



UNIVERSITI PUTRA MALAYSIA

***EXPOSURE TO PM10 AND RESPIRATORY HEALTH AMONG
WELDERS IN METAL WORKING FACTORY, SERI KEMBANGAN,
SELANGOR***

**BY
NUR AIDA BINTI AZIZ**

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ABSTRACT

EXPOSURE TO PM₁₀ AND RESPIRATORY HEALTH AMONG WELDERS OF METAL WORKING FACTORY IN SERI KEMBANGAN, SELANGOR

Background: Welding fume exposure in the workplace is a serious occupational hazard and about 800,000 welders are employed full time worldwide. Welding is the process of joining metal part in which the surface layers of the metals are in most cases heated to fusion, with or without pressure. It is one of the key components of numerous metal working industries which potentially have physical and chemical health hazards. **Objective:** The aim of this study was to determine the association between personal exposure to PM₁₀ and lung functions as well as respiratory symptoms among welders of metal working factory and office workers as comparative group. **Methodology:** A cross-sectional comparative study was conducted among 33 welders working at metal working factory and 43 office workers as comparative group. A purposive sampling method was used to select on the respondents based on inclusive criteria such as male, age range between 18 to 45 years, no past history of chronic lung disease, and at least 1 year experienced on working. Questionnaire based on ATS was used to collect information on socio-demographic and respiratory symptoms. The lung function test was also performed using Chestgraph HI-101 as well as measured their personal PM₁₀ exposure using GillAir Pump. **Result:** The mean exposure level of PM₁₀ among welder was $444.9 \mu\text{g}/\text{m}^3 \pm 198.4$ compared to only $116.4 \mu\text{g}/\text{m}^3 \pm 9.81$ among the comparative group. There was significant different in FVC (liter) with $z = -2.93$, $p = 0.03$, FEV₁ (liter) with $z = -3.10$, $p = 0.02$, FVC% predicted $z = -3.15$, $p = 0.02$ and FEV₁% predicted with $z = -3.81$, $p < 0.001$ between the exposed group and comparative group. Prevalence of respiratory symptoms was significantly higher among exposed group compared to comparative group for chronic cough (O.R = 6.67, 95% CI 1.68-26.5, $p = 0.003$), Chronic phlegm (O.R 13.2, 95% CI 3.83-45.7, $p < 0.001$) and chest tightness (O.R = 24, 95% CI = 2.92-197.2, $p < 0.001$). Spearman's rho test showed there was no significant association ($p > 0.05$) between lung function with the level of PM₁₀ and duration of employment. The logistic regression showed that exposure to PM₁₀ can increase risk of chronic cough and exposed group is one of the factors contributing to significant risk of chronic cough, chronic phlegm and chest tightness even after adjusted for smoking. **Conclusion:** Results from this study found that exposure to respirable particle PM₁₀ can increase risk of respiratory health by shows the reduction in lung function and increase prevalence of respiratory symptom among welders

Keywords: PM₁₀, lung function test, respiratory symptom, welders

ABSTRAK

PENDEDAHAN KEPADA PM₁₀ DAN KESIHATAN PERNAFASAN DALAM KALANGAN PENGIMPAL PEKERJA KILANG LOGAM PEMBUATAN DI SERI KEMBANGAN, SELANGOR.

Latar belakang: Kimpalan wasap pendedahan di tempat kerja adalah hazad pekerjaan yang serius dan lebih kurang 800,000 orang pengimpal bekerja sepenuh masa di seluruh dunia. Kimpalan adalah proses menggabungkan bahagian logam di mana lapisan permukaan logam dalam kebanyakan kes digabungkan menggunakan haba, dengan atau tanpa tekanan. Ia merupakan salah satu komponen utama dalam industry kerja logam yang berpotensi mempunyai bahaya kesihatan fizikal dan kimia. **Objektif:** Tujuan kajian ini adalah untuk menentukan kaitan di antara pendedahan peribadi kepada PM₁₀ dan fungsi paru-paru serta gejala-gejala pernafasan di kalangan pengimpal yang bekerja di kilang logam dan pekerja pejabat sebagai kumpulan perbandingan. **Metodologi:** Satu kajian perbandingan keratan rentas telah dijalankan di kalangan 33 pengimpal yang bekerja di kilang logam dan 43 pekerja pejabat daripada sebagai kumpulan perbandingan. Satu kaedah pensampelan bertujuan telah digunakan untuk memilih responden berdasarkan kriteria seperti lelaki, julat umur antara 18 hingga 45 tahun, tiada sejarah penyakit paru-paru kronik, dan sekurang-kurangnya 1 tahun tempoh bekerja. Borang soal selidik ATS telah digunakan untuk mengumpul maklumat mengenai gejala sosio-demografi dan pernafasan. Ujian fungsi paru-paru juga telah dijalankan menggunakan Chestgraph HI-101 dan seperti persampelan pendedahan PM₁₀ peribadi dengan menggunakan pam GillAir. **Keputusan:** Tahap pendedahan min PM₁₀ antara pengimpal adalah $444.9 \mu\text{g}/\text{m}^3 \pm 198.4$ berbanding hanya $116.4 \mu\text{g}/\text{m}^3 \pm 9.81$ di kalangan kumpulan perbandingan. Terdapat perbezaan yang signifikan dalam FVC (liter) dengan $z = -2.93$, $p = 0.03$, FEV₁ (liter) dengan $z = -3.10$, $p = 0.02$, % FVC pula mendapati $z = -3.15$, $p = 0.02$ dan FEV₁ dengan $z = -3.81$, $p < 0.001$ antara kumpulan terdedah dan kumpulan perbandingan. Prevalens gejala pernafasan lebih tinggi dikalangan kumpulan yang terdedah berbanding dengan kumpulan perbandingan untuk batuk kronik (OR=6.67, 95%CI-1.68-26.5, $p = 0.003$), kahak kronik (OR=13.2, 95%CI-3.83 -45.7, $p < 0.001$) dan sesak dada (OR=24, 95% CI=2.92-197.2, $p < 0.001$). Ujian Spearman rho menunjukkan tiada korelasi yang signifikan ($p > 0.05$) antara fungsi paru-paru dengan tahap PM₁₀ dan tempoh pekerjaan. Regresi logistik menunjukkan bahawa pendedahan kepada PM₁₀ meningkatkan risiko batuk yang kronik dan kumpulan terdedah adalah salah satu factor yang menyumbang kepada risiko penting batuk kronik, kahak kronik dan ketegangan dada walaupun selepas diselaraskan untuk merokok. **Kesimpulan:** Hasil kajian ini mendapati bahawa pendedahan zarah nafas PM₁₀ boleh meningkatkan risiko kesihatan pernafasan dengan menunjukkan pengurangan dalam fungsi paru-paru dan kekerapan peningkatan gejala pernafasan di kalangan pengimpal.

Kata kunci: PM₁₀, ujian fungsi paru-paru, gejala pernafasan, pengimpal

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CHAPTER 1

INTRODUCTION

1.1 Background

Welding provides a powerful manufacturing tool for high quality joining of metallic components. Essentially, all metals and alloys can be welded; some with ease, others requiring special precautions. For hundreds of years, even since metals were used by man, joining parts was accomplished by riveting, screwing or bolting. In the last decades that these traditional methods have been replaced almost entirely by welding. Electric welding was introduced in about 1940 and manual metal arc welding has become the predominant method. Uncoated and acidic coated electrodes were used up to the early 1950s. These electrodes produced an abundance of fumes. By the mid 1950s basic coated electrodes were mainly used. In the 1970s gas shielded welding and tungsten inert gas welding were introduced. Welding on aluminum and on zinc primed steel occasionally took place before 1970. Until 1976 welding was performed mainly on mild steel. From 1977 onwards stainless steel was gradually introduced and by 1990 about 50% of the welding arc time was carried out on stainless steel (Danielsen, 1993).

Essentially, all metals and alloys can be welded; some with ease, others requiring special precautions. Of these processes, some of the more common types include shielded manual metal arc welding (MMAW), gas metal arc welding (GMAW), flux-cored arc welding (FCAW), submerged arc welding (SAW), gas tungsten arc welding (GTAW), and others such as, plasma arc welding, and oxygas welding. Each method has its own particular metallurgical and operational advantages, and each may present its own potential health and safety hazard. Thus, welders are not a homogeneous group. They work under a variety of conditions—outdoors, indoors in open as well as confined spaces, underwater, and above ground on construction sites, utilizing a large number of welding and cutting processes (NIOSH U.S, 2002).

The welding exposure is unique. There is no material from any other source directly comparable to the composition and structure of welding fumes. The composition and the rate of generation of welding fumes are characteristic of the various welding processes, and are affected by the welding current, shielding gases, and the technique and skill of the welder. The type of welding process is directly related to the amount of fumes and gases that are generated. Therefore, it is important to have a basic understanding of the welding process in order to assess the risk of exposure. The American Conference of Governmental Industrial Hygienist (ACGIH) has assigned welding fumes a Threshold Limit Value of 5 milligrams per cubic meter (mg/m^3) as a TWA for a normal 8-hour workday and a 40-hour

workweek. The rationale of the limit is based on the risk of toxic effect caused by welding fumes (ACGIH, 1994).

The chemical properties of welding fumes can be quite complex it is due to most welding materials are alloy mixtures of metals characterized by different steels that may contain iron, manganese, silica, chromium, and nickel. Fumes generated from stainless steel electrodes usually contain about 20 % chromium with 10 % nickel, whereas fumes from mild steel welding are usually > 80 % iron with some manganese and no chromium or nickel present. Both chromium and nickel have been classified as human carcinogens (NIOSH U.S, 2002).

Several irritant gases, such as carbon monoxide, ozone, and oxides of nitrogen, may be generated in significant quantities during common arc welding processes due to different shielding gases and fluxes used. The particles size distribution of welding fumes is an important factor in determining the hazard potential of the fumes because it is an indication of the depth to which the particles may penetrate into the lungs and the number of particles retained therein. Most of the particles in welding fume are less than 1µm in diameter when produced, but they appear to grow in size with time due to agglomeration. Common chemical hazards include particulate and gases (Ozdemir, 1995).

When a welder strikes an arc, the arc's heat vaporizes a small quantity of metal and releases welding fumes into the air, which can adversely affect the health

of the welder as well as the health of those in the immediate area (Rice, 2011). Occupational exposure to welding fume is a serious occupational health problem all over the world. National Institute of Occupational Health and Safety (NIOSH) estimated that 400,000 workers are employed in the U.S. as welders, cutters, solderers, and brazers in the U.S. in 1999. An estimated 800,000 workers are employed full-time time as welders worldwide. Still much larger numbers, believed to be more than one million, perform welding intermittently as part of their work duties. Large numbers of welders experience some type of adverse health effect. Respiratory effects seen in full-time welders have included bronchitis, airway irritation, metal fume fever, lung function changes, increased susceptibility to infection, and a possible increase in the incidence of lung cancer. Even less information is available about the systemic and dermal effects after welding fume exposure (NIOSH U.S, 2002). IARC was finally concluded that welding fumes are possibly carcinogenic to human (IARC, 1990)

1.2 Problem Statement

Rapid industrialization has resulted in increasing the welding industry in Malaysia especially in metal working and manufacturing industry. Most of the welders at the medium industries perform their work without proper and complete personal protective equipment. They just wear used clothes to cover their breathing zone and the same cloth used repeatedly during their work days. As they performed worked in the open situation, the dust concentration must be higher due to not proper ventilation were considered to control the high released of welding fumes especially during increase of production.

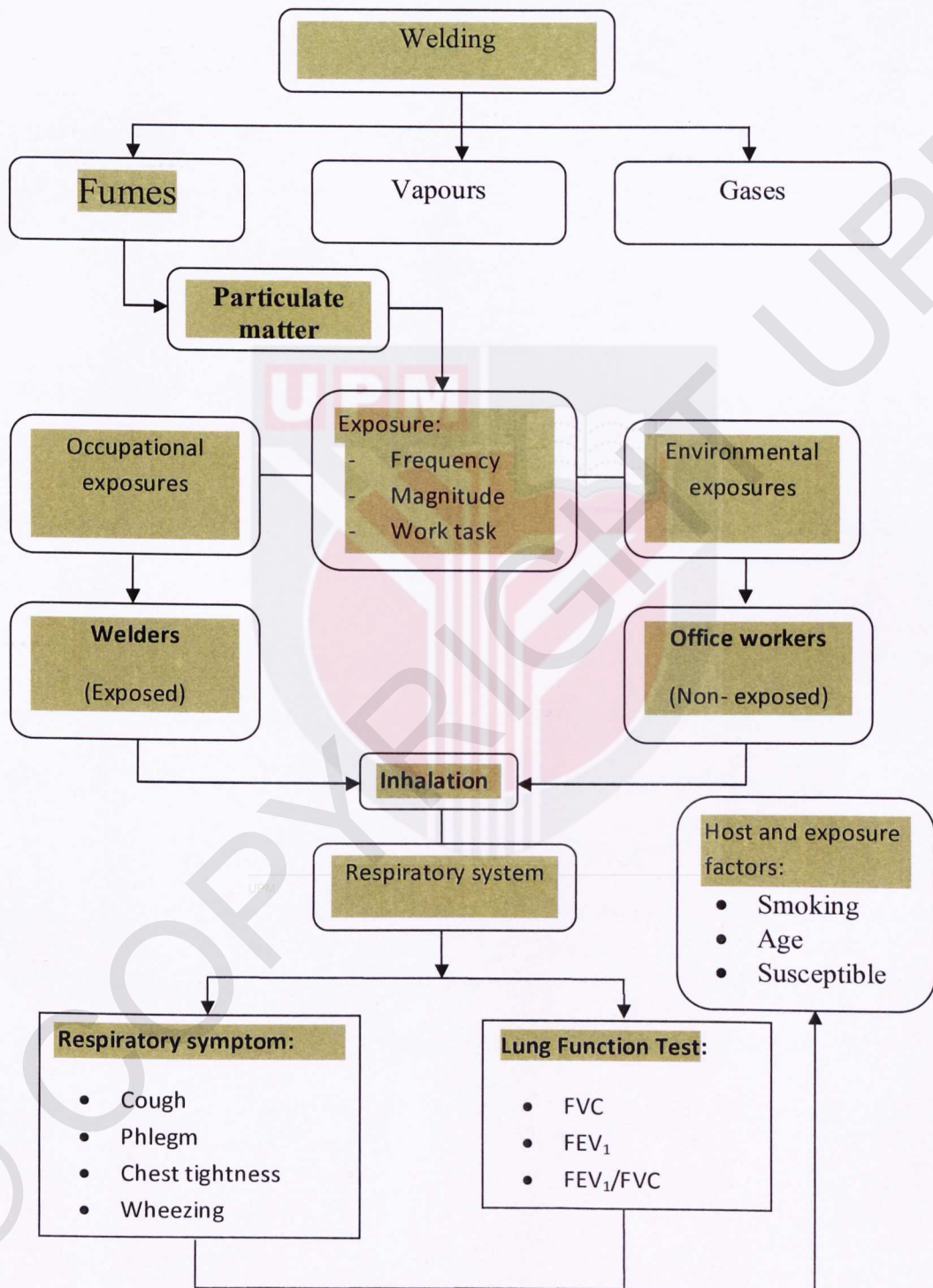
As illustrated in Figure 1.1, welding activities released fumes in the air upon cooling and condensation of substances volatilized by the heat of the welding process. As a rule, the particle size of fumes is in the micron or submicron range, but such particles may coalesce and form larger aggregates. Most fume particles are in the “respirable” category, and may thus penetrate deep into the respiratory system and be deposited there. Therefore, all welding processes involve the potential hazards for inhalation as welders are exposed to a varied tiny mixture of toxic particulates that are believed to put a large number of workers at increased risk of adverse health effects.

Welding exposure adversely affect respiratory as the primary route was mainly by inhalation. Inhalation of welding fume produces several unusual clinical

syndromes in welders with different acute and chronic effect. Metal fume fever is the most frequently observed acute respiratory illness of welders, and may occur during and after welding activities meanwhile a follow up study was investigated the long-term exposure to welding fumes particulates found the decline in FEV₁ among welders compared to non-welders (Sigve, 2008). In addition, welders also increased risk to have respiratory symptoms due to exposures to welding fumes. However, other than exposure to PM₁₀ there are some predictors that also can influence the respiratory health of the welders such as smoking status, work duration and age.

Therefore, the aim of this study was to determine the relationship between personal exposures to PM₁₀ on respiratory health among welders and un-exposed group as comparisons.

Figure 1.1 : Conceptual frameworks:



1.3 Study Justification

Welders are exposed to a varied mixture of toxic particulates and noxious gases that are believed to put a large number of workers at increased risk of adverse health effects. However there have been numerous studies of welding exposure but there were limitation as the result of the study on respiratory health have not been consistent. This study is important to carry out because to know the effect on respiratory health of welders who is exposed to welding particles of PM₁₀, particularly in Malaysia industry as there are limited data and only a few research been done for this study. It was determined through the symptoms of respiratory abnormalities and lung dysfunction observed in the welders and unexposed group.

Hence, this study was gathered the information on PM₁₀ exposures and respiratory health of workers. The results obtained from this study can be used to recommend the preventive and control measures in order to minimize the exposures and enhance the respiratory health and protection of the workers. The suggestion can depends on hierarchy of control such as eliminate, substitute or engineering control as well as personal protection by provided protective respirator to all expose workers which expose more than the limit. Other than that, the results from this study also can be benefited as references for further or longitudinal study especially in Malaysia.

1.4 Study Objective

1.4.1 General objective:

This study was to determine the relationship between personal exposure to PM_{10} with respiratory health among welders of metal working factory and office workers as comparative group.

1.4.2 Specific objectives:

1. To compare concentration of personal PM_{10} exposure among welders and non-exposed group.
2. To compare the respiratory symptoms among welders and non-exposed group.
3. To compare lung function level (FVC, FEV_1) among welders and non-exposed group.
4. To determine the relationship between personal PM_{10} exposure with lung function among welders.
5. To determine the relationship between duration of work with lung function among welders.

1.5 Study Hypothesis

1. The concentration of personal PM_{10} exposure is significantly higher among welders compared to non-exposed group.
2. The respiratory symptoms are significantly higher among welders compared to non-exposed group.
3. Lung function (FVC, FEV_1) are significantly lower among exposed group compared to non-exposed group.
4. The personal exposure to welding fumes (PM_{10}) is significantly associated with lung function among welders.
5. The duration of work is significantly associated with lung function among welders.

1.6 Definition of Variables

1.6.1 Conceptual Definition

a) Particulate Matter 10 (PM₁₀)

Particulate matter is identified as coarse particles consist of airborne solid particles and liquid droplets which are smaller than 10micrometer.

b) Chronic cough

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

c) Chronic phlegm

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

d) Chest tightness

A combination of cough or phlegm or increase of cough or phlegm in cases where the subject coughs or having phlegm continuously (ATS, 1978)

e) Wheezing

A rasp or whistle sound during breathing. Having wheezing of whistling sound in breathing associated with breathlessness on most days or nights (ATS, 1978)

f) Forced Vital Capacity (FVC)

Maximum volume of air exhaled after doing maximum inspiration expressed in Liter. FVC reduce in condition that cause restriction in lung volume, air flow limitation or sub maximum inspiration of respondent (ATS, 1995).

g) Forced Vital Expiratory Volume in One Second (FEV_1)

Forced expiratory in one second defined as air volume in liter that being exhales as much as can in first one second, expressed in liters. FEV_1 will be reduced if there are obstructions in air flow (ATS, 1995).

1.6.2 Operational Definition

a) Particulate Matter (PM₁₀)

Particles of 10 micrometer or less in aerodynamic diameter was collected by using personal air sampling pump with Mixed Cellulose Ester (MCE) filter, 0.8 microns. Concentration of PM₁₀ particles were measured in micrograms per cubic meter.

a) Chronic cough

Symptoms of chronic cough identified from the study based on questionnaire (ATS, 1978).

b) Chronic phlegm

Symptoms of chronic phlegm identified from the study based on questionnaire (ATS, 1978).

c) Chest tightness

Symptoms of chest tightness identified from the study based on questionnaire (ATS, 1978).

d) Wheezing

Symptoms of wheezing identified from the study based on questionnaire (ATS, 1978).

e) Forced Vital Capacity (FVC)

The measurement of maximally and forcefully exhales the volume of air by using spirometer (Model Chestgraph HI-101) expressed in liters (ATS, 1995).

f) Forced Vital Expiratory Volume in One Second (FEV₁)

The measurement of maximal volume of exhaled in 1 second of FVC by using spirometer (Model Chestgraph HI-101) expressed in liters (ATS, 1995).



CHAPTER 2

LITERATURE REVIEW

2.1 Welding Process

Welding is the method of joining two metal parts together by applying intense heat between them, which causes the parts to melt and intermix. This process can be done directly between the two parts or through the use of an intermediate molten filler metal. The filler, base metal and base metal coating used during welding operations and the subsequent gases that are formed during the welding process release small, solid particles into the air creating a plume. This plume is called "welding fumes."

2.2 Welding emission

Each welding technique and application produces a characteristic range of particulate composition and morphology. The factors affecting the quantity of fume generated are the process and process parameters, of which the process is the most important factor. Besides, welding released fumes into the air when welders strike an

arc and the arc's heat vaporizes a small quantity of metal and releases fumes. The Particulate matter and particulate-phase hazardous air pollutants are the major concerns in the welding processes. The electric arc is known as welding process that has greatest emission potential while the lower operating temperatures of the other welding processes can cause fewer fumes to be released. Most of the particulate matter produced by welding is submicron in size and, as such, is considered to be all PM_{10} (U.S EPA).

The elemental composition of the fume varies with the electrode type and with the work piece composition. Hazardous metals designated in the 1990 Clean Air Act Amendments that have been recorded in welding fume include manganese (Mg), nickel (Ni), chromium (Cr), cobalt (Co), and lead (Pb). Gas phase pollutants are also generated during welding operations, but little information is available on these pollutants. Known gaseous pollutants (including "greenhouse" gases) include carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_x), and ozone (O_3) (U.S. EPA)

2.3 PM_{10} deposition in lung of welder

The releasing fumes of metal-rich fine particles may be inhaled by welders and nearby workers. Welding generates high levels of metal fume, which is comprised primarily of fine and ultrafine particles. As all particles of welding fumes are considered to be all PM_{10} it is can be considered among the most harmful of all

air pollutants. When inhaled, these particles evade the respiratory system's natural defenses and lodge deep in the lungs. Health problems begin as the body reacts to these foreign particles. PM_{10} can increase the number and severity of asthma attacks, cause or aggravate bronchitis and other lung diseases, and reduce the body's ability to fight infections.

Although particulate matter can cause health problems for everyone, certain people are especially vulnerable to PM_{10} adverse health effects. These susceptible populations include children, the elderly, exercising adults, and those suffering from asthma or bronchitis. Of greatest concern are recent studies that link PM_{10} exposure to the premature death of people who already have heart and lung disease, especially the elderly.

2.4 Mechanism of particles and response of respiratory tract

When particles are in the air, there is the chance that someone inhaled them. How far the particle gets in the air passages of the respiratory system and what it does when it is deposited, depends on the size, shape, and density of the particulate material. There are three regions which are considered as respiratory system, that is first, upper airways include nasal passages, nasopharynx, oral cavity, pharynx and larynx, second the conducting airways which consist of trachea, bronchi and bronchioles while third, the pulmonary zone, comprise of respiratory bronchioles alveolar sacs and alveoli.

Particles are deposited in the lungs by one of four different ways: interception, impaction, sedimentation, and diffusion. In general, particles having an aerodynamic diameter of greater than 10 μm are deposited in the nasopharyngeal region (upper airway passages - nose, nasal cavity and throat) largely by impaction. This mechanism is prominent because of the high air speed and the many turns in the nasopharyngeal air way. The changes in airflow direction cause many particles to hit the walls of the air passage and so the particles deposit or settle in this region. Smaller particles with an aerodynamic diameter of about 0.003 to 5 μm are deposited (CCOHS, 2011).

In the tracheobronchial and alveolar regions, Sedimentation is the most common method because at this point the air has slowed enough for particles to "settle" out. When the air gets to the alveolar region (the lower lung area), it has slowed even more. The air is essentially calm. Particulates that make it this far into the lungs are usually 0.5 μm or smaller. They enter the lung essentially by randomly landing on the membrane or other parts of the lung. ACGIH has categorized the respirable ($\leq 10 \mu\text{m}$) Particulate Mass-TLV's are for particulates that are small enough to reach the gas exchange region and are hazardous only if they are deposited in that region (CCOHS, 2011).

The ability of the lung trying to protect itself against inhaled particles, clearance will determine the adverse health effects of exposure to PM_{10} releasing from the welding fumes. There are two clearance mechanisms: the mucociliary

system and the alveolar macrophages. Particles deposited in the ciliated region of the trachea bronchial airway, rise on the mucociliary ladder to be expelled by coughing or swallowing. Particles deposited on the terminal bronchioles are cleared by lung macrophages (CCOHS, 2011).

2.5 Effect of exposure to PM₁₀ on respiratory health

Therefore, exposure to welding fumes can cause numerous health problems due to present of respirable particles PM₁₀. The degree of the risk to welder's health from fume exposure depends on the composition, concentration, and the length of time the welder is exposed. When inhaled, acute exposure to welding fumes can result eye, nose, and throat irritation, fever, chills, nausea, shortness of breath, muscle pain and metallic taste in the mouth. Chronic exposure to welding fumes can result in respiratory effects, including coughing, decreased pulmonary function, and occupational asthma (Mansour, 2010). Therefore, a study by Kim *et. al.* (2005) concluded that high levels of welding fume exposure induce acute systemic inflammation in a relatively young, healthy working population.

Many of the reported epidemiology studies are difficult to compare because of the wide differences in worker populations, industrial settings, welding techniques, duration of exposure, and other occupational exposures besides welding fumes. Epidemiological studies have indicated that large numbers of welders experience some type of respiratory illness. Respiratory effects observed include

acute and chronic bronchitis, air passage irritation, pneumoconiosis “arc welder’s siderosis”, occupational asthma, and possible increase in the incidence of lung cancer. The presence of soluble metals such as iron, chromium, nickel, copper, and manganese, and the various complexes formed by these different metals in welding fumes are likely to be important in the pulmonary responses observed after welding fume exposure (Mansour, 2010).

This study was focused more on the effect on respiratory symptoms and lung function cause by welding releasing PM_{10} . In addition, the previous study showed chronic bronchitis was found in 21.7% of welders who were non-smokers, 15.4% of welders who were ex-smokers, but none of controls who were non-smokers had chronic bronchitis. The frequency of chronic bronchitis in welders who smoked was higher than the controls who smoked ($p = 0.017$). Historical cohort study by Sharifian in 2011 showed that respiratory symptoms were more frequent among welders after adjusting for cigarette smoking, but the differences was significant for symptoms of chronic bronchitis ($p = 0.02$).

Besides that, the previous study to relate duration of employment with respiratory effects among welders have shown that there were significant differences in pulmonary function tests and occurrence of chronic bronchitis between welders with more or less than 20 years at work (Ozdemir, 1995). The other study done by other researcher was found that the welders with more than 10 years of exposure to welding fumes showed risk of respiratory impairment more than three times greater

than those exposed for less than 10 years (Rastogi, 1991). For the lung function results, a finding in Sharifian *et.al.* (2011) also showed the averages of all lung parameters of welding were lower than controls, but the difference of means was significant for FEF (forced expiratory flow) in 25-75% and average FEV₁ and FEV₁/FVC was lower in high exposure welders significantly (p=0.04 and 0.01 respectively). However, many researchers have evaluated the effects of welding fume inhalation but there are differences between findings in various studies due to bias from in smoking status of study subjects, time-weighted average of exposure time, type of welding processes, existence and usage of protective measures and protective devices (Sharifian, 2011).

Besides, the parameters of lung function test between welders who smoked showed significant differences from those controls who smoked. The previous studied also shown that the pulmonary function tests have no significance different between control and exposed group but the measuring parameters significantly higher in the control group. Erhabor *et al.*, (2001) reported that the arc-welders were found to have characteristically lower lung function parameters than controls

A study by Ozlem Ozdemir *et al.*, (1995) concludes that respiratory symptoms and chronic bronchitis were more prevalent in welders. Welders who smoked showed a higher frequency of chronic bronchitis than controls who smoked. Last but not least welders have an increased risk of chronic bronchitis and impairment of pulmonary function. A finding suggests that the average pulmonary

function values of welders were lower relative to control with dose-effect relationship between work duration and pulmonary function impairment (Sharifian, 2011). The development of chronic bronchitis and other work related respiratory symptoms in welders related to exposure to a combination of dust and irritant gases in the work place. Many studies have noted an increased prevalence of cough and phlegm among welders. Several previous studies have noted that chronic bronchitis to be more prevalent in welders, however, this association has not been found in all studies (Bradshaw, 1998).

However, the type and amount of welding fumes and effect of respiratory symptoms depends on duration of welding, welding methods, welding material, ventilation facilities and respiratory protection. Besides, the contents of the welding fumes depend on the components of the base metal, coatings and/or filler materials and the temperatures used in the welding process. Moreover, in confined spaces, welding can be deadly. Without enough ventilation, toxic fumes and gases can be much stronger (Rice, 2011).

CHAPTER 3

METHODOLOGY

3.1. Study location

This study was carried out in metal working factory located in Seri Kembangan, Selangor. In this company, the main process involved was welding processes especially in metal working work such as manufactured gates, metal skeleton, door and roof top. Welders were the subject in this study because they were directly exposed to welding fume every day during the work time and the comparative group who have low exposure to welding fume.

3.2. Study design

This study design is cross-sectional comparative study which involved of two different groups, exposed and non-exposed group. The PM_{10} exposures and variables that related to the respiratory health were measured.

3.3. Subjects/respondents

3.3.1 Sampling frame

The exposure group is selected among welders and office workers from Universiti Putra Malaysia administration department. They were all selected according to purposive sampling which take into account the inclusive and exclusive criteria before been selected as subject.

Inclusion criteria:

1. Male workers (welders and office workers)
2. Minimum work employment was 1 year or above.
3. Age range between 18 to 45 years.
4. Healthy workers (there are no diagnose of having any types of chronic pulmonary diseases, no obesity)

Exclusion criteria:

1. Part-time workers / practical students
2. Past occupational activities of workers with exposure to asbestos, silica, paints and solvents

3.3.2 Sample size

A study by Lillienberg *et.al*, (2008) stated a significant relation to welding at work and chronic bronchitis rather than occupational asthma. Ministry of Health Malaysia defined chronic bronchitis as the presence of increased bronchial secretions with chronic cough and expectoration on most days for at least 3 months a year in two consecutive years (MOH). Hence, a study in Iran showed the prevalence of chronic bronchitis was found in 11.6% of auto assembly welders and 2.3% in unexposed group (Sharifian, 2011).

The sample size calculation is use to determine the adequacy as described by Rubinson and Neutens. The formula as;

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

Where,

N = sample size

e = sampling error (0.05)

p = 0.116 (11.6% prevalence of chronic bronchitis studied by Sharifian *et. al.* in 2011)

z = standard score

So, the sample size for this study:

$$\begin{aligned} N &= (1.96/0.05)^2 (0.116)(1-0.116) \\ &= 60 \end{aligned}$$

However, in this study, after taking into account the exclusion and inclusion criteria, only 33 numbers of respondents were selected for exposed group and 43 numbers of respondents in comparative group.

3.3.3 Sampling method

Purposive sampling is used as a method of sampling the respondents. This is a type of non-random sampling which respondents are specifically sought out because they meet the criteria required for this study.

3.4 Instrumentations

3.4.1 Questionnaire

The adult questionnaire adapted from American Thoracic Society (ATS) was used to collect the information on current respiratory symptom experiencing by the workers. Questionnaire was also gathered the data on respondent's background, smoking habit, working history, employment status and history of diseases.

3.4.2 Anthropometry measurement equipments

- i. SECA body meter is used to measure the height of respondents.
- ii. SECA weighing machine is used to measure the weight of respondents.

3.4.3 Pulmonary Function Test (Spirometry)

Chestgraph HI-101 model is used to measure the FVC and FEV₁ of the respondents. This model recorded the volume of air exhaled from the workers lungs after a maximal expiration.

3.4.4 Gravimetric dust sampler/ personal air sampling

GillAir personal sampling pump is used to measure PM₁₀ among respondents. The other sampler components including cyclone, filter Cassette, 0.8 micron Mixed Cellulose Ester (MCE) membrane filter and calibrator jar. Other side equipment used is 0.001 sensitivity analytical balance, static neutralizer and forceps.

3.5 Data collection

3.5.1 Questionnaire

Questionnaires were distributed to all selected respondents who were interested to take part. The respiratory symptoms questionnaire was derived from American Thoracic Society which comprises of questions on respiratory symptoms (cough, phlegm, wheeze and chest tightness). The interview session was carried during the respondents resting time. The respondents also were asked about their activity at the workplace, working experience, personal background, economic status and respiratory symptoms. This was to ensure that all questions were fully answered by them.

3.5.2 Personal PM₁₀ exposures

This assessment was done by following the method suggested by NIOSH for respirable particles.

a) Preparation of samplers before sampling

Firstly, the filters were equilibrated in an environmentally controlled weighing area or chamber for at least 2 hour. Then, in the same area, the filters are weighed and recorded the filter tare weight, W_1 (mg). There are a few things were

considered, 1) zero the balance for each weighing, 2) handle the filter with forceps and 3) pass the filter over an anti-static radiation source and steps is repeated if filter does not release easily from the forceps or if filter attracts balance pan. After that, the filter was assembled in the filter cassette and close firmly to avoid from around leakage. A plug was placed in each opening of the filter cassette. Lastly, the cyclone's grit cap was removed before use and the interior of cyclone is inspected. The sampler was prepared for the purpose of sampling and blanks.

b) During sampling

Firstly, each personal sampling pump was calibrated to 1.7ℓ/min with a representative sample in line. Personal particle samplers were placed in the breathing zone of participants on their lapels, to monitor exposures to the particles with an aerodynamic mass median diameter less than 10µm (PM₁₀) and the pump was placed in a padded pouch that was carried by the participant. The sampling was taken for 8 hours during the workdays. The air was collected on an encased in a cassette and placed downstream of the cyclone.

c) Sample preparation

The top and bottom plug was removed from the filter cassette. It was equilibrated for at least 2-hour in a chamber. Next, each filter, including field

blanks was weighed. The post sampling weight and tare weight was recorded.

Anything remarkable about a filter was also recorded.

d) Concentration calculation

The concentration of PM₁₀ concentration was calculated by using this formula:

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

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 of flow rate (1.7ℓ/min)

3.5.3 Lung Function Test

Lung function test was done following the standard by ATS. Prior of using the spirometer, it was first calibrated by injecting 3 liters of air into the spirometer using a three liters syringe. Error allows in 3% or 50mL of air. After that, the height and weight of respondents was measured in time and inserted into spirometer.

The appropriate technique was instructed and demonstrated to respondents. It was included the correct posture, inhale rapidly and completely, position of the mouthpiece and exhaled with maximal force. Then, respondent was asked to be in correct posture which is standing in straight position with head slightly elevated. After that, the maneuver was performed as instructed and demonstrated before. Firstly, the mouthpiece was ensured it was placed in mouth and close lips around the mouthpiece. Inhaled completely and rapidly with a pause less than 1 second and blast exhale maximally until no more air can be expelled. Last but not least, the instruction was repeated as necessary and minimum three maneuvers were repeated and no more than eight are usually required. However, the test repeatability was checked and more maneuvers were performed as necessary. The air breath in and out from lung during measurement was recorded and displayed a graph called spirogram.

Respondents are observed and encouraged by researcher throughout the procedure for the quality control purposes. Most common cause is inconsistent reading due to poor subjects' technique. The result is valid if subject give a full cooperation during the test. At least 3 acceptable results were taken. Validity requirements depends on the subject that were not doing the activity such as coughing, completing the expiration too early, and obstruction of tongue or teeth.

All the respondents performed lung function test using a spirometer. During each test, raw lung function values and the percentage of predicted values, which

were calculated automatically by comparing with reference (predicted) value for Malaysian males people were obtained as suggested by Singh et.al (1993).

Table 3.1: reference (predicted) value for Malaysian males

Sex	Age	Predicted value
Male	20-69	FVC = 0.0407(Height) + 0.0296(Age) – 2.343L FEV ₁ = 0.0353(Height)+ 0.0315(Age) – 1.784L

Source: Singh *et al.* (1993)

Then FEV₁% predicted and FVC% predicted was calculated by using the formula as follow:

$$\text{FVC\% Predicted} = (\text{FVC Measured}/\text{FVC Predicted}) \times 100$$

$$\text{FEV}_1\% \text{ Predicted} = (\text{FEV}_1 \text{ Measured}/\text{FEV}_1 \text{ Predicted}) \times 100$$

Lastly, the abnormalities and pattern of lung and types of ventilatory defects of the respondents were determined based on standard category where normal is according to FVC% predicted above 80%, FEV₁ % predicted above 80% and ratio is 70% and above (ATS, 2005).

3.6 Analysis test

Data obtained from this study were analyzed using Statistical Packages for Social Sciences (SPSS, version 20). Frequency distribution were generated for socio-demographic data and respiratory symptoms reported. The comparison test between groups was used Mann-Whitney test due to not normally distributed data between lung function and concentration of PM₁₀. Two by two tables and Chi-squared tests were performed to test differences in the proportion respiratory symptoms among two groups. Spearman Rho's Correlation analysis was used to detect the relationship between two variables Logistic regression was performed, where odds ratios and 95% confidence intervals (CI) were estimated examining the occurrence respiratory symptom taking into account several potential risk factors such as PM₁₀ concentration, exposure group and smoking. All statistical tests were two sided; a p value of 0.05 or less was adopted for statistical significance.

3.7 Quality Control

The questionnaire performed the pre-test on 10% of the sample size. The pre-test is to verify the reliability of the questionnaire that was used to the respondents which to make sure that the respondents understand the contents of the questions. Furthermore, the questionnaire was given and interviewed was carried out for all the respondents. The equipment use in the study was calibrated using standard and recommended procedure by the manufacturer before the measurements started.

3.8 Study Limitation

Besides a strict compliance on measurements and data collection, the main limitations of this study were follows:

- i. This study is cross sectional study which can only collect information on exposure and health status at the same time. The design attempt to assess exposures data retrospectively under the assumption that the concentration contrasts measured today have been constant over time (WHO, 2002)
- ii. Limited studies on welding fumes and respiratory health done locally. Within the constraint of limited baseline data and references which is difficult to discuss and make comparison on the findings.
- iii. Limitation and difficulties in the measurement of personal exposure, as well as to get the real duration of exposure because welding process was not done continuously due to weather condition and welders did not have proper seat during work.
- iv. Confounding variables are very important in the study related to long-term exposure to welding fumes. These include smoking habits, health status, age, physical status, and duration of exposure. In this study, it was difficult to find the non-smokers respondents as the respondents were male workers.

3.9 Ethical consideration

- i. The approval was obtained from Medical Researcher Ethic Committee, Universiti Putra Malaysia (UPM).
- ii. The permission was obtained from the employer/head of department of the factories/offices.
- iii. Written consent was obtained from the respondents prior to the study.
- iv. All the information about the respondents is private and confidential and never shared with third party.

CHAPTER 4

RESULTS

4.1 Background and selection of respondent

This study was conducted to determine the relationship between personal exposures to welding fume (PM_{10}) and the respiratory health among welders in metal working factory. This study has been conducted on 33 welders while 43 office workers were selected as the comparative group. The office workers were those who work in office building and not exposed to welding fume directly compared to welders who involved in metal manufacturing and foundry work industry.

Based on the purposive sampling method, this study involved welders who fulfilled the inclusive criteria such as male, age range between 18 to 45 years, no past history of chronic lung disease, and at least 1 year experienced working as welders were selected. The inclusive criteria were the same between welders and comparative group.

4.2 Response Rate

In this study out of 45 welders screened only 33 of them fulfilled the inclusive criteria for involvement in this research. All of 33 respondents gave a full cooperation for this study because of their employer gave commitment and encouraged them to participate in this study. The comparative group had 51 initial samples and only 43 were selected due to the rest of them did not fulfilled the inclusive criteria. All of the respondents gave full cooperation towards this study and done the test completely. Therefore, the response rates for both groups were respectively 100%.

4.3 Descriptive and bivariate Analysis

4.3.1 Age and physical status among respondents

Age of the respondents between exposed and comparative group were compared. The result shows on the table 4.1 below. The median age for exposed group was 31 years old with mean rank is 37.6. Meanwhile, the median age for non-exposed group was also 31 years with mean rank is 39.2. The age range is between 19 to 45 years for exposed group compared to 22 to 45 years among non-exposed group which fulfilled the inclusive criteria that is age is set within range 18 to 45 years old. Based on Mann-Whitney U Test, the table below shows the comparison

between group and there is no significant different between exposed and non-exposed group.

As shown by Table 4.1, the median for height and weight for exposed group were 1.67m (IQR=0.07) and 64 Kg (IQR=13) with each mean rank were 34.7 and 38.9. For the non-exposed group, the median for height is 1.65m (IQR=0.10) and mean rank is 34.9. Meanwhile for weight of the non exposed group is 62 Kg (IQR=16) with mean rank is 38.9. All the variables in this table were match in order to control for confounder that can affect the results obtained. Therefore, there was no significance different for age, height and weight between both groups.

Table 4.1 : Comparison of age, height and weight between two study groups

variables	Exposed (n=33)			Non-exposed (n=43)			z value	p value
	Median (IQR)	Range	Mean rank	Median (IQR)	Range	Mean rank		
Age (years)	31(14)	19-45	37.6	31(11)	22-45	39.2	-0.315	0.753
Height (m)	1.67(0.07)	1.60-1.83	34.7	1.65(0.10)	1.60-1.85	34.9	-1.652	0.098
Weight (Kg)	64(13)	42-89	38.9	62(16)	42-95	38.9	-0.178	0.858

N=76

4.3.2 Ethnicity and education level

Table 4.2 showed the information on distribution of socio-demographic status such as ethnicity and education level of respondents. The respondents were from various ethnicity and education level. Most of the respondents were Malays workers for both group and most of the respondents were finished their study after Sijil Pelajaran Malaysia (SPM) for exposed group and at least Sijil Tinggi Pelajaran Malaysia for non-exposed group. This was shown on the table below. The homogeneity of the respondents were also been maintain as only male workers are selected for both groups.

Table 4.2 : Distribution of ethnicity and education of respondents

Variables	Number (%)	
	Exposed (n=33)	Non-exposed (n=43)
Race		
Malay	18 (54.4)	37 (86)
Chinese	9 (27.3)	-
Indian	-	6 (14)
Others	6 (18.2)	-
Education		
PMR	7(21.2)	1(2.2)
SPM	12(36.4)	16 (35.6)
STPM/Diploma	-	18 (40)
Others	14(42.4)	8(18.6)

N=76

4.3.3 Work and history of employment

Table 4.3 showed the non-exposed group has number of working years longer than the study group. Non- parametric test was carried out due to not normally distributed data. The distributions shows the median duration of work for exposed group is 5 years (IQR = 5) and non-exposed group is 4 years (IQR = 6). The statistical analysis showed there is no significance different between both groups.

Table 4.3 : Comparison of work duration between two study groups

Variables	Exposed (n=33)			Non-exposed (n=43)			z value	p value
	Median (IQR)	Range	Mean rank	Median (IQR)	Range	Mean rank		
Work duration (years)	5(5)	1-15	38.8	4(6)	1-18	38.3	-0.095	0.924
N=76								

4.3.4 Smoking status

Smoking was also one of the confounder that can influence the results of lung function. Therefore, the smoking status between both group was taken into consideration but was controlled in order to get no significant different between both group. As stated in the Table 4.4 below, most of the respondents were non-smokers which is 63.6% for exposed and 69.8% for non-exposed group. Statistical analysis shows there was no significant different between both groups.

Table 4.4 : Comparison of smoking status between two study groups

Variable	Number (%)		χ^2	p value
	Exposed (n=33)	Non-exposed (n=43)		
Smokers	12(36.4)	13(30.2)	0.32	0.573
Non-smokers	21(63.6)	30(69.8)		

N=76

4.3.5 Personal welding fume (PM₁₀) exposure

Monitoring of the level of individual exposure to PM₁₀ at the workplace was carried out for the welders and comparative group. The normality test was done for both groups and it was found that the data for PM₁₀ were not normally distributed. Table 4.5 shows the median (IQR) for both groups. Welders were exposed to 4 times higher concentration levels of PM₁₀ which is 471.6±343.9 µg/m³ compared to only 121.1± 6.3µg/m³ for comparative group. Results from the Mann-Whitney U analysis shows there was a significant difference ($z = -7.32$, $p < 0.001$) in the concentration levels ranged from 122.3 to 863.0µg/m³ and 87.9-121.8µg/m³ for the study and comparative group.

Table 4.5 : Comparison of exposure to PM₁₀ between two study groups

variable	Exposed (n=33)			Non-exposed (n=43)			z value	p value
	Median (IQR)	Range	Mean rank	Median (IQR)	Range	Mean rank		
PM ₁₀ (µg/m ³)	471.6 (343.9)	122.3-863.0	57.0	121.1 (6.3)	87.9-121.8	20.5	-7.321	0.001*

*significant at $p < 0.05$

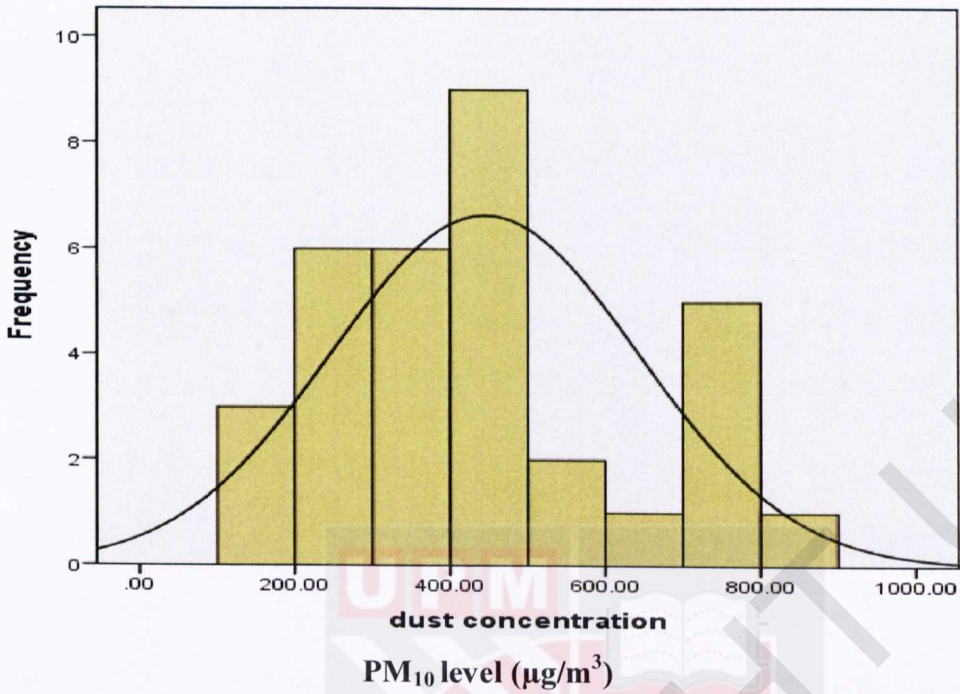


Figure 4.1 : Distribution of personal exposure level to PM₁₀ among exposed group.

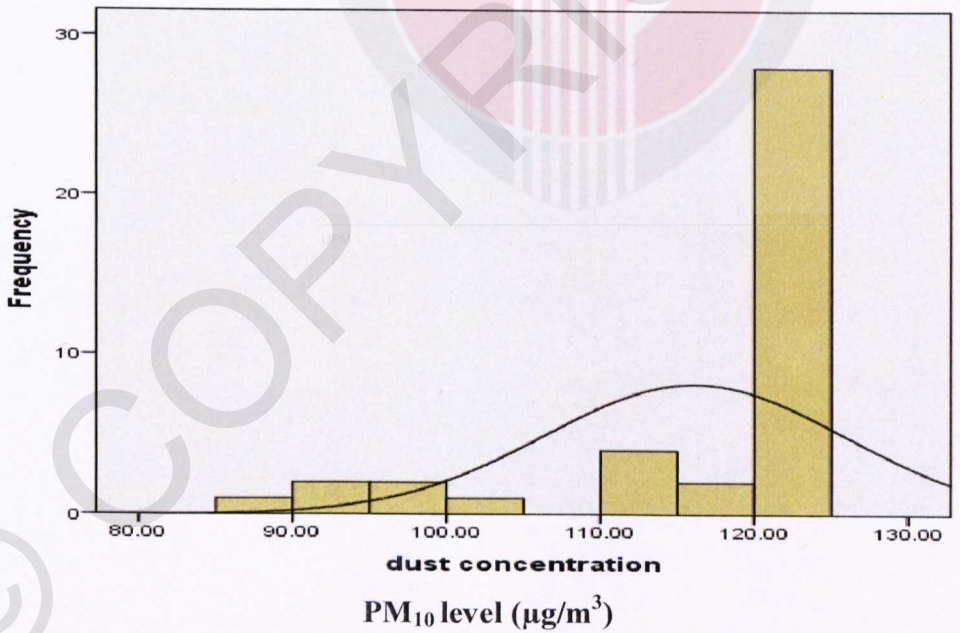


Figure 4.2 : Distribution of personal exposure level to PM₁₀ among non-exposed group.

4.3.6 Respiratory symptom

Respiratory symptoms among the respondents were determined through questionnaires based on American Thoracic Society (ATS, 1978). The Chi-square (X^2) showed that several symptoms such as chronic cough, phlegm and chest tightness were significantly higher reported among exposed groups compared to control groups as shows in Table 4.6. As illustrated in Figure 1, among these 4 symptoms, a higher proportion of the exposed group had symptom on chronic cough (78.6%) than did the non-exposed group (21.4%), chronic phlegm (82.6%) compared to non-exposed group (17.4%) and chest tightness (92.3%) compared to non-exposed group (7.7%). The different is on wheezing symptom where the exposed group did not reported on the wheezing symptom. Apart from that, the table shows the Logistic regression analysis for reported respiratory symptoms after adjusted for smoking factor and the results shows increase risk on chronic cough only for smokers who was exposed to welding fumes (PM_{10}).

Table 4.6 : Comparison of respiratory symptoms after adjustment for smoking status between two study groups

Variables	Exposed (n=33)	Non- exposed (n=43)	Crude OR (CI 95%)	Adjusted OR (CI 95%)	p value
Chronic cough	11(33.3)	3(7.0)	6.67 (1.68-26.46)	12.57 (3.07-51.4)	0.003*
Chronic phlegm	19(57.6)	4(9.3)	13.23 (3.83-45.69)	3.40 (1.20-9.40)	<0.001*
Chest tightness	12(36.4)	1(2.3)	24.0 (2.92-197.2)	2.00 (0.59-6.70)	<0.001*

Adjusted for smoking factor
 *significant at p<0.05
 OR significant >1

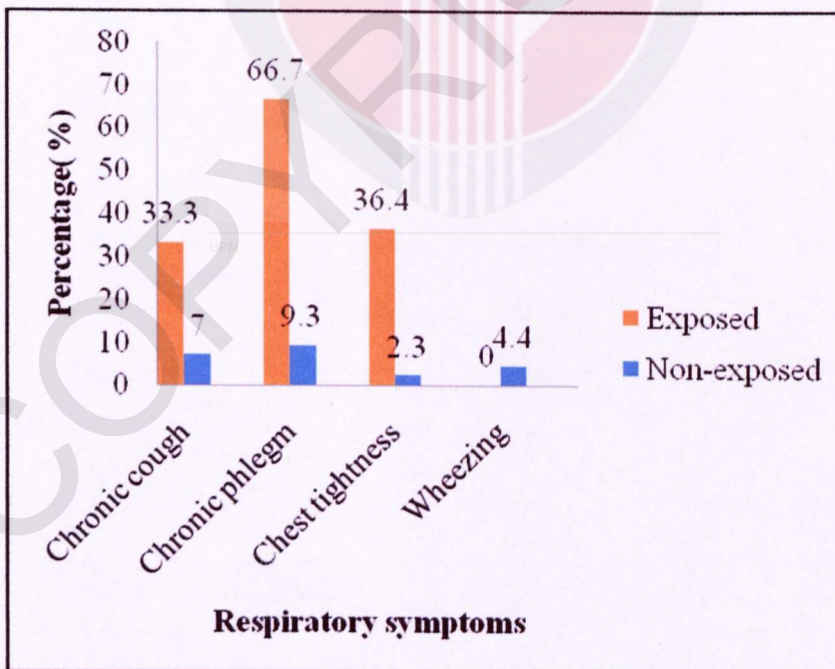


Figure 4: Percentage of respiratory symptoms between two groups

4.3.7 Lung function test

Lung function test was performed to determine the lung function of the respondents and was analyzed to see their association with the concentration of PM₁₀. As shown in Table 4.7, Mann-Whitney U test showed that the welders FVC (liter), FEV₁ (liter), FVC% predicted, FEV₁% predicted and FEV₁/FVC% shows significant difference between welders and comparative groups. It clearly shows the reduction of lung function in exposed group.

Table 4.7 : Comparison of Lung Function parameters between two study groups

variables	Exposed (n=33)			Non-exposed (n=43)			z value	p value
	Median (IQR)	Range	Mean rank	Median (IQR)	Rang e	Mean rank		
FVC (liter)	2.98(0.25)	1.88-3.29	30.1	3.10(0.29)	2.63-4.15	45.0	-2.93	0.03*
FEV ₁ (liter)	2.78(0.69)	1.63-3.12	30.0	2.93(0.46)	1.76-3.28	45.4	-3.10	0.02*
FVC% predicted	81.4(21.0)	58.1-97.4	29.4	89.5(18.3)	57.8-113.1	45.5	-3.15	0.02*
FEV ₁ % predicted	80.8(19.5)	56.1-103.3	27.5	87.9(18.6)	51.9-105.7	47.0	-3.81	<0.001*
% FEV ₁ /FVC	99.6(11.6)	74.0-112.8	35.7	102.1(9.7)	90.8-137.2	40.1	-0.97	0.332

*Significant different at p < 0.05

The lung function abnormalities among the respondents were determined by categorizing the data of spirometry test according to the grade of lung abnormality (ATS, 1991) as shown in Table 4.8. The data were analyzed using the Chi-square test and also estimated the risk (OR). The results of abnormalities of lung function showed that FVC% predicted (OR=0.41, 95% CI=0.153-1.105) did not have significant risk compared to FEV₁% predicted (OR=2.95, 95% CI= 1.11-7.9) among welders. There was significance different of FEV₁ % between exposed and comparative group. The reduction in FEV₁ is determining the obstructive impairments of lung among welders.

Table 4.8 : Comparison of lung function abnormalities based on two study group

Variables	Number (%)		Odds Ratio (95% CI)	p value
	Exposed (n=33)	Non-exposed (n=43)		
FVC% predicted				
Abnormal	14(42.4)	10(23.3)	0.41	0.075
Normal	19(57.6)	33(76.7)	(0.153-1.105)	
FEV1% predicted				
Abnormal	16(48.5)	6(14.0)	2.95	0.001*
Normal	17(51.5)	37(86.0)	(1.105-7.889)	

*Significant different at $p < 0.05$

4.3.8 Relationship between exposure level to welding fume (PM₁₀) and Lung Function

Spearman Rho's test was carried out for (FVC, FEV₁) measured (liter) , (FVC, FEV₁) predicted and FEV₁/FVC% in correlated with concentration of personal PM₁₀ exposure among group to determine the correlation of these two variables. Result showed that there were no significant associations ($p > 0.05$) between exposure to PM₁₀ and work duration with lung functions parameters among the exposed group

Table 4.9 : Relationship between welding fume (PM₁₀) and Lung Function

PM ₁₀ ($\mu\text{g}/\text{m}^3$)	Exposed group ($n=33$)	
	r value	p value
FVC (liter)	0.74	0.68
FEV ₁ (liter)	-0.14	0.44
FVC% predicted	-0.12	0.52
FEV ₁ % predicted	-0.29	0.10
% FEV ₁ /FVC	-0.20	0.27

4.3.9 Relationship between duration of work and Lung Function among the exposed groups

Spearman Rho's test was carried out for (FVC, FEV₁) measured (liter), (FVC, FEV₁) predicted and FEV₁/FVC% in correlated with duration of work among group to determine the correlation of these two variables. However, result in table 4.10 was showed that there is no significant correlation between (FVC, FEV₁) measured (liter), (FVC, FEV₁) predicted and FEV₁/FVC% and duration of work in years as shown in the table below.

Table 4.10: Relationship between duration of work and Lung Function

Duration of work (years)	Exposed group (n=33)	
	r value	p value
FVC (liter)	-0.24	0.18
FEV ₁ (liter)	-0.46	0.07
FVC% predicted	0.11	0.56
FEV ₁ % predicted	-0.19	0.28
% FEV ₁ /FVC	-0.33	0.06

4.4 Logistic Regression

Logistic regression was performed to determine the main factor contributing to chronic cough, chronic phlegm and chest tightness of respondents. As presented in Table 12, results from analysis revealed that after adjusted for smoking factor, exposed group have risk to get chronic cough (\pm OR = 9.59), chronic phlegm (\pm OR = 15.8), and chest tightness (\pm OR = 23.9) compared to non-exposed group. Welders who exposed to high exposures of PM₁₀ have 12 times risk to get chronic phlegm after adjusted for smoking.

Table 4.12: association between respiratory symptoms and PM₁₀ after adjusted for smoking status

	Crude OR (95%CI)	Adjusted OR (95%CI)	Wald	p value
<u>Chronic cough</u>				
Exposed group	6.67 (1.68-26.46)	9.59 (1.92-47.78)	7.60	0.006*
<i>PM₁₀ category</i>				
High exposure	5.64 (1.64-19.45)	5.03 (1.25-20.3)	5.16	0.023
<i>Niegelkerke R² = 0.457</i>				
OR adjusted for smoking factor.				
<u>Chronic phlegm</u>				
Exposed group	13.2 (3.83-45.69)	15.8 (4.11-60.9)	16.1	<0.001*
<i>PM₁₀ category</i>				
High exposure	12.9 (4.02-41.2)	12.0 (0.86-9.78)	16.7	<0.001*
<i>Niegelkerke R² = 0.446</i>				
OR adjusted for smoking factor.				
<u>Chest tightness</u>				
Exposed group	24.0 (3.83-45.7)	23.9 (2.88-197.2)	8.66	0.003*
<i>PM₁₀ category</i>				
High exposure	7.20 (1.94-26.8)	6.77 (1.79-25.6)	7.94	0.005
<i>Niegelkerke R² = 0.346</i>				
OR adjusted for smoking factor				

N=76, Significant at $p < 0.05$

OR significant >1

Reference PM₁₀ high Category > 264.1 $\mu\text{g}/\text{m}^3$

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Background and selection of respondents.

This chapter reviewed and discussed the finding gathered from this cross-sectional comparative study on exposure to welding fume (PM_{10}) and respiratory health among welders and comparative group. Upon granted the approval by the Ethics Committee of Faculty Medicine and Health Sciences, the measurement on welding fume (PM_{10}) and respiratory health (included respiratory symptoms and Lung Function Test) for this study were started in February 2012 and finished in mid of April.

This study was performed among the welders in metal working factory in Seri Kembangan, Selangor as to determine the relationship between personal exposure to welding fume (PM_{10}) and the respiratory health. Respondents were purposively sampling according to inclusive criteria before the assessment has been conducted. Therefore, after screening, only 33 welders were selected from the factory and 43 office workers were selected from the administration department of

University Putra Malaysia. The comparative group was chosen among office personnel who worked in the office building directly did not expose to welding fume. The inclusive criteria were established in order to control the confounding factors that may influence the outcome of the study.

Respondents were interviewed to gather the information on socio-demographic data, smoking habit, health status, work employment history, family respiratory health history and respiratory symptoms using a set of questionnaire adapted from American Thoracic Society (ATS, 1978). Two tests were performed which is the measurement of personal PM_{10} exposures and Lung Function Test. All the selected subjects completed the tests successfully.

5.2 Study background, socio-demographic data and physical status

This study involved 33 welders who had been doing metal gas (oxygen) arc welding. All welders had been working for about 46 hours a week in open spaces and without respiratory protective devices. The respondents were based on the screening with the inclusive and exclusive criteria. Based on the purposive sampling method, this study involved welders who fulfilled the inclusive criteria such as male, age range between 18 to 45 years, no past history of chronic lung disease and kidney failure, and at least 1 year experienced working as welders were selected. The inclusive criteria were same between welders and comparative group except for

workplace condition where the comparative group was mainly office personnel (UPM staff) who worked in office building.

There were no significant differences between the mean age, height, and smoking habits of welders and comparative group. This study also involved several ethnicities of welders which are Malay (51.4%), Chinese (31.4) and others (Indonesian and Myanmar) was only 17.2%. Study by Nadiah (2007) which was only involved Malaysian male welders. Mean of duration of employment for welder was 5 years (range 1-15 years) which mean is same with comparative group (range 1-18 years). Welders were do not have certificate as competence person for welding activity based on education level of them were 34.3% in Sijil Pelajaran Malaysia (SPM) and 40.9% included in others level (included primary school and no school at all).

Social demography data were the initial essential data taken among respondents because some of the demography data has been controlled due to confounder factor among respondents. According to Djodibroto (2009) factors such as age, race and smoking habit were gave effect on value of lung function. Therefore this study was restricted to only male, thus controlling gender difference. Previous study by Djodibroto in 2009 showed the effect of smoking was observed in Malay males group 10-19 years of age as they had lower lung function compared to the non-smokers. So, it was important to control the smoking status factor among

welders and comparative group to avoid interference in outcome of respiratory health.

As shown earlier in Chapter 4, there were several data such as age, race, smoking status; education level and duration of work were all compared in both groups. Factors that were contributed to affect the outcome of this study such as age and smoking habit were controlled during the selection of respondents and data analysis. Through statistical test were carried out, these factors is found to equal or match between the two study groups, and it will not interfere with the results. All of the demography characteristics were analyzed using non-parametric test and therefore, median and interquartile range (IQR) was selected to compare between subjects.

5.3 Level of exposure to welding fume (PM₁₀)

For the mean concentration of PM₁₀ exposures, the results showed welders working in metal working factory were exposed to 4 times higher concentration levels of welding fume (PM₁₀) which mean is $444.9 \pm 198.4 \mu\text{g}/\text{m}^3$ compared to only $116.1 \pm 9.81 \mu\text{g}/\text{m}^3$ in comparative group. Therefore, results from the statistical analysis Mann-Whitney U shows that there was a significant difference ($z = -7.32$, $p < 0.001$) in the concentration levels ranged from 122.3 to $863.0 \mu\text{g}/\text{m}^3$ and 87.9- $121.8 \mu\text{g}/\text{m}^3$ for the study and comparative group. The previous study conducted among 70 welders of shipyard by Nadiah (2007) showed mean value of PM₁₀

recorded among welders ($1793 \pm 3289 \mu\text{g}/\text{m}^3$) was 35 times higher compared to mean value among comparative group ($50.53 \pm 11.32 \mu\text{g}/\text{m}^3$). Welder's exposure at the shipyard was also 4 times higher compared to welders in this present study.

5.4 Comparison of reported respiratory symptoms between the study and comparative groups

The respiratory symptoms studied in this study were chronic cough, chronic phlegm, chest tightness, and wheezing based on ATS questionnaire. Among these 4 symptoms, welders have 24 times showed symptom of chest tightness (OR=24, 95% CI = 2.92-197.2) followed by chronic phlegm which is 13 times (OR=13.23, 95% CI = 3.83-45.7) and lastly is chronic cough where is almost 7 times (OR=6.67, 95% CI=1.68-26.5) compared to comparative group. Symptoms on chronic cough ($p=0.003$), chronic phlegm ($p<0.001$) and chest tightness ($p<0.001$) also shows a significant difference between exposed and non-exposed group. A local study by Nadiah (2007) among shipyard welders showed that there was a significant difference in prevalence of respiratory symptom between welders and comparative group only for chronic phlegm (OR= 1.71, 95% CI = 0.76-3.87) and the rest (cough, chest tightness and wheezing) were not showed significant difference. Besides that, previous study by Ozdemir (1995) on a 110 of manual arc welders exposed primarily to mild steel welding showed that respiratory symptoms ($p<0.005$) were more prevalent among confined-space welders. In cases of chronic exposures it has often been difficult to differentiate between the effects due to occupation and those due to

cigarette smoking. As revealed by logistic regression, smoking will increased risk of having chronic cough 2 times higher among welders exposed to welding fume (PM_{10}).

5.5 Comparison of lung functions between the study and comparative groups

Lung function test was done at both group based on procedure from American Thoracic Society (ATS, 2005) using the spirometer (Chestgraph HI-101). The values for predicted FVC and FEV_1 have been calculated to get the percentage value of predicted FVC and FEV_1 . The result clearly shows that all lung parameters have shown significant reduction among exposed group compared to the comparative group ($p < 0.05$). Compared with present study, previous study done by Zeeba *et.al.*(2009) among 137 spot welders in automobile assembly only showed the significant reduction values for FEV_1 and $FEV_1/FVC\%$. Moreover, the finding of abnormalities for the indicator FVC% predicted and $FEV_1\%$ predicted were higher among the study group compared to comparative group. This study can support the statement by EPA where exposure to respirable particle can promote adverse health effect to lung.

5.6 Relationship of welding fume (PM₁₀) between lung function and duration of work

Result from the Spearman Rho's test performed finds that there have no significant inverse associations between exposure to PM₁₀ and lung function and duration of exposure. This result clearly shows that the lung function parameters for exposed group was significantly lower compares to comparative groups as r-values shows negative value for all parameter except for FVC measured. This might due to small sample size of study group. Moreover, the air pollutant effects are influence by many factors such as level of exposure, individual susceptibility, age, duration of exposure, health status and smoking habit (WHO, 2000). This lung function test was performed at the welders worked in open air with poor respiratory protective devices. The working conditions are important for welders' respiratory health.

5.7 Factors contributing for risk of respiratory symptoms among respondents

Logistic regression test was done to determine main factors contributing towards significant difference of having risk on respiratory symptoms after adjusted for smoking factors. Table 12 shows the possible exposed group and exposure to high concentration (reference value mean > 264.1 $\mu\text{g}/\text{m}^3$) of welding fume (PM₁₀) to be mostly associated with welding related respiratory symptoms such as chronic cough, chronic phlegm and chest tightness. There was significant increase of risk

for developing chronic cough, chronic phlegm and chest tightness symptoms by expose to welding fume. However, high exposure to PM_{10} shows significant increase risk of having chronic phlegm.

5.6 Conclusion

This study successfully demonstrated that occupational exposure to elevated concentrations levels to PM_{10} in welding fume through the significant different showed in chronic cough, chronic phlegm and chest tightness symptom of respiratory among the welders compared to office workers (non-exposed group). Secondly, the lung function test also showed the reduction of FVC, FEV_1 measured (liter) and FVC, FEV_1 predicted (%) among welders than comparative group. Result of this finding on respiratory symptom and lung function test between welders and comparative group are consistent with the findings of other occupational exposure to PM_{10} in welding fume conducted by other researchers. However, in this study welders who exposed to PM_{10} did not show significant correlation with (FVC, FEV_1) measured (liter), (FVC, FEV_1) predicted and $FEV_1/FVC\%$. . Lastly, the logistic regression showed that smoking can increase risk of having chronic cough, chronic phlegm and chest tightness among welders who exposed to PM_{10} . In addition, the exposed group is one of the factors contributing to significant increased risk of chronic cough, chronic phlegm and chest tightness even after adjusted for smoking. The exposure to high concentration of PM_{10} is 12 times increased risk of having chronic phlegm among welders

This present study has successfully answered to the research hypotheses as follows:

- i. The personal exposure level to PM_{10} in welding fume is significantly higher among welders compared to the comparative group.
- ii. The symptom of chronic phlegm and chest tightness is significantly higher among welders compared to the comparative group.
- iii. The level of (FVC, FEV_1) measured (liter) and (FVC, FEV_1) predicted is significantly lower among welders than comparative group.
- iv. There is no significant relationship between exposure level to PM_{10} in welding fume and (FVC, FEV_1) measured (liter), (FVC, FEV_1) predicted and $FEV_1/FVC\%$.

5.7 Recommendations

The recommendations given were based on the finding. Further study is needed as this study showed significant association of exposure to PM_{10} in welding fume and respiratory health (respiratory symptom and lung function). As the chronic cough, chronic phlegm and chest tightness showed the highest symptoms had by welder, the further examined on the lung is recommended. For further study, the sputum test and chest x-ray should be done among welders to detect any lung impairment or diseases if any. It was good to recommend that welders to stop smoking as smoking can increase risk of adverse respiratory health.

The welding process is a high risk activity because the fume releasing was not only consisting of particulate matter but also heavy matter. The monitoring and assessment of personal air exposure at the work place with welding fume exposure should be done at the possible interval. The purposed is (1) to control the permission exposure limit so that it will not higher than permissible limit by law, (2) select appropriate controls/respiratory protection and (3) to determine the effectiveness of controls/respiratory protection.

The hierarchy of control of PM_{10} releasing at the workplace should be implemented as far as practicable in order to protect the workers health. The hierarchies of control that can be used are as follow:

i. Substitution

It may possible to change the welding process to a type of welding that has a lower rate of generation. It is because the different types of welding are associated with different rates of fumes generation. Most of the welders in this factory were used gas metal arc welding (Oxygen welding) which is stated as moderate release of fumes (Jerome Spear, Spears Consulting, LP presentation at 2010 AIHCE).

ii. Administrative control

Limiting the generation of welding fume begins at the design stage. All other things being equal, a properly sized weld will result in the lowest amount of welding fume for a given process and set of procedures. Over welding, on the other hand, unnecessarily increases welding fume. As the amount of weld metal increases, the amount of fume also increases. Other than that is reducing worked time in contaminated area.

iii. Personal Protective Equipment (PPE)

Personal protective equipment is useful as an interim measure until engineering controls can be installed or when engineering controls are impracticable. Most are 1) half face air purifying respirator, 2) Powered air purifying respirator with loose fitting headpiece (protection factor of 25), 3) Half

face air purifying respirator with hoses to filters that attach to back of welders belt (this takes up less room under the welding mask and the cassettes last longer as they are away from the welding plume and 4) full face air purifying respirator built into a welding mask (protection factor of 50). All respirators are uncomfortable to a degree, especially for the first-time user. Selecting the right type goes a long way toward making wearing it more bearable.



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APPENDIX 1

**APPROVAL LETTER FROM FACULTY RESEARCH ETHIC
COMMITTEE**

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APPENDIX 2

**CONSENT LETTER AND HANDOUT ON INFORMATION
ON RESEARCH TO RESPONDENTS**

UPM



CONSENT FORM (RESPONDENT)

RESEARCH TITLE :

EXPOSURE TO PM₁₀ AND RESPIRATORY HEALTH AMONG WELDERS IN METAL WORKING FACTORY, SERI KEMBANGAN, SELANGOR

RESEARCHER :

NUR AIDA BINTI AZIZ

I Identity Card No.
 address.....

.....hereby voluntarily agree to take part in the clinical research *(clinical study, questionnaire study/ drug trial) specified above.

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

I wish to *know/don't wish to know the results of the tests performed on my sample.

* 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 clinical research.

Date

Signature
 (Researcher)

PENERANGAN KEPADA PESERTA

TAJUK KAJIAN: EXPOSURE TO PM₁₀ AND RESPIRATORY HEALTH AMONG WELDERS IN METAL WORKING FACTORY, SERI KEMBANGAN, SELANGOR

PENGENALAN

Partikel halus (PM₁₀) boleh memberikan kesan buruk kepada fungsi paru-paru secara akut atau kronik.

APAKAH TUJUAN KAJIAN INI?

Kajian ini adalah bertujuan untuk mengenalpasti hubungan antara pendedahan kepada partikel halus (PM₁₀) dengan fungsi paru-paru di kalangan pengimpal.

SIAPAKAH YANG PERLU TERLIBAT DALAM KAJIAN INI:

- Pekerja lelaki sahaja
- Bekerja sebagai pengimpal
- Pekerja di bahagian admin

APAKAH JENIS UJIAN YANG AKAN DILAKUKAN?

Sebagai responden dalam kajian ini, anda diharap dapat memberi sedikit kerjasama kepada pengkaji untuk menjalankan ujian dalam kajian ini yang akan dilakukan oleh penyelidik tanpa mengganggu proses pekerjaan anda:

- Membenarkan penyelidik membuat pengukuran tahap partikel halus (PM₁₀) yang terdedah di ruang pernafasan anda.
- Membenarkan penyelidik untuk membuat ujian fungsi paru-paru anda menggunakan alat (spirometer).
- Memberikan maklumat yang berkaitan kajian kepada penyelidik untuk menganalisis data dengan menggunakan borang kajian selidik.

ADAKAH BAYARAN DIKENAKAN?

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

APAKAH FAEDAH DARIPADA KAJIAN INI

(a) KEPADA ANDA SEBAGAI RESPONDEN?

Dapat mengetahui keadaan fungsi paru-paru setelah terdedah dengan partikel halus daripada proses pengimpalan yang boleh memberikan kesan buruk kepada paru-paru

Dapat mengambil langkah berjaga-jaga hasil daripada keputusan kajian untuk memastikan kesejahteraan dan kesihatan paru-paru terjamin

b) KEPADA PENKAJI?

Memberikan pengetahuan baru mengenai hubungan antara partikel halus (PM_{10}) terhasil daripada proses pengimpalan dengan fungsi paru-paru

Dapat memberikan cadangan yang sesuai bagi menambahbaikkan kepada kesihatan fungsi paru-paru masyarakat yang terdedah kepada partikel halus (PM_{10})

ADAKAH TERDAPAT RISIKO DALAM KAJIAN INI?

Kajian ini tidak melibatkan pengambilan sampel darah atau apa-apa bahagian badan. Oleh itu, tidak terdapat risiko yang buruk dalam kajian ini. Kajian ini adalah selamat untuk dilakukan selain dapat memberikan banyak faedah samada kepada anda sebagai responden atau pengkaji.

APAKAH HAK ANDA?

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



ADAKAH MAKLUMAT PERIBADI SAYA DALAM KAJIAN INI SULIT?

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

APAKAH YANG HARUS ANDA LAKUKAN?

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

Terima kasih atas kerjasama dan bantuan anda.

SIAPAKAH YANG BOLEH ANDA HUBUNGI SEKIRANYA TERDAPAT PERSOALAN SEPANJANG KAJIAN INI?

Nur Aida bt. Aziz

Penyelidik

B. Sc. Kesihatan Persekitaran dan Pekerjaan,
Fakulti Perubatan & Sains Kesihatan, UPM

Tel: 017-4659228

Email: reda08@yahoo.com

BORANG PENYERTAAN PESERTA

1. Saya,.....No. K/P.....bersetuju untuk menyertai kajian bertajuk “Pendedahan kepada Partikel Halus(‘Fine & Ultrafine Particles’) dan Fungsi Paru-paru Di Kalangan Pekerja Mesin Fotostat”.
2. Saya telah membaca dan memahami isi kandungan kajian berdasarkan apa yang telah dinyatakan di dalam **“PENERANGAN KEPADA PESERTA”** yang telah dilampirkan bersama surat kebenaran ini dan penerangan tambahan daripada penyelidik.
3. Saya faham bahawa kajian ini dijalankan untuk mengenalpasti hubungan antara pendedahan kepada partikel halus (PM2.5) dengan fungsi paru-paru di kalangan pengimpal.
4. Saya faham bahawa kajian ini mungkin akan melibatkan fizikal dan mental berdasarkan aktiviti pengutipan data yang dijalankan.
5. Saya faham bahawa segala maklumat yang diberikan dan segala keputusan yang saya perolehi adalah sulit dan hanya akan digunakan untuk tujuan penyelidikan dan rujukan penyelidik.
6. Saya juga faham bahawa maklumat ini boleh digunakan untuk penerbitan tetapi setiap individu tidak akan dinyatakan identitinya.
7. Saya faham bahawa saya mempunyai hak untuk menarik diri dan juga mempunyai hak untuk menarik semula keizinan pada bila-bila masa sekiranya perlu apabila merasa tidak selesa pada mana-mana ujian atau aktiviti yang dijalankan oleh penyelidik semasa kajian dijalankan dan tiada sebarang tindakan boleh dikenakan ke atas tindakan tersebut.



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FACULTY OF MEDICINE AND HEALTH SCIENCES
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

.....
(Tandatangan peserta)

Nama :

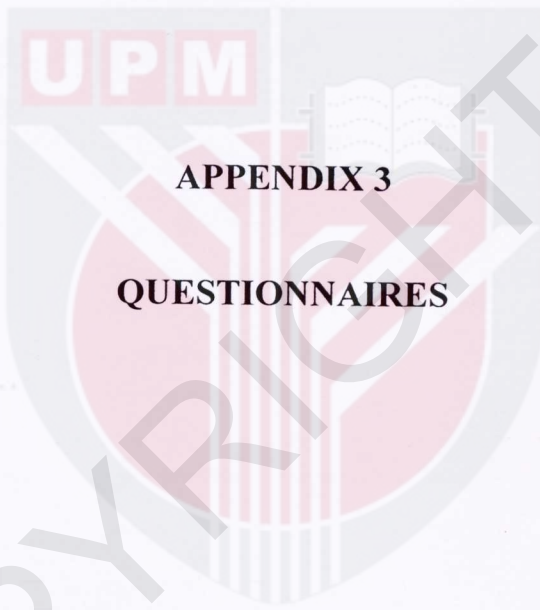
No. K/P :

Tarikh :



UPM





APPENDIX 3

QUESTIONNAIRES

UPM



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**PENDEDAHAN PARTIKEL HALUS (PM_{2.5}) DAN FUNGSI PARU-PARU DI
KALANGAN PENGIMPAL DALAM SEKTOR PERKILANGAN LOGAM**

Dengan ini, sukacita dimaklumkan bahawa pihak tuan telah disenaraikan sebagai salah seorang responden dalam satu kajian penyelidikan yang mengkaji hubungan antara pendedahan kepada partikel ternafas (PM_{2.5}) dan hubungannya dengan fungsi paru-paru. Oleh yang demikian, saya memohon jasa baik pihak tuan untuk menjawab soalan-soalan yang terdapat dalam borang soal selidik ini secara tepat dan jujur. Segala maklumat kajian yang diterima akan dirahsiakan. Kerjasama dari pihak tuan amatlah dihargai.

No Responden:

Tarikh:

No Telefon: -

Tandatangan: _____

SULIT

A. LATAR BELAKANG RESPONDEN

1. Nama: _____

2. Alamat: _____

3. No. telefon: _____

4. Pekerjaan: _____

5. Umur: _____ tahun Tarikh Lahir: _____

6. No kad pengenalan: _____

7. Jantina: lelaki / perempuan

8. Tinggi: _____ cm Berat: _____ kg

9. Bangsa:

Melayu

Cina

India

Lain-lain: _____

10. Warganegara: _____

11. Tahap pendidikan: PMR/ Tingkatan 3

SPM/ Tingkatan 5

STPM/ Diploma

Ijazah

12. Status perkahwinan:

Bujang

Berkahwin

Duda/Janda

13. Jumlah pendapatan: RM _____

B. SEJARAH PERUBATAN

14. Adakah anda mengalami masalah paru-paru sebelum masuk bekerja?

Ya

Tidak

15. Pernahkah anda mengalami sebarang penyakit berikut?

Bronkitis kronik

Pneumonia

Asma / lelah

TB

16. Adakah penyakit yang tersebut di atas disahkan oleh doktor?

Ya

Tidak

Tidak berkenaan

C. BUTIR-BUTIR PEKERJAAN

17. Pekerjaan sekarang: _____ Tempoh bekerja: _____

tahun

18. Pekerjaan dahulu: _____ Tempoh bekerja: _____ tahun

19. Di bahagian mana anda bekerja:

Pentadbiran

Pengeluaran

Lain-lain: _____

20. Adakah anda terdedah kepada debu/habuk semasa bekerja?

Ya

Tidak

Jika 'Ya', berapa lama anda terdedah dalam sehari? _____ Jam

21. Apakah pendedahan kepada habuk di tempat kerja anda?

Kurang

Sederhana

Teruk

22. Adakah anda selesa bekerja di tempat ini?

Ya

Tidak

D. SEJARAH PENYAKIT

	YA	TIDAK
1. Pernahkah mengalami masalah pernafasan?		
2. Apakah penyakit berkenaan?		
I. Asma		
II. Emtisema		
III. Pleurisy		
IV. Barah paru-paru		
3. Masih mengidap penyakit tersebut?		
4. Adakah penyakit anda disahkan oleh doktor?		
5. Bila penyakit bermula?		
6. Adakah mendapat tawatan untuk penyakit tersebut?		
7. Adakah anda masih mendapat rawatan?		

E. BATUK, KAHAK, KESESAKAN NAFAS, DAN NAFAS BERBUNYI BATUK

	YA	TIDAK
1. Adakah anda selalu mengalami batuk?		
2. Berapa kalikah anda mengalami batuk dalam sehari? _____ kali sehari		
3. Adakah anda mengalami batuk pada waktu siang atau waktu malam?		
4. Adakah anda mengalami batuk semasa bangun daripada tidur atau pagi-pagi?		
5. Adakah anda mengalami batuk hampir setiap bulan untuk 3 bulan berturut-turut dalam setahun?		
6. Berapa lamakah anda mengalami masalah sebegini?		
7. _____ bulan/tahun		
8. Adakah anda mengikuti rawatan?		

KAHAK (PHLEGM)

	YA	TIDAK
1. Adakah anda selalu mengalami batuk berkahak?		
2. Adakah anda mengalami batuk berkahak pada waktu siang atau waktu malam?		
3. Adakah anda mengalami batuk berkahak semasa bangun daripada tidur atau pagi-pagi?		
4. Adakah anda mengalami batuk 2 kali sehari atau 4 kali atau lebih dalam seminggu?		
5. Adakah anda mengalami masalah batuk berkahak untuk 3 bulan atau lebih secara berturut-turut?		

KESESAKAN NAFAS

	YA	TIDAK
1. Adakah anda selalu mengalami kesesakan nafas atau dada apabila batuk?		
2. Adakah anda mengalami masalah ini ketika bekerja?		
3. Adakah anda mendapat rawatan doktor?		
4. Adakah anda telah menjalani ujian X-ray?		

NAFAS BERBUNYI (WHEEZING)

	YA	TIDAK
1. Pernahkah anda terasa nafas anda berbunyi seperti wisel?		
2. Berapa lamakah dada berbunyi ini berterusan? _____ bulan		
3. Adakah anda mendapat rawatan doctor untuk masalah ini?		

F: SEJARAH PENYAKIT KELUARGA

Sejarah penyakit ahli keluarga seperti ibu bapa, adik beradik atau keluarga.

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

G. TABIAT MEROKOK

23. Adakah anda masih menghisap rokok?

<input type="checkbox"/>
<input type="checkbox"/>

Ya

Tidak

24. Berapa batang rokok anda hisap dalam sehari?

_____ batang