UNIVERSITI PUTRA MALAYSIA

ASSOCIATION BETWEEN CEMENT DUST EXPOSURE ($PM_{2.5}$) AND RESPIRATORY HEALTH AMONG CEMENT WORKERS IN BAHAU, NEGERI SEMBILAN

NURUL SHAHIRA BINTI AHMAD RAZLAN

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BY

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ABSTRACT

ASSOCIATION BETWEEN CEMENT DUST EXPOSURE (PM2.5) AND RESPIRATORY HEALTH AMONG CEMENT WORKERS IN BAHAU, NEGERI SEMBILAN

NURUL SHAHIRA BINTI AHMAD RAZLAN

Introduction: Cement industry possesses a variety of occupational hazards which can lead to major constituent of airborne dust in the air. High concentration of dust has been associated with decreased in ventilatory lung function, airway inflammation and prevalence of respiratory symptoms. A comparison was done between two groups of workers, which were administrative and manufacturing workers in the cement industry. **Objective:** To determine the exposure level of cement dust and respiratory health implications among cement workers in Bahau, Negeri Sembilan. **Methodology:** A cross sectional study was carried out among 88 administrative workers as the comparative group and 88 manufacturing workers as the exposed group. A set of questionnaires which was adapted from the American Thoracic Society was used to obtain background information as well as respiratory symptoms among the respondents. For the personal exposure level of cement dust ($PM_{2.5}$), a Gilian GilAir-3 Air Sampling Pump was used and placed at the breathing zone area for assessing personal exposure in 8 hours towards cement dust. For lung function performance, a Spirometry test was used. Meanwhile, to assess airway inflammation, a NIOX MINO was used to determine the exhaled nitric oxide in worker's breath. All respondents were chosen based on inclusion criteria, which include male and age of 18 to 55 years old workers. **Results:** The concentration of personal exposure level ($PM_{2.5}$) among manufacturing was high compared to administrative workers which was 10.60 mg/m^3 that exceed the permissible exposure limit 5 mg/m^3 set by Factories and Machinery (Mineral Dust) Regulations 1989. The lung function abnormality was higher among manufacturing workers with OR=3.82 for FVC% and OR=5.16 for FEV_1%. For respiratory symptoms, cough was reported the most among manufacturing with OR=2.40 after it has been adjusted for age and smoking. FENO level were reported, significantly higher among manufacturing workers. There was a significant correlation between personal exposure level ($PM_{2.5}$) and lung function FVC%. Working duration showed a significant correlation of FEV_1/FVC% among all respondents. **Conclusion:** The study found that personal exposure to cement dust ($PM_{2.5}$) may affect lung function and also increased the high level of FENO which indicate an airway inflammation especially among manufacturing workers.

Keywords: Cement industry, personal exposure level ($PM_{2.5}$), lung function, Fractional Exhaled Nitric Oxide (FENO), respiratory symptoms.

ABSTRAK

PERKAITAN DI ANTARA PENDEDAHAN HABUK SIMEN ($PM_{2.5}$) DAN IMPLIKASI KESIHATAN PERNAFASAN DI KALANGAN PEKERJA SIMEN DI BAHAU, NEGERI SEMBILAN.

NURUL SHAHIRA BINTI AHMAD RAZLAN

Pengenalan: Industri simen mempunyai banyak hazad pekerjaan yang boleh mendedahkan kepada masalah habuk bawaan udara. Pendedahan yang tinggi terhadap kepekatan habuk telah dikaitkan dengan penurunan fungsi paru-paru, radang inflimasi dan juga peningkatan terhadap simptom pernafasan. Perbezaan di antara dua kumpulan pekerja telah dilakukan di industri simen iaitu pekerja di antara bahagian pentadbiran yang bertindak sebagai kumpulan perbandingan manakala bahagian pembuatan yang bertindak sebagai kumpulan pendedahan. **Objektif:** Objektif kajian ini adalah bertujuan untuk menentukan tahap pendedahan habuk simen terhadap implikasi masalah pernafasan di kalangan pekerja simen di Bahau, Negeri Sembilan. **Metodologi**: Kajian keratan rentas telah dilakukan di kalangan 88 pekerja pentadbiran iaitu kumpulan perbandingan dan 88 pekerja pembuatan iaitu kumpulan pendedahan. Satu set soal selidik yang diadaptasi daripada 'American Thoracic Society' telah digunakan untuk mengetahui maklumat latar belakang dan juga simptom pernafasan di kalangan responden. Bagi mengukur tahap pendedahan individu terhadap habuk simen ($PM_{2.5}$), 'Gilian GilAir-3 Air Sampling Pump' telah digunakan dan diletakkan di kawasan zon pernafasan pekerja bagi menilai tahap pendedahan individu selama 8 jam terhadap habuk simen. Bagi prestasi fungsi paru-paru, ujian Spirometry telah digunakan. Manakala, untuk menilai radang inflimasi, NIOX MINO telah digunakan untuk mengetahui hembusan nitrik oksida di dalam nafas pekerja. Kesemua responden telah dipilih berdasarkan kriteria tertentu iaitu meliputi lelaki dan pekerja berumur sekitar 18 sehingga 55 tahun. **Keputusan:** Kepekatan pendedahan individu terhadap $PM_{2.5}$ adalah lebih tinggi di kalangan pekerja pembuatan berbanding pekerja pentadbiran iaitu 10.60 mg/m^3 dan telah melebihi tahap limitasi pendedahan yang telah ditetapkan oleh Peraturan Jentera dan Kilang (Habuk Mineral) 1989. Fungsi abnormaliti paru-paru lebih tinggi berbanding pekerja pembuatan dengan nilai OR=3.82 bagi FVC% dan OR=5.16 bagi FEV_1%. Bagi gejala pernafasan,batuk adalah antara yang tertinggi dilaporkan di kalangan pekerja pembuatan dengan OR=2.40 walaupun telah dikawal dengan umur dan status merokok. Tahap FENO juga dilaporkan tinggi di kalangan pekerja pembuatan. Terdapat hubungan diantara tahap pendedahan individu terhadap $PM_{2.5}$ dan fungsi paru-paru (FVC%). Durasi bekerja juga menunjukkan hubungan diantara fungsi paru-paru FEV_1/FVC% diantara semua pekerja. **Konklusi:** Kajian ini mendapati bahawa pendedahan individu terhadap habuk simen ($PM_{2.5}$) akan mengakibatkan rendah fungsi paru-paru dan juga meningkatkan tahap FENO yang mengukur radang inflamasi terutama di kalangan pekerja pembuatan.

Kata kunci: Industri simen, tahap pendedahan inidividu ($PM_{2.5}$), fungsi paru-paru, pecahan hembusan nitrik oksida (FENO), simptom pernafas

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LIST OF ABBREVIATIONS

ATS	American Thoracic Society
ATS-DLD	American Thoracic Society- Division of Lung Disease
DOSH	Department of Safety and Health
FENO	Fractional Exhaled Nitric Oxide
FEV_1	Forced Expiratory Volume in One Second
FEV_1/FVC	Forced Expiratory Ratio
FVC	Forced Vital Capacity
IQR	Inter quartile range
mg/m^3	Milligram per meter cube
OR	Odd ratio
OSHA	Occupational Safety Health Act
ppb	Parts per billion

CHAPTER 1

INTRODUCTION

1.1 Introduction

Rapid development and modernization of today's generations has made the industry to speed up their power in producing more supply of materials. The cement industry is one of the industries that have to increase its production to meet the demands in providing materials to the development of construction industries. According to the International Trade and Industry Minister, Datuk Seri Mustapa Mohamed, cement and concrete are important economic pillars that contribute about 4% of the Malaysia's gross domestic product. There is a report stating that there is a strong growth demand during the last few years and it is expected to increase due to government spending on infrastructure projects (Malaysia Cement Industry Report, 2015). However, such great development has its own toll where a lot of side effect had been made to the health of the environment and also the community.

Cement is a fine and grayish green powder with an aerodynamic diameter ranging from 0.05 to 10 μm (Manjula et al., 2013). Portland cement is the most

commonly used cement and it is mainly used for building material for land-based and offshore installations (Nordby et al., 2011). Cement is a mixture of calcium oxide 62-66%, silicon dioxide 19-22%, aluminium trioxide 4-8 %, ferric oxide 2-5 %, magnesium oxide 1-2%, and an insoluble residue 0-61-2% containing around 0-1% free silica (Pimentel and Menezes, 1978). It involves multistage processes which includes quarrying, crushing, raw milling, blending and production of clinker, milling and lastly packing area (Rachiotis et al., 2012).

The manufacturing process of making cement is divided into two stages. In the first stage, the raw materials which consist of 60% of limestone and 40% of red soil are crushed and ground into the raw mill. The fine particles will then be heated under the high temperature of 1500 ℃-1800 ℃ into the rotary kiln to form a clinker which will then be stored and cooled at cement mill gantry. On the next stage, which is stage 2, the cooled clinker will be mixed with gypsum and other additives and it will ground in the clinker mill to produce cement. The final product will then be transferred into the silos as bulk or packed for packing and transport (Kakooei et al., 2011; Tungu et al., 2012).

Portland cement is one of the lists of minerals that can be found in Factories and Machinery (Mineral Dust) Regulations 1989. A variety of pollutants may exist in Portland cement which can contribute to atmospheric pollution, such as gaseous pollutant and most importantly, particulates. Other pollutants such as heavy metals

(Nickel, Cobalt, Lead, and Chromium) also exist and can affect the community nearby and specifically the workers in the cement industry who are exposed to this pollutant directly.

Particulate matter is a matter that exists in the cement dust. There are three categories of dust, which is inhalable dust, respirable dust and total dust. For inhalable dust, the dust particle is consisting of less than 10 μm meanwhile for respirable dust, the dust particles measure is less than 2 μm and lastly for total dust it includes all airborne particles regardless of the size or composition. Nordby et al. (2011) stated that, inhaled particles can penetrate and deposit in different parts of the human respiratory system which is from nose and mouth to the bronchi and alveoli of the lung. The probability of inhalation is depending on the particle aerodynamic diameter, air movement around the body and also the breathing rate. Particulate that has a diameter of smaller than 10 micrometers can get into the large upper branches just below the throat meanwhile, particles which is smaller than 2.5 micrometers can penetrate deeper into the alveolar portions of the lung (Jang, 2012).

The whole cement manufacturing process has eventually led to a greater health impacts especially from the dust exposure. Pneumoconiosis is considered as an occupational lung disease which is often found in the workplace. The common causes of pneumoconiosis are inhalation of asbestos, silica or coal dust and only workers who exposed to these dusts will develop pneumoconiosis. It develops when

airborne dust, particularly mineral dust is inhaled and the dust particles remained in the lung which eventually will cause inflammation or fibrosis. The inflammation is created due to the lung tissue trying to get rid the dust particles whereby the cell from immune system will fight the dust particles thus created inflammation. If the inflammation is severe enough, breathing will be affected. Dry cough and shortness of breath were the common symptoms of fibrosis.

According to Al-Neaimi et al. (2001), chronic exposure to cement dust has been reported to increase the prevalence of chronic respiratory symptoms and decreased the ventilator capacity. The dust generated from this industry may cause health problem to cement workers either through dermal contact or inhalation. This includes lung impairment, coughing, aggravation of asthma, chronic bronchitis, mucus secretion and all of this due to the inflammation of the respiratory tract, which make people more prone to having infections of the respiratory tract (Ahmad et al., 2013). Symptoms like coughing, shortness of breath, chest pain and wheezing have become the most complained symptoms made by the workers.

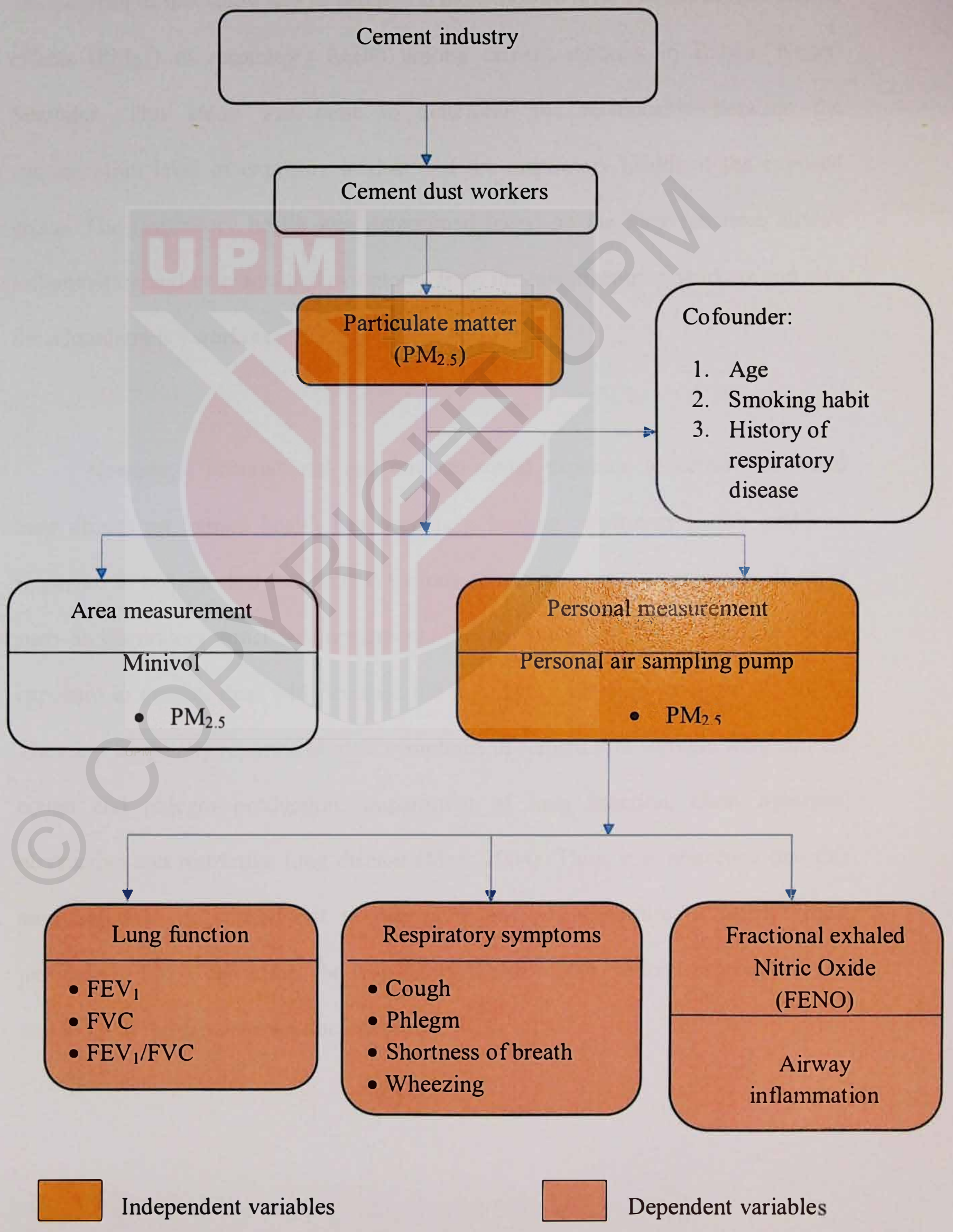
1.2 Problem Statement

Occupational disease is related to exposure to hazards occurs in the workplace. According to statistics from the Department of Occupational Safety and Health Malaysia, occupational lung disease has been the third most common occupational disease experienced by the workers in 2015 which, total up to 126. People who are involved in highly dusty environments are the main concern in terms of their safety and such populations includes workers from cement plants and quarries (Noor et al., 2000). Fell et al. (2010) stated that cement dust particle has created a major constituent of airborne dust in the cement industry.

There were several clinical and epidemiological studies showed that there were higher incidences of respiratory system impairment and prevalence of respiratory symptoms among cement production workers (Oleru, 1984; Poornajaf et al., 2010; Kakooei et al., 2011). Cement dust comprises various types of particulate matter that were more hazardous to health, particularly particulate matter less than 10 microns (PM_{10}) and less than 2.5 ($PM_{2.5}$) (Shoba and Gopal, 2012). Based on statistics from Cement Industries of Malaysia Berhad's (CIMA) Sustainability Report (2011), dust emission from their plant, particularly in Bahau is contributing to a high emission of dust in the environment. This would create a concern to the people nearby especially to the workers who are directly exposed to this pollution.

Based on the study by Noor et al. (2000), the prevalence of cough, chest tightness and phlegm was significantly higher in cement workers. Moreover, according to the previous study by Meo et al. (2013), cement workers who are exposed to duration of greater than 10 years showed a significant reduction of their lung function capacity relative to their matched controls. All previous studies have proven that cement dust exposure can impose a great impact of respiratory illness among worker especially in prolonged exposure. Unfortunately, there is a limited study done and no current research on the exposure of cement dust and the prevalence of respiratory disease and airway inflammation in Malaysia. The previous research done in Malaysia was back in 2000 which were published by Noor et al. in Rawang. Thus, the current status of cement dust exposure among cement workers and their associated respiration health is limited.

1.3 Conceptual Framework



1.4 Study Justification

The purpose of this study was to determine the exposure level of cement dust and its effects ($PM_{2.5}$) to respiratory health among cement workers in Bahau, Negeri Sembilan. This study was done to determine the relationship between the concentration level of exposure to dust and the respiratory health of the exposed group. The respiratory health was determined based on the lung function, airway inflammation and its associated symptoms from the manufacturing workers and also the administrative workers.

Nowadays, occupational and environmental exposure to cement dust and their effects on human health has become a leading respiratory health problem. Exposure to cement dust has caused various acute and chronic respiratory diseases such as respiratory function impairment. Present study has found that long term exposure to cement dust will decrease the pulmonary function (Meo et al., 2013). The most frequently reported clinical symptoms in cement mill workers were chronic cough and phlegm production, impairment of lung function, chest tightness, obstructive and restrictive lung disease (Meo, 2004). Thus, it is important that this study need to be carried out to determine how the exposure of cement dust, particularly $PM_{2.5}$ can affect the respiratory health of the workers especially those that work in the cement manufacturing area.

The significant of the cement dust exposure was able to determine by comparing the workers from manufacturing area and administrative area. Thus difference or gap of getting the risk of respiratory symptoms could be clearly seen between these two groups although it involve in the same study population. Those workers who are at risk of developing a respiratory problem can be detected at an early stage before any sign and symptoms appear. Hence, preventive measure such as medical surveillance or awareness programs in controlling this occupational disease should be done to reduce the level of exposure in workplace and increase productivity of workers. This action is aligned with Factories and Machinery (Mineral Dust) Regulations 1989, which require the employee who exposed with cement dust to undergo a prescribed medical examinations and pulmonary function test including forced vital capacity and forced expiratory volume at one second.

Furthermore, most of the workers work in 8 hour shift or more depending on the required duration. Thus, we could see if there is a possibility that the level of exposure can be prolonged and decrease the lung function if they work for more than 10 years. But most importantly, this study was able to provide an update about the current status of the respiratory health of cement workers in Malaysia that associated with the exposure of cement dust. All data from this research could be used by any relevant management in the cement industry thus able to identifying the suitable control measure to protect the health, safety and welfare of workers in order to reduce the exposure of dust.

1.5 Definition of Variables

1.5.1 Conceptual Definition

1. Cement industry

Cement industry is a production of a dusty operation with a lot of risk exposure to cement particles and mostly the exposure occurs during most of the manufacturing process. Workers in the cement industry are exposed to various health hazards during cement production and handling which include cement dust, high temperature and noise. However, the major occupational hazard in the cement production is cement particles which were emitted into the environment with higher concentration at packing and crusher section (Aminian et al., 2013).

2. Particulate matter ($PM_{2.5}$)

$PM_{2.5}$ or fine particles are particles with aerodynamic diameter less than 2.5 micrometers (μm) (USEPA, 2005). This particle will get into the deepest portions of the lungs (Jang 2012). The sources of this particle were mainly from the gas emitted at power plants, industries and automobiles react in the air (The Conference Board of Canada, 2013). However, long-term exposure to $PM_{2.5}$ is associated with an increased in the long-term risk of cardiopulmonary mortality (WHO, 2013).

3. Personal air sampling measurement

Personal air sampling is a method that was preferred to be used to evaluate the worker exposure to airborne chemicals. The worker wears a sampling device that collects air sample and is placed as close as possible to the breathing zone area. This is where the concentration of the airborne contaminant entering the nostrils and has been defined as the zone in front of the face within 20 to 30 cm diameter from the nostrils. (DOSH, 2002)

4. FEV_1 (Forced expiratory volume)

It is refers as a measurement of maximal volume of air expelled in the first second of forced expiration. FEV_1 is the most frequent used index to observe the airways obstruction, bronchoconstriction or bronchodilation (ATS, 2005).

5. FVC (Force vital capacity)

It is refers to a maximal volume of air exhaled with maximally forced effort from a maximal inspiration, expressed in litres at body temperature and ambient pressure saturated with water vapour (ATS, 2005).

6. Exhaled Nitric Oxide Level (FENO)

A non-invasive method used to measure the concentration of exhaled breath of nitric oxide. It is used to identify the airway inflammation in the lung that provides a

complementary tool to other ways of assessing airways disease including asthma (ATS, 2011).

7. Cough

Cough is a rapid expulsion of air from the lungs which typically clear the lung airways of fluids, mucus, or other material (Medicine.Net, 2016).According to the American Thoracic Society, cough is experienced for at least four days in a week for three consecutive months.

8. Phlegm

Phlegm is a condition occurs for at least four days in a week for at least 3 consecutive months or more during the year (ATS, 2013)

9. Shortness of breath

It is often described as an intense tightening in the chest, air hunger or a feeling of suffocation or known as dyspnea. Function of the heart and lungs is transporting oxygen to the tissues and removing carbon dioxide, thus problem with either of this process will affect the breathing mechanism (Mayo Clinics, 2016).

10. Wheezing

It is a high-pitch whistling sound made when breathing. According to the American Thoracic Society, it occurs during exhalation and can sometimes occurs during inhalation due to the obstruction of throat, pharynx, trachea or bronchi (ATS, 2013)

1.5.2 Operational Definition

1. Particulate matter ($PM_{2.5}$)

$PM_{2.5}$ concentrations are measured by using a personal monitoring instrument attached at the breathing zone of the workers. For the air monitoring concentration, Dustrak Air Monitor is used and the unit of the concentration measured is in mg/m^3 (DOSH, 2002).

2. Personal air sampling measurement

Personal air sampling is measured by using personal pump and the concentration is equal to the mass of the contaminant collected divided by the volume of air passed through the collection device or mg/m^3 (DOSH, 2002).

3. FEV_1 % (Forced expiratory volume percentage)

The measurement of maximal volume of air expelled in the first second of forced expiration is by using spirometry (Chestograph HI-105). The value of FEV_1 from the spirometer was divided with the predicted FEV_1 of the respondent (ATS, 2014).

4. FVC % (Forced vital capacity percentage)

The measurement of maximal volume of air exhaled with maximally forced is by using spirometry (Chestograph HI-105). The value of FVC from the spirometer was divided with the predicted FVC of the respondent (ATS, 2014).

5. Fractional exhaled nitric oxide (FENO)

The measurement of the concentration of exhaled breath of nitric oxide is measured by using a NIOX-MINO device which is a non-invasive method and easy to perform with an accurate reading. The unit of the concentration measured is in ppb (parts per billion) (ATS, 2011).

6. Cough, phlegm, shortness of breath, wheezing

All these respiratory symptoms are identified through questionnaires based on the American Thoracic Society (ATS-DLD, 2013).

1.6 Objective of Study

1.6.1 General Objective

To determine the **exposure level of cement dust and respiratory health implications** among cement **workers** in Bahau, Negeri Sembilan.

1.6.2 Specific Objective

1. To identify the **sociodemographic background of occupational exposure** of the respondents.
2. To compare the **respiratory symptoms** reported by the administrative and manufacturing workers.
3. To compare the **concentration of personal exposure level** of $PM_{2.5}$, **lung function** and **Fractional Exhaled Nitric Oxide (FENO)** between **administrative and manufacturing** workers in the cement industry.
4. To determine the association between **personal exposure levels of $PM_{2.5}$** and **the lung function of cement workers.**
5. To determine the association between **working duration and lung function of the cement workers.**

1.7 Hypothesis

1. The **exposure level of $PM_{2.5}$** between **manufacturing workers is significantly higher** than the administrative group in the cement industry.
2. The **respiratory symptoms** reported by the **manufacturing workers are significantly higher** compared to administrative group.
3. The **lung function of manufacturing workers is significantly lower** than administrative group in the cement industry.
4. The **FENO concentrations significantly higher among manufacturing workers** compared to the administrative group in cement plant.
5. There is a **significant association between personal exposures level of $PM_{2.5}$ and lung function** among cement workers.
6. There is a **significant association between working duration and lung function** among cement workers.

CHAPTER 2

LITERATURE REVIEW

2.1 Cement industry in Malaysia

Cement industry is one of the industry that is used to provide building materials which is cement for the construction of land based buildings or off shore installation. However, cement industry possesses a variety of occupational hazards which can lead to the major constituent of airborne dust particles in the air. According to Mehraj and Bhat (2007), cement industry is responsible for contributing various pollutants in the air such as gaseous pollutant and also particulate matter. Such pollutant for example heavy metals, inhalable particles (PM_{10} and $PM_{2.5}$) can affect anyone that live or working at the cement industry.

In Malaysia, cement industry is an important economic pillar to sustain economic development in Malaysia. However, such development has its own effect. According to a local study, it was found that Portland cement dust in cement industry in Rawang releases high concentration of dust into the surrounding area. The high

concentration of dust exposure has been associated with decreased in ventilatory lung function of workers and thus responsible for the prevalence of respiratory symptoms among workers which include cough and phlegm (Noor et al., 2000). One of the examples from international study also found that there is a significant relationship between cement dust exposures and minor degree of restrictive ventilator impairments (Poornajaf et al., 2010).

Worker's exposures were due to the processes that involved in the cement production process itself. The processes involve include quarrying, crushing, clinker production, milling process, transport and storage. Each of the process has its own hazard. According to Zeleke et al. (2010), workers in crusher and packing department were the most highly exposed for dust exposure. Activities during crushing process involved crushing of raw materials into smaller particles. Thus it creates a high concentration of dust in the air which goes the same with packing process.

2.2 Releasing of particulate matter ($PM_{2.5}$) from cement industry

Particulate matter is a complex, multi-pollutant mixture of solid and liquid particles suspended in gas. The physical properties of particulate matter include mass, surface area and number or size or distribution of particles as well as its physical state (Ristovski et al., 2011). Particulate matter is usually generated through variety of

manmade and natural sources. Natural sources include pollen, spores, bacteria and suspended materials. Meanwhile, manmade sources include industrial emission and combustion of by-products from motor vehicle, power plant and any other industries (Jang, 2012). According to Kalafatoglu et al. (2001), the potential source of particulate matter emission in cement plant is from the raw material handling, grinding, blending and delivery, clinker storage, cement storage and bulk loading and packaging of the final product.

$PM_{2.5}$ is a particle with aerodynamics diameter less than 2.5 micrometers (μm) (USEPA, 2005) which when inhaled; it will penetrate deeper into the alveolus of the lung (Jang, 2012). According to the study carried out by Kakooei et al. (2012), concentration of respirable dust (11.96 mg/m^3) was reported to be released from the cement industry. The data has actually exceeded the recommended value made by Occupational Safety Health Act (OSHA) where the Permissible Exposure Limit (PEL) is 5 mg/ m^3. The particulate matter also was present high in the environment of cement factory. Moreover, the level of cumulative cement dust exposure which was estimated at 11.41-423.98 mg/m^3 per year has contributed a high risk of developing chronic respiratory symptoms when working for many years (Poornajaf et al., 2010). This finding was further supported by Zeleke et al. (2010) which stated that occupational exposure to respirable dust was greatly associated to acute and chronic health effects of respiratory system and lung function performance. Among

the most common health conditions caused by respirable dust exposure are Chronic Obstructive Pulmonary Disease (COPD), impaired lung functions and ischemic heart disease (da Silva et al., 2012).

2.3 Assessment of lung function test

Lung function test is done to measure how well the lung function. The instrument used to measure the effectiveness of lung function is the spirometry. It is a basic test which measures the air that is expired and inspired which then detects the presence or absences of lung disease, lung impairment or monitors the effect of occupational or environmental exposure. It also determines the effect of medicine (Moore, 2012).

Abnormalities in lung function can be divided into two categories which are obstructive and restrictive. Obstructive occurs when the amount of air cannot be exhaled out from the lungs due to some obstruction of airflow. When a patient has an obstructive disease, the air volume in the lung will be expelled more slowly and this will indicate a smaller FVC. Obstructive maybe occur due to the smooth muscle contraction, inflammation, mucus plugging or airway collapse in emphysema. Meanwhile restrictive disease is where the chest muscle cannot expand enough thus loss in lung volume (Moore, 2012).

According to Noor et al. (2000), exposure to cement dust might possibly lower the lung function of the workers. This is further evidenced by prominent lower FVC, FEV_1, FEV_1% observed in the high exposure group compared to the medium and low exposure group. Furthermore, a study from Neghab and Choobineh (2007) also indicated that there was a general tendency for some parameters of pulmonary function to be lower due to chronic exposure to cement dust.

Oleru (1982) stated that the physically active cement loader with higher exposure level will have a higher lung function problem than the less exposed with less physically active maintenance workers. This was also prove by a study carried out by Poornajaf et al. (2010) which reported that ventilatory function of exposed workers had 35.7% of abnormality in lung function compared to 5.7% of those who were unexposed.

Table 2.3: Evaluation of lung function

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

(Source: Miller, 2005)

2.4 Requirement of lung function assessment in cement dust industries

Lung function assessment is important assessment to determine the factors which have contributed to the degradation of lung function. Cement dust industries offers a variety of pollutant from its dusty operation in various manufacturing process. Some studies have suggested that there was an association between cement dust exposures with chronic impairment of lung function and respiratory symptoms (Neghab and Choobineh, 2007). Noor et al. (2000) has also proved that there was an association between total dust exposure and respiratory symptoms such as cough, phlegm, chest tightness and also lung function measurement. There was another study further supported that there was an association between the development of chronic obstructive pulmonary disease (COPD) and exposure to cement dust.

However, it may need to look for the other factor that may further exacerbate the damage to the pulmonary epithelium by cement dust. Al Neaimi et al. (2001) reported that the differences in exposed and unexposed smokers were still obvious even after adjusting for age, BMI and smoking. Those subgroups that have to spend more of their time in the factory will have more positive association between cement dust and adverse respiratory function. Long term duration response effect was also considered to further exacerbate the lung function. Meo et al. (2013) found that long term exposure to cement dust prominently decreased the pulmonary function. Thus requirement of conducting lung function test in cement dust should be further analyzed to determine the factors that contribute to degradation of lung function among the exposed workers.

2.5 Fractional exhaled nitric oxide (FENO)

Fractional exhaled nitric oxide (FENO) is a non-invasive method which are easy to perform, reliable and useful tool to measure the airway inflammation and assessing the airway disease (Dwelk et al., 2011). The measurement of FENO using NIOX MINO can measure the concentration of exhaled breath of nitric oxide produced by the subjects. However, FENO has a several confounders that need to be considered such as age, atopy, height, smoking and use of inhaled corticosteroids (Khalili et al., 2007).

Nitric oxide (NO) is produced in lungs and some of it is breathed out. It is an important mediator of inflammatory response and it involved in the regulation of vasodilation, neurotransmission and cell mediated immunity. Increased levels of nitric oxide in the breath were often related to lung inflammation and asthma (Hewitt et al., 2008). Production of endogenous NO is due to the activation of induce isoform synthase (Rahman et al., 1998). It can be induced by certain cytokines and the activation of it can cause the increased production of NO in exhaled air.

According to the American Thoracic Society guidelines, the interpretation of FENO concentrations is categorized as low when <25 ppb (eosinophilic inflammation is unlikely), while intermediate 25-50 ppb (non-specific inflammation) and lastly high when >50 ppb, which is significant eosinophilic inflammation.

However, studies on biomarkers of airway inflammation among cement factory were insufficient (Tungu et al., 2012). This was proven by a recent study from Norway which found that there was a small across shift decrease in FENO concentration among cement production worker but does not show clear association between dust exposure and lung function changes (Fell et al., 2011). There is also a need for further investigation for any association between dust exposure and FENO concentration.

There are various factors in considering the level of FENO measurement. That includes food and beverages that were consumed by an individual. The patients should refrain from eating and drinking 1 hour before the test as the ingestion of nitrate contain food such as ingestion of caffeine, lettuce would lead to alteration of FENO level. Meanwhile, alcohol ingestion would reduce FENO in patients with asthma and healthy subjects. Besides that, it is recommended that this test should be performed before conducting spirometer. This is because spirometry manoeuvres have been shown to reduce the exhaled of NO levels. Smoking also can reduce the levels of FENO. However, despite the effect of smoking; smokers with asthma still have a raised FENO.

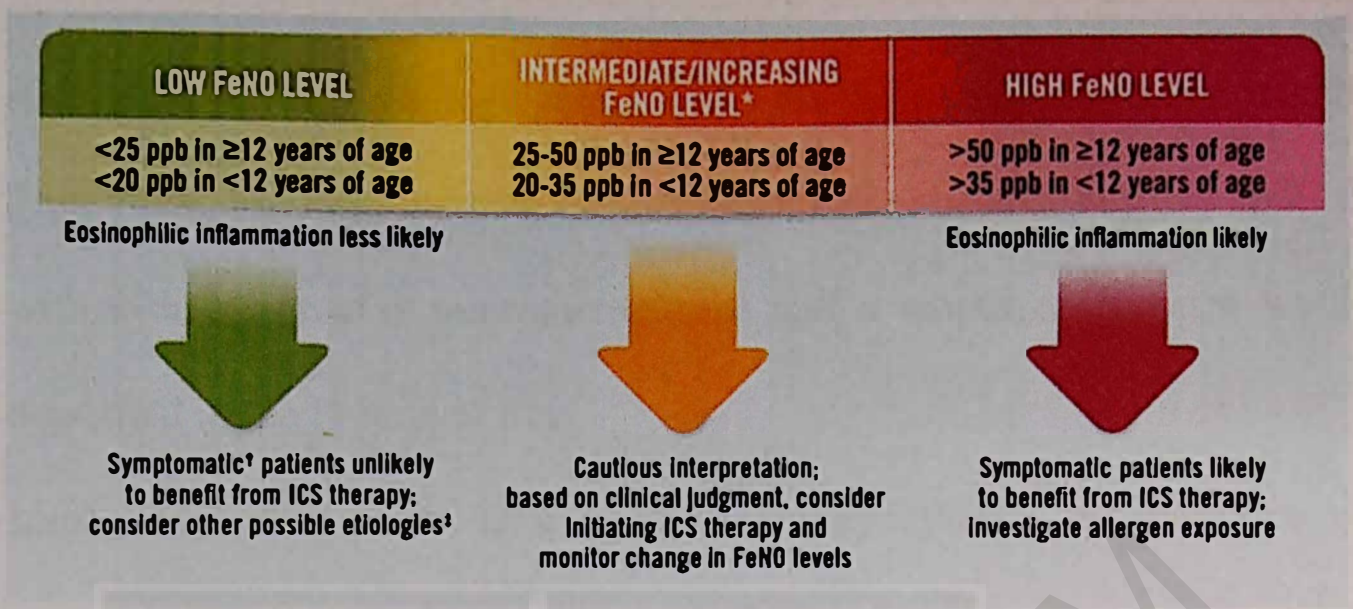


Figure 2.5 : Intrepretation of FENO concentration (Source: NIOX, 2015)

2.6 Mechanism and response of respirable dust in the lung

Lung is an organ where it responsible in bringing the oxygen from the atmosphere through inhalation and exchanging it back for carbon dioxide to be released through exhalation. Although lung has a specific mechanism in protecting the particles from being inhaled which is through the nose and cilia but lungs can be constantly exposed to danger from the dusts we breathe. Inhalation is the major route of exposure in the workplace especially when working in a dusty condition. When there is a particle in the air, there is a chance that we might inhale based on the size, shape and density of the particles. Particles can be deposited into the lungs through four different ways:

1. Interception: A particle deposited or intercept when it travels so close to the surface of airways passage which leads to the particles touches it surface. This method is important for the fibres such as asbestos. For example: fibres with a diameter of 1 micrometre (μm) and a length of 200 μm would be deposited in the bronchial tree.
2. Impaction: when there is a bend in airway system, the particles which suspended in the air do not turn with the air but rather impact or stick to a surface. The impaction is based on the air velocity and the particle mass.
3. Sedimentation: when particles travel thought air, the gravitational forces and air resistance has eventually overcome the tendency of the particle to stay up. This result that the particles will settle in the surface of the lung and deposition is most common in bronchi and the bronchioles. Sedimentation is not an important factor for aerodynamic diameter less than 0.5 μm.
4. Diffusion: random motion of particles similar to gas molecules in the air when particles are smaller than 0.5 μm. It is the most important mechanism for deposition in the small airways and alveoli.

The lung is protected by a series of mechanical defences in different region of the respiratory system. If dust were inhaled, the first thing that catches the dust is the nose. Nose will be the efficient filter to protect any particles and removing it by sneezing. However if the particles are small enough to go through the bronchiole, mucus that lined in the air tube will catch the particles and tiny hair called cilia will

move the particles upward and cough out to remove the particles. If all of these defence mechanism cannot avoid the dust particles, there is another defence mechanism that can protect which is macrophages. Macrophages help by swallowing the particle when dust entering the air sacs and the lower part of the airways where there are no cilia (Canadian Centre for Occupational Health & Safety, 2017).

If respond of the mechanism is poor, irritant dust that settles in the nose can led to the rhinitis and inflammation of the bronchi in the bronchioles. Meanwhile, if the particles evade elimination in the nose and upper airways, the particle will settle in the sacs and cause the macrophages to fail and led to scarring of the tissue (Canadian Centre for Occupational Health & Safety, 2017).

2.7 Respiratory disease and occupational disease that is related to cement industries

Occupational diseases are a group of diagnoses caused by the inhalation of dust, chemicals or proteins. Pneumoconiosis is term used to describe occupational disease associated with inhaling mineral dust. The severity is depending on the material that were inhaled and duration of the exposure (ATS, 2009). Neghab and Choobineh (2007) indicate in their study that respiratory tract disorders are the results of inhalation of airborne dust. Chronic bronchitis often associated with emphysema has been reported as the most frequent respiratory disease. There is also silicosis followed by mixed dust pneumoconiosis have been claimed to be the greatest risk for

cement workers. They also indicate that there is a high prevalence of cough, phlegm, wheezing and shortness of breath recorded among cement factory workers in Iran which contradict with other research.

Meanwhile, Al Neaimi et al. (2001) have shown that adverse respiratory health effects seen in the exposed to cement dust, has increased its frequency of respiratory symptoms and decreased ventilator observed among cement dust workers. This finding which could not be explained by age, BMI, and smoking thus are likely to cause by exposure to cement dust. This study suggested that the inhalation of cement dust irritates the respiratory epithelium and demonstrates that coughing, wheezing, dyspnoea, sinusitis, shortness of breath; bronchitis and bronchial asthma were significantly greater among the exposed workers compared with the unexposed workers.

CHAPTER 3

METHODOLOGY

3.1 Study Design

A cross sectional study was selected for this study. It was used to measure the exposure level of cement dust and also to identify the respiratory health simultaneously between the administrative worker and manufacturing workers in the cement industry.

3.2 Study Location

Cement industry area in Bahau, Negeri Sembilan was selected as the study location for this study. This location is one of the leading and biggest cement industry in Malaysia located near to Banjaran Titiwangsa which is the source of raw materials of cement production. This factory has a quarry activity in front of it and the workers may have exposed or have a direct exposure of cement dust in the manufacturing process.

Figure 3.2.1 : Map of the study location in Negeri Sembilan (Source: Google Mapp)

Figure 3.2.2 : Maps of Cement Industry in Bahau (Source: Google Map)

3.3 Sampling

3.3.1 Sample Population

All workers who work at the manufacturing area which highly and directly exposed to cement dust ($PM_{2.5}$). Meanwhile, the comparative group was from the administrative workers who worked in the office that have less exposure to the cement dust ($PM_{2.5}$). The manufacturing and administrative workers are from the same sample population.

3.3.2 Sample frame

A total number of 145 respondents were selected for the study. Study sample consists of 2 groups which were categorized by manufacturing group (exposed group) and administrative group (comparative group). The selection of these two groups was based on the inclusive criteria.

3.3.3 Sample Unit

There were two sample units for this study:

1. Manufacturing workers who were highly and directly exposed to cement dust particularly $PM_{2.5}$.
2. Administrative workers who worked at the office which is not directly exposed to cement dust.

3.3.3.1 Inclusion criteria

1. Age (18 to 55 years old)

The workers must be in certain age especially when undergo lung function test. A study by Pruthi and Multani (2012) showed that there was a significant relationship between the declined of lung function at the age of 56-75 years. It is because as the person aged, the elasticity of the lung may be decreased. Thus, it increases the rigidity of chest wall and reduced the forced expiratory volume in first second (Knudsan et al. 1983). Furthermore, at the age of 55 years, the weakened outward muscular force that combined with increased stiffness of the chest wall will probably results a decrease in the number of parenchymal elastic fibers (Silverstein et al., 2008).

2. Malaysian citizen and male gender

Most of the Malaysian has been injected with Bacillus Calmette-Guérin (BCG) vaccination. Thus, this ensures that any infectious disease such as tuberculosis can be controlled during taking any measurement especially during lung function test. This was due to the fact that there was a potential for transmission of tuberculosis (TB), various viral infections, opportunistic infections and nosocomial pneumonia occur through aerosol droplets (Miller, 2005). Male gender was selected because predominant worker in the cement industry was male.

3. Working duration of equal or longer than 6 months

This ensures that the workers exposure is not due to the previous exposure. According to Meo et al. (2013), long term duration of exposure to fine particles increased the prevalence of respiratory disease. Besides that, a worker that does not work permanently or has been exposed to previous working environment does not correlate with the decline of lung function (Hamdan, 2007). Thus, only permanent workers and registered with the cement industry with 8 hour working per day were selected.

3.3.3.2 Exclusion criteria

1. Medical history or undergo any treatment

Those who undergo any abdominal or chest surgery was excluded in this study as it can affect the test being conducted. Furthermore, worker that is sick or having any symptoms related to respiratory disease during the sampling is conducted was excluded from the study sample.

3.3.4 Sampling method

A simple random sampling was used to select the sample population. The respondent was chosen randomly from each department. The respondent who wanted to take part in this study was given the consent form for approval. The name list was obtained

from the management and only those who matched the inclusion criteria were chosen for this study.

3.3.5 Sample Size

To measure the sample size, Lemeshaw et al. (1990) was referred to find the mean between two groups.

To determine the mean between two groups population, below are the calculations:

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

where;

μ_1 = estimated mean (Larger)

μ_2 = estimated mean (smaller)

$Z_{1-\alpha/2}$ 95% = 1.98

$Z_{1-\beta}$ 95% = 0.842

σ = estimated standard deviation

The sample size determined by using mean of lung function based on study by Noor et al. 2000

Exposed = (3.02± 0.08) (mean±standard error)

Comparative = (2.69 ± 0.11)

$$n = \frac{2(o.646)^2\{1.98 + 0.842\}^2}{(3.02 - 2.69)^2}$$

n = 61 respondent + 20% non-response rate

n = 73 respondent

The total population of the two groups which were the administrative group and manufacturing group was **146 respondents.**

Based on the sample size calculations, the highest sample population is 73 respondents after considering the non- response rate by the respondent. A total of **145 respondents** (exposed and comparative groups) were selected as the study population from the cement industry

3.4 Study instrumentation

3.4.1 Questionnaire

The questionnaire used in this study was adapted from the American Thoracic Society for adult respiratory health disease (ATS-DLD).

3.4.2 Personal sampling

Personal sampling was done by using a personal sampling pump. Gillian or GilAir-3 has an automatic constant flow which assures flow is maintained within 5% of the initial set point even with varying of back pressures due to flow restrictions or build-up of material on the filter. It feature a fault light indicator where it activates when the pump flow control is outside +/-5% of the required flow rate such as low battery level, blocking of tube or filter. If the conditions persist, the pump automatically shut down and freezes the timer. The pump resumes a normal sampling when fault condition is cleared before shutdown and a fault light is turning off. The GilAir-3 also feature Battery Test indicator light where it illuminates when the battery can provide a minimum of 8 hours of operating.

Figure 3.4.2: Gilian GilAir-3 Air Sampling Pump (Source: Sensidyne)

Personal sampling method was based on the OSHA Analytical Method – Particulates Not Otherwise Regulated (Respirable Fraction). This method was used to determine the number of sampling required based on the given flow rate and volume and also type of method used to analyse the sample. The flow rate used was 1.7 L/min by using a nylon cyclone with duration of 8 hours straight of sampling and a 37 mm diameter of PVC was used. Furthermore, in order to determine the selection of workers needed, a Guideline on Monitoring of Airborne Contamination for Chemicals Hazardous to Health was used in which referring to the Website of Department of Occupational Safety and Health. The selection of workers was based on the work practice, duration and also the proximity to the source.

3.4.3 Lung function

Evaluation of lung function was done by using Chestgraph HI-105. This instruments was fully met the ATS recommendation which can assess the COPD and also lung age of the respondents. Fully equip with an accuracy of within +/- 3% or +/- 50 mL, whichever is greater and it capable of data logged at about 300 of respondents.

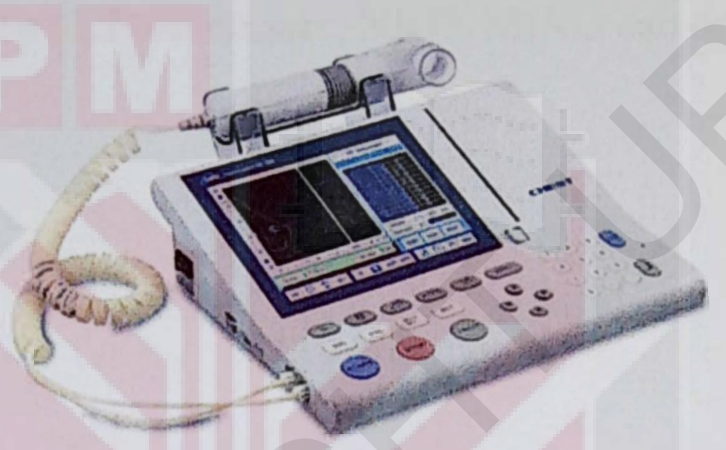


Figure 3.4.3 :Chestgraph HI-105 (Source: Chest M.I. Inc.)

3.4.4 Fractional Exhaled Nitric Oxide (FENO)

A NIOX MINO was used to assess the FENO of the respondent. NIOX MINO is a non-invasive and simple instrument used to detect exhaled nitric oxide which means evaluating the inflammatory response of asthma. This instrument provides NO scrubber which contains potassium permanganate that specially designed for removal of specific gaseous contaminants from the airstream and also does not support for bacterial and fungal growth. Furthermore, NIOX MINO can detect a maximum range of 5 to 300 ppb.

Figure 3.4.4: NIOX MINO

3.5 Data collection

3.5.1 Questionnaire

Simple structured questionnaires were distributed to all the respondents and a consent form was given. The questionnaire is adapted from the American Thoracic Society for adult respiratory health disease (ATS-DLD). This set of questionnaire was given in order to measure the respiratory symptoms experienced by the workers.

The questionnaire consists of the following:

Section A: Basic demographic information of the respondent, smoking habit

Section B: Basic occupational information and occupational history

Section C: History of respiratory symptom (cough, phlegm, wheezing, shortness of breath)

Section D: Allergic

Section E: Awareness on occupational health

3.5.2 Personal exposure monitoring

To measure the personal exposure monitoring, personal air sampling pump was used. The level of dust exposure was measured at the breathing zone of the respondent which was defined as a hemisphere in front of the shoulders with a radius of 6–9 in. The air sampling pump was clipped at the workers belt while the cassette was clipped at the respondent's collar shirt. Basically, the sampling pump will draw the air into the filter through the sampling cassette according to the flow rate that has

been set up. All the particles that have been collected will be deposited at the filter and the concentration of the exposure can be measured based on the 8 hours of their work shift.

To determine the concentration of the collected sample, the filter paper was weighted using analytical balance before and after taking sample. Thus when divided by the sample volume, the airborne concentration of dust will be able to be determined. The air sampling pump must be correctly assembly so it does not restrict the movement of the worker while doing their daily job routine.

Below are the procedures of taking personal air sample:

1. Air sampling pump was pre-calibrated on site before any sampling is conducted.
2. A worker that has been selected in the specific work area was brief to explain the purpose of conducting the monitoring. The information regarding the worker was recorded including the date monitor and location of sampling.
3. The inlet and outlet plug was removed from the sampling cassette and assemble the cassette with the nylon cyclone to connect with the flexible connecting tube. The connecting tube was also connected to the air sampling pump to moves air for collection of sample into the filter.
4. The calibrated air sampling pump was fixed on the selected worker's waist while the collection device (cassette containing filter and cyclone) was fixed on the worker's collar around the breathing zone.

5. The start time was recorded while the worker allowed continuing his daily task.
6. The worker's performance task was observed every 4 hours intervals in order to check if any problems happen or sign of overloading in the filter paper.
7. According to the duration of sample for each cassette calculated, the cassette was not been replaced with the other new cassette due to the calculation made according to the OSHA method which enable for it to take 8 hour straight of sample.
8. The air sampling pump was pause whenever the respondent was rest during break hour.
9. After it has finished the first sampling cassette, the collected sample was immediately capped back with interchanged inlet and outlet plug
10. The sampling cassette was then placed in the reseal bag and label.
11. After all sample cassette has been required in the 8 hours shift, the air sampling device is stop and time taken was recorded in order to determine the number of hours the sampling is conducted.
12. The device was undergo post calibration or checked for accurate calibration.

Calculation involved in measuring the concentration of dust:

$$C = \frac{(W_2 - W_1) - (B_2 - B_1)}{V\ (L)} \times 10^3\ (mg/m^3)$$

Where: W_1 = tare weight of filter before sampling (mg)

W_2 = post sampling weight of sample- containing filter (mg)

B_1 = mean tare weight of blank filters (mg)

B_2 = mean post sampling weight of blank filters (mg)

V = volume as samples at the nominal flow rate

3.5.3 Lung Function test

A spirometer was used to measure the flow and volume of air entering and leaving the lung. It includes the measurement of forced vital capacity (FVC), force expiratory volume in one second (FEV_1) and other force expiratory flow measurement. The respondent was asked to exhale into the mouthpiece provided in order to measure the capacity of air force out form the lungs. This spirometer will determine the type of impairment of the respondent might have based on the level of exposure exposed.

Before the lung function test is to be conducted, the respondent should avoid on eating a large meal within 2 hours before the test. Besides that, the respondent

was asked to avoid wearing a cloth that can restrict the full chest and abdominal expansion (Miller et al. 2005). This lung function test procedure was conducted under the supervision of medical doctor and assist by researcher. All the data was interpreted and diagnosed by the medical doctor or any equivalent expertise in this field.

Below are the procedures of performing lung function test based on Miller et al. (2005):

1. The spirometer calibration was checked.
2. The test was explained to the subject and asks about smoking, recent illness, medications, etc.
   - Measure weight and height without shoes
3. The test was instruct and demonstrated to the subject:
   - Correct posture with head slightly elevated
   - Inhale rapidly and completely
   - Position of mouthpiece and exhaled with maximal force
4. Perform manoeuvre (closed circuit method)
   - Have subject assume the correct posture
   - Attach nose clip, place mouthpiece in mouth and close lips around the mouthpiece
   - Inhale completely and rapidly
   - Exhale maximally until no more air can be expelled while maintaining an upright posture

- Repeat instructions as necessary, coaching vigorously
- Repeat for a minimum of three manoeuvres; no more than eight are usually required
- Check test repeatability and perform more manoeuvres as necessary

5. Perform manoeuvre (open circuit method)
   - Have subject assume the correct posture
   - Attach nose clip and inhale completely and rapidly
   - Place mouthpiece in mouth and close lips around the mouthpiece
   - Exhale maximally until no more air can be expelled while maintaining an upright posture
   - Repeat instructions as necessary, coaching vigorously
   - Repeat for a minimum of three manoeuvres; no more than eight are usually required
   - Check test repeatability and perform more manoeuvres as necessary

3.5.4 Fractional Exhaled Nitric Oxide (FENO)

Fractional exhaled nitric oxide measurements were performed according to the American Thoracic Society and European Respiratory Society guidelines. NIOX MINO was used to measure Nitric Oxide (NO) in human breath. It is suitable to measure the airways inflammations using non-invasive method which will give an accurate result of the concentration of the nitric oxide. The respondent was required to breathe into the mouthpiece attached to the recording device (NIOX MINO) to measure the concentration.

It begins with the respondent to fully empty the lung by doing a full exhalation outside of the mouthpiece. Then, the respondent was asked to make a fast and deep inhalation through the filter or mouthpiece of the NIOX MINO. Next, the respondent was asked to exhale slowly and steadily for 6 seconds by maintaining a constant air speed in which a machine would emit a continuous humming sound if they breathe correctly. The device will alert the respondent whether the exhalation is strong or too weak based on the visual display. The measurement stops when it does not fulfil the exhalation correctly thus the display helps the respondent to control the speed of the air being exhaled. A correct measurement of the air being exhaled will be appeared in the screen display. The next respondent was provided with a new mouthpiece in order to avoid contaminations.

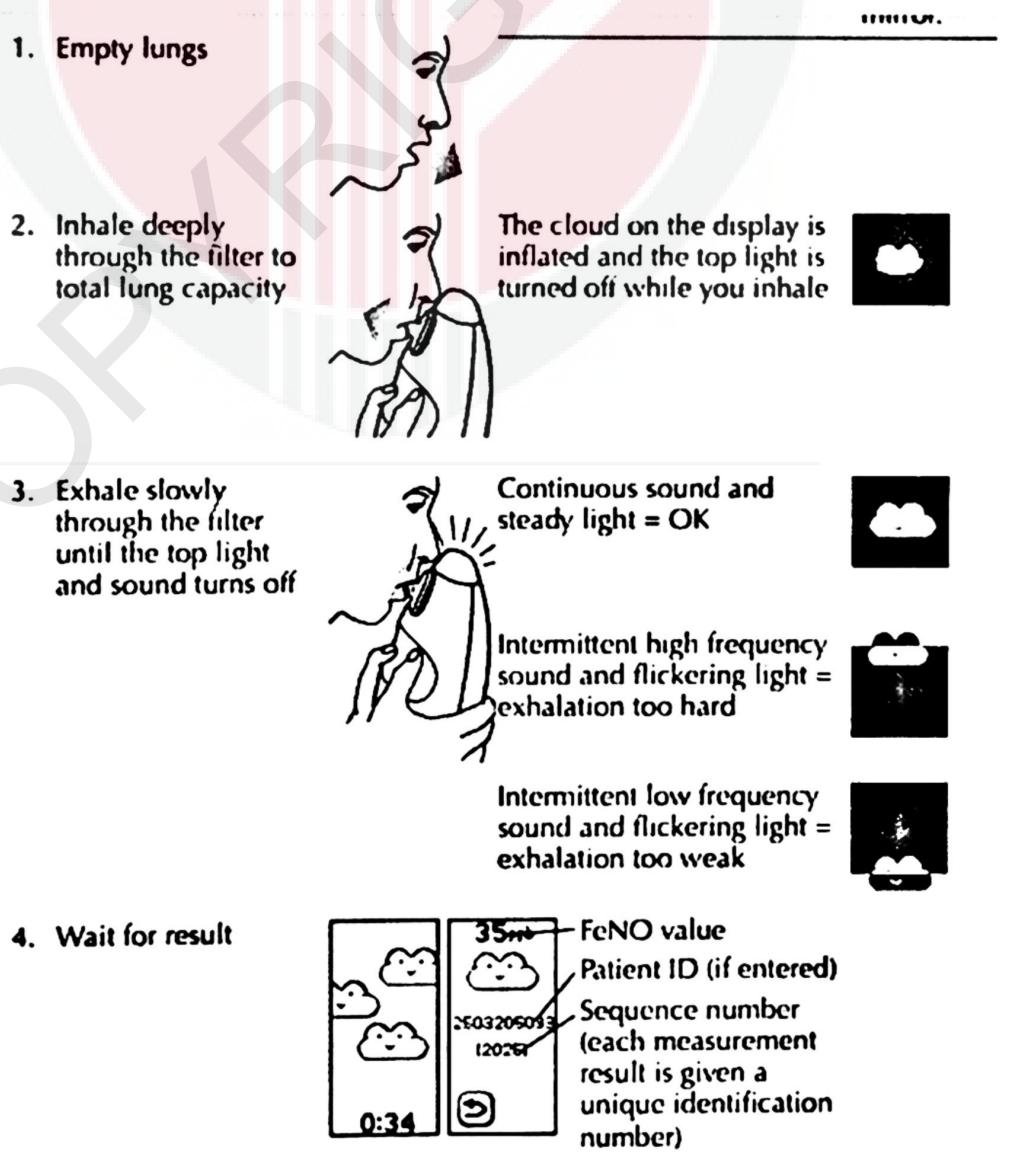


Figure 3.5.4: Step in measurement of FENO (Source: Aerocrine NIOX MINO User Manual, 2014)

3.6 Quality Control

1. Questionnaire validation

The questionnaire used was adapted from the American Thoracic Society. The questionnaire has undergone a pilot test study in order to evaluate the effectiveness of the questions and the level of understanding of the respondents. The pilot study was conducted on other cement industrial workers with 10% of the study sample thus any changes can be made according to the respond from the respondent during pilot test study.

2. Calibration

All instruments were calibrated before and after used in order to avoid any irrelevant data that may affect the result of the study. This include instrument like air sampling pump, spirometer and NIOX MINO. The calibration of the instrument used was done based on the standard operating procedures. Besides that, some sample were taken triplicate to ensure the precision and accuracy of the data obtained.

3.7 Ethical Consideration

Approval from the Ethics committee of Faculty Medicine and Health Sciences was obtained prior to the study. Besides that, all respondents have been informed and briefed about the purpose of the study. The respondent information sheet and consent

form was distributed to workers before they participated in the study. All the information regarding the respondent personal information were kept confidential and only for the purpose of the study.

3.8 Data analysis

1. To identify the sociodemographic background of the respondent.

A descriptive analysis was used to identify the sociodemographic background from all of the respondent workers.

2. To compare the respiratory symptoms reported by the administrative and manufacturing workers

Chi-Square analysis was used to measure the categorical data (respiratory symptoms) of the workers in the cement plant.

3. To compare the concentration of personal exposure level of $PM_{2.5}$, lung function and Fractional Exhaled Nitric Oxide (FENO) among administrative and manufacturing workers in cement industry.

Either independent t-test or Mann- Whitney test was used for parametric or non-parametric respectively.

4. To determine the association between personal exposures and lung function among cement workers.

Either Spearman rho for non-parametric or Pearson correlation for parametric was used to determine the correlation between two factor.

5. To determine the association between working duration and the lung function among the cement workers.

Either Spearman rho for non-parametric or Pearson correlation for parametric was used to determine the correlation between two factor.

CHAPTER 4

RESULTS

4.1 Selection of respondents

This study was conducted among cement workers in Bahau, Negeri Sembilan. There were two departments involved in this study, the manufacturing and administrative department. The sub-departments of these two departments involved are consisted of Plant Admin, Manufacturing, Mechanical, Electrical, Safety Health Environment (SHE), Planner, Quality Control, Quarry, Transport Service, Human Resource, Procurement, Finance, Inventory and Information and Communication Technology (ICT). The selections of respondents were based on the inclusion criteria such as age, male and Malaysian citizen and respondents that work equal or longer than 6 months in duration. All respondents were mainly Malay due to the majority of the workers involved from that plants were Malay in ethnicity. A total of 168 respondents were selected in this study.

Table 4.1: Total populations according to department in cement factory

Groups variable	Total N = 168
Manufacturing	84 (50.0%)
Administrative	84 (50.0%)

From Table 4.1, a total of 50% of the respondents involved were from the manufacturing department, while remaining 50% were from the administrative department. All of the respondents were entirely male due the inclusion criteria.

4.2 Respondent background

This study involved 168 respondents. It involved Malay, Chinese and Indian. Mostly workers at cement factory are Malay which consists about 94.0% of the population selected compared to other races. The general income was mostly below RM 2000 and the highest education level received was Master. However, most of the workers only required SPM level as their highest level of education. In term of age, workers in administrative department are much older than workers in manufacturing department. A range of 41 to 50 years old workers were from administrative department while, 31 to 40 years old were from manufacturing department.

Table 4.2: Respondent's background of administrative and manufacturing department workers

Variables	Manufacturing (N=84)	Administrative (N=84)
	Number (%)	Number (%)
Race		
Malay	74 (88.1)	79 (94.0)
Chinese	1 (1.2)	1 (1.2)
Indian	9 (10.7)	4 (4.8)
Income		
≤ 2000	28 (33.3)	34 (40.5)
2001- 3000	21 (25.0)	16 (19.0)
3001- 4000	18 (21.4)	10 (11.9)
4001- 5000	4 (4.8)	9 (10.7)
> 5000	13 (15.5)	15 (17.9)
Education level		
UPSR	4 (4.8)	2 (2.4)
PMR	2 (2.4)	1 (1.2)
SPM	45 (53.6)	48 (57.1)
Diploma	16 (19.0)	15 (17.9)
Degree	17 (20.2)	17 (20.2)
Master	0 (0)	1 (1.2)
Age		
20-30	25 (29.8)	22 (26.2)
31-40	33 (39.3)	20 (23.8)
41-50	15 (17.9)	27 (32.1)
51-60	11 (13.1)	15 (17.9)

4.3 Anthropometrical data of the respondents

Confounding factors such as age, weight and height were compared within both groups. Normality test was done for the entire variables and the statistical results showed a normal distribution function. Thus, Independent t-test was done to determine if there is any significant difference between those variable among the two study groups. There was no significant difference of age, weight and height between manufacturing and administrative workers in the cement factory.

Table 4.3: Anthropometric data of administrative and manufacturing workers

Variables	Manufacturing (N=84)	Administrative (N=84)		
	Mean ± SD	Mean ± SD	t statistics	p value
Age	36.64 ± 9.52	39.24 ± 10.24	1.701	0.091
Weight (kg)	78.96 ± 16.22	76.71 ± 13.53	- 0.978	0.330
Height (cm)	168.98 ± 5.34	168.49 ± 6.54	- 0.531	0.596

Independent t-test
* Significant $p < 0.05$

4.4 Smoking habit

Smoking habit also can be one of the confounder that affects lung functions. However, due to the number of respondents were male and mostly were smokers. Thus, matching of respondents was required in term of number of cigarettes per day that were categorized into smoking group. The total number of smokers among manufacturing workers was 53.6% while, total number of smokers among administrative workers was 41.7%. There was no significance difference obtained in number of cigarettes per day between these two groups.

Table 4.4: Smoking habit of administrative and manufacturing workers

Variable	**Manufacturing (N=84)**	**Administrative (N=84)**	x^2	**p value**
	Number (%)	Number (%)		
Smoking status				
Smoker	45 (53.6)	35 (41.7)	2.386	0.122
Non smoker	39 (46.4)	49 (58.3)		
Smoking Group				
< 10 (Light)	13 (15.5)	10 (11.9)	0.144	0.931
10 – 20 (Moderate)	30 (35.7)	24 (28.6)		
> 20 (Heavy)	2 (2.4)	1 (1.2)		

Chi-Square
*Significant $p < 0.05$

4.5 Working duration

Results from Mann Whitney U test showed that the mean of working duration for administrative workers were longer as compared to manufacturing workers. The range of working duration for administrative workers was 1-23 years while manufacturing workers was 1-20 years. However, there was no significant difference of working duration between the two studied groups.

Table 4.5: Comparison of working duration between administrative and manufacturing workers

Variable	Manufacturing (N=84)		Administrative (N=84)			
	Median (IQR)	Range	Median (IQR)	Range	z value	p value
Working duration (years)	7.50 (15.0)	1-20	9.50 (17.0)	1-23	- 0.368	0.713

Mann Whitney U Test
*Significant $p < 0.05$

4.6 Comparison of concentration of personal exposure level ($PM_{2.5}$) in administrative and manufacturing workers

The sample size for determining the personal exposure level was based on DOSH method which is Guidelines on Monitoring of Airborne Contaminant for Chemicals Hazardous to Health. Thus, only 58 samples were taken to represents each of the workers that work in administrative or manufacturing department. The monitoring for personal exposure level was done during their working hours. Mann Whitney U test was conducted and the results showed that there was a significant difference in personal exposure level of $PM_{2.5}$ between the two groups. The statistical result showed that the personal exposure level of $PM_{2.5}$ was higher in manufacturing compared to administrative group.

Table 4.6.1: Comparison of personal exposure level of $PM_{2.5}$ between administrative and manufacturing workers

Variable	**Manufacturing (N=29)**		**Administrative (N=29)**			
	Median (IQR)	Range	Median (IQR)	Range	z value	p value
$PM_{2.5}$ (mg/m^3)	2.68 (5.90)	0.351 - 10.60	1.88 (2.27)	0.029 – 5.63	- 2.527	**0.012***

N=58
Mann Whitney U test
*Significant $p < 0.05$

The percentage of having $PM_{2.5}$ exceeding the permissible exposure limits which is stated in Factories and Machinery (Mineral Dust) Regulations 1989 was higher in manufacturing workers compared to administrative workers. About 34.5% contribute to the total of high concentration of dust in time weighted average of 8 hours working. The permissible exposure limits set is 5 mg/m^3 while the range of concentration obtained is between 0.351 to 10.60 mg/m^3.

Table 4.6.2: Concentration of $PM_{2.5}$ exceeding the permissible exposure limit between administrative and manufacturing

Variables	Manufacturing (N=29)	Administrative (N=29)
	Number (%)	Number (%)
$PM_{2.5}$ exceed	10 (34.5)	2 (6.9)
$PM_{2.5}$ not exceed	19 (65.5)	27 (93.1)

N=58

4.7 Comparison of lung function between administrative and manufacturing workers

Lung function was conducted to all of the respondents. Mann Whitney U test was conducted to determine if there was a significant difference between the lung function in both groups. The results showed a significant difference of FVC% and FEV_1% between these two groups of respondents with $p < 0.05$. However, FEV_1/FVC does not show any significant difference from the statistical results obtained.

Table 4.7: Comparison of lung function between administrative and manufacturing workers

Variable	Manufacturing (N=84)	Administrative (N=84)	z value	p value
	Median (IQR)	Median (IQR)		
FVC (Liters)	3.06 (0.75)	3.10 (0.71)	- 0.482	0.630
FEV_1 (Liters)	2.69 (0.59)	2.74 (0.56)	- 0.796	0.426
FVC%	85.60 (17.97)	90.95 (15.14)	- 2.359	**0.018***
FEV_1%	87.02 (19.08)	93.73 (15.51)	- 3.015	**0.003***
FEV1/FVC%	103.18 (7.44)	103.25 (5.59)	- 0.692	0.489

Mann Whitney U test
*Significant $p < 0.05$

4.8 Comparison of lung function abnormalities between administrative and manufacturing workers

All data from lung function test was categorized into different categories based on ATS (2005). Chi square test was done to compare the status of lung function among these two groups of respondents. There was a significant difference of abnormalities found among the manufacturing and administrative workers. Logistic regression was run to obtain the adjusted OR. The OR for abnormalities of lung function among manufacturing workers compared to administrative workers was still significantly higher with FVC% (OR=3.821) and FEV_1% (OR=5.161) even after adjusting for age and smoking status.

Table 4.8.1: Comparison of abnormalities in lung function between administrative and manufacturing workers

Variable	**Abnormalities**	**Manufacturing (N=84)**	**Administrative (N=84)**		
		Number (%)	Number (%)	OR 95%CI	*OR 95% CI
FVC%	Abnormal	22 (26.2)	7 (8.3)	**3.903*** (1.565, 9.735)	**3. 821** (1.524, 9.583)
	Normal	62 (73.8)	77 (91.7)		
FEV_1%	Abnormal	18 (21.4)	4 (4.8)	**5.455*** (1.760, 16.909)	**5.161** (1.654, 16.102)
	Normal	66 (78.6)	80 (95.2)		
FEV1/ FVC%	Abnormal	84 (100)	84 (100)	-	-
	Normal	-	-		

Chi Square test
*Significant OR > 1 95% CI
*Adjusted OR for age and smoking status

The data of lung function test was also categorized into different degree of abnormalities which is normal, mild, moderate and severe. Chi Square test was done to determine the different degrees of lung function among the two groups of respondents. The results showed that there was a significant difference of FVC% and FEV_1% found between the two study groups with $p < 0.05$.

Table 4.8.2: Comparison of abnormalities in lung function between administrative and manufacturing workers

Variable	Abnormalities	Manufacturing (N=84)	Administrative (N=84)	x^2	p value
		Number (%)	Number (%)		
FVC%	Normal	62 (73.8)	77 (91.7)	13.819	**0.003***
	Mild	14 (16.7)	6 (7.1)		
	Moderate	8 (9.5)	0 (0)		
	Severe	0 (0)	1 (1.2)		
FEV_1%	Normal	66 (78.6)	80 (95.2)	11.342	**0.010***
	Mild	14 (16.7)	2 (2.4)		
	Moderate	3 (3.6)	1 (1.2)		
	Severe	1 (1.2)	1 (1.2)		
FEV1/FVC %	Normal	84 (100)	84 (100)	-	-
	Mild	-	-		
	Moderate	-	-		
	Severe	-	-		

Chi Square test
*Significant $p < 0.05$

4.9 Comparison of respiratory symptoms between administrative and manufacturing workers

Respiratory symptoms of respondents were categorized according to cough, phlegm, wheezing and chest tightness. Chi Square test was done to compare the significance difference between these two groups. The result obtained shows that cough was the most significant symptoms experienced compared to other symptoms. Logistic regression was done and the result showed that OR was still significantly high after adjusting for age and smoking status with OR= 2.400.

Table 4.9: Comparison of respiratory symptoms among administrative and manufacturing workers

Variables	**Manufacturing (N=84)**	**Administrative (N= 84)**			
	Number (%)	Number (%)	OR	95% CI	* OR (95% CI)
Cough					**2.400**
Yes	25 (29.8)	13 (15.5)	**2.314***	**(1.089, 4.918)**	
No	59 (70.2)	71 (84.5)			**(1.119, 5.147)**
Phlegm					
Yes	30 (35.7)	23 (27.4)	1.473	(0.765, 2.837)	-
No	54 (64.3)	61 (72.6)			
Wheezing					
Yes	16 (19.0)	9 (10.7)	1.961	(0.813, 4.728)	-
No	68 (80.9)	75 (89.3)			
Chest tightness					
Yes	13 (15.5)	10 (11.9)	1.355	(0.558, 3.287)	-
No	71 (84.5)	74 (88.1)			

Chi Square test
*Significant OR > 1 95% CI
*Adjusted OR for age and smoking status

4.10 Comparison between Fractional Exhaled Nitric Oxide (FENO) between administrative and manufacturing workers

Chi square test was done to compare the FENO level among the two studied groups. The result showed that there was no significant difference between those two groups. This FENO test was done for a total of 44 respondents only if they showed symptoms during the lung function test.

Table 4.10: Comparison between Fractional Exhaled Nitric Oxide (FENO) between administrative and manufacturing workers

Variables	Manufacturing (N=24)	Administrative (N=24)	x^2	p value
	Number (%)	Number (%)		
FENO				
> 50 High	4 (16.7)	0 (0)		
25-50 Intermediate	7 (29.2)	4 (16.7)	6.303	**0.043***
< 25 Low	13 (54.2)	20 (83.3)		

Chi Square test
*Significant $p < 0.05$

4.11 Correlation between $PM_{2.5}$ exposure level and lung function among the respondents

4.11.1 Correlation between age and lung function among the respondents

Spearman rho correlation test was done to determine the correlation between age and lung function among the manufacturing workers (exposed group) and administrative workers (comparative group). There was a significant association between age and FEV_1 and FEV_1/FVC among cement workers.

Table 4.11.1: Association between age and lung function among the respondents

Age	Manufacturing (N=84)		All respondents (N=168)	
	r value	p value	r value	p value
FVC%	0.046	0.676	0.136	0.079
FEV_1%	0.061	0.582	0.222	**0.004***
FEV_1/FVC%	0.019	0.866	0.169	**0.029***

Spearman Rho
*Significant $p < 0.05$

4.11.2 Correlation between $PM_{2.5}$ exposure level and lung function among the respondents

Correlation between $PM_{2.5}$ and lung function was test it statistical data by using Spearman rho due to its not normally distributed data. The result show that there was a significant correlation between $PM_{2.5}$ and lung function among exposed group with r value = -0.360, p value = 0.05. The numbers of respondents selected are representative of manufacturing and administrative workers based on DOSH method which is Guidelines on Monitoring of Airborne Contaminant for Chemicals Hazardous to Health which explained on the total number of respondents being select. A total of 29 workers from manufacturing and 29 workers from administrative were chosen as a representative to determine the correlation between $PM_{2.5}$ exposure level and lung function among the respondents.

Table 4.11.2: Correlation between $PM_{2.5}$ exposure level and lung function among the respondents

$PM_{2.5}$	Manufacturing (N= 29)		All respondents (N=58)	
	r value	p value	r value	p value
FVC%	- 0.360	**0.05***	0.070	0.604
FEV_1%	- 0.314	0.097	0.030	0.824
FEV_1/FVC%	0.002	0.990	-0.124	0.354

Spearman Rho
*Significant $p < 0.05$

4.12 Correlation between working duration and lung function among cement workers

According to the statistical test by using Spearman rho, there was significant correlation between working duration and lung function among cement workers. The FEV_1/FVC showed r value = 0.156 and p value of 0.044. The p value showed a number of less than 0.05.

Table 4.12: Correlation between working duration and lung function among cement workers

Working duration	Manufacturing (N=84)		All respondents (N=168)	
	r value	p value	r value	p value
FVC%	0.036	0.742	0.042	0.585
FEV_1	0.088	0.427	0.121	0.117
FEV_1/FVC	0.055	0.617	0.156	**0.044***

Spearman Rho
*Significant $p < 0.05$

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Discussion

5.1.1 Respondents background

This study was conducted to determine the association between cement dust exposure ($PM_{2.5}$) and respiratory health implications among cement dust workers. Respondents for this study involved a total of 168 respondents and all of the respondents were given a consent form before the collection data. The respondents involved were categorized into two sample units which were administrative that represent as the comparative group and manufacturing that represents as the exposed group. Most of the workers in this cement industry were male with majority of them had a total income of less than RM2000. Their highest education backgrounds were SPM level and with only 1% of them had Master in Degree. Even though, the background level of education obtained was only in secondary level but they knew

the basic awareness regarding the respiratory health concern at work through questionnaire on the awareness on occupational health.

5.1.2 Comparison and matching of respondents

In order to control the confounding factors that might influence the lung function and airway inflammation test, a matching process of respondents was required between administrative and manufacturing workers. According to American Thoracic Society (2011), lung function and airway inflammation are greatly influenced by age, weight, height and smoking status. Working duration also could be one of the factors that greatly influence both test results.

As for the anthropometrical data, mean weight and height for manufacturing workers was 78.96 kg and 168.98 cm respectively, while mean weight and height for administrative workers was 76.71 kg and 168.49 kg respectively. The results from statistical analysis showed that there was no significant difference in age, weight and height between two groups thus these factors were successfully controlled. However, in descriptive analysis, most of the workers involved in administrative was much older with a range of 41 to 50 years old compared to manufacturing workers which is 31 to 40 years old. In terms of working duration, it seemed that the administrative had longer working duration with a range of 1 to 23 years compared to manufacturing workers with a range of 1 to 20 years duration.

This might due to the fact that older workers in manufacturing might have a length disability due to the injury or illness occurs from the work area of manufacturing process, thus unable to return to work as the recovery process takes a long time. Meanwhile, for the administrative the longer working duration might influence their work experience thus enable them to continue their work until late age. This statement can be supported by a study done by Besen et al. (2016) that determine the relationship between age, tenure, and disability duration in persons with compensated work-related conditions. In addition, manufacturing workers mostly had a rotated shift and extended durations of 8 hours or more a day for nearly 20 years while office workers only perform their daily routine jobs in the office within office hour which is 8 hours. This enabled the administrative workers to feel comfortable in handling their task thus prolonged the length of working duration.

For the next cofounder which was smoking status, a matching process was also done in order to control the influence of lung function and airway inflammation result. Because the selection of respondent was entirely male, the smoking status cannot be neglected between those two groups. It is important to control the smoking status of the respondents as previous study by Noor et al. (2000) suggested that smoking might aggravate the adverse effect of cement dust on the workers' lung function. Thus, manufacturing workers who were smokers was matched with administrative workers that were smokers and the same process was done towards non-smoker of manufacturing and administrative. The smoking status was actually

matched for the number of cigarettes taken per day and based on the result of statistical analysis; it showed that there were no significant differences between administrative and manufacturing workers in term of number of cigarettes taken per day. This method was also done by past study, Al Neaimi et al. (2001) which conducted their study among workers at cement factory in United Arab Emirates (UAE).

5.1.3 Comparison of concentration of personal exposure level (PM2.5) in administrative and manufacturing

Cement dust was considered as one of the mineral dust listed in Factories and Machinery (Mineral Dust) Regulations 1989. The permissible exposure limit for average of 8 hours period for respirable dust is 5 mg/m^3. The respondent obtained from this personal exposure level monitoring was (N=29) from manufacturing and (N=29) from administrative. The selection of respondents is based on the Guidelines on Monitoring of Airborne Contaminant for Chemicals Hazardous to Health. Only representatives from each department are selected to represent the exposure.

From the results, the mean of $PM_{2.5}$ obtained was 4.34 mg/m^3 with a range of 0.351 mg/m^3 to 10.60 mg/m^3 which are already exceeding the permissible exposure limits. The results obtained already proved that manufacturing workers who work directly with cement dust has exposed to higher concentrations of dust in time

weighted average of 8 hours compared to administrative workers. Previous finding by Kakooei et al. (2011) in cement factory in Iran found that, mean air concentration of respirable dust for exposed group was 11.96 mg/m^3. It already exceeded the recommended threshold limit value (TLV) based on the American Conference of Governmental Industrial Hygienists (ACGIH) for nuisance particles which is 5 mg/m^3.

Meanwhile, a local study by Noor et al (2000) in Rawang found that the highest exposure group was exposed to was 8049.86 μg/m^3 of a fine dust, which is almost 54 times higher than the recommended limit set by the country (Malaysian Air Quality Guidelines =150 μg/m^3). Even though the measurement taken was compared with MAQC, however this finding can still be a reference of how dusty the cement industry really is and how it will affect the measurement of personal exposure. This congruent with the result obtain that personal exposure to $PM_{2.5}$ does exceed the permissible exposure limit.

Although, the administrative workers did not have a high number of mean of exposure level $PM_{2.5}$ as compared with manufacturing workers which is 1.98 mg/m^3, however, the range obtained was from 0.0029 mg/m^3 to 5.63 mg/m^3 which eventually exceed the permissible exposure limit of 5 mg/m^3. The justification of the findings was due to the fact that the office area located very near to the cement processing. The administrative workers may expose to cement dust during break

hour as they have to walk through the cement process to go to the cafeteria and also prayer room. There would also be a cross contamination as the office door always open due to in and out of workers thus affecting the concentration of personal exposure among administrative and making the exposure to dust to be exceeds above limits. However, the result showed a significant difference of $PM_{2.5}$ between two groups which manufacturing recorded as the highest concentration in 8 hours.

5.1.4 Comparison of lung function between administrative and manufacturing

Lung function test was done conducted by using Spirometer Chestgraph HI-105.Lung function test was done to measure the ability of lung function among all respondents. From the result of statistical analysis, it showed that there is a significant difference of lung function values which are FVC% and FEV_1% between administrative and manufacturing workers. The mean of FVC% among manufacturing is 88.73±16.07 while the mean of FVC% among administrative is 91.52±10.86. For FEV_1%, mean for manufacturing is 90.44±18.30 while mean for administrative is 94.18±11.37.

From the result obtained, the reduction of lung function was basically occurred mostly among manufacturing workers compared to administrative workers. This statement can be supported by a previous study from Al Neaimi et al. (2001) which has demonstrated that the ventilatory functions (FVC%, FEV_1%) were

significantly lower in the cement mill workers compared with the unexposed subjects which is the administrative group. A similar study was also found by Poornajaf et al. (2010) where the results indicated that the exposed workers had significantly lower ventilator indices of FVC, FEV_1, and FEV_1/FVC than the control group. They found about 35.7% of the exposed workers had abnormality in lung function compared with 5.7% of those unexposed. Meanwhile, for this study, it was found that about 26.2% develop abnormal lung function among manufacturing compared 8.3% from administrative workers.

Logistic regression was conducted after the result found that there is a significant difference between abnormalities of lung function. The result after adjusting for age and smoking status were still significant among manufacturing workers where the odd ratio for FVC% is 3.821 and odd ratio for FEV_1% is 5.161. There are actually 3.8 times more likely for the manufacturing workers to get a restrictive disease (FVC %) and 5.1 times more likely to get chronic obstructive disease (FEV_1%).

Manufacturing workers who likely to get restrictive type disease may have a hard time in fully expanding their lungs when inhale. Thus, it is difficult to fill the lungs with air and results in restriction when fully exhaled. This condition can be classified as silicosis where the inhaled of dust causes inflammation or scarring of the lung tissue (Caronia, 2017). Meanwhile, the result of significant FEV_1% may cause the manufacturing workers to get chronic obstructive disease which indicating

the exhaled air comes out more slowly than normal. There is a study by Neghab and Choobineh (2007) where they stated that chronic bronchitis has been the most frequent respiratory disease experienced by the exposed group in cement factory. In conclusion, finding from this study were clearly indicating that the decline of lung function can be due to the exposure of personal cement exposure ($PM_{2.5}$) based on other previous study.

5.1.5 Comparison of respiratory symptoms between administrative and manufacturing

Prevalence of respiratory symptoms among manufacturing workers was higher compared to administrative workers for cough. The prevalence of cough for manufacturing workers was contributing about 29.8% compared to 15.5% for administrative workers. After controlling for age and smoking status, the prevalence of respiratory symptoms was still higher among manufacturing workers compared to administrative workers for cough (OR = 2.40, CI% = 1.12, 5.15). The manufacturing workers were 2.4 times higher risk to develop cough as compared to administrative workers.

A previous study done by Noor et al. (2000) also found that cough was significantly higher among the exposed group than the control group. About 25 % of the workers who directly exposed to cement dust were reported for having cough compared to 5.7 % from the control group. A similar result was also obtained by

Zeleke et al. (2011), where chronic cough were significantly higher in prevalence than control. The increased in prevalence of cough may be due to high dust exposure, which caused by resuspension of dust particles during the shoveling piled dust. This activity may produce a continuous supply of dust to the breathing zone area, thus affecting the workers by depositing in the upper part of the airway.

Cough is the body's natural response in forcing the dirt and debris out of the lungs. Once the dust and dirt enter the lungs, cilia are unable to move freely in order to combat the particles out of the body. The infection will set in if the debris rest inside the lungs and cause the cilia to stop moving (Boehlke, 2013). In conclusion, many findings have supported that cement dust exposure and adverse respiratory health effects such as chronic cough have reported higher prevalence among exposed cement dust workers compared to control (Groneberg et al., 2006).

5.1.6 Comparison between Fractional Exhaled Nitric Oxide (FENO) between administrative and manufacturing workers

Analysis of airway inflammation among respondent was analyzed using NIOX MINO Airway Inflammation Monitor. The reading of FENO value was measured in part per billion and the all the classifications of FENO level were based on ATS guideline. A level less than 25 part per billion (ppb) was considered low, 25 to 50 ppb was considered intermediate while more than 50 ppb was considered heavy

exhaled of nitric oxide. The respondents were ensured that they met the criteria of performing FENO. This is done by selecting respondents who are free from any upper respiratory infection in order to avoid any incorrect FENO reading due to influence of medical status. The NIOX MINO Airway Inflammation monitor was performed only among manufacturing group (N=24) and administrative group (N=24). The justifications for this action was due to the limited budget of undergo a FENO assessment to all 168 respondents. Thus, only selected respondent who showed a symptom from doing lung function test was recruit in doing this FENO test.

Based on the result, the level of measured Fractional Exhaled Nitric Oxide (FENO) among manufacturing workers was recorded higher compared to administrative workers. The high level of FENO which is above 50 ppb was recorded among manufacturing workers with a total of 4 respondent compared to 0 respondent among administrative workers. According to Meo et al. (2014), the level of FENO was significantly increased with the increase of exposure dust level among cement mill workers compared to control. They found that the mean of FENO in ppb among exposed group was 31.71 ± 2.96 while the control group was 25.39 ± 2.46. Besides that, another study by Ulvested et al. (2001) reported that exposure to gas and dust would induce an airway inflammation. It was hypothesized that construction workers who has been exposed to dust for 1 year would have an early sign of upper and lower

airway inflammation as compared to the other workers. Sauni et al. (2012) also agreed with the statement where it found that exposure to silica dust among silica workers has caused an inflammatory response which demonstrated by increased alveolar concentration of Nitric Oxide. All of the studies above were in line with this finding that found manufacturing workers who directly exposed to dust may induce an airway inflammation.

5.1.7 Correlation between $PM_{2.5}$ exposure level and lung function among the respondents

Based on the result, there was a correlation between $PM_{2.5}$ exposure levels and lung function among manufacturing workers. The significant correlation is based on FVC% which recorded a p value less than 0.05 and r value of - 0.360. The r value shows that the decline of FVC% is the result from the increasing concentration of $PM_{2.5}$ among manufacturing workers. This result is congruent with a previous study from Poornajaf et al. (2010) who found 49% of personal exposure measurements that exceed the limits had lower lung function parameter in exposed workers compared to control. The FVC% which indicating the restrictive disease would likely to occur if there is continuity of personal exposure of $PM_{2.5}$. Mostly the result of concentration of $PM_{2.5}$ among manufacturing workers was exceeding the permissible exposure limit thus this result were significantly correlated the lung function status of the manufacturing workers even after adjusting for age and smoking status.

In conclusion, the decline of FVC where people with restrictive lung disease cannot fully fill the lungs with air can be due to the particles that deposited in the bronchial tree. This statement is supported by a study by Nordby et al. (2011) where the deposition eventually makes the person to restrict their lung to fully exhale air thus declining the lung function status.

5.1.8 Correlation between working duration and lung function among cement workers

Based on the result, the working duration and lung function showed a significant correlation among all respondents. The FEV_1/FVC among all respondents had a p value= 0.044 and r value =0.156. Although based on table 4.5, the result showed that comparison of working duration among manufacturing and administrative does not have significant difference but this result actually proved that the working duration does reduce the lung function. This statement can be supported by a study from Meo et al. (2013) where long term exposure for more than 10 years to cement dust prominently decreased the pulmonary function.

5.2 Conclusion

This study has found that personal exposure to cement dust ($PM_{2.5}$) may affect the lung function and also increase the high level of FENO which indicating airway inflammation especially among manufacturing workers compared to administrative workers. Besides that, the prevalence of respiratory symptoms was higher especially cough among manufacturing workers compared to administrative workers even after adjusting for age and smoking status. This showed that manufacturing workers are at high risk to get respiratory disease specifically restrictive airways disease with the high concentration of personal exposure to cement dust that exceed the permissible exposure limit set by Factories and Machinery (Mineral Dust) Regulations 1989.

Result obtained from statistical analysis that was used to test the hypothesis in the study proved that:

1. Concentration of exposure level of $PM_{2.5}$ between manufacturing workers is significantly higher than the administrative group in the cement industry.
2. The lung function of manufacturing workers is significantly lower than administrative group in the cement industry.
3. The respiratory symptoms reported by manufacturing workers are significantly higher compared to administrative group.
4. The Fractional Exhaled Nitric Oxide (FENO) level among manufacturing workers is significantly higher compared to administrative workers.

5. There is significant correlation between personal exposures with lung function among cement workers.
6. There is a significant correlation between working duration and lung function among cement workers.

5.3 Recommendation

Based on the result obtained, such recommendation need to be made as the level of personal exposure of $PM_{2.5}$ has exceeded the permissible exposure limit thus affecting the lung function and airway inflammation. The management of the company should take action and shall follow the Factories and Machinery (Mineral Dust) Regulations 1989.

5.3.1 Medical examination

A need of medical examination shall be arranged for the workers that exposed to dust. A periodical medical examination is very important as it can detect early changes of occupational disease to the workers. Examinations can include chest x-ray, lung function test, detailed examination for tuberculosis and any other laboratory test that is necessary. Any occupational related health disease should be taken into serious consideration and investigated as to prevent further occurrences.

5.3.2 Control equipment

Implement a control measure by using water spray for removing the airborne dust in the air. This method can be done to ensure that the workers exposure towards dust can be maintained below the limits. Water spray is used as method to suppress or capture the airborne dust and minimize the distance it travels. Any machinery operated should be inspected especially by a competent person.

5.3.3 Frequency of monitoring

Every worker who is engaged with any mineral process shall conduct an exposure monitoring in order to determine if any of the workers may be exposed to mineral dust at or above the action level which in this case for respirable dust ($PM_{2.5}$), the action level is 2.5 mg/m^3 due to its permissible exposure limit is 5 mg/m^3. Due to result showed that mostly the concentration of personal exposure level $PM_{2.5}$ in 8 hours has exceeded the limit, thus the worker exposure monitoring shall be conducted and repeat the monitoring once in every three months. The exposure monitoring was conducted to ensure that the exposure of cement dust can be controlled and inspected if it is exceeding a certain limit. The result of monitoring shall also be notified to the workers especially if it exceeds the limits without regard the use of respirator so that the workers can be in alert state about the status of exposure and take precaution by themselves.

5.3.4 Training and facilities

The management can provide a specific locker or changing room for the workers to change their clothes. A separate locker or separate dust proof locker can keep the workers' clothes in a hygienic condition thus prevent if any of the dust to be intact to the clothes. A training regarding the respiratory disease or any related course about occupational respiratory disease should be conducted to ensure the workers aware about disease related and manage to prevent the exposure of cement dust.

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APPENDICES

APPENDIX 1:
ETHICS APPROVAL

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

Research title	:	**Association Between Cement Dust Exposure (PM_{10} And $PM_{2.5}$) And Respiratory Health Among Cement Workers In Bahau, Negeri Sembilan**
Study Site	:	**Bahau, Negeri Sembilan**
JKEUPM Ref No.	:	**FPSK(EXP16-OSH)U009**
Researcher	:	**Nurul Shahira Bt Ahmad Razlan**
Supervisor	:	**Assoc Prof. Dr. Juliana Bt Jalaludin**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 18/10/2016
2. Respondent Information Sheet & Consent (English) Version 2 dated 15/12/2016
3. Respondent Information Sheet & Consent (Malay) Version 2 dated 15/12/2016
4. Proposal (English), Version 1 dated 18/10/2016
5. Questionnaire (Malay), Version 1 dated 18/10/2016
6. Curriculum Vitae of:
    a. Assoc Prof. Dr. Juliana Bt Jalaludin

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

Decision by JKEUPM:

[X] Approved

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

[ ] Disapproved

Please note that the approval is valid until 15 December 2017

Researchers should comply with the following:

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

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

APPENDIX 2:

RESEARCH PERMISSION FROM COMAPNY

A member of UEM

NSCI/HRD/Kebenaran Penyelidikan - 2017
17hb. Mac 2017

Nurul Shahira Binti Ahmad Razlan
Fakulti Perubatan dan Sains Kesihatan,
Universiti Putra Malaysia,
43400 UPM, Serdang,
Selangor Darul Ehsan.

Cik Nurul,

PERKARA : KEBENARAN MENJALANKAN KAJIAN PENYELIDIKAN KE ATAS PEKERJA

Pihak Syarikat telah meluluskan permohonan anda untuk menjalankan Kajian Penyelidikan Ke atas Pekerja, Negeri Sembilan Cement Industries Sdn. Bhd.

Sepanjang tempoh kajian penyelidikan itu anda adalah tertakluk dibawah peraturan Syarikat seperti berikut :-

1. **Tempoh Kebenaran**

   Sepuluh (10) hari bermula 22 Mac 2017 hingga 31 Mac 2017.

2. Anda wajib menghadiri *Safety Induction*/Induksi Keselamatan sebelum anda menjalankan Kajian Penyelidikan. Induksi Keselamatan ini akan berlangsung selama setengah hari. Kehadiran diWAJIBkan.

3. **Peraturan Syarikat**

   Sepanjang tempoh anda menjalankan penyelidikan, anda tertakluk kepada Peraturan Syarikat dan sebarang pelanggaran peraturan boleh dikenakan tindakan tatatertib terhadap anda tertakluk dengan peraturan Syarikat.

4. **Laporan Hasil Penyelidikan**

   Anda perlu menyerahkan satu salinan lengkap hasil penyelidikan tersebut untuk simpanan dan rujukan Syarikat.

5. **Akta Kerahsiaan**

   Anda tidak dibenarkan menyebarkan sebarang maklumat Syarikat secara langsung atau tidak langsung samada secara bertulis, lisan atau melalui media sosial sepanjang tempoh penyelidikan tersebut tanpa kebenaran dari Syarikat.

6. **Insuran**

   Anda mesti dilindungi oleh plan Insuran Universiti/Kolej atau persendirian sepanjang tempoh anda menjalani penyelidikan di Syarikat ini. Pihak Syarikat tidak menyediakan sebarang Perlindungan Insuran keatas anda.

Negeri Sembilan Cement Industries Sdn Bhd (37414-H)
Lot 3323, Mukim Of Kepis, Kuala Jelai, 72100 Bahau, Negeri Sembilan, Malaysia
Tel : +606-453 2030 Fax : +606-454 3869 Website : www.cima.com.my

APPENDIX 3:
CONSENT FORM

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

BORANG B1: PENERANGAN DAN PERSETUJUAN RESPONDEN

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

1.TAJUK KAJIAN

Hubungan Antara Pendedahan Debu Simen ($PM_{2.5}$) dan Kesihatan Pernafasan di Kalangan Pekerja Simen di Bahau, Negeri Sembilan.

2. PENGENALAN

Industri simen adalah salah satu industri yang menyediakan bahan binaan untuk kegunaan pembinaan bangunan. Walau bagaimanapun, industri simen mempunyai banyak hazad pekerjaan yang boleh mendedahkan risiko masalah kesihatan kepada orang awam dan juga pekerja seperti habuk bawaan udara. Pendedahan yang tinggi terhadap kepekatan habuk telah dikaitkan dengan penurunan fungsi paru-paru dan peningkatan terhadap hembusan Nitrik Oksida (FENO) atau radang inflamasi serta masalah simptom pernafasan di kalangan pekerja. Hal ini kerana, penyakit berkaitan masalah paru-paru adalah merupakan masalah yang ketiga biasa yang dialami oleh penyakit berkaitan pekerjaan.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Responden dikehendaki untuk menjawab soal selidik untuk mendapatkan maklumat mengenai tahap kesihatan anda. Selain daripada itu, responden diminta untuk menjalankan ujian fungsi paru-paru dengan menggunakan alat Spirometer dan ujian hembusan Nitrik Oksida (FENO) dengan menggunakan NIOX MINO. Berat dan tinggi responden akan direkodkan. Responden juga akan dibimbing untuk mengunakan alat Spirometer dan NIOX MINO oleh penyelidik. Responden akan menggunakan 'mouthpiece' yang akan ditukar ganti untuk setiap individu yang menjalankan ujian dan dikehendaki untuk menjalankan ujian tersebut sehingga mendapat keputusan yang terbaik.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Responden yang mempunyai masalah kesihatan atau menjalani rawatan berkaitan masalah jantung atau sistem pernafasan adalah tidak digalakkan untuk menyertai kajian ini. Hanya responden yang mempunyai kriteria tertentu sahaja yang dibolehkan untuk menyertai kajian. Berikut adalah senarai responden yang boleh menyertai kajian:

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

- Berumur 18 tahun hingga 55 tahun.
- Warganegara Malaysia dan jantina lelaki
- Pengalaman kerja tidak kurang atau lebih 6 bulan.
- Bekerja 8 jam sehari secara tetap
- Tidak mempunyai sistem masalah pernafasan semasa melakukan ujian

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Responden akan dapat mengetahui tahap kesihatan paru-paru dan saluran pernafasan mereka akibat terdedah kepada pencemaran habuk daripada kilang.

b) KEPADA PENYELIDIK?

Penyelidikan ini akan dapat membantu penyelidik untuk mengenal pasti tahap pencemaran yang berlaku di kilang. Tahap pencemaran yang berlaku di kilang mungkin menyumbang kepada faktor permasalahan sistem pernafasan para pekerja. Gejala-gejala yang dihidapi dapat digunakan sebagai penunjuk kepada tahap risiko kesihatan pekerja.

6. ADAKAH IA BERISIKO?

Tiada sebarang risiko merbahaya dalam kajian ini. Kesemua prosedur ujian fungsi paru-paru dan FENO akan berada di bawah pengawasan doktor perubatan dan dibantu oleh penyelidik. Semua data akan ditafsirkan dan didiagnos oleh doktor perubatan atau mana-mana pakar yang setara dalam bidang ini.

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Maklumat dan identiti yang diberikan untuk kajian ini akan kekal sebagai sulit dan tidak akan didedahkan. Butiran maklumat hanya akan digunakan untuk kajian penyelidikan dan keputusan hanya boleh diakses oleh pasukan penyelidik. Segala butiran individu tidak akan dimasukkan ke dalam mana-mana bahagian notis penyelidikan dan penerbitan.

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

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

PROFESOR MADYA DR JULIANA JALALUDIN
Penyelia utama
Jabatan Kesihatan Persekitaran dan Pekerjaan
Fakulti Perubatan dan Sains Kesihatan
Universiti Putra Malaysia (UPM)
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E-mel: juliana@upm.edu.my

NURUL SHAHIRA BINTI AHMAD RAZLAN
Penyelidik
Jabatan Kesihatan Persekitaran dan Pekerjaan
Fakulti Perubatan dan Sains Kesihatan
Universiti Putra Malaysia (UPM)
H/P: 017-2963424
E-mel: shahira.razlan@gmail.com

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

9. PERSETUJUAN

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

.....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

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

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

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

*potong yang tidak berkenaan

Tandatangan .....
(*Responden*)

Tandatangan .....
(*Saksi*)

Tarikh :.....

Nama :.....

No. K/P: .....

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

Tarikh .....

Tandatangan .....
(*Penyelidik*)

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

FORM B1: RESPONDENT'S INFORMATION SHEET AND CONSENT

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

1. STUDY TITLE :

Association between cement dust exposure ($PM_{2.5}$) and respiratory health among cement workers in Bahau, Negeri Sembilan

2. INTRODUCTION:

Cement industry is one of the industries that provide building materials for building construction. However, cement industry possesses a variety of occupational hazards which can lead to risk of health problem to the public and workers due to the airborne dust particles in the air. High concentration of dust exposure has been associated with decreased in ventilatory lung function and high level of Exhaled Nitric Oxide (FENO) or airway inflammation and prevalence of respiratory symptoms among workers. Occupational lung disease has been stated as the third common occupational disease experienced by the workers.

3. WHAT WILL YOU HAVE TO DO?

The respondent need to fill up the questionnaire in order to get the information regarding the respondent's health status level. Besides that, the respondent will asked to carry out the lung function test using Spirometer and Fractional Exhaled Nitric Oxide (FENO) using NIOX MINO.Weight and height of the respondent will be recorded. The respondent will be guided by the researcher to use the Spirometer and NIOX MINO. Each of the respondent that undergo lung function test and FENO will use a different mouthpiece and need to perform the test until they get the best result.

4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

Respondent who have health problem or undergo treatment related to heart problem or repsiratory system is not recommended to participate in this study. The respondent who only comply to the inclusion criteria are welcome and will be selected as a participant in this research study. The inclusion criteria are as follows:

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

- Age 18 to 55 years old
- Malaysian citizen and male gender
- Working duration of equal or longer than 6 months
- Working permanently 8 hours a day
- Not having any symptoms of upper respiratory illness during sampling

5. WHAT WILL BE THE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

From the test conducted, the respondent will be able to know their lung function level and respiratory health due to the cement dust exposure at the industry.

(b) TO THE INVESTIGATOR?

This study will help the researcher to identify the level of exposure exist in cement industry. The exposure level in this industry could be the contributing factor of respiratory health problem among workers. All of the symptoms identified can be the indicator of the workers health risk.

6. WHAT ARE THE POSSIBLE RISKS?

There is no possible risk arise from this study. All procedure involved in lung function test will be supervise by medical doctor and assist by researcher. The data will be interpreted and diagnose by the medical doctor or any equivalent expertise in this field.

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

All the information and identity of the respondent given will remain private and confidential. The information obtained will only used for research purpose and all the result can only be accessed by the research team. The details of the individual will not be included in any part of the research and publication notice.

Please initial here if you have read and understood the contents of this page_____

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

ASSOCIATE PROFESSOR DR JULIANA JALALUDIN
Main Supervisor
Department of Environmental and Occupational Health
Faculty Medicine & Health Sciences
Universiti Putra Malaysia (UPM)
Office: 03-89472397
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Department of Environmental and Occupational Health
Faculty Medicine & Health Sciences
Universiti Putra Malaysia (UPM)
H/P: 017-2963424
Email: shahira.razlan@gmail.com

Please initial here if you have read and understood the contents of this page_____

9. CONSENT

I ..... Identity Card No. .....
address.....
. .....hereby voluntarily agree to take part in the research stated above *(clinical /drug trial/video recording/ focus group/interview-based/ questionnaire-based).

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

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

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

* delete where necessary

Signature .....
(Respondent)

Signature .....
(Witness)

Date :.....

Name :.....

I/C No. :.....

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

Date .....

Signature .....
(Researcher)

APPENDIX 4:
QUESTIONNAIRE

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

BORANG SOAL SELIDIK

TAJUK:

HUBUNGAN ANTARA PENDEDAHAN DEBU SIMEN ($PM_{2.5}$) DAN KESIHATAN PERNAFASAN DI KALANGAN PEKERJA SIMEN DI BAHAU, NEGERI SEMBILAN

Tarikh soal selidik

_____ /_____ / _____
HARI BULAN TAHUN

Terdapat **LIMA** bahagian di dalam soal selidik ini dimana **BAHAGIAN A** tentang maklumat peribadi, **BAHAGIAN B** tentang maklumat pekerjaan, **BAHAGIAN C** tentang sejarah kesihatan pernafasan, **BAHAGIAN D** tentang alahan dan **BAHAGIAN E** tentang kesedaran kesihatan pernafasan.

Sila fahami dan jawab semua soalan di dalam borang kaji selidik. Anda diminta untuk mengisi kesemua soalan tersebut. Sila jawab soalan-soalan tersebut dengna tulus dan tepat. Sekiranya mempunyai sebarang pertanyaan atau memerlukan pertolongan bagi mengisi borang kaji selidik ini, anda boleh meminta bantuan daripada penyelidik di dalam kajian ini. Selepas tamat menjawab kesemua soalan, borang kaji selidik ini perlu dikembalikan.

Terima kasih kerana sudi menjawab boring kaji selidik ini.

SEMUA MAKLUMAT YANG DIPEROLEHI DALAM KAJIAN INI ADALAH SULIT DAN HANYA DIGUNAKAN BAGI TUJUAN PENYELIDIKAN SAHAJA.

BAHAGIAN A: MAKLUMAT PERIBADI

Umur :

Jantina : Lelaki ☐ Perempuan ☐

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

Status Perkahwinan : Bujang ☐ Berkahwin ☐

Berat : .....kg Tinggi : .....cm

Status merokok : Tidak pernah ☐

Merokok ☐ ..... Tahun

Berhenti ☐ ..... Tahun

Vaping ☐ ..... Tahun

Kekerapan merokok: Tiada ☐

Merokok ☐ .....batang/sehari

Vaping ☐ hari/30ml

Pengangkutan ke tempat kerja:

Motosikal ☐

Kereta ☐

Lain-lain ☐

BAHAGIAN B: MAKLUMAT PEKERJAAN

1) Sejarah pekerjaan terdahulu

1. Sebelum bekerja di syarikat sekarang, pernahkan anda bekerja di tempat lain?

   Ya ☐ Tidak ☐

2. Jika Ya, sila nyatakan pekerjaan dan tempat pekerjaan anda yang terakhir:

   _____

3. Berapa lamakah anda telah bekerja di syarikat terdahulu?

   _____ Tahun

4. Adakah pekerjaan terdahulu menyebabkan anda mengalami sebarang gangguan kesihatan seperti penyakit peparu?

   Ya ☐ Tidak ☐ Jika Ya, sila nyatakan masalah kesihatan: _____

2) Maklumat pekerjaan semasa

Posisi : _____

Jabatan : _____

1. Berapa lamakah anda telah bekerja di syarikat ini?

   _____ Tahun

2. Status pekerjaan:

   Separuh masa ☐ Sementara ☐

   Sepenuh masa ☐ Kontrak ☐

3. Waktu bekerja:

Shift bergilir ☐ .....jam Petang ☐ .....jam

Waktu pejabat ☐ .....jam Malam ☐ .....jam

4. Adakah tempat bekerja anda berdebu?

Rendah ☐

Sederhana ☐

Tinggi ☐

5. Adakah tempat bekerja anda mempunyai sistem pengudaraan?

Ya ☐ Tidak ☐

BAHAGIAN C: SEJARAH KESIHATAN PERNAFASAN

1. Adakah anda mempunyai sebarang sejarah penyakit berkaitan pernafasan? Contoh asma, pneumonia jangkitan salur pernafasan

Ya ☐ Tidak ☐ Jika Ya, sila nyatakan: _____

Sejak _____

2. Adakah anda menerima sebarang rawatan perubatan atau mengambil ubat berkaitan penyakit pernafasan dalam tempoh 6 minggu ini?

Ya ☐ Tidak ☐ Jika Ya, sila nyatakan: _____

Pada _____

3. Adakah anda pernah menjalani pembedahan berkaitan masalah pernafasan atau jantung?

Ya ☐ Tidak ☐ Jika Ya, sila nyatakan: _____

Pada _____

4. Adakah ahli keluarga anda mempunyai sebarang sejarah penyakit berkaitan pernafasan?

   contoh: Asma, Jangkitan salur pernafasan

   Ya ☐ Tidak ☐ Jika Ya, sila nyatakan: _____

Simptom Pernafasan: BATUK

1. Adakah anda kerap batuk?

   Ya ☐ Tidak ☐

2. Adakah anda sering batuk 4 hingga 6 kali sehari atau berlarutan selama 4 hari seminggu?

   Ya ☐ Tidak ☐

3. Adakah anda batuk semasa bangun daripada tidur atau pada waktu pagi?

   Ya ☐ Tidak ☐

4. Adakah anda batuk waktu siang atau malam?

   Ya ☐ Tidak ☐

5. Adakah anda batuk untuk selama 3 bulan berturut-turut dalam setahun?

   Ya ☐ Tidak ☐

6. Bilakah kerap anda batuk?

   Demam ☐ Pagi/sejuk ☐

   Bekerja ☐ Seharian ☐

7. Berapa tahun lamakah anda mengalami batuk ini?

   Sila nyatakan: _____

Sistem pernafasan: KAHAK

1. Adakah anda sering berkahak berpunca daripada bahagian dada anda?

   Ya ☐ Tidak ☐

2. Adakah anda berkahak lebich daripada 2 kali sehari dan berlarutatan selama 4 hari dalam seminggu?

   Ya ☐ Tidak ☐

3. Adakah anda batuk batuk semasa bangun daripada tidur atau pada waktu pagi?

   Ya ☐ Tidak ☐

4. Adakah anda batuk berkahak waktu siang atau malam?

   Ya ☐ Tidak ☐

5. Adakah anda berkahak untuk selama 3 bulan berturut-turut dalam setahun?

   Ya ☐ Tidak ☐

6. Bilakah kerap anda mengeluarkan kahak?

   Demam ☐ Pagi/sejuk ☐

   Bekerja ☐ Seharian ☐

7. Berapa tahun lamakah anda kerap mengeluarkan kahak ini?

   Sila nyatakan: _____

Simptom pernafasan: NAFAS BERBUNYI

1. Adakah nafas anda sering berbunyi seperti wisel?

   a) Apabila anda mengalami selsema Ya ☐ Tidak ☐

   b) Kadang kala di samping selsema Ya ☐ Tidak ☐

   c) Hampir setiap hari(siang atau malam) Ya ☐ Tidak ☐

2. Jika Ya (Untuk jawapan a, b, c) berapa lamakah perkara ini berterusan?

_____ Tahun

3. Pernahkah anda mengalami nafas berbunyi sehingga sukar bernafas?

Ya ☐ Tidak ☐

Simptom pernafasan: SESAK DADA

1. Pernahkah anda mengalami susah bernafas dan terasa sesak di dada?

Ya ☐ Tidak ☐

2. Bilakah kerap anda mengeluarkan kahak?

Demam ☐ Pagi/sejuk ☐

Bekerja ☐ Seharian ☐

3. Pernahkah anda mengalami sesak di dada selama 2 bulan berturut?

Ya ☐ Tidak ☐

BAHAIGIAN D: ALAHAN

1. Adakah anda mempunyai sebarang alahan? Contoh: makanan laut, kekacang, debu, gas, bulu

Ya ☐ Tidak ☐

2. Adakah anda mempunyai haiwan peliharaan? Contoh: kucing,

Ya ☐ Tidak ☐

3. Adakah anda mempunyai karpet di rumah?

Ya ☐ Tidak ☐

4. Adakah anda tidur di bilik berhawa dingin setiap hari?

Ya ☐ Tidak ☐

5. Adakah anda mempunyai simptom-simptom alahan? Contoh: bitnik merah,gatal pada kulit, batuk, sesak nafas

Ya ☐ Tidak ☐ Jika Ya, nyatakan: _____ sejak _____

6. Adakah anda menerima sebarang rawatan perubatan atau mengambil ubat untuk alahan dalam tempoh 6 minggu ini

Ya ☐ Tidak ☐ Jika Ya, nyatakan: _____ pada _____

BAHAGIAN E: KESEDARAN KESIHATAN PEKERJAAN

1. Adakah anda sedar risiko pekerjaan terhadap kesihatan pernafasan anda?
   Ya ☐ Tidak ☐

2. Adakah anda memakai alat pernafasan yang sesuai semasa bekerja?
   Ya ☐ Tidak ☐

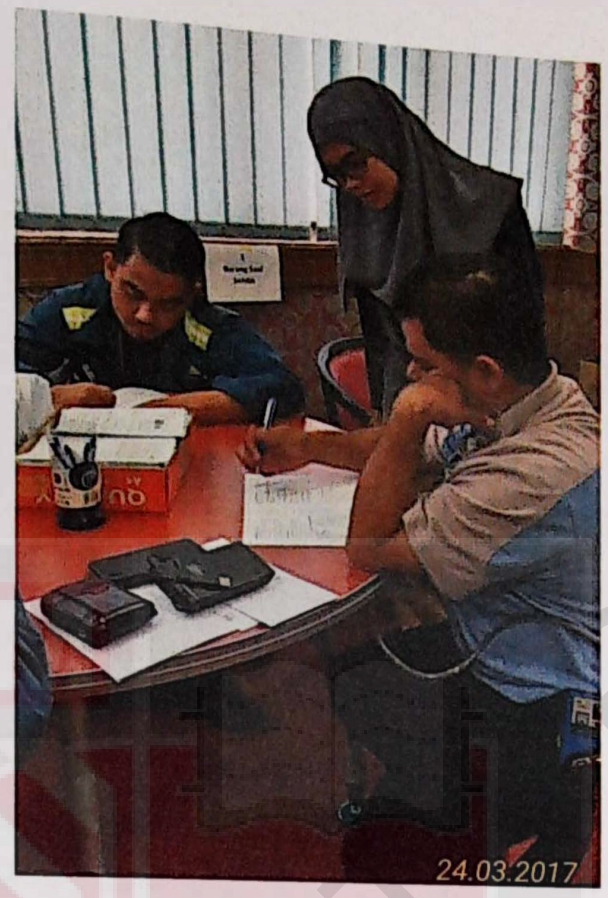
3. Adakah anda membersihkan pakaiana anda sebelum pulang ke rumah?
   Ya ☐ Tidak ☐

4. Adakah anda mempunyai pengetahuan tentang sebarang masalh pernafasan?
   Ya ☐ Tidak ☐

5. Adakah anda berpendapat alat perlindungan pernafasan yang diberikan mencukupi untuk melindungi pernafasan anda?
   Ya ☐ Tidak ☐

APPENDIX 5:

PICTURE OF RESEARCH



a) Briefly explained the research and guide the respondent in answering the questionnaire.

b) During conducting a lung function test.