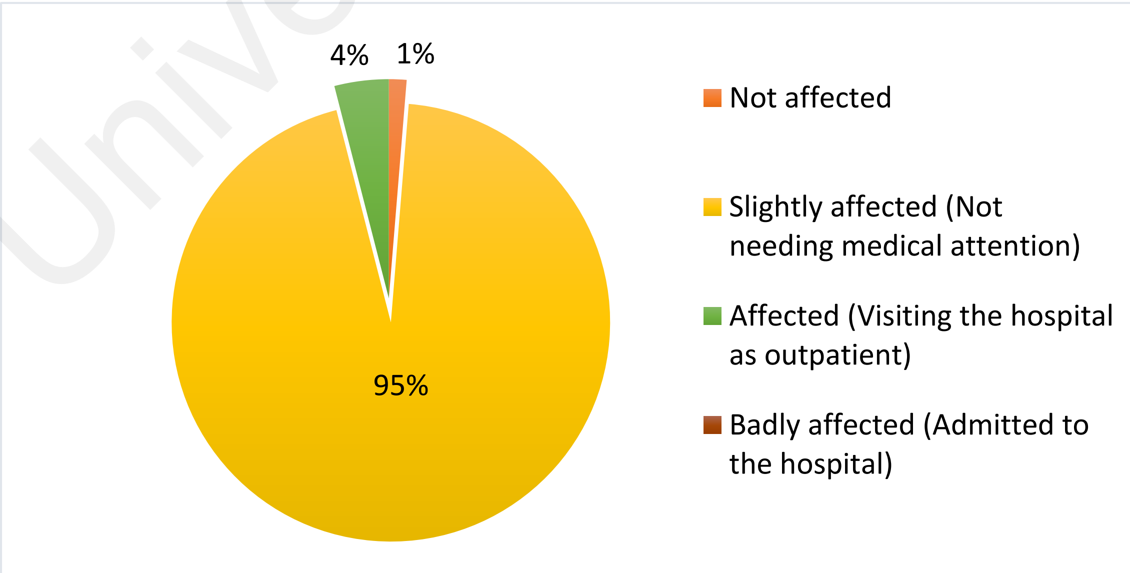

Figure 4.20: The extent of air pollution affecting the respondents in Johan Setia

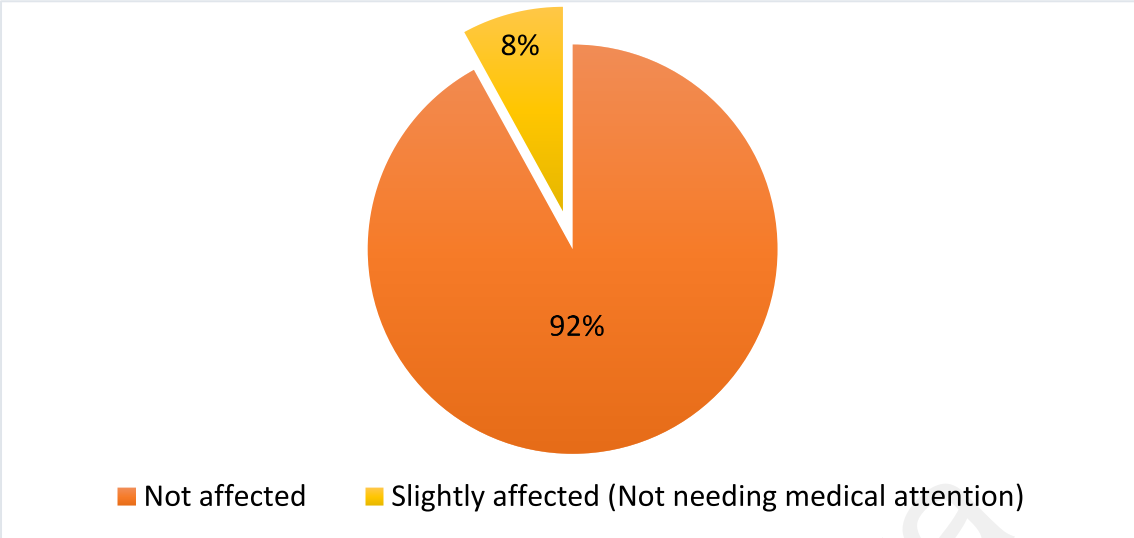

Figure 4.21: The extent of air pollution affecting the respondents in Kuala Selangor

Figure 4.22 shows the last question from Section B, on how frequent the resident in Johan Setia experiences open burning in their neighbourhood. 52 (69.3%) responded on 'Weekly basis', 17 (22.7%) on 'Daily basis', 5 (6.7%) on 'Few times in a year', and 1 (1.3%) on 'Monthly basis. Figure 4.23 shows the responses from respondents in Kuala Selangor on the same question, 19 (76%) said on 'Monthly basis and 6 (24%) on 'Few times in a year'.

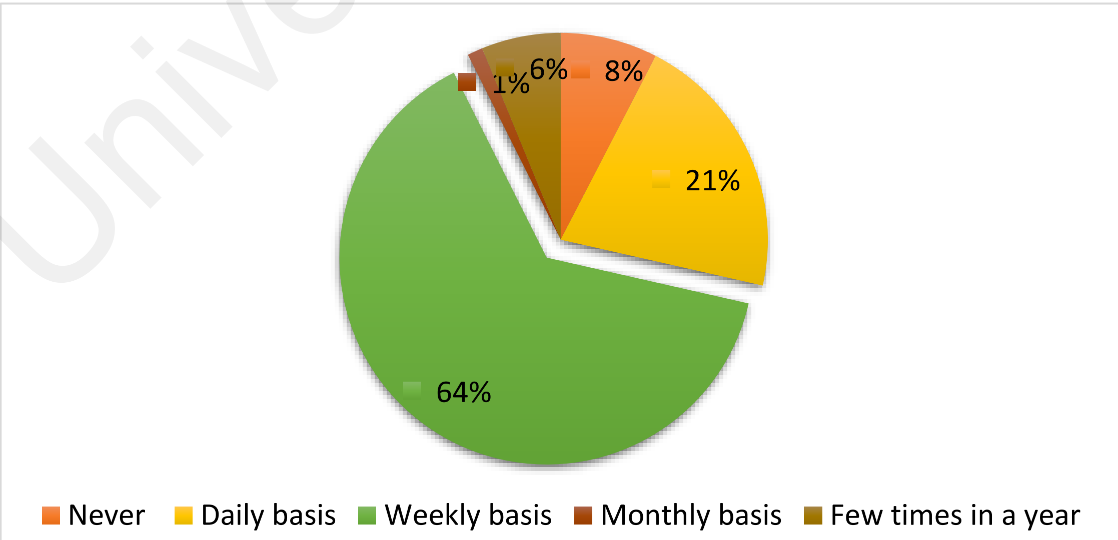

Figure 4.22: Frequecy of experiencing open burning in neighbourhood in Johan Setia

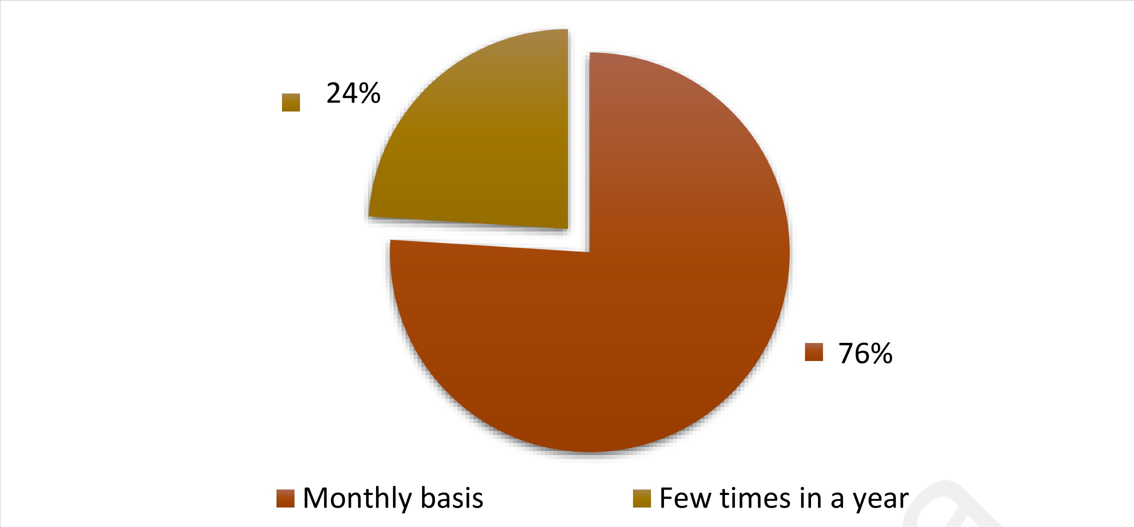

Figure 4.23: Frequecy of experiencing open burning in neighbourhood in Kuala Selangor

4.1.3 Section C: Attitudes Towards Environmental Protection

This section consists of three questions on the attitudes of the respondents towards environmental protection as following, 'Individuals who pollute should be penalized if responsible of open burnings, 'Improving the environmental quality is the responsibility of every citizen,' and final question as 'I do not face environmental pollution as a continuing matter.'

Figure 4.24 shows the positive responses from respondents in Johan Setia towards the statement, 'Individuals who pollute the environment should be penalized if responsible of open burning,' 72 (96%) of respondents agree and 3 (4%) strongly agree. For responses in Kuala Selangor, 23 (92%) agree and remaining 2 (8%) strongly agree to the statement as shown in Figure 4.25 below.

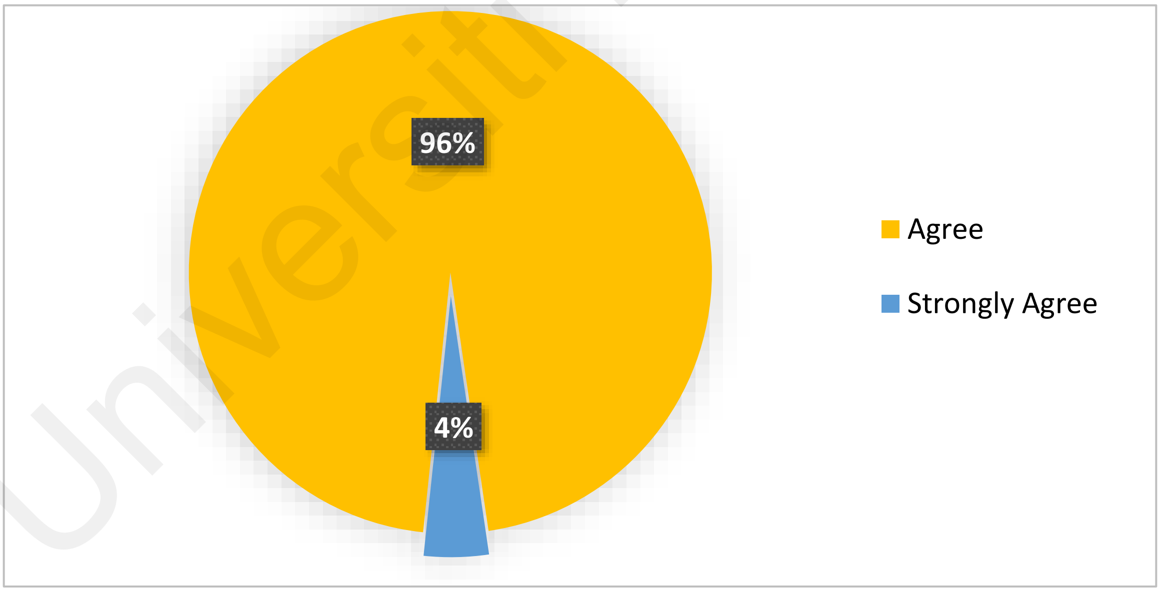

Figure 4.24: Responses from Johan Setia on statement, 'Individuals who pollute should be penalized if responsible of open burnings'

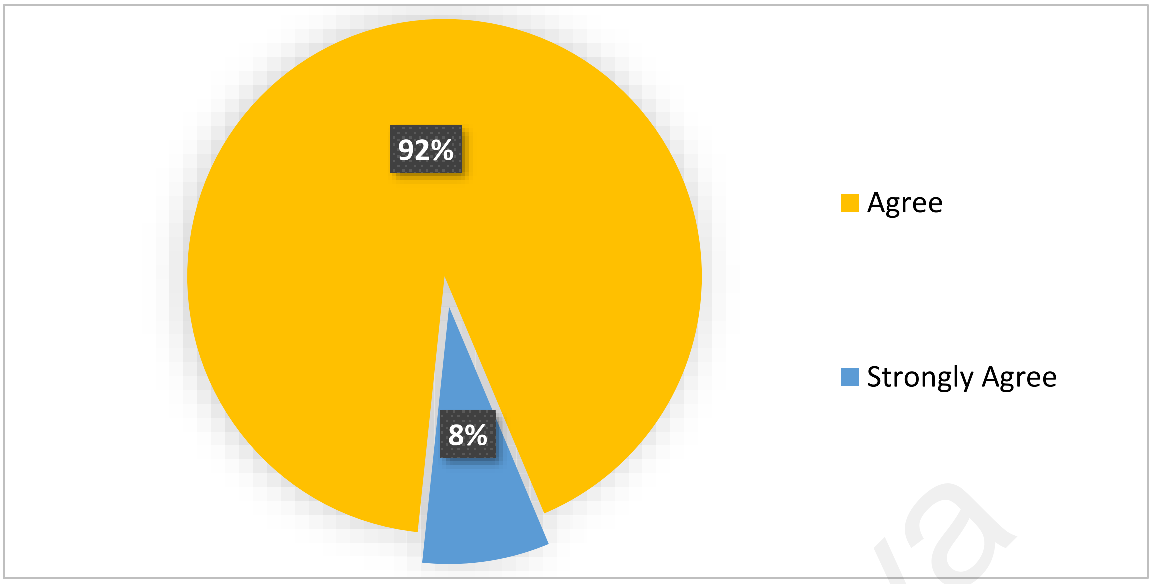

Figure 4.25: Responses from Kuala Selangor on statement, 'Individuals who pollute should be penalized if responsible of open burnings'

Figure 4.26 below shows the responses from respondent in Johan Setia on the statement, 'Improving the environmental quality is the responsibility of every citizen.' 72 (96%) of respondents agree to the statement and remaining 3 (4%) strongly agree whereas in Kuala Selangor, 23 (92%) of the respondents agree and 2 (8%) strongly agree as shown in Figure 4.27 below.

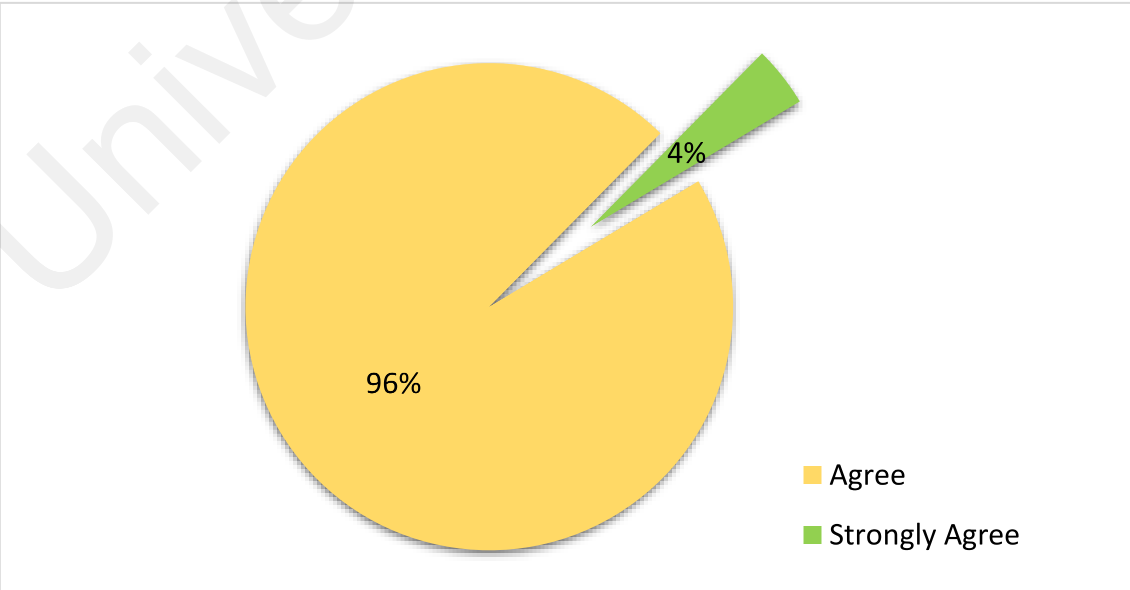

Figure 4.26: Responses from respondent in Johan Setia on the statement 'Improving the environmental quality is the responsibility of every citizen'

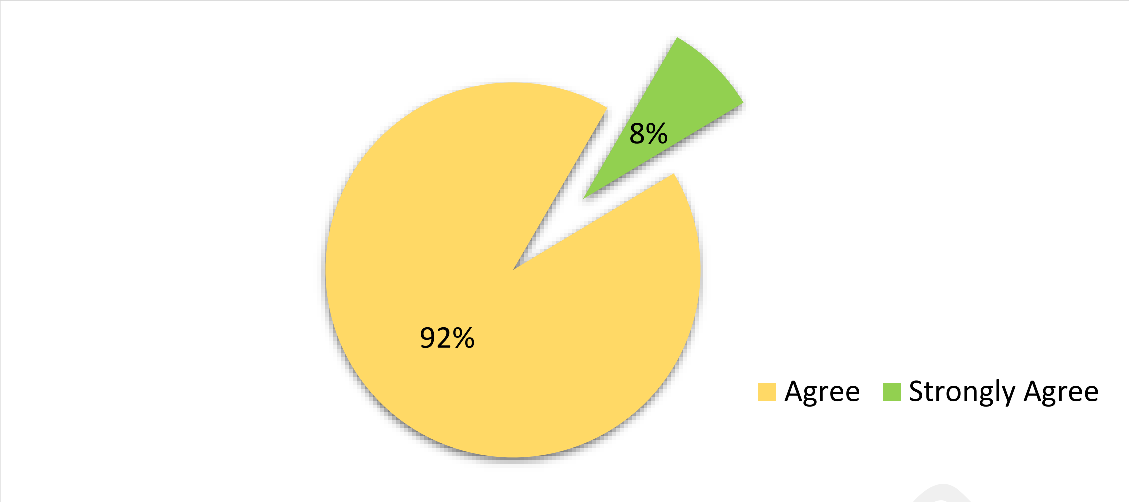

Figure 4.27: Responses from respondent in Kuala Selangor on the statement 'Improving the environmental quality is the responsibility of every citizen'

Closing question in this section is on statement, 'I do not face environmental pollution as a continuing matter.' The respondents from Johan Setia 70 (93.3%) disagree with the statement, 3 (4%) strongly disagree, 1 (1.3%) were neutral and another 1 (1.3%) agreed with the statement as shown in Figure 4.28 below. As for site in Kuala Selangor, 23 (92%) of the respondents disagree and remaining 2 (8%) strongly disagree with the statement as shown in Figure 4.29 below.

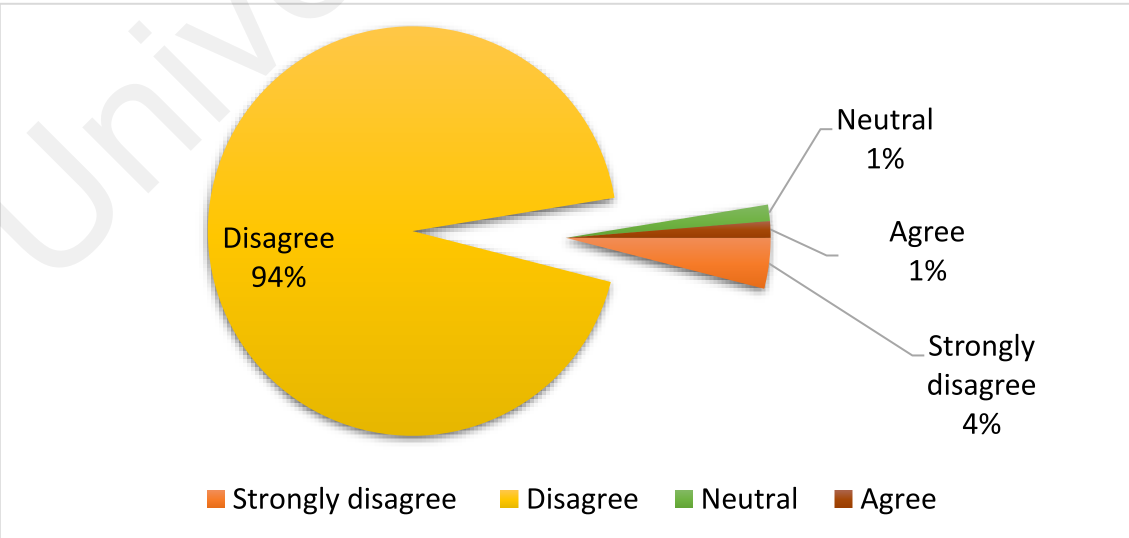

Figure 4.28: Responses from Johan Setia on statement, 'I do not face environmental pollution as a continuing matter'

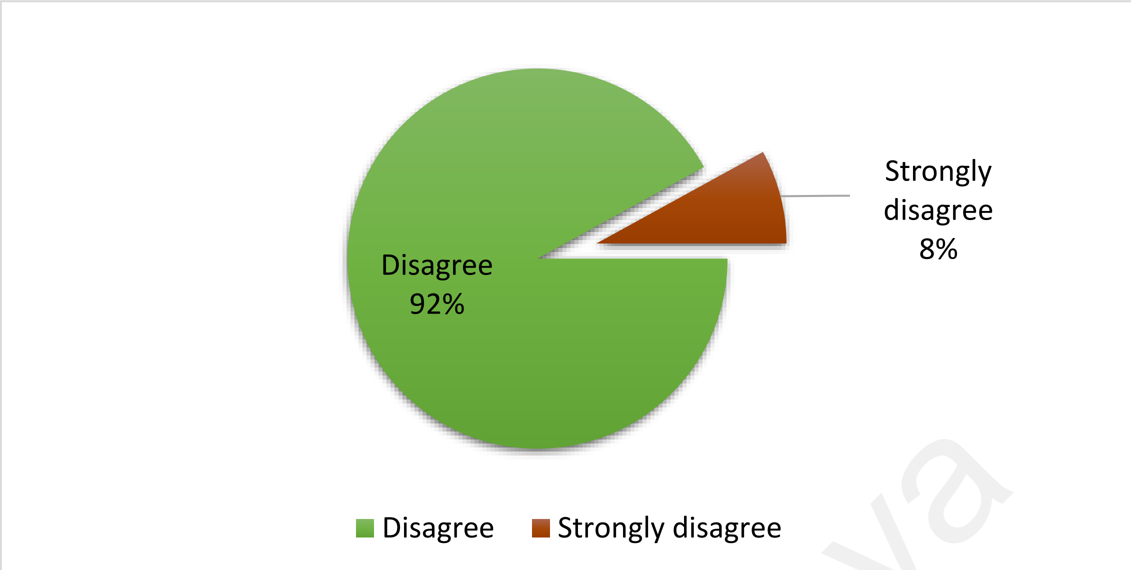

Figure 4.29: Responses from Kuala Selangor on statement, 'I do not face environmental pollution as a continuing matter'

4.1.4 Section D: Poor Air Quality Effects on your Children

This is the final section in the questionnaire, section D is mainly on poor air quality effects on the respondents' children. This section consists of nine questions as followings, 'since when does the child suffer from asthma, during poor air quality does the child show any respiratory symptoms such as coughing while eating or soon after eating, does the child experience shortness of breath during physical activities, vomit when coughing, cough more when awake than when asleep, cough on first lying down or bending over, gets sound sleep during night.' During poor air quality, does the child limited in doing any activities at home for instance, house chores or while running around. The final question was, 'does the child have lots of energy.'

Figure 4.30 below depict the question on since when the children in Johan Setia were suffering from asthma and 53 (70.7%) responded not asthmatic, 21 (28%) responded asthmatic since born and 1 (1.3%) for three years ago. Considering that, Kuala Selangor responded 20 (80%) children not asthmatic and remaining 5 (20%) were asthmatic since born as shown in Figure 4.31 below.

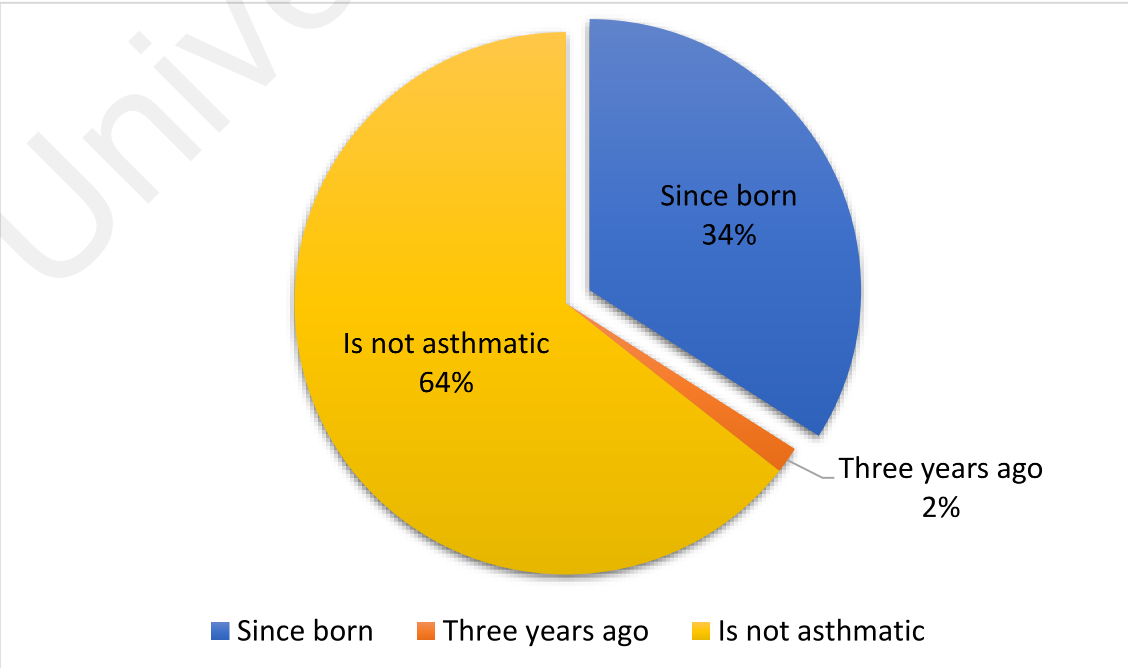

Figure 4.30: Response on children's asthmatic condition status in Johan Setia

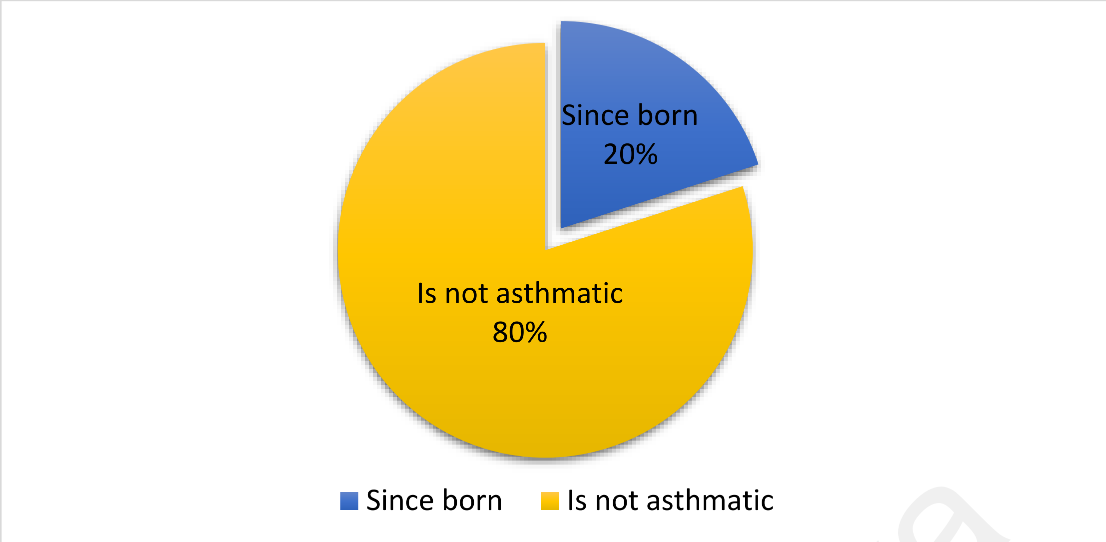

Figure 4.31: Response on children's asthmatic condition status in Kuala Selangor

Figure 4.32 shows the following responses for following question, during poor quality in the neighbourhood on how often does the child cough while eating or soon after eating. Respondent from Johan Setia depict that 66 (88%) children cough occasionally (only once in a day), and remaining 9 (12%) responded sometimes (two or three times in a day). For Kuala Selangor, most of the parents responded 16 (64%) never and remaining 9 (36%) responded occassionally (only once in a day) and its shown in Figure 4.33 below.

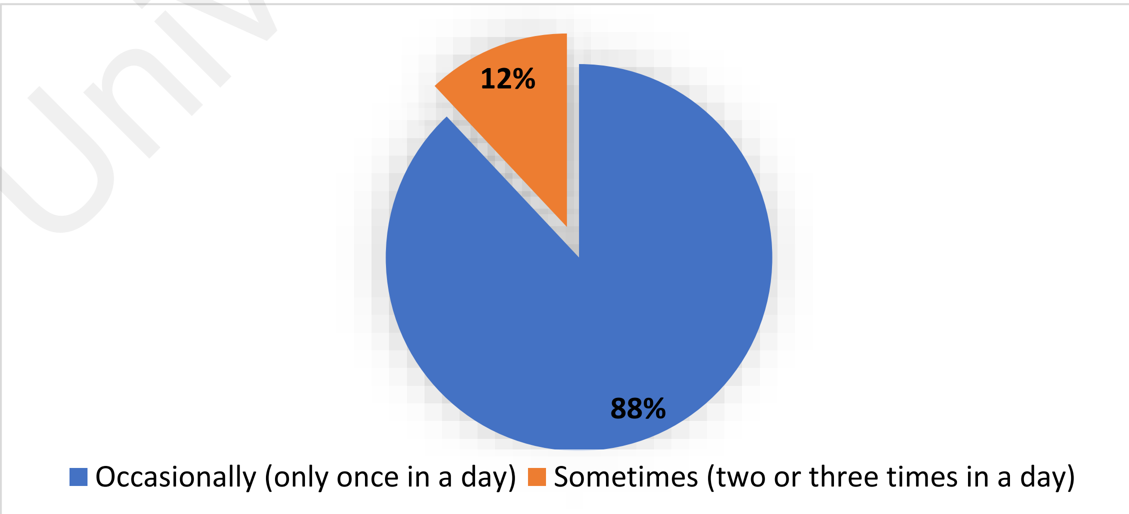

Figure 4.32: Responses from respondents in Johan Setia on how frequent their child cough during and after meal

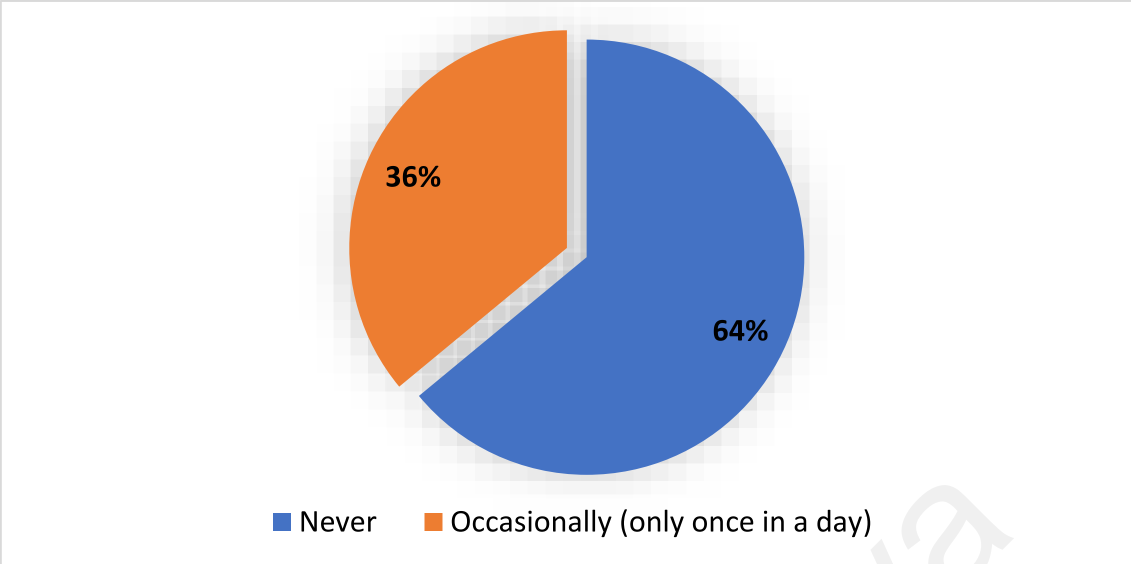

Figure 4.33: Responses from respondents in Kuala Selangor on how frequent their child cough during and after meal

Figure 4.34 below shows the reponses for the following question on, 'during poor air quality, does the child experience shortness of breath during physical activities', 63 (84%) of the responses were occasionally (only once in a day), 9 (12%) responded sometimes (two or three times in a day) and remaining 3 (4%) responded never. Whereas in Kuala Selangor, 19 (76%) responded occasionally (only once in a day) and remaining 6 (24%) were never experiencing shortness of breath during physical activities as shown in Figure 4.35.

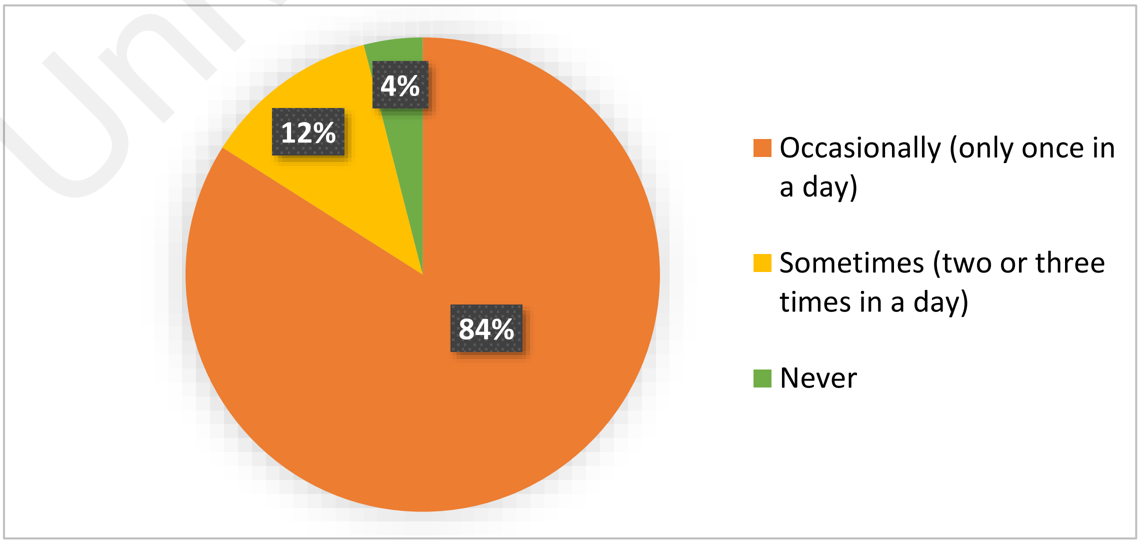

Figure 4.34: Responses on 'Child experiencing shortness of breath during physical activies' from Johan Setia

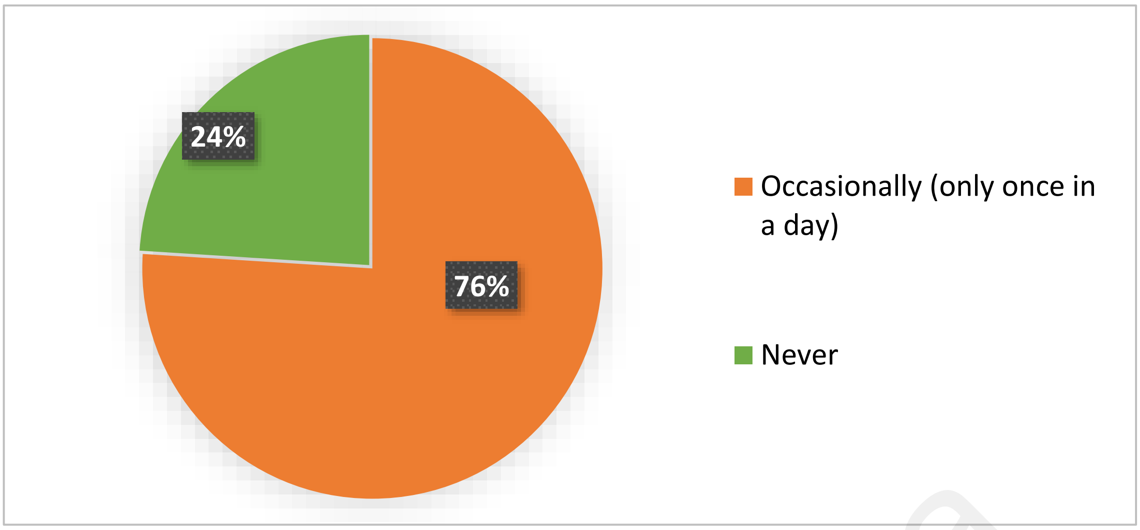

Figure 4.35: Responses on 'Child experiencing shortness of breath during physical activies' from Kuala Selangor

Figure 4.36 shows the responses for the following question on, 'during poor quality does the child vomit when coughing.'Respondents from Johan Setia shows that 55 (73.3%) does occasionally (only once in a day), 16 (21.3%) on sometimes (two or three times in a day) and remaining 4 (5.3%) were never. For children in Kuala Selangor, it was more positive as most of the respondent responded 24 (96%) never and only respondent 1 (4%) responded ocassionally (only once in a day) as shown in Figure 4.37 below.

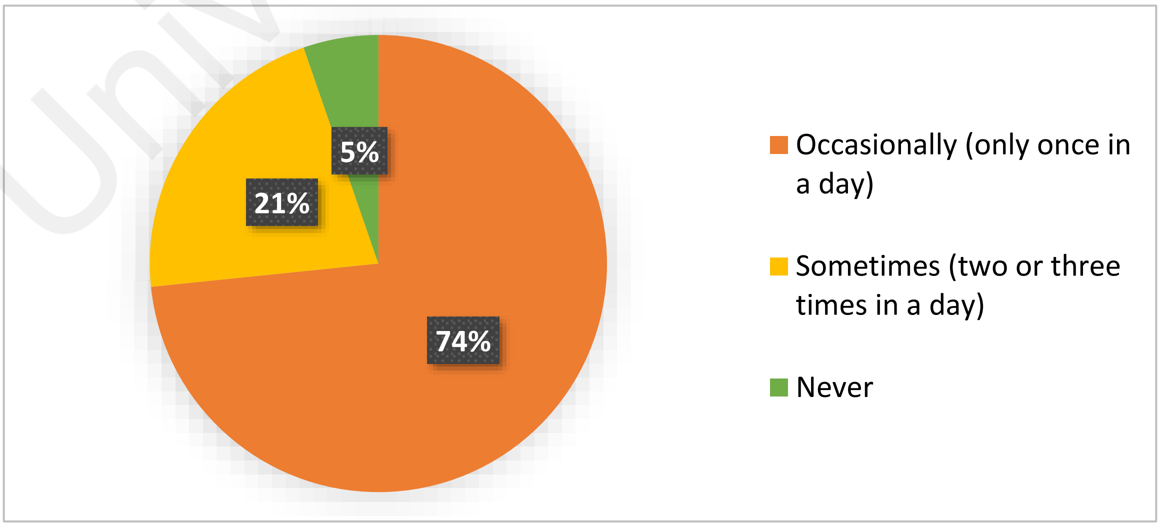

Figure 4.36: Responses on 'Does child vomit when coughing' from Johan Setia

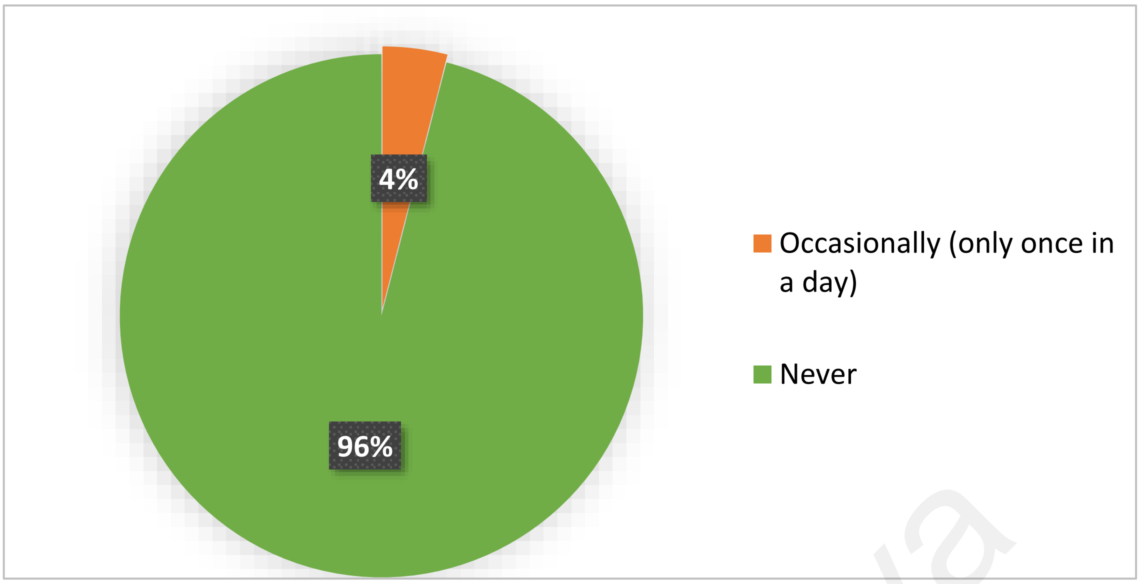

Figure 4.37: Responses on ‘Does child vomit when coughing’ from Kuala Selangor

Figure 4.38 exhibit the reponses based on the following query in the questionnaire, ‘during poor quality does the child cough more when awake then when asleep’. Respondents from Johan Setia responded 64 (85.3%) ‘Yes’ and remaining 11 (14.7%) responded ‘No’. Whereas in Kuala Selangor, all the parents answered 25 (100%) ‘Yes’, as shown in Figure 4.39 below.

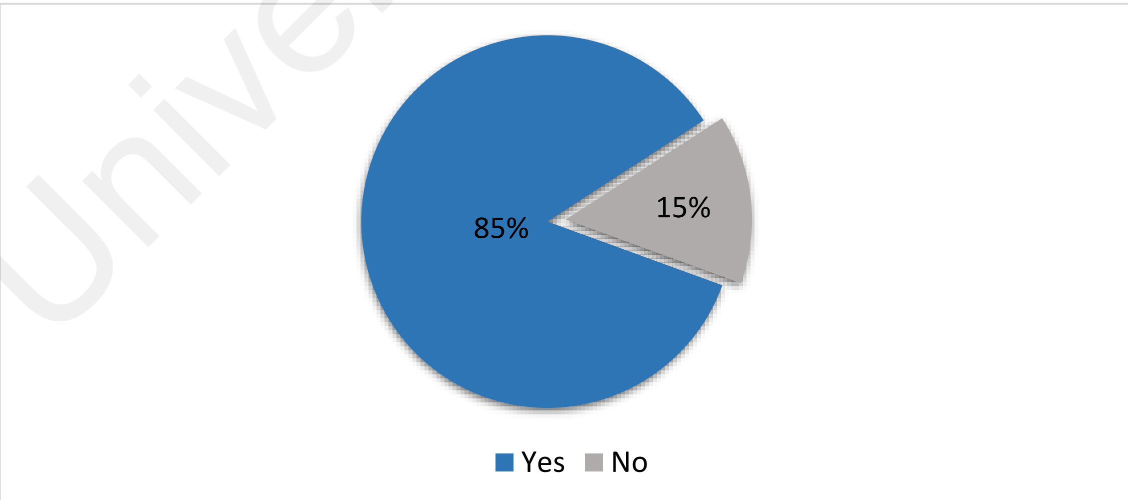

Figure 4.38: Responses on ‘Does child cough more when awake then asleep’ from Johan Setia

Figure 4.39: Responses on 'Does child cough more when awake then asleep' from Kuala Selangor

Figure 4.40 shows the responses on the following question on, 'during poor air quality, does the child cough on first lying down or bending over.'63 (84%) of respondent from Johan Setia responded occasionally (only once in a day), 9 (12%) sometimes (two or three times in a day) and 3 (4%) responded never. For Kuala Selangor 12 (70.8%) of the response were never and 7 (29.2%) were occasionally (only once in a day) as shown in Figure 4.41 below.

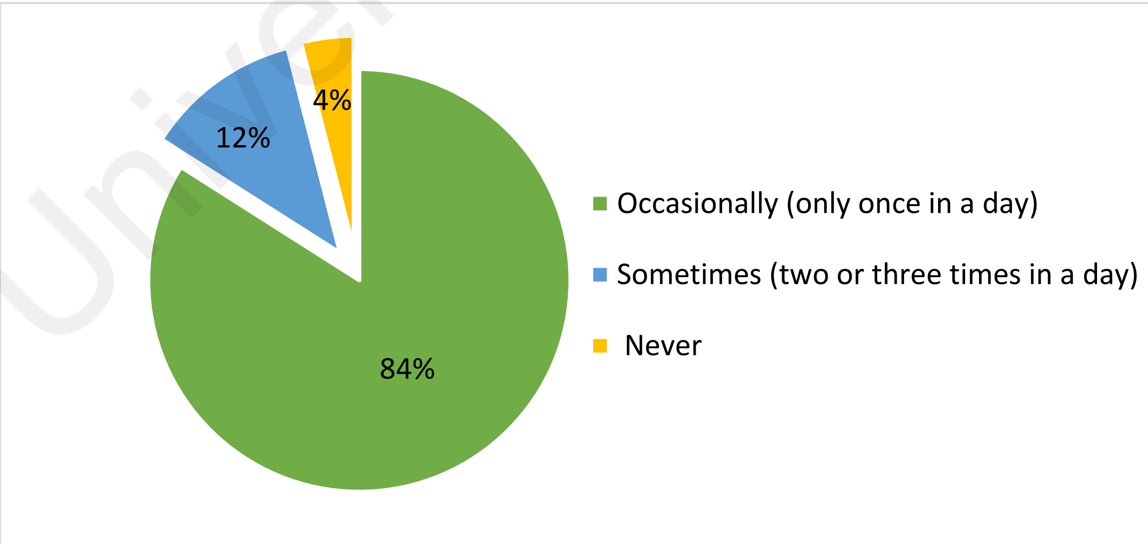

Figure 4.40: Responses on 'Does the child cough on first lying down or bending over' from Johan Setia

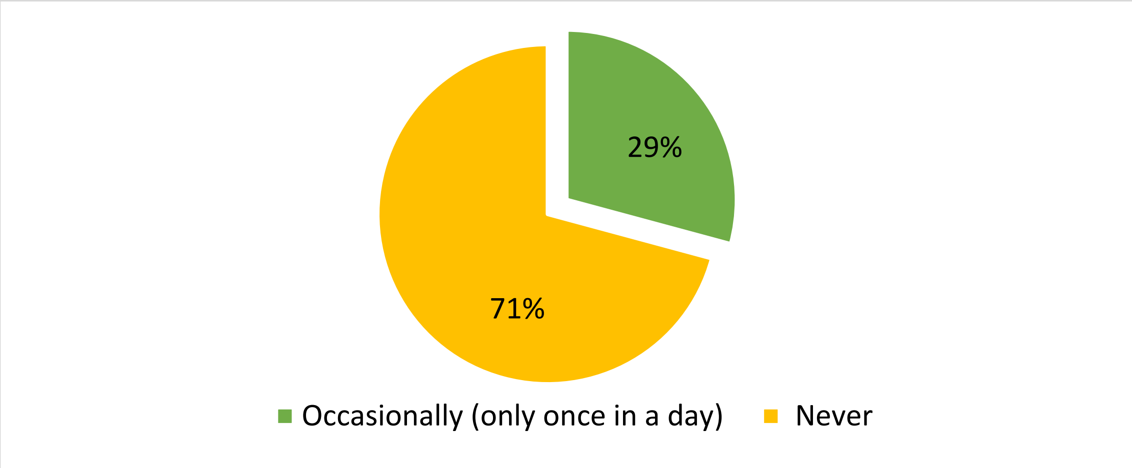

Figure 4.41: Responses on 'Does the child cough on first lying down or bending over' from Kuala Selangor

Figure 4.42 below shows the responses for the following question, 'during poor air quality, does the child sleep soundly during night'. 56 (74.7%) of the responses from Johan Setia were 'Yes' and 19 (25.3%) were 'No'. For Kuala Selangor, all the responses were 25 (100%) 'Yes' for sleping soundly at night as shown in Figure 4.43 below.

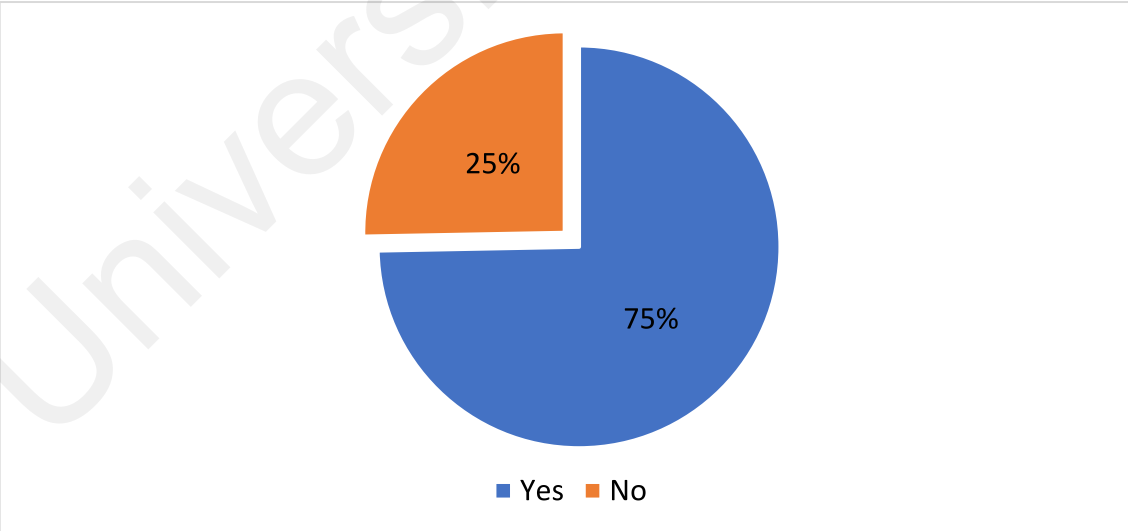

Figure 4.42: Responses on 'Does the child sleep soundly at night during poor air quality' from Johan Setia

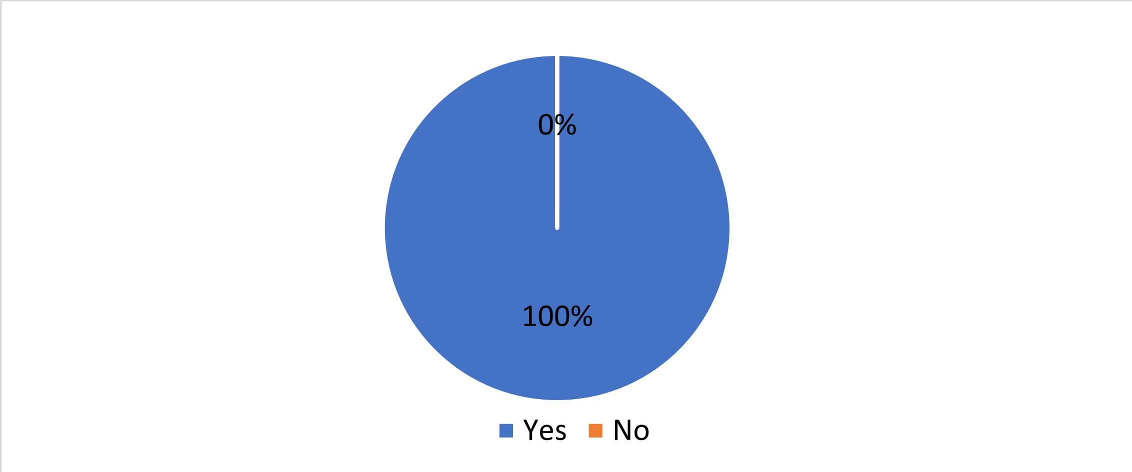

Figure 4.43: Responses on 'Does the child sleep soundly at night during poor air quality' from Kuala Selangor

Figure 4.44 below shows the responses on the following questions from questionnaire, 'during poor air quality, does the child is limited in doing any activites at home for instance while doing house chores or while running around. Responses from Johan Setia showed 34 (45.9%) occasionally (only once in a day), 24 (32.4%) sometimes (two or three times in a day), 13 (17.3%) and 3 (4%) never. Whereas for Kuala Selangor, 18 (72%) of the response were occasionally (only once in a day) and 7 (28%) for never out of breath as shown in Figure 4.45.

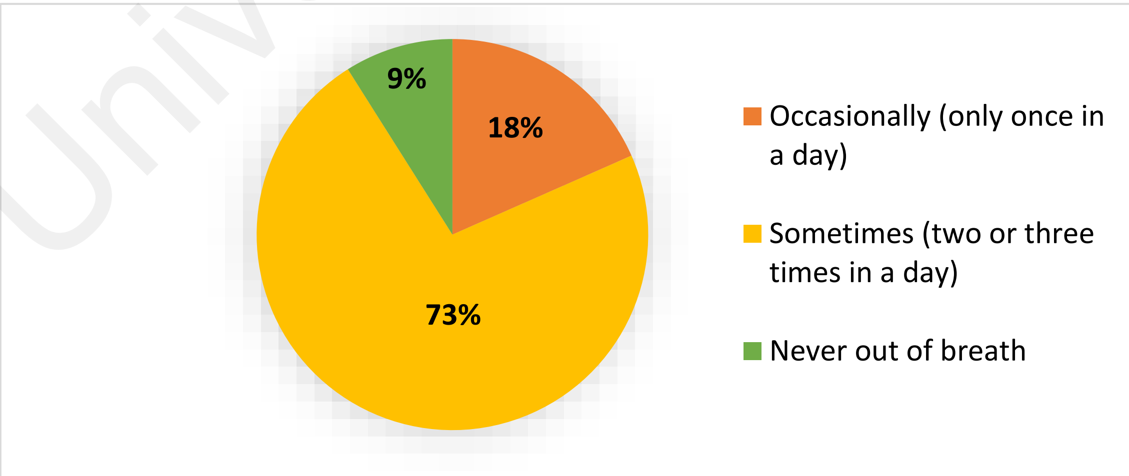

Figure 4.44: Responses on 'Limitation of child doing activities at home' from Johan Setia

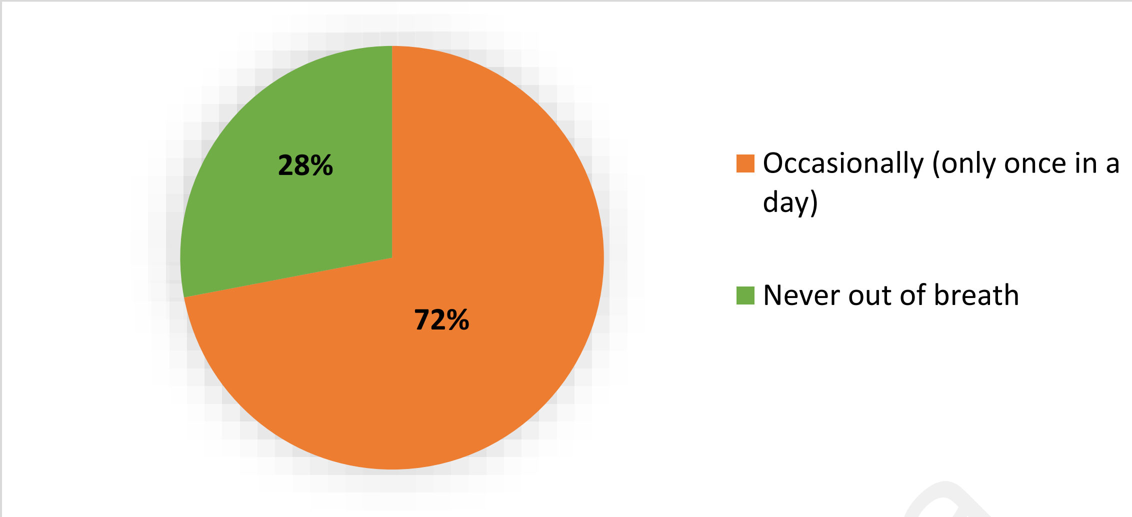

Figure 4.45: Responses on 'Limitation of child doing activities at home' from Kuala Selangor

The last question from Section D, does the child in research area has lots of energy. Responses from Johan Setia was 55 (73.3%) 'No' and 20 (26.7%) were 'Yes' as shown in Figure 4.46 below. Whereas for Kuala Selangor, it was positive as all the parents responded 25 (100%) 'Yes' as shown in Figure 4.47 below.

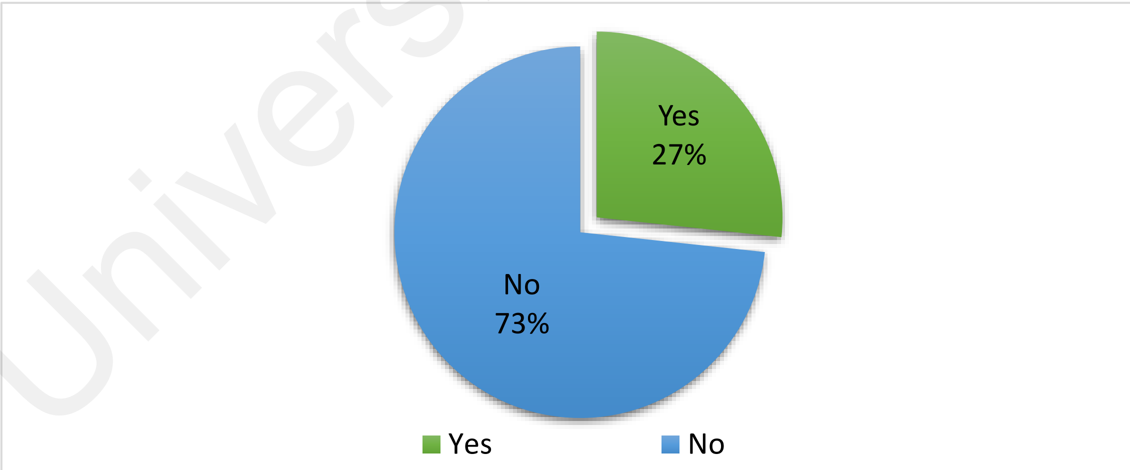

Figure 4.46: Responses on 'Does child has lots of energy overall' in Johan Setia

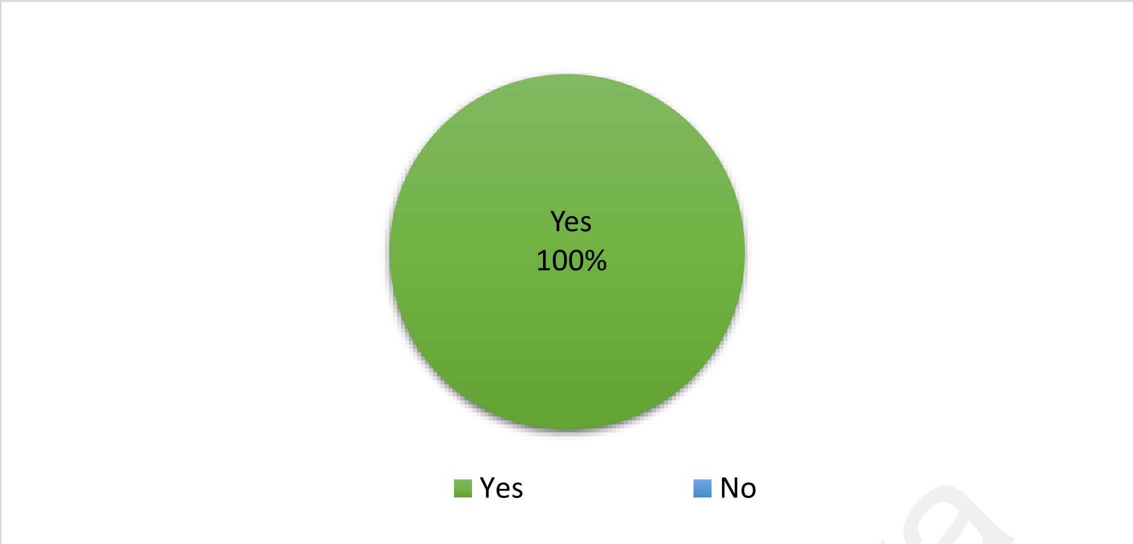

Figure 4.47: Responses on 'Does child has lots of energy overall' in Kuala Selangor

4.2 Data Analysis of API Data

4.2.1 Kuala Selangor

Table 4.1 below reveals the average reading for PM_{10} and $PM_{2.5}$ in ($\mu g/m^3$) for control site in Kuala Selangor. Standard query of yearly reading for the years 2018, 2019 and 2020 were analyzed to study the trend of these pollutant. Table below was tabulated after assaying raw data provided by DOE and attached as APPENDIX G.

Table 4.1: Annual average reading of PM for year 2018, 2019 and 2020

STATION ID	LOCATION	DATE TIME	PM_{10} AVG ($\mu g/m^3$)	$PM_{2.5}$ AVG ($\mu g/m^3$)
CA18B	Kuala Selangor, SELANGOR	2018	25.934	18.938
CA18B	Kuala Selangor, SELANGOR	2019	31.923	24.082
CA18B	Kuala Selangor, SELANGOR	2020	20.743	15.248

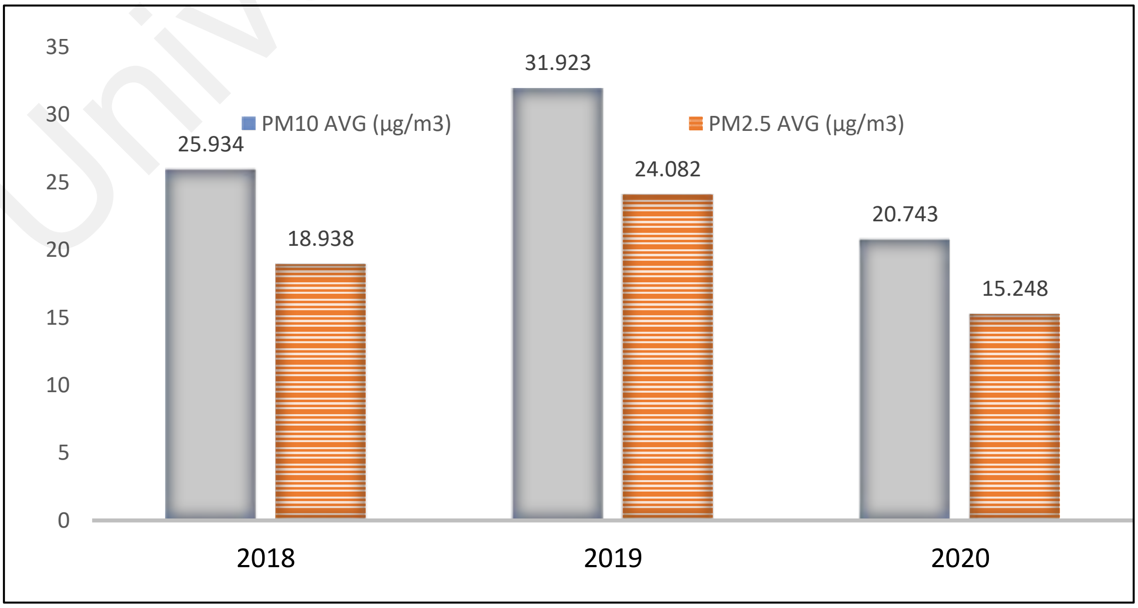

Figure 4.48: PM_{10} and $PM_{2.5}$ average annual concentration for 2018, 2019 and 2020 in Kuala Selangor

4.2.2 Johan Setia

Table 4.2 below shows the reading for PM_{10} and $PM_{2.5}$ in ($\mu g/m^3$) for study site in Johan Setia. Standard query of monthly reading for years 2018, 2019 and 2020 were analyzed to study the trend of these pollutants. The average for 2018 was taken over an eleven-month period since January data is not available. Table below was tabulated after assaying raw data provided by DOE and attached as APPENDIX G.

Table 4.2: Monthly reading of pollutants in Johan Setia for year 2018

STATION ID	LOCATION	YEAR 2018	PM_{10} 1H (µg/m3)	$PM_{2.5}$ 1H (µg/m3)
MCAQM001	Johan Setia	Jan	0	0
MCAQM001	Johan Setia	Feb	33.93	25.07
MCAQM001	Johan Setia	Mar	24.17	16.69
MCAQM001	Johan Setia	Apr	22.65	16.33
MCAQM001	Johan Setia	May	27.83	23.57
MCAQM001	Johan Setia	Jun	27.38	21.55
MCAQM001	Johan Setia	Jul	34.14	24.38
MCAQM001	Johan Setia	Aug	59.15	43.592
MCAQM001	Johan Setia	Sep	41.90	32.971
MCAQM001	Johan Setia	Oct	28.79	24.467
MCAQM001	Johan Setia	Nov	24.94	20.610
MCAQM001	Johan Setia	Dec	25.77	21.951
Average annual reading			**31.88**	**24.65**

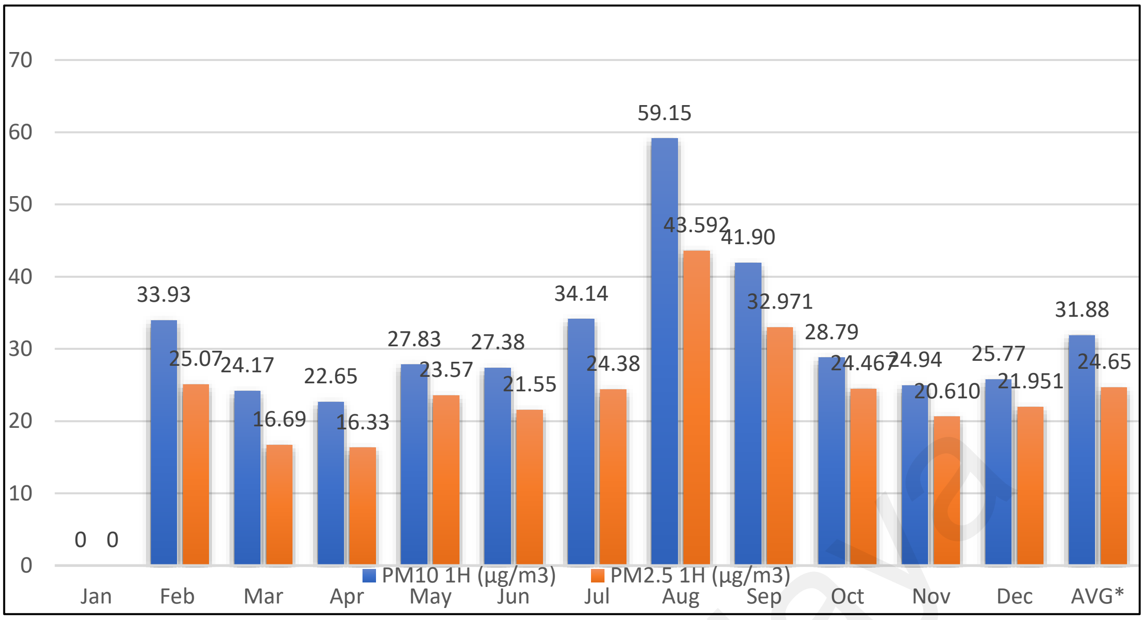

Figure 4.49: PM monthly reading for year 2018 in Johan Setia

Table 4.3 below shows the reading for PM_{10} and $PM_{2.5}$ in ($\mu g/m^3$) for study site in Johan Setia. Standard query of monthly reading for year 2019 were analyzed to study the trend of these pollutant. The average for the year 2019 was taken over a twelve-month period.

Table 4.3: Monthly reading of pollutants in Johan Setia for year 2019

STATION ID	LOCATION	YEAR 2019	PM_{10} 1H ($\mu g/m^3$)	$PM_{2.5}$ 1H ($\mu g/m^3$)
MCAQM001	Johan Setia	Jan	31.87	30.06
MCAQM001	Johan Setia	Feb	52.15	39.84
MCAQM001	Johan Setia	Mar	59.65	45.56
MCAQM001	Johan Setia	Apr	48.49	34.24
MCAQM001	Johan Setia	May	38.59	26.87
MCAQM001	Johan Setia	Jun	26.50	18.82
MCAQM001	Johan Setia	Jul	45.57	33.00
MCAQM001	Johan Setia	Aug	78.09	33.05
MCAQM001	Johan Setia	Sep	126.63	109.39
MCAQM001	Johan Setia	Oct	37.49	28.96
MCAQM001	Johan Setia	Nov	42.53	29.96
MCAQM001	Johan Setia	Dec	36.67	25.68
Average annual reading			**52.02**	**37.95**

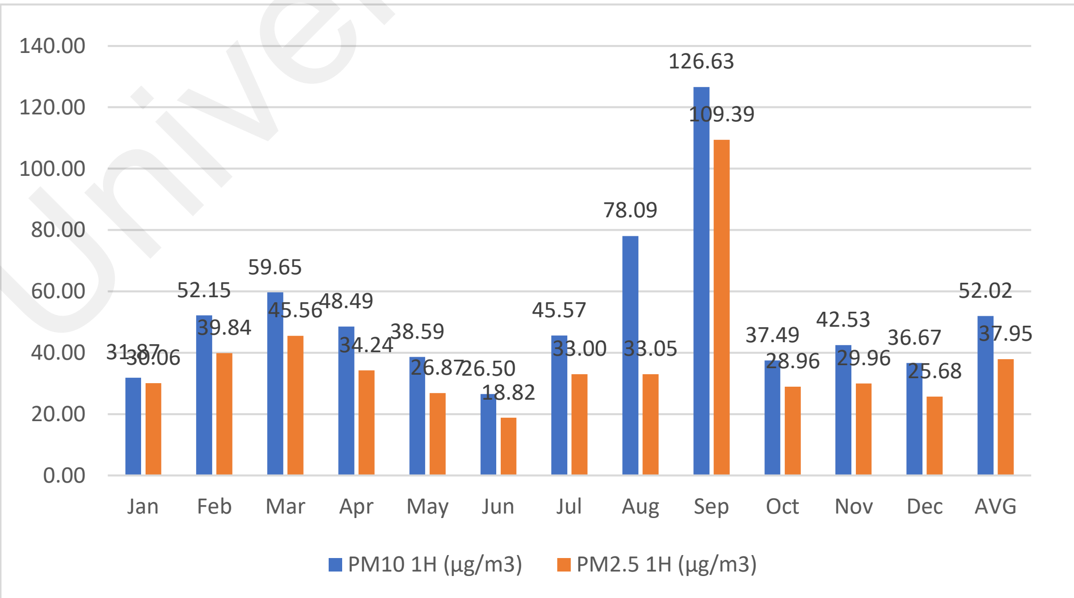

Figure 4.50: PM monthly reading for year 2019 in Johan Setia

Table 4.4 below shows the reading for PM_{10} and $PM_{2.5}$ in (µg/m^3) for study site in Johan Setia. Standard query of monthly reading for year 2020 were analyzed to study the trend of these pollutant. The average for the year 2020 was taken over a twelve-month period.

Table 4.4: Monthly reading of pollutants in Johan Setia for year 2020

STATION ID	LOCATION	YEAR 2020	PM_{10} 1H (µg/m^3)	$PM_{2.5}$ 1H (µg/m^3)
MCAQM001	Johan Setia	Jan	38.32	27.59
MCAQM001	Johan Setia	Feb	42.06	28.00
MCAQM001	Johan Setia	Mar	47.31	36.43
MCAQM001	Johan Setia	Apr	29.28	22.45
MCAQM001	Johan Setia	May	37.34	28.47
MCAQM001	Johan Setia	Jun	40.93	29.32
MCAQM001	Johan Setia	Jul	32.86	22.69
MCAQM001	Johan Setia	Aug	42.03	33.84
MCAQM001	Johan Setia	Sep	26.50	20.98
MCAQM001	Johan Setia	Oct	32.76	26.72
MCAQM001	Johan Setia	Nov	21.99	19.38
MCAQM001	Johan Setia	Dec	34.31	24.86
Average annual reading			**35.47**	**26.73**

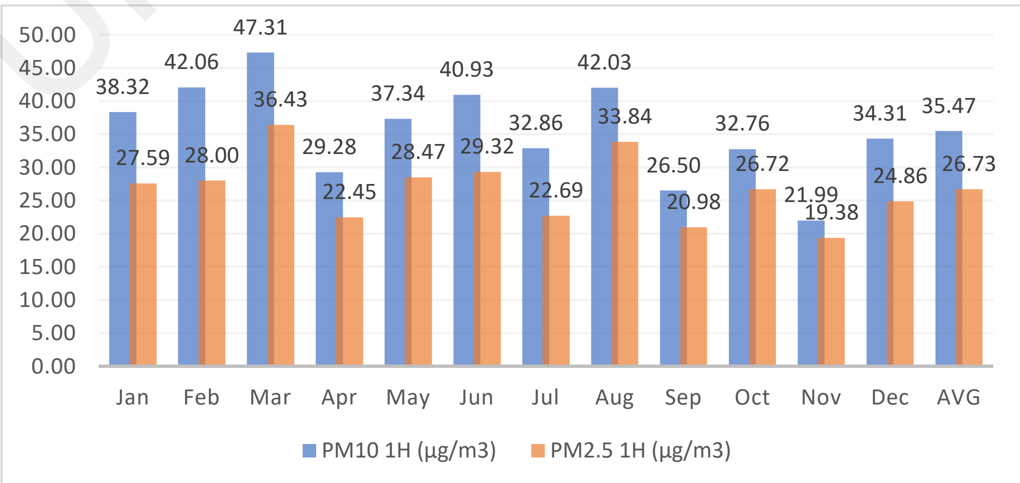

Figure 4.51: PM monthly reading for year 2020 in Johan Setia

Table 4.5: Average annual reading for all pollutants in Johan Setia for year 2018, 2019, 2020

Location	Year	PM_{10} 1H (µg/m^3)	$PM_{2.5}$ 1H (µg/m^3)	SO_2 1H (ppm)	NO_2 1H (ppm)	O_3 1H (ppm)	CO 1H (ppm)
Johan Setia	2018	31.88	24.65	36.0909	54.0000	0.0180	4.6694
Johan Setia	2019	52.02	37.95	38.0120	56.0000	0.0979	4.0303
Johan Setia	2020	35.47	26.73	27.0151	36.0000	0.0114	4.2380

Table 4.5 above shows the overall average reading for PM_{10} and $PM_{2.5}$ in (µg/m^3), SO_2 1H (ppm), NO_2 1H (ppm), O_3 1H (ppm) and CO 1H (ppm) for study site in Johan Setia. Standard query of annual reading for years 2018, 2019 and 2020 were analyzed to study the trend of these pollutants.

4.2.3 Statistical Analysis of API Data

Analysis below shows there was a statistically consequential dissimilarity connecting the means of different groups of pollutants according to the hourly API reading demonstrated by *one-way* ANOVA where the *f*-ratio value is 4.03506 and *p*-value is .014725 which is less than .05 alpha level and the outcome is significant at $p < .05$. However, the ANOVA does not specifically show which mean is different from another, therefore to determine that a multiple comparisons test is needed.

Descriptive

	Mean	Std. Deviation	Mean Square	F	Sig.
PM_{10}	23.847	23.0797	119.37	F= 4.03506	p < .05
$PM_{2.5}$	17.866	17.0759	89.33		
SO_2	0.0009	0.0009	0.0046		
NO_2	0.0078	0.0078	0.0392		
O_3	0.5076	0.4806	2.5379		
CO	0.0009	0.0009	0.0046		
Total	8.451	15.7579	211.2817		

ANOVA

	Sum of Squares	df	Mean Square	
Between groups	2661.4998	4	665.375	F= 4.03506
Within groups	3297.9686	20	164.8984	
Total	5959.4685	24		

4.2.4 Independent *t*-test

Analysis of variance revealed there is no equal variance across the API data from Johan Setia and Kuala Selangor, therefore Levene test was conducted to substantiate the assumption. Independent *t*-test was aimed on data from both sites with a 95% confidence interval for the mean difference. Based on the analysis, it was found that the both PM reading in Johan Setia and Kuala Selangor has different *t*-values from each other and variances of PM for both sites are not equal and differences proclaimed between the control and study site.

Group Statistics					
	Location	N	Mean	Std. Deviation	Std. Error Mean
PM_{10}	KS	36	26.21	11.462	1.910
	JS	36	38.90	20.077	3.346

Independent Samples test								
Levene's Test for Equality of Variance				**t-test for Equality of Means**				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Standard Error Difference
PM_{10}	Equal variance assumed	2.79	0.09	-3.29	70	0.002	-12.69	3.85
	Equal variance not assumed			-3.29	55.62	0.002	-12.69	3.85

95% Confidence Interval of the Difference	
Lower	Upper
-20.38	-5.00
-20.41	-4.97

Group Statistics					
	Location	N	Mean	Std. Deviation	Std. Error Mean
$PM_{2.5}$	KS	36	19.44	9.75	1.63
	JS	36	29.09	16.06	2.67

Independent Samples test								
Levene's Test for Equality of Variance				**t-test for Equality of Means**				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Standard Error Difference
$PM_{2.5}$	Equal variance assumed	1.00	0.32	-3.08	70	0.003	-9.65	3.13
	Equal variance not assumed			-3.08	57.71	0.003	-9.65	3.13

95% Confidence Interval of the Difference	
Lower	Upper
-15.87	-3.41
-15.92	-3.39

CHAPTER 5: DISCUSSION

5.1 Introduction

The present stage concludes the outcome of the research and discussion over it. It is fractionated into three segments. The initial segment includes determination of relationship between current API and preschool children's respiratory health whereas second part is consisting of determination on the level of awareness on the current air quality based on API in Johan Setia. Lastly, determination of pollutants trend in the air by studying the API of year 2018-2023.

5.2 Determination of relationship between current API and preschool children's respiratory health

The average annual concentration of particulate matter for three consecutive years from year 2018 until 2020 showed that the level of PM has been steadily increasing as the average value of PM_{10} were only 31.88 µg/m^3 in 2018 and increased to 52.02 µg/m^3 in 2019 and $PM_{2.5}$ annual reading rose from 24.65 µg/m^3 to 37.95 µg/m^3, respectively. Exposure to PM concentration that is surpassing the World Health Organisation Air Quality recommendation which is supposed to be only 40 µg/m^3 for PM_{10} and 15 µg/m^3 for $PM_{2.5}$ has surpassed the limit value and turn significantly hazardous to growing children as it has larger impacts on their life expectancy. This was supported with the findings from the pre-schooler respiratory health symptoms revealed by the parents in the questionnaire. In Johan Setia almost half of the pre-schoolers shown symptoms such as coughing (88%), shortness of breath (84%), vomiting (85%), limitation in physical activities (45.3%), less energetic (73.3%). In addition, most of the respondent are permanent residence in Johan Setia as 77.3% of respondent have been living in Johan Setia for more than 10 years duration and 18.7% has been residing for more than 5 years, this explains the respiratory symptoms shown by the children in Johan Setia due to prolong and continuous exposure of PM in ambient air on children whilst being outdoor carrying out their daily activities such as playing. In addition, 80% of the population reside in non-rural area are unveil to air pollutants level nominally exceeded WHO guideline limitation and that is merely 9 out of 10 people draw breath carrying high air contaminant (Ibrahim et al., 2021). Most of the children in Johan Setia, are aged between 4, 5 and 6 years old, where 38.7% children are about 6 years old, 33.3% of children are 5 years old and remaining 28% are 4 years old. Children at this age are still developing their lung function unlike fully grown adult lung and more susceptible to risk from air pollution as they are more active and breathe in great deal amount of air into their lung. According to Garcia et al. (2021), research conveyed that long term $PM_{2.5}$ exposure is directly correlated with lower pulmonary function and slower lung function development in children. Decrease in growth of lung function will lead to escalation in risk of developing COPD later in life as young lungs are different to matured lungs and lung function peaks only by the age of 20-25 years. In comparison with Kuala Selangor, the average age of children in control site are similar to children in Johan Setia, where 56% of children are 6 years old, 20% are 5 years old and 28% are 4 years old and almost 60% of the respondents have been residing in Kuala Selangor for more than 10 years and 36% more than 5 years. Children in Kuala Selangor showed very minimal respiratory health symptoms compare to children in Johan Setia. About 64% parents responded 'Never' on how frequent their child cough while or soon after eating, 96% responded 'Never' to child vomiting when coughing and 100% parents addressed children sleep soundly during night in Kuala Selangor. The average yearly mean concentration of PM in Kuala Selangor was within annual standard range for three consecutive years, 2018-2020. The ambient air in Kuala Selangor is perceived to be cleaner and healthier than ambient air in Johan Setia thus children in Kuala Selangor are less likely susceptible to respiratory problems. However, the children in Johan Setia and Kuala Selangor are mostly not asthmatic since born but there are high chances of asthma occurrence in children in Johan Setia if they are continuously exposed to compromised ambient air early in life and higher chances of developing asthma in later age compared to their peers in Kuala Selangor. Growing evidence from studies reveals that asthma can develop at any age and mostly develops the first symptoms in childhood (Gehring et al., 2020). During personal communication with Mrs Rahimah, a general clinical staff from government health clinic in Kampung Kebun in Johan Setia, set forth that overall admission rate for children in the past compared to 2018, 2019, 2020 and 2021 has been steadily snowballing as many cases were referred to hospital admissions or emergency room visit. Common symptoms shown by the children were mostly asthma, whooping cough and fever. These finding were supported as shown on graph below as Figure 5.1 stipulating the overall trend of concentration for both PM in Johan Setia are within moderate to unhealthy level and its influence on API index.

According to Ciabattini et al. (2021), the coalition linking exposure toward $PM_{2.5}$ or PM_{10} and threat to lung cancer in children justifiably soaring than approximated in previous studies. Death caused by poor air quality are as following, coronary heart disease (40%), apoplexy (40%), COPD (11%) and acute lower respiratory infections in children (3%) and reveals the majority vast of deaths are from cardiovascular disease with higher daily number of hospitalizations (Stafoggia et al. 2022). Another study found that exposure of PM_{10} and $PM_{2.5}$ is certainly correlated with occurrence of hypersensitive condition like asthma along with allergic rhinitis in children as they are more liable and prone to air pollution exposure in comparison to grown-ups (Li et al. 2022). Neck and neck, even short-term exposure of PM proven to be detrimental as daily concentration of PM were directly associated with paediatric asthma- related hospital visits (Islam et al., 2021). PM able to penetrate intensely to the inside of the lungs and increase the extremity of bronchial asthma in children, exacerbating bronchitis and COPD as respirational system is usually the primary border of passage into the human anatomy and responsible for 6.4 million death every year globally (Tiotiu et al, 2020).

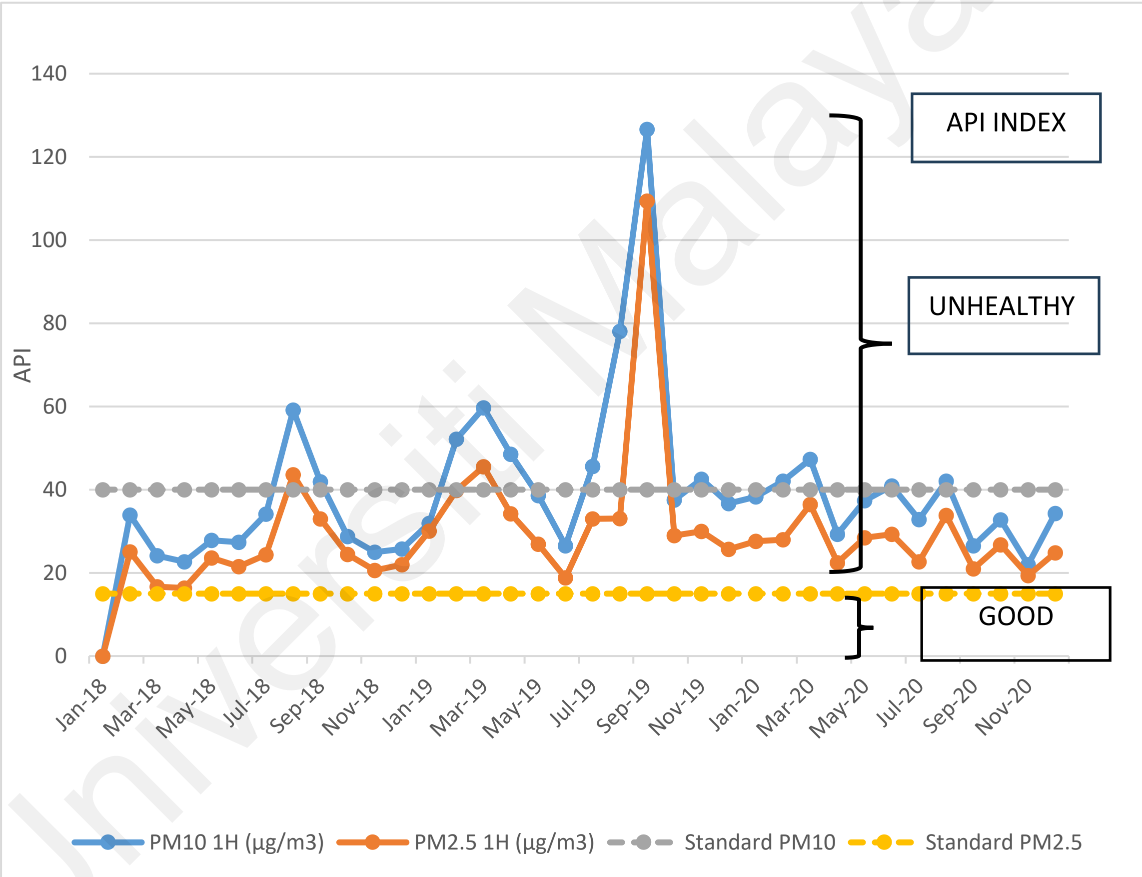

Figure 5.1: API Status and PM reading in Johan Setia

5.3 Determination on the level of awareness on the current air quality based on API in Johan Setia

To study the level of awareness in parents/ guardian KAP section were included in the questionnaire, generality of the participants was informed of their ambient air along with its impact. About 94.7% of respondents in Johan Setia stated that they are slightly affected (without needing medical attention) during poor air quality in their neighbourhood, 4% is affected and in need of outpatient treatment unlike in Kuala Selangor where 92% of the respondents were not affected with the air pollution in their neighbourhood and only 8% were slightly affected, (without needing medical attention). In 2018, the PM average annual mean concentration was higher than the annual standard limit and exceeding standard limit value set by authorities in their neighbourhood thus explains the acute effects on the surpass of air quality utmost values in non-rural area faced by the public as sequel especially to sensitive groups like children. In light to further substantiate, question on current ambient status was asked to the respondents, interestingly, over 52% of respondents were satisfied and rated their current ambient air quality as slightly better and 40% said about the same and 6.7% slightly worse and about 90.7% of the respondent's residence and their children's preschool are within 5km radius. Overall, more than 60% of respondents in Johan Setia were aware of their ambient air quality and their responses suggest that air quality awareness is high respectively to respondents in Kuala Selangor and not only in areas with increasing number of days of poor air quality like in Johan Setia. The responses on KAP section from the survey implicit the responders in Johan Setia and Kuala Selangor were informed of and alert of their ambient air. According to Hou et al. (2021), environmental health literary is vital to promote understandings and avoidance behaviour in reducing the disastrous out-turn of ambient air pollution vulnerability on human well-being. Review on public perception and awareness on ambient air reveals the direct connection with consequences of environmental threats as the behaviour influences their well-being (Cancila et al. 2019). About 73.3% of respondents in Johan Setia has secondary education and 26.7% tertiary education, which implicit the overall respondents have formal education and education has significant influence on both site respondent's awareness on ambient air quality. The study found that the respondents had significantly higher levels of good knowledge of ambient air quality in their neighbourhood. The responses from survey also signifies about 96% of the respondents in Johan Setia and 92% of respondents from Kuala Selangor has positive attitudes towards environmental protection where the respondents acknowledge individuals who pollute should be penalized if responsible for open burnings and agreed bettering the environment quality is the responsible of each taxpayer. This study also demonstrates positive attitudes towards environmental protection were significantly increasing with good practise among employed and self- employed respondents respectively in Johan Setia and Kuala Selangor. Majority of these groups were full-fledged which conclusively rise protective beliefs and behaviours towards environmental protection and their children's respiratory health. The survey's outcome also consistent with study conducted by Al-Shidi et al. (2021), that participator with tertiary-level education has exalted perceptivity on air pollution and its health effect compared to those with primary level of education. Apart from education background, duration of stay of the respondents or the length of stay in a community is also affecting the awareness level of a respondent as it can be precise based on their observation. This is crucial to inference educational campaigns and policy directions (Odonkor & Mahami, 2020).

5.4 Determination of pollutants trend in the air by studying the API of year 2018- 2023

Only PM were considered as main pollutant in plotting the pollutant trend on account of to its subfix frequently has maximal value in comparison to other pollutants. PM has potential remaining in the ambient air for long period and able to circulate in atmospheric up to weeks, the particulate is also able to transport to distant locations with no anthropogenic emission found in that area (Sentian et al., 2022). PM is also emitted in the atmosphere in prime form from construction sites, open burning and motor vehicles. From the analysis of API data, the reading of $PM_{2.5}$ were gradually increasing from year 2018 (24.65 $\mu g/m^3$) to 2019 (37.95 $\mu g/m^3$) and reduced to 26.73 $\mu g/m^3$ in 2020 as for PM_{10} it was also increasing from 31.88 $\mu g/m^3$ in 2018 to 52.02 $\mu g/m^3$ in 2019 and reduced to 35.47 $\mu g/m^3$ in 2020. The Movement Control Order (MCO) that was administered within Malaysia on 18th March 2020 regarding prevalent control to reduce the movement and minimize daily outdoor activities during Covid-19 outbreak, created a good transition in air quality status (Nadzir et al. 2020). During the MCO stretch it was revealed that reduction in mankind activities could remarkably reduce air pollution along with improvement in human well-being (Othman et al, 2021). This implementation has indirectly improved the air quality from 'Moderate' to 'Good,' However, the air quality trend begins to deteriorate as the restriction order were gradually ease. A forecast of air quality trend was stipulated using the linear regression analysis using existing API data used in the study to convey the future air quality reading of particulate matters for following years (2018-2023). The estimated forecast is shown to be increasing on fixed rate at 34.95 $\mu g/m^3$ by 2023 for $PM_{2.5}$ and 48.50 $\mu g/m^3$ for PM_{10} respectively as shown in Figure 5.2 and 5.3 below. The pollutants reading in future will be as peak as in 2019 due to surge in number of vehicles and operational of manufactories as the restriction are uplifted and business and activities are resumed to operate as usual to ease the economic burden faced during closure of economic sector. Klang, despite being categorize as industrial zone it is still surrounded with residential areas with sensitive groups of being residing including vulnerable children (Li et al. 2022).

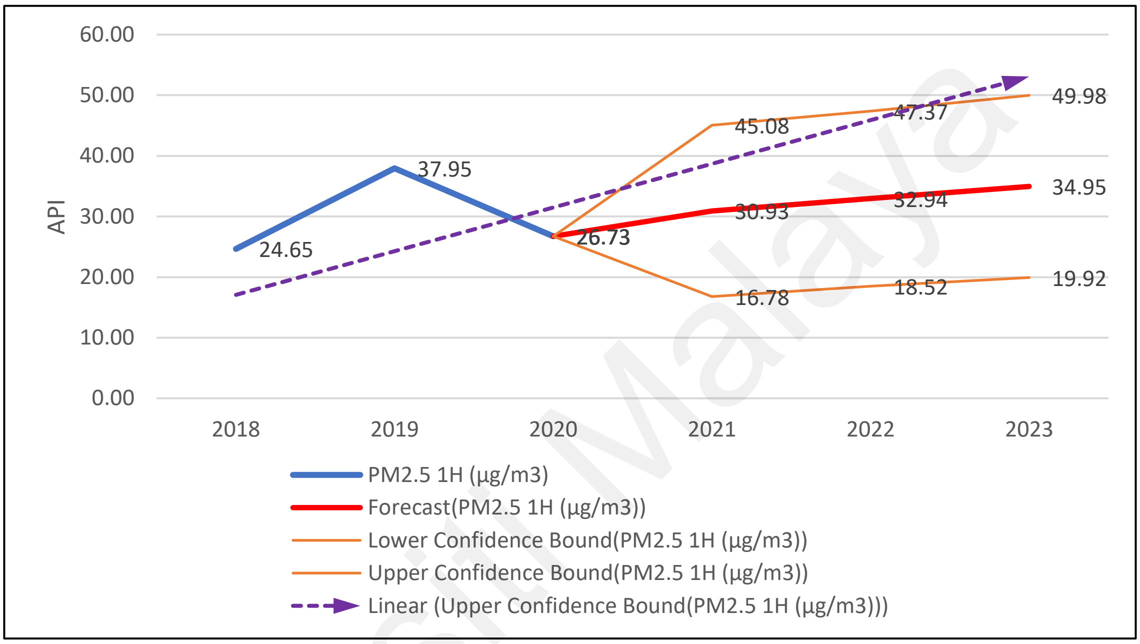

Figure 5.2: Forecast of $PM_{2.5}$ reading for year 2018-2023

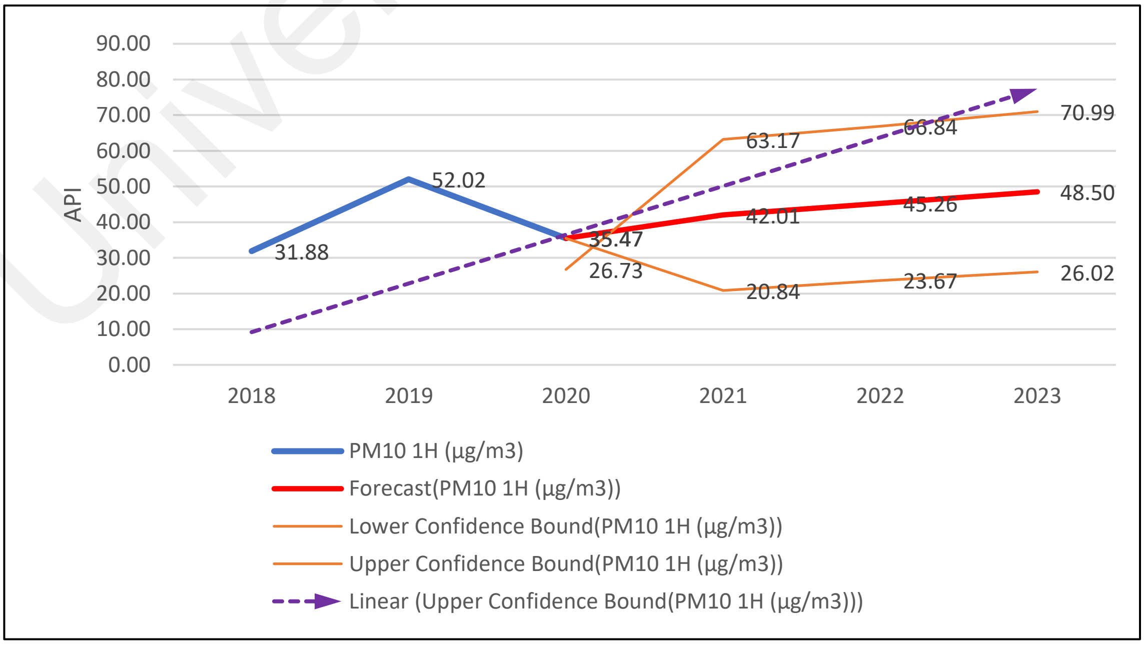

Figure 5.3: Forecast of PM_{10} reading for year 2018-2023

CHAPTER 6: CONCLUSION AND RECOMMENDATION

6.1 Research Conclusion

The aim of this research is directed towards improving the quality of life of pre-schoolers in Johan Setia by having a detailed assessment on the contaminant present in the ambience by studying the pollutant present in the ambient air and its adverse effects to pre-schoolers respiratory health. Poor air quality and its growing effect is now fully acknowledged to be notable to acute health effects such as asthma attacks, COPD and more in children. Preliminary assumption on poor API quality in Johan Setia were further revealed by statistical test by providing associations on observed value and expected value. Further analysis such as multiple comparison needed to analysis possible pairwise means.

The research identified there is relationship between exposure of pollutants and preschool children respiratory health as average annual concentration of PM_{10} and $PM_{2.5}$ has been increasing steadily from 2018 and 2019 and exceeded the standard range limit set by WHO. Either short-term or long-term exposure could deteriorate respirational well-being of a sensitive group. This proven as almost half of the pre-schooler in Johan Setia is showing poor respiratory health indicators such as persistent coughing, vomiting, shortness of breath and limitation in their physical daily activities and its coherent with the growing hospitalization admission rate in children in Johan Setia.

In addition, larger part of the parents is mindful of the ambient air along with its impact to their children as majority of the respondents suggest authority to penalize individuals who pollute and responsible for open burnings and grasp environmental pollutions as continuing issue. As in reduction of PM in 2019 during MCO revealed mitigation of air pollutants can be attained on condition that traffic emanation and industry exhalation are sternly supervised by whistle-stopper.

Finally, the pollutant trend for coming years was stipulated to show the possible pollutant reading for upcoming years in Klang since its entity known as main economic region surrounded with large, scaled industries and port and residential areas. During MCO period its proven exemplary air quality days can be attained even in urban areas if the aggregate of motorized vehicles on the road and industrial exhalation can be governed. The findings could motivate efforts in enhancing air quality in Johan Setia by the authorities because improved air quality means improved lung function for posterity.

6.2 Recommendation for future work

For future work, the following should be considered in moving towards healthier environment for sensitive groups:

1) Right public attitude and behaviour can be achieved by increasing public awareness on public health through education system. Environmental based education system with detailed learning modules right from preschool and primary education aids in moulding the community towards risk, exposure and disease outcome of modern-day ambient air pollutants.
2) Cooperation between whistle-blowers and community into translating realistic and effective policies has the potential to minimize air pollution to avoid it damaging or taking toll on public health.
3) Cooperation between government department with researcher such as improvement in the latest data availability and accessibility between researcher and data providers as it will help researchers to be prepared to deal with challenges of applying for data from various data providers.

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