ASSESSMENT OF OCCUPATIONAL EXPOSURE TO METAL FUMES AND ASSOCIATED RESPIRATORY HEALTH SYMPTOMS AMONG SMALL SCALE WELDERS IN DAR ES SALAAM

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By

Godfrey George Meena

A Dissertation Submitted in (Partial) Fulfillment of the Requirements for the Degree of Master of Science (Environmental and Occupational Health)

Muhimbili University of Health and Allied Sciences
October, 2017

CERTIFICATION

The undersigned certify that she has read and here by recommend for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled: ***Assessment of Occupational Exposure to Metal Fumes and Associated Respiratory Health Symptoms among Small Scale Welders in Dar es Salaam***, in (Partial) fulfillment of the requirements for the degree of Master of Science (Environmental and Occupational Health) of Muhimbili University of Health and Allied Sciences.

_____

Dr Aiwerasia Vera Ngowi (PhD)

Supervisor

_____

Date

DECLARATION

AND

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I, **Godfrey George Meena,** declare that this **dissertation** is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature……Date……

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DEDICATION

This work is dedicated to my beloved grandmother, Elizabeth Elisha, for the inspiration in education and tireless efforts to send me to School and make sure I achieve the best in education.

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LIST OF ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
BEI	Biological Exposure Index
COPD	Chronic Obstructive Pulmonary Disease
IARC	International Agency for Research on Cancer
ICP-AES	Inductively coupled Plasma Atomic Emission Spectroscopy
MCE	Mixed Ester Cellulose
MS-WF	Mild Steel Welding Fumes
MIG	Metal Inert Gas
MUHAS	Muhimbili University of Health and Allied Sciences
NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Authority
PAW	Plasma Arc Welding
PPE	Personal Protective Equipment
SAW	Submerged Arc welding
SMAW	Shielded Metal arc Welding
SPSS	Statistical Package for Social Science
SSI	Small Scale Industry
TIG	Tungsten Inert Gas
TLV	Threshold Limit Value
WHO	World Health Organization

DEFINITION OF TERMS

Small scale industry: A small-scale industry is a project or firm created on a small budget or for a small group of people usually less than 10 workers. A small-scale industry produces its goods using small machines, less power and hired labor. It is located within a single place and produces goods meant for few people

Informal sector: refers to a sector where workers who are self employed, or who work for those who are self employed. People who earn a living through self employment in most cases are not on payrolls, and thus are not taxed.

Welder: is a tradesperson who specializes in fusing materials together. The term welder refers to the operator; the machine is referred to as the welding power supply. The materials to be joined can be metals (such as steel, aluminum, brass, stainless steel etc.).

Back welder: refer to a person who performs different tasks near the welding operation or around the welding workplace.

Personal air sampling: is the air sampling using personal sampling pump to measure personnel exposure to airborne contaminants over an eight-hour period (or the full work shift) and is representative of the individual's breathing zone.

Welding fumes: are a complex mixture of metallic oxides, silicates and fluorides. Fumes are formed when a metal is heated above its boiling point and its vapours condense into very fine, particles (solid particulates). Welding fumes generally contain particles from the electrode and the material being welded.

Sputum: refers to mucus secretion from the lungs, bronchi, trachea that is ejected through the mouth.

Wheezing: refers to a whistling sound that can be made while breathing that may be a symptom of an illness or other causes or conditions.

Cough: refers to a sudden and often repetitively occurring reflex which helps to clear the large breathing passages from secretions, irritants, foreign particles and microbes.

ABSTRACT

Background: Occupational respiratory health symptoms are among the leading cause of occupational morbidity and mortality cases worldwide. Studies show that many workers in developing countries, who engaged in small scale welding operations in the informal sector, have been exposed to high level of multiple health hazards. This study therefore was designed to assess occupational exposure level to metal fumes containing Cadmium, Nickel and chromium, and associated respiratory health symptoms among small scale welders in Dar es Salaam.

Methodology: a cross sectional study using quantitative **approach employed** the use of interview based questionnaires was conducted, observation checklist and laboratory analysis of 30 personal air samples (NIOSH 7300 Methods). A multistage sampling technique with probability methods was used to select study area (Districts, Wards and welding workplaces). A simple random sampling was used to select study participants. Data analysis was done using statistical package for social sciences (SPSS) version 16.

Results: The study was involved 110 Male small scale welders from three Districts (Temeke, Ilala and Kindondoni) of Dar es Salaam Region with Mean age of 34±11.6 years and illiteracy rate of 1.8%. The prevalence of respiratory health symptoms highly reported were Cough 40%, Breathlessness 27.3%, phlegm 24.5%, Wheeze 24.5, and Chest tightness 24.5%. the study suggest that small scale welders were exposed to high mean concentration level above TLV limit for total metal fume 6.57±2.50mg/m^3 but below the limit level for its elements; Cadmium (Cd) 0.00163 mg/m^3, Chromium (Cr) 0.07346 mg/m^3, and Nickel (Ni) 0.09809 mg/m^3. The proportion of utilization of appropriate PRPEs among small scale welders was low (2%) and findings showed that there was statistical significant evidence ($p<0.005$) that welders who were not used PRPEs were 5 times likely to develop respiratory health symptoms compared to those who were used.

Conclusion and Recommendation: This study was found high occupational exposure level to metal fumes among small scale welders in Dar es Salaam. Implementation of sound control measures at the source of fumes is highly encouraged in order to minimize exposure concentration to the safe acceptable level.

CHAPTER ONE

1. INTRODUCTION

1.1 Background

Welding is an operation that aims to obtain coalescence produced by localized heating to an appropriate temperature with or without the application of pressure or filler metal. There are more than 80 different types of welding and associated processes, some of the most common types of welding are: arc welding, which includes "stick," or shielded metal arc welding (SMAW), the gas-shielded methods of metal inert gas (MIG) and tungsten inert gas (TIG), plasma arc welding (PAW) and submerged arc welding (SAW). Other welding processes may use oxy-acetylene gas, electrical current lasers, electron beams, friction, ultrasonic sound, chemical reactions, heat from fuel gas and robots (1).

Electric arc welding is the commonest welding technologies used in small scale industries in developing countries including Tanzania (2). It can produce dangerous fumes (a complex mixture of gases and oxides or salts of metals) that may be hazardous to the welder's health (3). The welding fume generated during the welding process possesses at least 13 metals, including manganese (mn), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), mercury (Hg), molybdenum (Mo), nickel (Ni), zinc (Zn), antimony (Sb), and vanadium (V) (4)(5).

Metal fumes cause occupational respiratory health symptoms which continue to cause serious public health problems and are among the leading cause of occupational morbidity and mortality cases worldwide. Studies show that individuals occupationally exposed to the fumes from welding operations have a higher incidence of acute and chronic health problems, including: nose/throat irritation, coughing, bronchitis, pneumonitis, metal fume fever (may affect up to 30% of workers), asthma, and cancer (6)(7).

ILO has estimated that over 2 million deaths are recorded every year from work related accidents and diseases and more than 160 million people suffer from occupational and

work-related diseases. Respiratory diseases and lung cancers account for about 70% of all occupational diseases and death worldwide (8).

According to the International Agency for Research on Cancer (IARC), Welding fumes are classified into group 2B (possibly carcinogenic to humans) (9). Nevertheless, nickel, cadmium, and chromium VI are three metals that were categorized as Class 1 IARC carcinogens in the early 1990s, based on sufficient evidence from experimental and epidemiological studies (10). Several studies showed that welders are exposed to carcinogenic metals (11)(12).

The American Conference of Governmental Industrial Hygienists (ACGIH) has currently set minimum acceptable exposure levels to carcinogenic metal fumes that the Biological Exposure Index (BEI) at 5 micrograms/g creatinine for workers exposed to airborne cadmium and the World Health Organization (WHO) proposed a health-based limit of 10 nmole/mmole creatinine (10 μg/g creatinines). ACGIH currently sets a TLV of 0.01 mg/m3 for the inhalable fraction of cadmium dust (13).

In Tanzania, since independence in 1961, occupational health and safety standards were provided for the Factories Ordinance Cap 297 of 1950. After nationalization in 1967, most of the factories were owned and managed by the Government. Enforcement of occupational health and safety standards was not effective due to the fact that the Government was playing the roles of employer, enforcer and regulator. Therefore, shortcomings in occupational health and safety were not well redressed. After the introduction of privatization policy in 1990s most of the factories were privatized. The management which took over did not consider occupational health and safety matters as important as other production goals, particularly financing of accident prevention. The privatization process introduced new and diverse technologies which added more challenges in the field of occupational health and safety while standards remained the same (14).

In view of this shortcoming, the Government through Public Service Reform Programme (PSRP) established Occupational Safety and Health Authority (OSHA) under the Executive Agency Act No. 30 of 1997. The establishment of the Agency was followed by enactment of the Occupational Health and Safety Act in the year 2003 to repeal the

Factories Ordinance; the Act harmonized the formulation of occupation health and safety policy of 2009. However, due to insufficient research, statistics and consistent case reporting, limited information is still known regarding magnitude of Work related diseases and occupational hazards exposure level among small scale workers in informal sector Country wide. This study therefore was specifically aimed to assess occupational exposure to metal fumes and associated respiratory health symptoms among small scale welders in Dar es Salaam.(14).

1.2 Problem statement

Welders are specifically involved with fusing metal materials together to obtain desirable objects for different purposes. They encounter metal fumes emitted during welding process which may result into serious respiratory health effects such as throat irritation, coughing, bronchitis, pneumonitis, metal fume fever, asthma, and lung cancer (1). Earlier detection of occupational exposure levels can help to improve workplace control measures and hence reducing likelihood of contacting respiratory health symptoms to acceptable level (6).

However, the uncontrolled rapid growth of informal sector in Tanzania has been influencing the relative increase in workforce engaged in welding operations and posing the risk of welders exposure to vast number metal fumes which make them susceptible to develop chronic respiratory diseases (15)(14). A qualitative situational analysis done in Tanzania, suggests that workers in informal sectors have high levels of exposure to multiple health hazards and that there is increased self-reported occupational health problems, particularly amongst welders and metalworkers (15).

Despite many efforts made by Tanzania to overcome the challenges of occupational health and safety yet the overall burden of workers exposure to multiple health hazards including dust, fumes, noise and sunlight still persists in many workplaces across the country (15) Limited information was known concerned occupational exposure level to welding fumes and associated respiratory health symptoms among small scale welders. This study therefore was aimed to assess occupational exposure to metal fumes;

Cadmium, Nickel and Chromium, and associated respiratory health symptoms among small scale welders in Dar es Salaam.

1.3 Problem analysis diagram

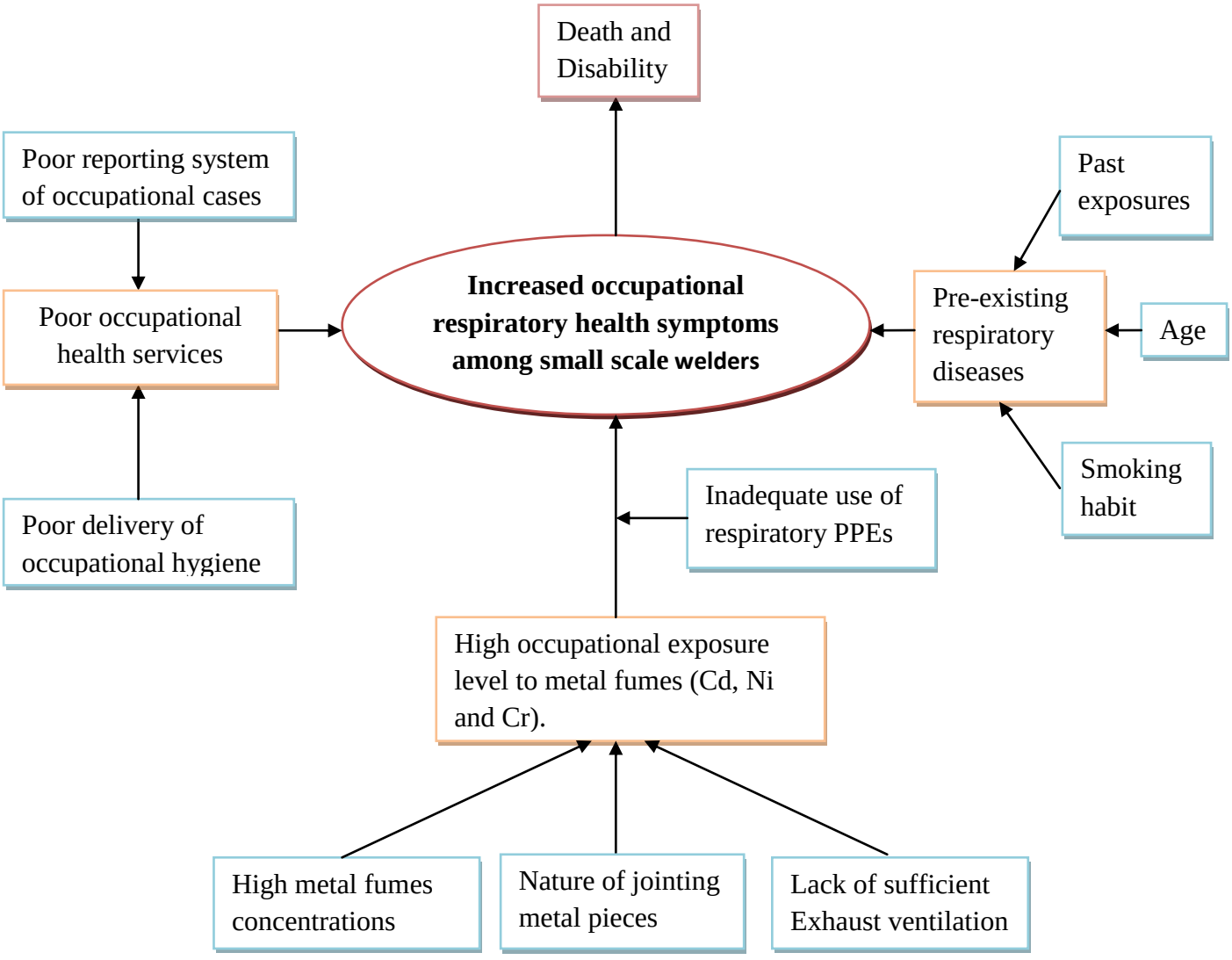


Figure 1.1: Problem analysis diagram

The problem analysis diagram (Figure 1.1) presents the high occupational exposure level to metal fumes containing Cadmium, Nickel and Chromium is a problem which occurs in most poorly managed welding industries, this problem results into numbers of occupational respiratory health effects such as Asthma, Bronchitis, Metal fume fever and lung cancer (16); occupational exposure level is usually caused by several factors generally categorized into individual, environmental, institutional, and social demographic factors.

Individual factors are the factors on the pathway from exposure to symptoms – i.e. it is meant to reduce high exposure dose, these are; inadequate use of protective equipments during working, low level of risk perception among welders, and poor working practices which facilitate exposure level e.g. bending to near the source of fumes.

Environmental factors in this context are the workplace conditions which increase the level of occupational exposure to metal fumes, these include Lack of exhaust ventilation system which increase fumes suspension, nature of jointing steel pieces such as stainless and mild steel pieces which contain difference amount composition of Cadmium, Nickel and chromium, long working duration and high concentration of suspended metal fumes which facilitate intake concentration of air contaminants to the body.

Institutional factors are government's institutional issues and challenges which compromise working environment and affect overall occupational health, safety and workers welfare, they play great role on increasing exposure level; these are lack of local mandatory exposure standards, lack of routine health surveillance and reporting of occupational health cases, poor delivery of occupational hygiene services and low capacity in controlling the current rapid growth of informal sector which effect the overgrowing small scale enterprises.

Demographic factors; such as age in sense that young and elder people have high exposure level compared to adults and lack of education which can affect risk perception and working practices. Risk factors however, are the factors influencing the occurrence of respiratory health symptoms, these factors include preexisting diseases (e.g. lung

function disorders) and cigarette smoking which tend to affect lung functions and therefore reduce air contaminants intake into the body.

1.4 Study rationale

The long term sustainable development goal of Tanzania is to reduce the poverty of her people and improve the working conditions of the entire workforce. It is therefore anticipated that information from this study will help in contributing more reliable information on occupational exposure level among small scale welders and associated respiratory health symptoms that will facilitate both, the private and the public, sectors into becoming the engine of healthy and safe working conditions through effective compliance of the national occupational safety and health (OSH) systems. This will entail the process of continuous adjustment of the legal and regulatory framework impacting on the performance of the working people to reduce production costs, enhance business ethics, improve industrial relations, increase productivity and face competitiveness.

This study has addressed the occupational exposure level to metal fumes and the magnitude of the respiratory health problem among small scale welders. The study therefore has added new knowledge and imparted better Altitude among the small scale welders and their employers on the necessity to improve workplace hygiene and implement routine on job trainings.

The findings from this study can also enlighten relevant authorities and interested parties on the existing problems and provide opportunities for further research acting to provide baseline information for policy makers. Thus an envisaged opportunity for continued efforts to improve work conditions in the small scale industries.

The dissertation of this study is important as the partial fulfillment of Master’s degree of science in Environmental and Occupational health at Muhimbili University of Health and Allied Sciences (MUHAS).

1.5 Research questions

Main question

What is the occupational exposure level to metal fumes; Cd, Ni and Cr, and associated respiratory health symptoms among small scale welders in Dar es Salaam?

Specific questions

i. What are the respiratory health symptoms associated with metal fumes containing heavy metals; Cd, Ni and Cr, among small scale welders?
ii. What are the Occupational exposure concentrations of heavy metals (Cd, Ni and Cr) contained in metal fumes?
iii. What is the proportion of welders using respiratory personal protective equipments (PPEs) in small scale welding workshops?

1.6 Study objectives

1.6.1 Main objective

To assess occupational exposure level to metal fumes containing Cadmium, Nickel and Chromium, and associated respiratory health symptoms among small scale welders in Dar es Salaam.

1.6.2 Specific objectives

i. To determine occupational exposure concentration of heavy metals (Cadmium, Nickel and Chromium) in metal fumes.
ii. To determine respiratory health symptoms prevalence among small scale welders in Dar es Salaam
iii. To determine proportion of welders using personal respiratory protective equipments (PPEs) in small scale welding workshops.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Metal fumes exposure

In the cross sectional study on Assessment of Welders Exposure to Carcinogen Metals from Manual Metal Arc Welding in Gas Transmission Pipelines, *Iran* by Golbabaei *et al*, 94 individuals from Gas Transmission Pipelines welders, Iran, Borujen in 2011 reported high exposure concentrations of metal fume and its elements (Cd, Cr and Ni) among Back Welders and Assistances groups. In addition, results showed that there are significant differences ($P<0.05$) between Welders and Back Welders with Assistances group in exposure with total fume and elements except Ni. Urinary concentrations of three metals including Cr, Cd and Ni among all welders were about 4.5, 12 and 14-fold greater than those detected in controls, respectively. Weak correlations were found between airborne and urinary metals concentrations (R2: Cr=0.45, Cd=0.298, Ni=0.362). the study concluded that Urinary metals concentrations could not be considerate as a biomarker for welders' exposure assessment (16).

The study by Koh *et al* involved a group of 240 male welders working at two shipyards who underwent an annual health examination in 2010 reported the mean cumulative fume exposure of 7.7mg/m^3 (3). The prevalence of Chronic Obstructive Pulmonary Diseases (COPD) was 15%. FEV1 and FVC showed non-significant negative correlations with cumulative fume exposure. Odds ratios of COPD were significantly elevated for the middle and high exposure groups compared with the low fume exposure group, the findings were supported an association between welding fume exposure and increased risk of COPD (17).

A qualitative situation analysis of small scale industry workers in Dar es Salaam involving interviews with 310 workers showed that there was a high level (>90%) of self-reported exposure to dust, fumes, noise or sunlight in certain occupational groups. There was low reported use of personal protective equipment. There was a high level of self-reported occupational health problems, particularly amongst welders and metalworkers (15).

2.2. Respiratory health symptoms

A study by Sultan T. (2014) on respiratory symptoms and respiratory function of welders in comparison to a "nonexposed group." reported that sixteen (39%) welders experienced bringing up phlegm from the chest first thing in the morning, compared with seven individuals (17.1%) in the nonexposed group. Eleven welders had chronic bronchitis, which they had experienced most days for as long as 3 months, compared with one person in the nonexposed group. The difference was statistically significant, and OR was 1.7 On the other hand, the difference in cough, shortness of breath and lung function was statistically insignificant when the welders were compared with the nonexposed group (18).

The study of exposure to welding fumes and lower airway infection with Streptococcus pneumoniae by Reetika et al reveal that the Mild Steel Welding Fumes (MS-WF) exhibited high oxidative potential. In A549 and BEAS-2B cells MS-WF increased pneumococcal adhesion and infection and platelet-activating factor receptor (PAFR) protein expression. Both CV-3988 and N-acetylcysteine reduced MS-WF–stimulated pneumococcal adhesion and infection of airway cells. MS-WF increased mouse lung PAFR mRNA expression and increased bronchoalveolar lavage fluid (BALF) and lung pneumococcal colony-forming units (CFU) values. In MS-WF–exposed mice CV-3988 reduced BALF CFU values. Hypersusceptibility of welders to pneumococcal pneumonia was in part mediated by the capacity of welding fumes to increase PAFR-dependent pneumococcal adhesion and infection of lower airway cells (19).

According to Kasprzak et al in the study of Nickel carcinogenesis, suggested that human exposure to highly nickel-polluted environments, such as those associated with nickel refining, electroplating, and welding, has the potential to produce a variety of pathologic effects. Among them are skin allergies, lung fibrosis, and cancer of the respiratory tract. The exact mechanisms of nickel-induced carcinogenesis are not known and have been the subject of numerous epidemiologic and experimental investigations. These mechanisms are likely to involve genetic and epigenetic routes. The present review provides evidence for the genotoxic and mutagenic activity of Ni (II) particularly at high doses. Such doses are best delivered into the cells by phagocytosis of sparingly soluble nickel-containing

dust particles. Ni(II) genotoxicity may be aggravated through the generation of DNA-damaging reactive oxygen species (ROS) and the inhibition of DNA repair by this metal (20).

Chronic occupational exposure to soluble hexavalent chromium (Cr+6) result in bronchitis, asthma, ulceration and perforation of the nasal septum and liver and kidney damage in exposed workers. In addition, chromium (VI) compounds are Mutagenic in both prokaryotic and eukaryotic cells in vitro. Surprisingly, both chromium (III) and chromium (VI) have been refractory in producing mutagenic DNA damage in cell free systems. A correlation exists between increased lung cancer risk in welders and increasing length of time since first exposure to Cr+6 containing fumes (21).

Cadmium is a naturally occurring component of the earth's crust. In the occupational environments, workers may be exposed to Cd through the inhalation of fumes generated during welding of cadmium-containing materials, or inhalation of particles of metal, oxide, and pigment dust. Cd can cause adverse effects on multiple organs, especially on the kidney which can results into Kidney stone and failure. The kidney is generally considered the critical organ. This metal can be easily absorbed into the body through the respiratory tract. This is because cadmium accumulates predominantly in the kidneys because of the long biological half time of 10–30 yr. In workers, cadmium has moreover been associated with an alteration of the lung function and has been suspected to cause lung and possibly prostate cancer (16)(22).

2.3. Respiratory personal protective equipment's (PPEs) use

The proper use of safety measures by welders is an important way of preventing and/or reducing a variety of health hazards that they are exposed to during welding, according to the study done in Zambia by Jessy Z.M, it was found that welders were exposed to welding hazards such as intense bright light, heat, noise, fumes and gases. Other hazards arose from poor housekeeping, unsafe work structures and tools such as grinders. Although the majorities (98%) of welders were aware of at least one type of welding hazard or PPE, about 2% were not aware of any hazards or any personal protective

measures. None of the welders used all the recommended PPE at any time during their work (8).

A cross-sectional descriptive study of 405 consenting welders conducted in southwestern Nigeria by Lyiade *et al* found that Less than half (186, 45.9%) of the welders possessed protective eye devices. Of these, only 39 (9.6%) made use of the devices always. Some of the reasons for not using the protective eye devices include discomfort and poor visibility (56, 13.6%) and inadequate appreciation of the necessity to wear it (49, 12.1%) (23).

Another cross-sectional study of 300 welders selected by simple random sampling from three districts of eastern Nepal by Shyam *et al*, found that Overall, 272 (90.7%) welders were aware of at least one hazard of welding and a similar proportion of welders were aware of at least one PPE. However, only 47.7% used one or more types of PPE. Education and duration of employment were significantly associated with the awareness of hazards and of PPE and its use. The welders who reported using PPE during welding were two times more likely to have been aware of hazards (24).

2.4. Literature review summary

Different studies show that welders are exposed to different form of occupational hazards including Metal fumes, these fumes contain difference composition of natural occurring hazardous metal including carcinogenic heavy metals; cadmium, Nickel and Chromium, which are very dangerous to the exposed welders health and can cause numbers of respiratory health effects such as occupational asthma, pneumococcal pneumonia, Metal fume fever, Bronchitis, ulceration and perforation of the nasal septum, and lung cancer.

However, most of these studies have been conducted in developed countries especially oversees where industrial sector has been major part of economic development but limited information concerned to exposure level to metal fumes among small scale welders was known in local settings of Tanzania. This study therefore was designed to cover the gap and open baseline opportunity for other researchers in Tanzania.

CHAPTER THREE

3. METHODOLOGY

3.1. Study design

The study was designed to be descriptive, cross sectional study using quantitative approach to assess occupational exposure to metal fumes containing carcinogenic heavy metals; Cadmium, Nickel and chromium and respiratory health symptoms among small scale welders in Dar es Salaam

3.2. Study area

The study was conducted at small scale welding workplaces located in Dar es Salaam. Dar es Salaam is the third fastest growing city in Africa (after Bamako and Lagos) and largest city of Tanzania located at 6°48' South, 39°17' East and the largest city in eastern Africa by population as well as a regionally important economic centre, the region had a population of 4,364,541 as of the official 2012 census which contribute over 13% of informal sector's employments in Tanzania (25)(15). It consists of five administrative districts: northern Kinondoni, central Ilala, Ubungo, southern Temeke, and Kigamboni.

3.3. Study Population

The study population was all welders working at small scale welding workshops in the study area.

3.4. Sample size determination

In estimating the sample size, the following assumptions were made;

- No national or local data on the prevalence of respiratory health symptoms among small-scale welders. Hence, prevalence of 15 % COPD was used from a study 240 male welders working at two shipyards who underwent an annual health examination in 2010 by Koh et al (17).
- There would be a 90% Response rate which was used for adjusting the study sample for non-response. Therefore, adjustment factor was 1/0.9 = 1.1

- Sample was drawn from a large population and therefore there was a formula employed in estimating the sample size.

Sample size was calculated based on the following formula by *Kothari 2004* (26).

$$\mathbf{n = \frac{z^2 p\,(100-p)}{\varepsilon^2}}$$

Where;

z = standard normal deviate= 1.96 for 95% confidence level

p = expected proportion with characteristics of interest (*Prevalence of 15 % COPD was used from a study 240 male welders working at two shipyards who underwent an annual health examination in 2010 by Koh et al* (17)*).* .

ε = margin error (precision)-*to be less than p/2.*

$$\mathbf{n=\frac{z^2 p\,(100-p)}{\varepsilon^2}}$$

Where z=1.96 (C.I. 95%)
p= 15

Important: $\varepsilon < p/2$
p/2= 15/2 = 7.5
Therefore ε is hereby taken as 7%

$$n = \frac{1.96^2 \times 15(100-15)}{7^2}$$

n= 100

Adjusted sample size for non-response = 100 x 1.1 = 110

Therefore an estimated **110** small scale welders were recruited for participation in this study with participation rate of **100%**.

3.4.1. Inclusion criteria

Small scale welders performing Shielding Metal Arc Welding (SMAW) who have been started working at least in the previous 12 months and whose workshops were found operational at the time of data collection and personal air sampling.

3.5. Sampling technique

3.5.1. Participants sampling

A multistage sampling technique with probability strategies was used to select 110 study subjects through the following stages;

First stage: three out of five districts of Dar es Salaam region were selected using simple random method

Second stage: one ward was selected from each district using simple random method and therefore the total number of 3 wards out of 73 wards was selected.

Third stage: systematic random method was used to select small scale welding workshops from each ward, where by at least 7 welding workshops were selected from each ward, hence the total number of 22 welding workshops was selected.

Fourth stage: List of welders was solicited from workshop managers to obtain a sampling frame and performed simple random sampling to select study subjects. 5 welders were selected from each workshop.

3.5.2. Personal air sampling

The total of 30 personal air samples contained metal fumes was collected (i.e. at least 1 sample from each workshop) according to U.S.A National Institute of Occupational Safety and Health (NIOSH) Method 7300. The cassette consisting a closed face 25 mm polystyrene filter containing a 0.8 μm pore size Mixed Ester Cellulose (MCE) was used to capture sample at the breathing zone and was connected to a personal sampling pump calibrated at flow rate of 2.0 ± 0.1 L/min.

The cellulose ester membrane (MCE) filters were weighed using the balance before and after air sampling. In all cases, the filters will be kept in desiccators for 24 hours before weighting. In addition, all samples were taken during the work shift (8hours).

For the determination of Cr, Ni and Cd, MCE filters were extracted, using digestion with HNO3 and then analyzed by Inductively Coupled argon Plasma, Atomic Emission Spectroscopy (ICP-AES) at National government chemist laboratory of Tanzania (6)

3.6. Data collection tools

Respiratory health symptoms data were collected using interview based questionnaire with structured questions adopted from British Medical Research Council (BMRC) standard questionnaires.

Laboratory analysis of 30 personal air samples using Inductively Coupled argon Plasma, Atomic Emission Spectroscopy (ICP-AES) method was done to determine concentration level of metal fumes: Cadmium, Nickel and Chromium.

Observation checklist was used to collect data regarding the use respiratory PPEs among study subjects.

3.7. Variables

3.7.1. Dependent Variables

The dependent variables (the outcome) of this study were respiratory health symptoms among small scale welders

3.7.2. Independent variables

- Demographic factors; Age, Sex and Educational level
- Individual factors; Cigarette smoking, pre existing diseases, PPEs uses
- Environmental factors; Exposure concentrations, Nature of jointing metal pieces, availability of PPEs, Working duration

3.8. Variable measurements

The prevalence of respiratory health symptoms was measured through Interview – administered questionnaire. Exposure levels were judged from air concentration levels of welding metal fumes; Cadmium, Nickel and Chromium against TLV exposure standards and the proportion of welders using respiratory personal protective equipments (PPEs).

3.9. Pretest of Tools

The Kiswahili version questionnaires were pre tested in the field to know if they were clearly understood by the participants and major corrections were made for better understanding of the participants without changing the meaning. Sampling pumps were also calibrated and tested within 8 hours prior data collection to see if they could manage to work properly within working duration.

3.10. Data collection procedure

Data were collected using interview based questionnaire for approximately 20 minutes in a private separate area within the workplace in the morning prior air sampling.

Laboratory analysis of 30 personal air samples using Inductively Coupled argon Plasma, Atomic Emission Spectroscopy (ICP-AES) (6) was done at Government Chemist Laboratory located at Ocean road City centre, 24 hours after Sampling and post weighing for obtaining concentrations of heavy metals; Cadmium, Nickel and Chromium.

Walkthrough observation using prepared observation checklist was done during air sampling to obtain data regarding PPEs use among the study subjects.

3.11. Data Management

Data were collected on daily basis from morning to evening in working days until the number of required subjects was obtained. On daily bases the researcher was counterchecking for accuracy and completeness of the filled questionnaires and all completed questionnaires were given number. Data entry after finishing data collection activity was done using Statistical Package for Social Sciences (SPSS) version 20.

Frequencies were run to check for missing data and correction in the entered data were made.

Questionnaires were stored safely in the data storage box while the soft copy data were stored in laptop computer and backup in flash disk.

3.12. Data analysis

Quantitative data analysis was done using Statistical Package for Social Sciences (SPSS) version 20. Frequencies and cross tabulations were used for data summarization, t test and Chi - square test was used to assess the statistical significance in difference of Continuous and categorical variables respectively. Multivariate logistic regression analysis was employed to show the intensity of the effect of independent variables and the respiratory health symptoms. Association between independent and dependent variable was considered significant if p-value was less than 0.05.

3.13. Ethical considerations

Research clearance was sought from Muhimbili University of Health and Allied Sciences Institutional of Review Board (MUHAS-IRB) and National Research Ethical Committee. Permission was also requested from respective Municipal Directors and Ward Executive Officers was informed during data collection in their respective areas.

During field work, Swahili summary information about the study was given out, explaining why the study has been carried out, by whom, and who would be involved. Respondents were asked for consent to be interviewed and use their photos during study results dissemination with assurance of no retribution for not participating. Those unwilling to participate were excluded in interview. Confidentiality of all study participants was assured. Everybody was informed that no names or direct indication made to the questionnaire except numerical identification.

CHAPTER FOUR

4. RESULTS

4.1. Socio-demographic of the study population

The study was conducted from 7th May to 14th July 2017 in three Districts of Dar es Salaam region namely; Ilala, Kinondoni and Temeke. A total of 110 small scale welders from three different wards (Buguruni, Kijitonyama and Chang'ombe) participated in this study, with a participation rate of 99% whereby all 110 (100%) participants were Male with mean age of 34 ± 11.6 years ranging from 17-60 years. Majority of the participants 21(36%) fell in the age group of 25 to 34 years.

The Mean BMI for participants was 22.73 ± 2.99 Kgm^{-2} which were almost equal to that of general population of Tanzania (22.7 Kgm^{-2}). Majority 68 (61.8%) had primary education while 2 (1.8%) had never attend to school at all. About 42 (38.2%) participants had work experience on welding industry of more than 10 years. Less than a half of participants 36 (32.7%) worked for more than 8 hours per day (Table 4.1).

Table 4.1: General Characteristics of the study population (n=110)

Characteristics	Frequency n (%)
Sex	
Male	110 (100)
Age group	
15-24	27 (24.5)
25-34	40 (36.4)
35-44	20 (18.2)
45-54	17 (15.5)
55+	6 (5.5)
BMI class (Kgm^{-2})	
18.5-24.9[b]	89 (80.9)
25.0-29.9[c]	18 (16.4)
>29.9[d]	3 (2.7)
Educational Level	
Never attended school	2 (1.8)
Primary	68 (61.8)
Secondary	38 (34.5)
Tertiary education	2 (1.8)
Welding work experience (Years)	
1-5	40 (36.4)
6-10	28 (25.5)
>10	42 (38.2)
Work duration (Hours)	
1-8	74 (67.3)
>8	36 (32.7)

Keys: BMI, Body Mass Index; [b] Normal weight; [c] Overweight; [d] Obese

4.2. Metal fumes concentrations (Personal exposure) among Participants

The results of 30 personal air samples taken around the breathing zone of study participants from each study workshop, show that exposure concentration of total fume was higher than exposure limit (TLV) set by ACGIH and there was statistical significance in difference between Mean exposure concentrations of total fume and those of its elements as compared to their Threshold Limit Values (p value < 0.001) as shown in Table 4.2.

Table 4.2: Concentrations of Total fume and Heavy metals in breathing zone among participants (mg/m^3)

Contaminants (TLV)	No of Samples	Mean±SD (mg/m3)	Minimum Conc.	Maximum Conc.	Sample exceeded TLV	Sample below TLV	p value
Total fumes (5)	30	6.57 ± 2.50	3.46	14.66	73%	27%	<0.001
Cadmium (0.002)	30	0.00163±0.001	0.00009	0.00472	23%	77%	<0.001
Chromium (0.5)	30	0.07346±0.09	0.00652	0.45699	0%	100%	<0.001
Nickel (0.1)	30	0.09809±0.04	0.02984	0.28189	26%	74%	<0.001

*Comparison with TLV (One sample *t* test). All limits are according to American Conference of Governmental Industrial Hygienist (ACGIH) guidelines

According to One sample *t* test, the mean concentration of total fumes was significantly differed by 1.57 mg/m^3 (20%) higher from the TLV but its elements were significantly differed by 0.00037 mg/m^3 (18.5%) for Cadmium (Cd), and 0.0019 mg/m^3 (1.91%) for Nickel (Ni) lower from their TLVs. Only Chromium (Cr) was differed significantly by 0.43 mg/m^3 (98.5%) lower from its TLV (Figure 1.2)

4.3. Respiratory Health Symptoms among Participants

Majority of participants (n= 97, 88.2%) reported to have experienced at least one of respiratory health symptom at some point within 12 months from the date of Data collection. The acute Respiratory Health Conditions (RHCs) which last for few hours (≤24 hours) after work shift (i.e. Runny nose, Irritated nose/throat, stuffy nose and metal fume fever) were found to be most prevalent respiratory health symptoms reported by 80.9% of participants followed by other major symptoms as shown in Figure 1.3 and Table 4.3.

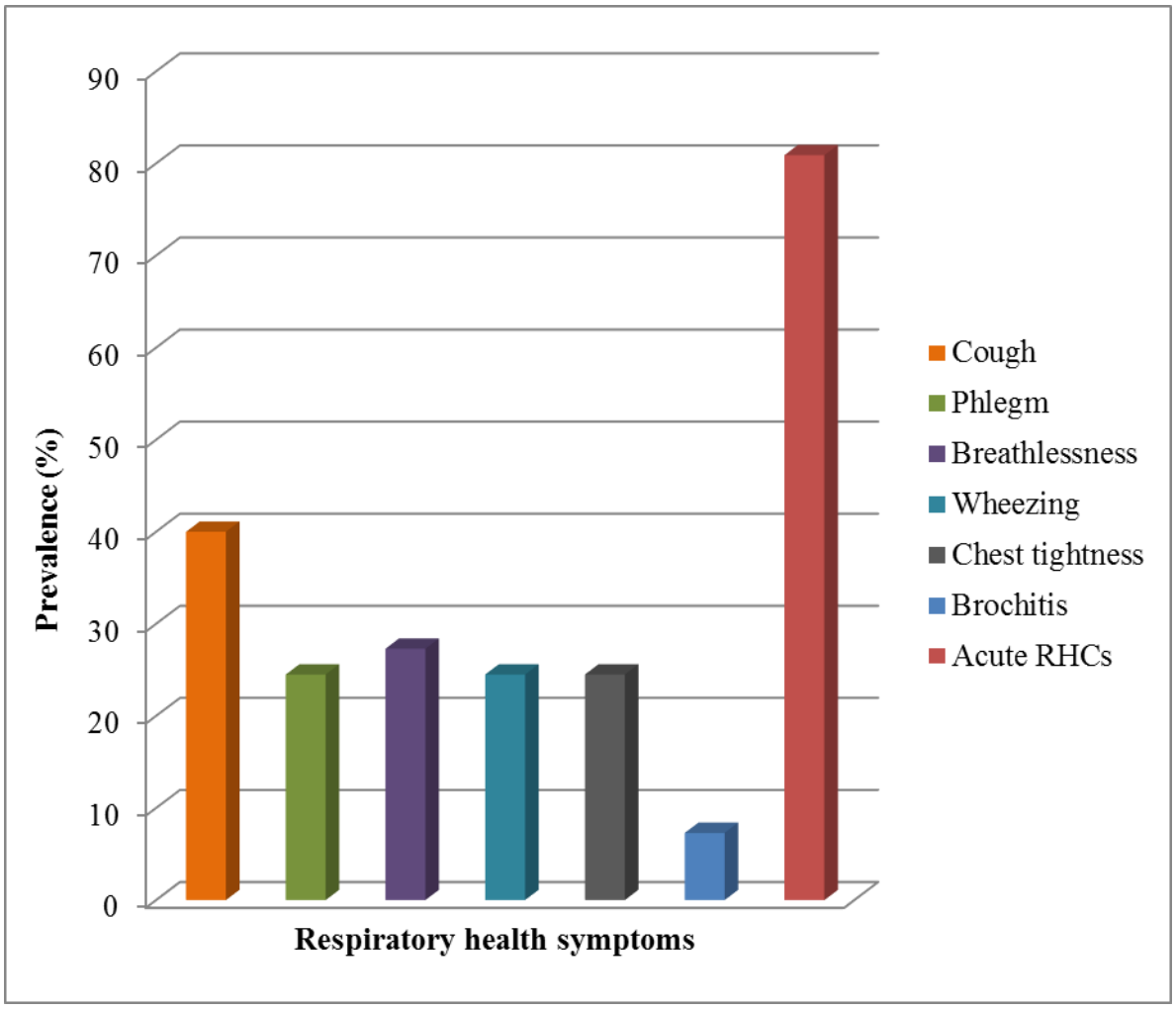


Figure 1.3: Distribution of Respiratory health symptoms among study participants

4.3.1. Severity of Respiratory heath Symptoms

Severity of respiratory health symptoms was determined by asking participants based on the conditions and duration of symptoms they had experienced in the last 12 months (Table 4.3). Majority of participants who reported Cough and Phlegm, they had experienced those symptoms in the first thing morning than during the day or at night. At least half of participants who reported cough and phlegm, they experienced frequent cough as much as 4-6 times a day for 4 or more days in a week and only few of them (3.6%) had experienced cough and phlegm on most of days as much as 3 consecutive months or more in a year (Table 4.3).

Almost all participants who reported to experience shortness of breath while walking with other people of their same age on a level ground they also reported the same symptom while walking at their own pace on a level ground. Majority of participants who reported shortness of breath when walking, they also reported the same when hurrying on a level ground or walking up a slight hill (Table 4.3). However, in this study many study participants (80.9%) reported more acute respiratory health conditions (i.e. runny nose, Irritated nose/throat, stuffy nose and metal fume fever) in past 12 months from the time of data collection than any other symptoms as shown in Table 4.3.

Table 4.3: Severity of Respiratory health symptoms among study participants (n=110)

Respiratory Health Symptoms	Frequency (n)	Percentage (%)
Cough	**44**	**40**
Cough first thing in the Morning	41	37.3
Cough during the day or at Night	36	32.7
Cough as much as 4-6 times a day for 4 or more days in a week	18	16.4
Cough as much as 3 consecutive months or more in a year	4	3.6
Phlegm	**27**	**24.5**
Cough with sputum first thing in the Morning	26	23.6
Cough with sputum during the day or at night	24	21.8
Cough with sputum as much as 4-6 times a day for 4 or more days in a week	16	14.5
Cough with sputum on most of days as much as 3 consecutive months or more in a year	4	3.6
Breathlessness	**30**	**27.3**
Troubled by shortness of breath when hurrying on level ground	30	27.3
Troubled by shortness of breath when walking with other people	27	24.5
Had to stop for breath when walking at own pace on level ground	23	20.9
Wheezing	**27**	**24.5**
Had attack of wheezing or whistling at any time in the last 12 months	27	24.5
Chest Tightness	**27**	**24.5**
Experienced chest tightness at any time in the last 12 months	27	24.5
Bronchitis	8	7.3
Had a period of increased cough with increased sputum production for as long as three weeks or more during the past 3 years	8	7.3
Acute Respiratory Health Conditions (RHCs)	**89**	**80.9**
Runny nose	73	66.4
stuffy nose	58	52.7
Irritated nose/throat	36	32.7
Metal fume fever	65	59.1

4.3.2. Past respiratory diseases among study participants

Pneumonia was the most reported respiratory disease diagnosed past 3 years by 6.36% of study participants followed by Pleurisy Bronchial Asthma and Hey fever. However, none of the respondents had reported to be diagnosed with Lung cancer.

The binomial logistic regression indicated no statistical significant in association between past respiratory diseases and the respiratory health symptoms reported by the participants (i.e. p value > 0.05)

Table 4.4: Past respiratory diseases reported by the study participants

Past respiratory diseases	Frequency (n)	Percentage (%)	p value
Pneumonia	7	6.36	0.999
Pleurisy	6	5.45	0.987
Bronchial Asthma	4	3.64	0.995
Hey fever	4	3.64	0.999

4.4. Protective equipments use among Participants

When asked whether they have been using any form of PPE during welding operation, over 95% reported to use PPEs. Majority of participants reported to use Goggles/face shield and below half of them reported to use any form of Personal Respiratory Protective Equipments (PRPEs) as indicated in figure 1.4 and Table 4.5.

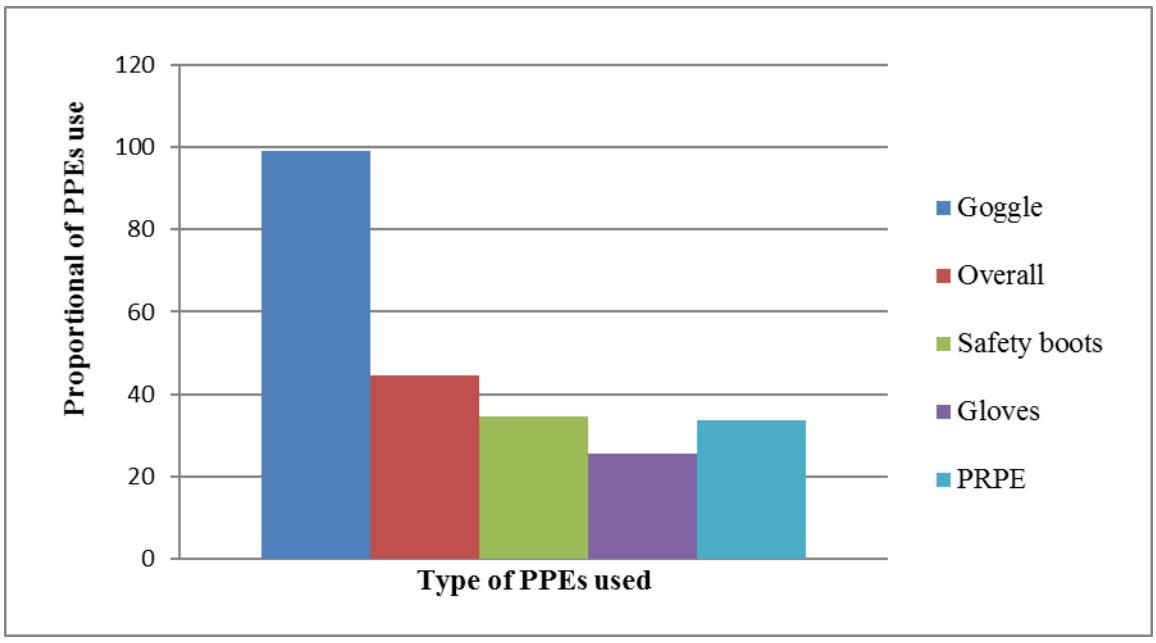


Figure: 1.4: Proportion of PPEs use among study participants

However, among those participants who reported to use any form of PRPE during welding operations, only 2% reported to use appropriate metal fumes respirators and Majority of Participants (over 50%) reported not to use any form of PRPEs (Figure 1.5 and Table 4.5). Chi square test indicated that there was statistical significance in difference between the proportions of PRPEs use in relation to the respiratory health status (with and with no respiratory health symptoms) whereby p value < 0.05.

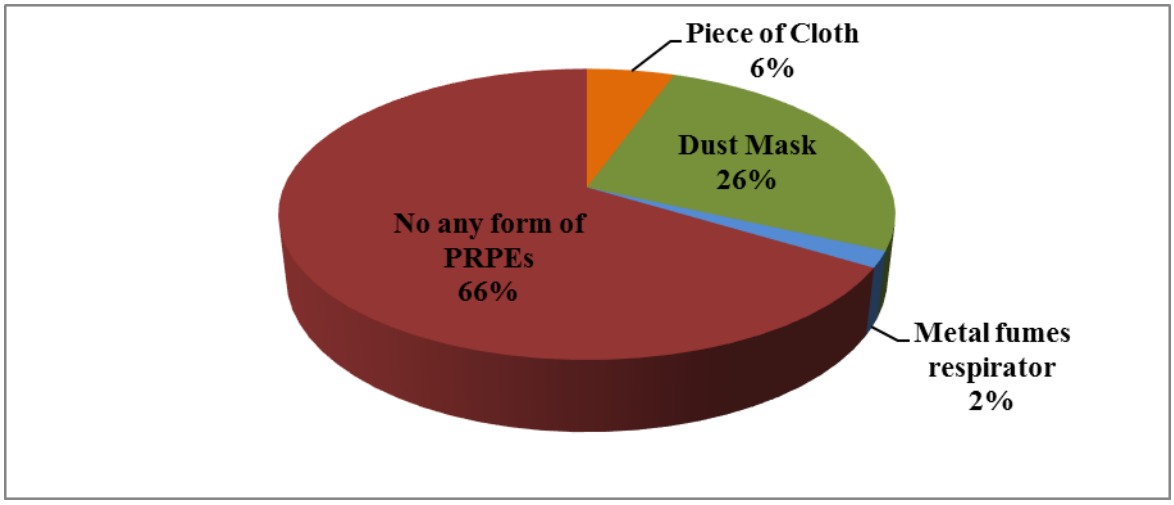


Figure 1.5: Proportion of PRPEs use among study participants

Table 4.5: Proportion of Personal Protective Equipments (PPEs) use among Participants (n = 110)

Type of PPEs used	Frequency (n)	Percentage (%)	p value
Any form of PPEs	**109**	**99.1**	**0.713**
Goggles	109	99.1	
Overall	49	44.5	
Safety boots	38	34.5	
Gloves	28	25.5	
PRPEs	**37**	**33.6**	**0.004***
• Piece of Cloth	6	5.5	
• Dust Mask	29	26.4	
• Metal fumes respirator	2	1.8	
• No any form of PRPEs	73	66.4	

Keys: * Statistically significant (Chi square test), will be observed if P<0.05; PPEs; Personal Protective Equipments, PRPEs; Personal Respiratory Protective Equipments.

Among those who reported to use any form of personal respiratory protective equipments, **none** of them were observed to wear any of those equipment during the day of data collection as shown in Table 4.5 A below.

Table 4.5 A: Workplace observation during the day of data collection

S/N	Observation criteria	Number	Percentage
1.	**PRPEs utilization during welding operation**		
	Welders who wore PRPEs	0	0
	Welders who not wore PRPEs	110	100
2.	**Workplace welding environment**		
	Indoor	0	0
	Out door	22	100
3.	**Workplace exhaust ventilation**		
	Workplace with exhaust ventilation	0	0
	Workplace with no exhaust ventilation	22	100
4.	**Workplace PRPEs sign or symbols**		
	Workplace with PRPEs signs or symbols	0	0
	Workplace with no PRPEs signs or symbols	22	100

4.5. Relationship between risk factors and the Occurrence of Respiratory Health Symptoms

4.5.1. Work duration (Years)

Chi squire test indicated that many participants who had worked for more than 5 years reported to have experienced cough in past 12 months compared to those who worked for 1 to 5 years. There was statistical significance in difference between the proportions of participants reported cough in those who worked for more than 5 years and those who worked for more 1 to 5 years i.e. $p<0.05$ (Table 4.6).

Table 4.6: Relationship between respiratory health symptoms and work duration among study participants

Respiratory symptoms	Work duration (years)		χ^2 value	p value
	1-5 Years (n =40) (%)	>5 Years (n = 70) (%)		
Cough			5.821	0.025*
Yes	13 (32.5)	31(44.3)		
No	27(67.5)	39(55.7)		
Phlegm			2.147	0.143
Yes	13 (32.5)	14 (20.0)		
No	27 (67.5)	56 (80.0)		
Breathlessness			3.31	0.069
Yes	15 (37.5)	15 (22.6)		
No	25 (62.5)	55 (78.6)		
Wheezing			2.696	0.117
Yes	15 (37.5)	12 (17.1)		
No	39 (62.5)	58 (82.9)		
Chest tightness			2.415	0.120
Yes	14 (35.0)	15 (21.4)		
No	26 (65.0)	55 (78.6)		
Acute RHCs			2.804	0.094
Yes	38 (95.0)	59 (84.3)		
No	5 (5.0)	11 (15.7)		

4.5.2. Education level

Chi squire test indicated the decrease in reported respiratory health symptoms as education level increases except for cough and phlegm provided their association is statistically significant. The only observed differences in proportions for cough and acute respiratory health conditions (runny nose, stuffy nose, irritated nose/throat, and metal fume fever) had statistically significant i.e. $p<0.05$ (Table 4.7)

Table 4.7: Relationship between respiratory health symptoms and education level among study participants

Respiratory symptom	Education level (n =110)				χ^2	p value
	None n = 2 (%)	Primary n = 68 (%)	Secondary n = 38 (%)	Tertiary n = 2 (%)		
Cough					11.264	0.01*
Yes	1 (50.0)	20 (29.4)	23 (60.5)	0 (0.0)		
No	1 (50.0)	48 (70.6)	15 (39.5)	2 (100)		
Phlegm					4.349	0.226
Yes	1 (50.0)	13 (19.1)	13 (34.2)	0 (0.0)		
No	1 (50.0)	55 (80.9)	25 (65.8)	2 (100)		
Wheezing						
Yes	0 (0.0)	19 (27.9)	8 (21.1)	0 (0.0)	1.975	0.578
No	2 (100)	49 (72.1)	30 (78.9)	2 (100)		
Breathlessness						
Yes	0 (0.0)	23 (33.8)	7 (18.4)	0 (0.0)	4.472	0.215
No	2 (100)	45 (66.2)	31 (81.6)	2 (100)		
Chest tightness						
Yes	0 (0.0)	23 (33.8)	6 (15.8)	0 (0.0)	5.57	0.135
No	2 (100)	45 (66.2)	32 (84.2)	2 (100)		
Acute RHCs					9.913	0.019*
Yes	2 (100)	54 (79.4)	33 (86.8)	0 (0.0)		
No	0 (0.0)	14 (20.6)	5 (13.2)	2 (100)		

Keys: *Chi-square test, $p<0.05$, Acute RHCs; Acute Respiratory Health Conditions (runny nose, stuffy nose, irritated nose/throat, metal fume fever).

4.5.3. Body Mass Index (BMI)

The results indicated statistical significance in association between Chest tightness and Body Mass Index (BMI); the high proportion of Chest tightness was reported by participants with high BMI above the normal range (Overweight) i.e. p value <0.05 (Table 4.8)

Table 4.8: Relationship between respiratory health symptoms and BMI among study participants

Respiratory symptoms		BMI groups		x^2 value	p value
		18.5-24.9 n (%)	>24.9 n (%)		
Cough					
	Yes	36 (40.0)	8 (40.0)	0.000	1.000
	No	54 (60.0)	12 (60.0)		
Phlegm					
	Yes	24 (26.7)	3 (15.0)	1.203	0.273
	No	66 (73.3)	17 (85.0)		
Breathlessness					
	Yes	22 (24.4)	8 (40.0)	1.996	0.158
	No	68 (75.6)	12 (60.0)		
Wheezing					
	Yes	20 (22.2)	7 (35.0)	1.443	0.230
	No	70 (77.8)	13 (65.0)		
Chest tightness					
	Yes	20 (22.2)	9 (45.0)	4.373	0.037*
	No	70 (77.8)	11 (55.0)		
Acute RHCs					
	Yes	75 (83.3)	14 (70.0)	1.883	0.170
	No	15 (16.7)	6 (30.0)		

4.5.4. Logistic regression of risk factors for Respiratory health symptoms

Binary logistic regression analysis results show that Personal Respiratory Protective Equipments (PRPEs) use among study participants was the most statistically significant predictor of all respiratory health symptoms; whereby those who were not used PRPEs were 11 times likely to develop ARCs, 6 times likely to develop wheeze, 5 times likely to develop Cough, Phlegm and Breathlessness, and 3 times likely to develop Chest tightness compared to those who were used PRPEs (i.e. p value < 0.05) (Table 9 A and B).

5. Table 9A: Predictors of Respiratory health symptoms among study participants

Respiratory symptoms	ß	S.E.	OR	95.0% C.I. for OR		p value
				Lower	Upper	
Cough						
Age	0.067	0.038	1.069	0.992	1.153	0.080
Work duration	-0.084	0.045	0.919	0.841	1.005	0.063
Education level	1.318	0.484	3.734	1.445	9.650	0.007*
Previous exposure	-0.203	0.493	0.816	0.310	2.147	0.681
Cigarette smoking	0.053	0.509	1.055	0.389	2.861	0.916
No PRPEs use	1.623	0.530	5.067	1.793	14.317	0.002*
Phlegm						
Age	0.052	0.043	1.053	0.969	1.145	0.226
Work duration	-0.013	0.048	0.987	0.899	1.084	0.784
Education level	0.700	0.510	2.013	0.741	5.471	0.170
Previous exposure	-0.629	0.531	0.533	0.191	1.486	0.229
Cigarette smoking	0.630	0.547	1.877	0.642	5.485	0.250
No PRPEs use	1.790	0.674	5.989	1.597	22.465	0.008*
Breathlessness						
Age	0.010	0.042	1.011	0.930	1.098	0.805
Work duration	0.026	0.051	1.027	0.928	1.135	0.608
Education level	-1.141	0.549	0.320	0.109	0.937	0.038*
Previous exposure	-0.061	0.541	0.941	0.326	2.719	0.911
Cigarette smoking	-0.295	0.543	0.745	0.257	2.159	0.587
No PRPEs use	1.790	0.604	5.988	1.834	19.545	0.003*

Table 9B: Predictors of Respiratory health symptoms among study participants

Respiratory symptom	ß	S.E.	OR	95.0% C.I. for OR		p value
				Lower	Upper	
Wheeze						
Age	0.041	0.046	1.042	0.952	1.140	0.377
Work duration	0.027	0.056	1.028	0.922	1.146	0.624
Education level	-0.474	0.546	0.623	0.214	1.814	0.385
Previous exposure	-0.142	0.558	0.867	0.290	2.591	0.799
Cigarette smoking	0.729	0.553	2.074	0.701	6.136	0.188
No PRPEs use	1.937	0.668	6.937	1.873	25.686	0.004*
BMI	0.723	0.518	2.061	0.746	5.689	0.163
Chest tightness						
Age	0.023	0.044	1.023	0.939	1.114	0.602
Work duration	-0.012	0.051	0.988	0.894	1.091	0.807
Education level	-1.144	0.546	0.318	0.109	0.928	0.036*
Previous exposure	-0.025	0.531	0.976	0.345	2.760	0.963
Cigarette smoking	0.283	0.516	1.327	0.482	3.649	0.584
No PRPEs use	1.336	0.560	3.803	1.270	11.394	0.017*
BMI	1.052	0.516	2.864	1.041	7.874	0.041*
Acute RHCs						
Age	0.107	0.051	1.113	1.008	1.229	0.035*
Work duration	-0.070	0.062	0.932	0.825	1.053	0.261
Education level	-1.238	0.770	0.290	0.064	1.310	0.108
Previous exposure	0.338	0.738	1.402	0.330	5.959	0.647
Cigarette smoking	0.426	0.783	1.531	0.330	7.107	0.586
No PRPEs use	2.448	0.827	11.563	2.288	58.423	0.003*

Keys: * Statistically significant, will be observed if P<0.05, OR; Odds ratio, 95% Confidence Interval, SE; Standard Error

Even after adjusted for Age, BMI, Work duration and Education level using multiple logistic regression analysis, Poor utilization of PRPEs were seen to influence the occurrence of respiratory health symptoms (i.e. Adjusted Odds Ratio > 1). There was enough evidence (p>0.05) to support for significant association.

CHAPTER FIVE

6. DISCUSSION

This study aimed to assess occupational exposure level to metal fumes in total and its elements; Cadmium (Cd), Chromium (Cr), and Nickel (Ni), and associated respiratory health symptoms among small scale welders in Dar es Salaam.

The results show that the mean concentrations of total fumes and its elements was higher and lower respectively than the exposure concentration limits (TLV) set by American Conference of Governmental Industrial Hygienist (ACGIH) guidelines, the higher elevation of total fumes concentration as compared to 3 composite metals; Cd, Cr and Ni may be due to the nature of base metal and electrode type used during welding operation. In this study, majority of welders were used iron and Stainless base metal types which produce low Cr and Cd as compared to other base metal types e.g. Stainless Steel.

The findings that the average occupational exposure level to total fumes was higher than the acceptable exposure limits (TLV) is supported by the comparison of mean concentration of total fumes against TLV which showed the statistically significant difference of total fumes by 20% higher than the exposure standard limit (TLV) indicating that control measures at the source of contaminants including natural and exhaust ventilation had failed to reduce exposure concentration to acceptable level.

The results are in agreement with a study done in Iran on Assessment of Welders Exposure to Carcinogen Metals from Manual Metal Arc Welding in Gas Transmission Pipelines by Golbabaei and colleagues, whereby the high mean concentration of total metal fume above standard limit (TLV); 11.2±3.9 mg/m^3 was detected in 59 samples collected around the breathing zone among welders (7). Chromium and Cadmium concentrations were lower than what it was found in this study with exception to Nickel, the high mean concentrations of total fumes and its elements reported by Iran study as compared to this study might be due to poor control measures taken during installation of pipeline in Iran as result of temporal working environment, and the nature of base metal and electrode types used during welding operations.

Also according Xianliang Wang and colleagues in their study done in central city of Anhui providence, China among vehicle welders, they reported high prevalence of neurological disorders in welder's exposure to cadmium as a component of welding fumes (11) which was not found in this study. In addition, Xianliang Wang reported high concentration of cadmium in breathing zone of welders; 0.17 (0.1-.3) mg/m3 which was almost 100 times the concentration reported in this study. Therefore, it seems that the potential probability of neurologic effects reported Xianling Wang was due to high exposure to Cadmium (Cd) which on other hand could be negligible among small scale welders in this study. However, the higher mean concentration of Cadmium reported in Wang study as compared to this study might be due to Oil contained metal materials used by vehicle welders in China which have been reported to contain high amount of Cadmium.

Occupational exposure to Nickel, Cadmium and Chromium has been associated with Lung Cancer, these heavy metals were categorized as class 1 IARC highly Carcinogens in early 1990s based on sufficient evidence from experimental and epidemiological studies (9)(27)(10). Although average exposure concentrations of Cd, Cr and Ni were found to be lower as compared to their TLVs but over 20% of samples were found to exceed TLVs for Nickel and Cadmium, therefore this study concludes that small scale welders were highly exposed to metal fumes and its elements and therefore it calls for the Government and public attention to take serious sustainable control measures in order to issuer healthier and safer working environment among small scale welders in Tanzania.

Apart from occupational exposure concentrations of metal fume and its elements, this study also investigated respiratory health symptoms associated with metal fume exposure, the results show that there was high reported proportion of acute respiratory health conditions which include runny nose, stuffy nose, irritated nose/throat and metal fume fever by over 80% followed by Cough, Breathlessness, Phlegm, Wheeze and Chest tightness.

These results are supported by Bala and Tabaku in their study done in Albania which determined COPD prevalence among welding and steel foundry workers, in which about 46.3% of workers reported experiencing Phlegm and 40.1% reported Cough (28). Similar

results were also observed in a study done in South Tehran on determination of prevalence of respiratory symptoms among industrial foundry workers by Ghasemkhani and colleagues were it was reported that, 41.6 % experienced Phlegm and 41.7% reported Breathlessness (29). The findings of Bala and Ghasemkhani studies have indicated higher prevalence of respiratory health symptoms compared to what was found in this study. This difference might be due to confined working environment of welders and foundry workers reported by Bala and Ghasemkhani which influenced the intake dose and effects as compared to open (Outdoor) working environment of small scale welders in Dar es Salaam.

Also a study done in Benin Nigeria on Occupational health problems among welders by Isah and Okojie, revealed that there was high prevalence of self-reported cases of respiratory health symptoms; Metal fume fever (43.8%), Cough (18.2%) and Breathlessness (5.4%) (30). However, this prevalence of Metal fume fever and the least are considered to be low compared to what was found to this study whereby the prevalence of metal fume fever was 59.1%. The difference in prevalence of these studies might be due to different factors including confounders; as to this study PRPEs use, Educational level, Body Mass Index and Age were found to be statistically significant predictors for most of respiratory health symptoms.

Whenever there is high occupational exposure level to metal fumes then the use of PRPEs are inevitable. The findings of this study indicating only 2% of welders reported to use proper metal fume respirators. This means high proportion (over 95%) of welders was daily exposed to dangerous metal fumes.

The findings are in agreement with a study done in Lusaka, Zambia on Occupational Hazards and Use of Personal Protective Equipment among Small Scale Welders by Jessy, it was reported that the majority (98%) of welders were aware of at least one type of welding hazard or PPE, about 2% were not aware of any hazards or any personal protective measures. None of the welders used all the recommended PPE at any time during welding operations (11). As to this study, although 2% of welders reported to use proper welding respirators in the current study, none of them was observed using them

during walkthrough observation. The reasons for not using respiratory protective equipments have been studied by numbers of researchers (23)(28).

Based on sufficient evidence from the current study, small scale welders were exposed to high concentration of metal fumes above acceptable level; the analysis indicated that those who were not used respiratory protective equipments were more than 5 times likely to develop respiratory health symptoms compared to those who were used. Therefore, the use of proper personal respiratory protective equipments should always be properly worn during welding operations.

6.1. Study limitations

6.1.1. Study design

This was a cross sectional, descriptive study that gave a snap shot of the existing situation in small scale welding operations in Tanzania. Due to this design, it was not possible at the time to establish causal – effect relationship and comparison between exposed and control groups. However, the study was able to establish metal fumes exposure level and respiratory health symptoms together with low PRPEs use among small scale welders. This information is useful for welders, regulatory authorities, policy makers and researchers when addressing issues related to workers' health.

6.1.2. Data collection

The data collection tool (structured questionnaires) collected some information which demanded memory recall such as previous respiratory diseases, smoking duration including number of cigarette smoked per day, and persistence of respiratory symptoms for three months or more. This provided an opportunity for recall bias which might have influenced our results.

Due to limited resources (Financial and time), it was not possible to conduct lung function test by spectrometry or Peak expiratory flow to determine lung capacity in relation to the respiratory health symptoms information captured by questionnaires, this could strengthen the findings of this study. However, standardized questionnaire adopted

from British Medical Research Council (BMRC) standard questionnaire for respiratory health symptoms was used to validate the respiratory health symptoms.

This study also established groups or categories among welders during analysis of respiratory health symptoms which may have resulted into misclassification bias. However, the results were important to show how various groups have different respiratory health symptoms. Also despite this limitation, the study findings can be generalized to all small scale welders in Tanzania, Sub Saharan Africa and other developing countries.

6.1.3. Data analysis

Respiratory health symptoms are reported to have a lot of risk factors (confounders). In this study, control for confounders was done so as to rule out non-work related factors that were associated with respiratory health symptoms. A multiple regression analysis was done, where age, BMI status, education level and smoking behavior were controlled.

Also workers who developed respiratory health symptoms at work could have left the welding job or shift to less stressful job. Involving workers who are currently at the workplaces might result into underestimation of the prevalence of respiratory health symptoms. However, this limitation was taken into consideration during data collection whereby inclusion criteria were set to include participants with at least 12 months of working experience.

CHAPTER SIX

7. CONCLUSION AND RECOMMENDATIONS

7.1. CONCLUSION

The findings indicated that welders were not only exposed to high mean concentration level of metal fumes but also they had poor utilization of proper PRPEs, therefore this study conclude that there was high occupational exposure level to metal fumes among small scale welders in Dar es Salaam which is also supported by the high prevalence of self-reported cases of respiratory health symptoms.

RECOMMENDATIONS

The implementation of sound occupational hygiene interventions on welding operations in informal sector has potential role of reducing the incidence of respiratory health diseases and offer safe working environment among small scale welders. It is therefore recommended that;

- Control measures at the source of Metal fumes such as installation of functional exhaust ventilation within welding workplaces, are encouraged in order to minimize metal fumes concentration to acceptable level.
- Awareness promotion on Occupational hygiene among welders should be implemented so as to let small scale welders know how dangerous to health metal fumes are, how close they have been exposed to and what they should do to avoid respiratory health effects.
- Cigarettes smoking cessation and Nutritional promotion program should be conducted among small scale welders. Stringent laws and bylaws should be adhered to Cigarettes smoking.
- The use of personal respiratory protective equipments such as appropriate respirators and masks should be encouraged in order to minimize the intake dose and prevent adverse respiratory health symptoms.
- Longitudinal and cross sectional studies (i.e. assessment of lung function capacity and monitoring of urinary metal biomarkers) should be conducted among small scale welders in order to determine the extent and association of metal fumes exposure in relation to respiratory health problems.

7.2. Observation Photos



Photo 1: A researcher taking weight and height information from one of the study participant**s** (Photo by S. Kapinda)



Photo 2: A research assistant tie up a personal air sampler in one of the study participants (Photo by G.G. Meena)



Photo 3: A welder performing Manual arc welding without any form of protective equipment (Photo by G.G. Meena)



Photo 4: Welders in different location performing Manual arc welding without any form of personal respiratory equipments (Photo by G.G. Meena)



Photo 5: A researcher conduct post weighing of sample filters in physiology laboratory at MUHAS (Photo by S. Kapinda)

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9. APPENDIX

Appendix I A: Consent Form - English Version

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES(MUHAS)
DIRECTORATE OF RESEARCH AND PUBLICATIONS

No …… Date ….....

Introduction

Greetings! My name is Godfrey George Meena a student of Master of Science in Environmental and Occupational Health at Muhimbili University. I am conducting a research on assessing Occupational exposure to metal fumes and associated respiratory health symptoms among small scale welders in Dar es Salaam.

About the study:

A total of 111 small scale welders are involved in this study, including you. I will ask you few questions regarding your experiences on occupational exposure to metal fumes and associated respiratory health symptoms. This would take approximately 20 minutes of your valuable time.

What Participation Involve

If you agree to join this study, you will be required to sign this consent form and answer the question that you will be asked by the researcher and to wear personal air sampling pumps during working hours for metal fumes sampling.

Benefits

You will not get direct benefits from the study. But, the information provided by you and air samples which will be taken from you will help us to understand Occupational exposure level to metal fumes and respiratory health symptoms in order suggest some improvement solutions.

Risk

We do not expect any harm will happen to you because of participating in this study.

Confidentiality

I wish to assure you that, this information will be treated in confidentiality between you and the researcher. All the information collected in the questionnaire forms will be entered in the computer with only the study identification number.

Voluntary participation

Taking part in this study is totally voluntary, that is, you can decide to participate or not. You can stop participating in this study at any time, even if you have already given your consent. Refusal to participate or withdrawal from the study will not involve penalty or loss of any benefits to which you are otherwise entitled.

Who to contact If you have any question about this study

You can contact the researcher, Godfrey George Meena of Muhimbili University of Health and Allied Sciences, P. O. Box 65001, Dar es Salaam, or the supervisor Dr. Aiwerasia Vera ngowi.

Do you agree? Yes…….. No……

Participant agrees ……..... Participants does not Agree. ……...…

I, …… Have read the contents of this consent form and my questions have been adequately answered. I therefore agree to participate in this study.

Signature of the participant ……. Date ……

Signature of the interviewer …… Date ……....

Appendix I B: Consent Form - Kiswahili Version

CHUO KIKUU CHA SAYANSI YA TIBA MUHIMBILI
IDARA YA UTAFITI NA UCHAPISHAJI

Namba ya Dododso …… Tarehe ……..……

Utambulisho.

Habari!! Naitwa Godfrey G. Meena, ni mwanafunzi wa chuo kikuu cha afya na sayansi shirikishi Muhimbili.Ninasoma shahada ya uzamili ya sayansi katika fani ya Manzingira na Afya Kazini. Ninafanya utafiti wa kutathmini kiwango cha athari za kikazi zitokanazo na moshi wa uchomeleaji wa vyuma pamoja na dalili za magonjwa ya mfumo wa hewa miongoni mwa wachomeleaji wa vyuma katika viwanda vidogo vidogo vilivyoko Dar es Salaam.

Kuhusu utafiti

Jumla ya wachomeleaji wadogo wadogo 110 watahusishwa katika utafiti huu ikiwemo wewe. Hivyo, ushiriki wako katika utafiti huu utahusu mimi kukuuliza maswali machache kuhusu dalili zinazoweza kukukabili za magonjwa ya mfumo wa hewa. Hii itachukua takriban dakika 20 ya muda wako.

Ushiriki wako katika utafiti huu.

Kama unakubali kujiunga na utafiti huu, utatakiwa kusaini fomu hii ya idhini na kujibu maswali utakayoulizwa na mtafiti pamoja na kuvaa pampu ya kuchukulia sampuli za moshi hewani katika muda wote utakaukuwa kazini.

Faida

Huwezi kupata faida moja kwa moja kutokana na utafiti huu. Lakini, habari zitakazotolewa na wewe pamoja na sampuli za moshi zitakazochukuliwa zitatusaidia kupata kuelewa namna kudhibiti athari zitokanazo na moshi wa uchomeleaji wa vyuma ili kuweza kushauri njia sahihi za kufanya kuondokana na magonjwa ya mfumo wa hewa.

Madhara.

Hatutarajii kuwa madhara yoyote yatatokea kwako kwa sababu ya kushiriki katika utafiti huu.

Usiri

Napenda kuhakikishia kuwa habari hii itakuwa ni siri kati ya wewe na mtafiti.Taarifa zote zitakazokusanywa katika dodoso hili zitaingizwa katika kompyuta kwa namba ya utambulisho wa utaafiti.

Ushiriki wa Hiari

Ushiriki wako katika utafiti huu ni hiari, unaweza kuamua kushiriki au la. Unaweza kuacha kushiriki katika utafiti huu wakati wowote, hata kama tayari ulishatoa idhini ya kushiriki.

Kukataa kushiriki au kujiondoa kutoka utafiti hakutahusisha adhabu au kupoteza faida yoyote ambayo ungeipata.

Mtu wa kuwasiliana naye kama una swali lolote kuhusu utafiti huu

Unaweza kuwasiliana na mtafiti, Godfrey G. Meena wa Chuo Kikuu cha Sayansi ya Afya S.L.P. 65001, Dar es Salaam, au msimamizi wake Dk. Aiwerasia Vera Ngowi.

Unakubali? Ndio …… Hapana.....

Mshiriki amekubali .... Mshiriki amekataa.....

Mimi, ... Nimesoma yaliyomo kwenye fomu hii na maswali yangu yamejibiwa vya kutosha . Hivyo kwa ridhaa yangu naridhia kukubali kushiriki katika utafiti huu.

Saini ya mshiriki ..... Tarehe …….....……

Saini ya mtafiti ..... Tarehe .....

Appendix IIA: Questionnaire for respiratory health symptoms (English Version)

QUESTIONNAIRE FOR ASSESSING RESPIRATORY HEALTH SYMPTOMS AND PPE USES AMONG SMALL SCALE WELDERS IN DAR ES SALAAM

SECTION A: INTRODUCTION

1. Identification number ID NO: ☐☐☐
2. Address _____
3. Sex [1] Male [2] Female ☐
4. How old are you? ☐☐ Years
5. How many working hours do you spend per day? _____ Hours per day
6. How long have you been doing this welding job? _____ Year(s)

SECTION B: EDUCATION AND OCCUPATIONAL HISTORY

7. What is your education level by school years?
   [0] None [1] (1-7) [2] (8-11) [3] (12-13) [4] College [5] University
8. Have you ever worked in the following work category in Small scale industry?

	1. Yes 2.No	Year	Months
[1] Welding	☐	☐☐	☐☐
[2] Painting	☐	☐☐	☐☐
[3] Carpentry	☐	☐☐	☐☐
[4] Metal smith	☐	☐☐	☐☐
[5] Manson	☐	☐☐	☐☐
[6] Mining	☐	☐☐	☐☐
[7] Foundry	☐	☐☐	☐☐
[8] Stone quarry or mine	☐	☐☐	☐☐
[9] Asbestos	☐	☐☐	☐☐
[10] Cotton, sisal, flax, tea factory	☐	☐☐	☐☐

SECTION C: RESPIRATORY HEALTH SYMPTOMS

I am going to ask you some questions, mainly about your chest. I would like you to answer Yes or No

I. COUGH

9. Do you usually cough first thing in the morning 1. [Yes] 2. [No]
10. Do you usually cough during the day or at night 1. [Yes] 2. [No]

If yes to any of the above:

11. Do you usually cough as much as 4-6 times a day for 4 or more days in a week

1.[Ye] 2. [No]

12. Do you cough like this on most of days for as much as 3 consecutive months or more in a year 1. [Yes] 2. [No]

II. COUGH WITH SPUTUM PRODUCTION

13. Do you usually cough with sputum first thing in the morning 1. [Yes] 2. [No]
14. Do you usually cough with sputum during the day and at night 1. [Yes] 2. [No]

If yes to any of the above

15. Do you cough with sputum as much as 4-6 times a day, or 4 or more days in a week

1. [Yes] 2. [No]

16. Do you cough with sputum on most of days for as much as 3 consecutive months or more in a year? 1. [Yes] 2. [No]

III. BREATHLESSNESS

17. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill?

1. [Yes] 2. [No]

18. Do you get shortness of breath walking with other people of your age on level ground? 1. [Yes] 2. [No]

If yes to any of the above:

19. Do you have to stop for breath when walking at your own pace on level ground?

1. [Yes] 2. [No]

IV. WHEEZING

20. Have you had attack of wheezing or whistling in your chest at any time in the last 12 months 1. [Yes] 2. [No]
21. How long do you have wheezing in your chest? ☐☐ ☐☐

If yes to the question 20 and 21, go to question 22:

22. Do you usually experience chest tightness while at work or just after work 1. [Yes] 2. [No]

23. For how long do you have this problem? ☐☐ ☐☐

V. BRONCHITIS

24. During the past 3 years have you had a period of increased cough with increased sputum production for as long as three weeks or more? 1. [Yes] 2. [No]

VI. OTHER SYMPTOMS

25. Have you had one or more of the following symptoms during or after your last shift?

i. Stuff nose 1. [Yes] 2. [No]
ii. Runny nose 1. [Yes] 2. [No]
iii. Irritated nose 1. [Yes] 2. [No]
iv. **Fever which last few hours after work shift** 1. [Yes] 2. [No]

SECTION D: PAST ILLNESS

In past 3 years have you ever had or been told that you have had any of the following;

26. An injury or operation affecting your chest 1. [Yes] 2. [No]
27. Heart trouble 1. [Yes] 2. [No]
28. Bronchitis 1. [Yes] 2. [No]
29. Pneumonia 1. [Yes] 2. [No]
30. Pleurisy 1. [Yes] 2. [No]
31. Pulmonary tuberculosis 1. [Yes] 2. [No]
32. Bronchial asthma 1. [Yes] 2. [No]
33. Hay fever 1. [Yes] 2. [No]
34. Any other chest trouble_____

SECTION E: TOBACCO SMOKING

35. Do you smoke cigarette now? 1. [Yes] 2. [No]

If No to question 35 go to Question 36

36. Have you ever smoked cigarette? 1. [Yes] 2. [No]

If yes go to Question 37 Year Month

37. For how long have you been smoking? ☐☐ ☐☐
38. How many cigarettes do you normally smoke per day? ☐☐ ☐☐
39. How long ago did you give up cigarette smoking? ☐☐ ☐☐

SECTION F: PERSONAL PROTECTIVE USES

40. Do you use any form of personal respiratory protective equipment? 1. [Yes] 2. [No]

If Yes above, go to Question 41

41. What type of personal respiratory protective equipment do you use?

i.	Piece of Cloth	1. [Yes]	2. [No]
ii.	Dust Mask	1. [Yes]	2. [No]
iii.	Fumes respirator	1. [Yes]	2. [No]

42. Have you ever inspected by Government Agency/Authority? 1. [Yes] 2. [No]

If yes to question 42 go to question 43

43. What did the Governmental Agency/Authority advised you concerning the exposure to metal fumes?

i. Never advised
ii. To improve exhaust ventilation
iii. To quit welding job
iv. To use respiratory protective equipment

Appendix IIB: Questionnaire for respiratory health symptoms (Swahili Version)

DODOSO LA UTATHMINI WA DALILI ZA MAGONJWA YA MFUMO WA UPUMUAJI YANAYOHUSISHWA NA ATHARI ZA MOSHI WA VYUMA BAINA YA WACHOMELEAJI WA VYUMA KWENYE VIWANDA VIDOGO DAR ES SALAAM

SEHEMU A: UTANGULIZI

1. Namba ya dodoso: ☐☐☐
2. Anuani _____
3. Jinsia [1] Mme [2] Mke ☐
4. Una umri gani? Miaka ☐☐
5. Unatumia muda gani kazini kwa siku? Saa _____ kwa siku
6. Umefanya kazi hii ya uchomeleaji kwa muda gani? Miaka _____

SEHEMU B: ELIMU NA HISTORIA YA KAZI

7. Una kiwango gani cha elimu kwa miaka ya masomo:
   [0] hakuna [1] (1-7) [2] (8-11) [3] (12-13) [4] Chuo [5] Chuo kikuu
8. Je umewahi kufanya kazi kwenye viwanda vidogo katika shughuli zifuatazo;

	1.Ndiyo 2. Hapana	Miaka	Miezi
[1] Uchomeleaji	☐	☐☐	☐☐
[2] Upakaji rangi	☐	☐☐	☐☐
[3] Ufundi seremala	☐	☐☐	☐☐
[4] Ufuaji vyuma	☐	☐☐	☐☐
[5] Ufundi uashi	☐	☐☐	☐☐
[6] Uchimbaji madini	☐	☐☐	☐☐
[7] Uyeyushaji wa vyuma	☐	☐☐	☐☐
[8] Upasuaji mawe	☐	☐☐	☐☐
[9] Asbestosi (Asbestos)	☐	☐☐	☐☐
[10] Kiwanda cha Pamba, Katani/Chai	☐	☐☐	☐☐

SEHEMU C: DALILI ZA MAGONJWA YA MFUMO WA UPUMUAJI

Ninakwenda kukuuliza maswali yatakayohusu hali ya kifua chako, nitaomba ujibu Ndiyo au Hapana

I. KUKOHOA

9. Je, huwa unakohoa kila uamkapo asubuhi? 1. [Ndiyo] 2. [Hapana]
10. Je, huwa unakohoa wakati wa mchana na usiku? 1. [Ndiyo] 2. [Hapana]

Kama jibu ni Ndio kwenye swali lolote hapo juu, jibu swali la 10 na 11:

11. Je, huwa unakohoa zaidi ya mara 4 au 6 kwa siku na kwa muda wa zaidi ya siku 4 ndani ya wiki? 1. [Ndiyo] 2. [Hapana]
12. Je huwa unakohoa kila siku zaidi ya miezi 3 mfululizo au zaidi ndani mwaka? 1. [Ndiyo] 2. [Hapana]

II. KUKOHOA MAKOHOZI

13. Je, huwa unakohoa makohozi kila uamkapo asubuhi?1. [Ndiyo] 2. [Hapana]
14. Je, huwa unakohoa makohozi wakati wa mchana na usiku?1. [Ndiyo] 2. [Hapana]

Kama jibu ni Ndio kwenye swali lolote hapo juu, jibu swali la 14 na 15:

15. Je, huwa unakohoa makohozi kwa zaidi ya mara 4 au 6 kwa siku na kwa muda wa zaidi ya siku 4 ndani ya wiki? 1. [Ndiyo] 2. [Hapana]
16. Je huwa unakohoa makohozi kwa zaidi ya miezi 3 mfululizo au zaidi ndani ya mwaka? 1. [Ndiyo] 2. [Hapana]

III. KUPUMUA KWA SHIDA

17. Je, unasumbuliwa na tatizo la kupumua kwa shida unapotembea haraka kwenye tambalale au mwinuko? 1. [Ndiyo] 2. [Hapana]
18. Je, huwa unapata tatizo la kupumua kwa shida unapotembea pamoja na watu wa rika lako kwenye tambalale au mwinuko? 1. [Ndiyo] 2. [Hapana]

Kama jibu ni Ndio kwenye swali lolote hapo juu, jibu swali la 18:

19. Je, iliwahi kukulazimu kusimama kidogo ili kuvuta pumzi wakati wa matembezi yako mwenyewe kwenye tambalale na mwinuko? 1. [Ndiyo] 2. [Hapana]

IV. KUPUMUA KWA KUKOROTA

20. Je, umeshawahi kupumua kwa kukorota wakati wowote ndani ya muda wa miezi 12 iliyopita 1. [Ndiyo] 2. [Hapana]

Kama jibu ni Ndio kwenye swali hapo juu, jibu swali la 20:

21. Ni kwa muda gani umekuwa ukipumua katika hali kama hii? Miaka_Miezi_Siku_
22. Je, huwa unahisi kubanwa kwa kifua wakati ukiwa kazini au baada ya kazi?

    1. [Ndiyo] 2. [Hapana]

23. Ni kwa muda gani umekuwa na tatizo la kubanwa kifua? Miaka___ Miezi_ Siku_

V. DONDA KOO

24. Ndani ya muda wa miaka 3 iliyopita, umewahi kupata vipindi vya ongezeko la kukuhoa au kukohoa makohozi kwa zaidi ya wiki 3 au zaidi 1. [Ndiyo] 2. [Hapana]

VI. DALILI ZINGINE

25. Je umewahi kuwa na dalili zifuatazo wakati au baada ya masaa ya kazi;

i.	Ukavu puani	1. [Ndiyo]	2. [Hapana]
ii.	Makamasi puani	1. [Ndiyo]	2. [Hapana]
iii.	Miwasho puani	1. [Ndiyo]	2. [Hapana]
iv.	Homa inayoisha masaa machache baada ya Kazi	1. [Ndiyo]	2. [Hapana]

SEHEMU D: HISTORIA YA MAGONJWA YA MFUMO WA UPUMUAJI

Ndani ya muda wa miaka 3 iliyopita, umewahi kuambiwa na daktari kwamba una moja au zaidi ya magonjwa yaliyoorodheshwa hapa chini;

26. Upasuaji ulioathiri kifua	1. [Ndiyo]	2. [Hapana]
27. Matatizo ya moyo (Heart trouble)	1. [Ndiyo]	2. [Hapana]
28. Maambukizi ya koo (Bronchitis)	1. [Ndiyo]	2. [Hapana]
29. Homa ya Bombom (Pneumonia)	1. [Ndiyo]	2. [Hapana]
30. Maumivu wakati wa kupumua (Pleurisy)	1. [Ndiyo]	2. [Hapana]
31. Kifua kikuu (Pulmonary tuberculosis)	1. [Ndiyo]	2. [Hapana]
32. Pumu (Bronchial asthma)	1. [Ndiyo]	2. [Hapana]
33. Homa kali (Hay fever)	1. [Ndiyo]	2. [Hapana]
34. Tatizo lingine la kifua (Taja)		

_____

SEHEMU E: UVUTAJI WA TUMBAKU/SIGARA

35. Je, unavuta sigara? 1. [Ndiyo] 2. [Hapana]

Kama jibu ni Hapana kwa swali namba 41 jibu swali la 36:

36. Je, uliwahi kuvuja sigara? 1. [Ndiyo] 2. [Hapana]

Kama jibu ni Ndio kwa swali lolote hapo juu, jibu maswali yafuatayo:	Mwaka	Mwezi
37. Kwa muda gani umekuwa ukivuta sigara?	☐☐	☐☐
38. Sigara ngapi huwa unavuta kwa siku?	☐☐	☐☐
39. Ni muda gani umepita tangu uache uvutaji sigara?	☐☐	☐☐

SEHEMU F: MATUMIZI YA VIFAA KINGA VYA MFUMO WA HEWA

40. Je huwa unatumia kifaa kinga cha mfumo wa hewa? 1. [Ndiyo] 2. [Hapana]

Kama jibu ni Ndiyo hapo juu, jibu swali la 41:

41. Huwa unatumia aina gani ya Kifaa kinga cha mfumo wa hewa?

i.	Kitambaa cha nguo	1. [Ndiyo]	2. [Hapana]
ii.	Maski ya vumbi	1. [Ndiyo]	2. [Hapana]
iii.	Kifaa maalumu cha kupumulia (Respirator)	1. [Ndiyo]	2. [Hapana]

42. Je umewahi kukaguliwa na Mamlaka yoyote ya Serikali?1. [Ndiyo] 2. [Hapana]

Kama jibu ni Ndiyo kwa swali namba 42, jibu swali la 43:

43. Mamlaka hiyo ilikushauri nini kuhusiana na kujikinga na athari za Moshi wa vyuma?

i.	Sijawahi kushauriwa	1. [Ndiyo]	2. [Hapana]
ii.	Kuboresha mfumo wa mzunguko wa hewa	1. [Ndiyo]	2. [Hapana]
iii.	Kuachana na kazi ya uchomeleaji vyuma	1. [Ndiyo]	2. [Hapana]
iv.	Kuvaa vifaa kinga	1. [Ndiyo]	2. [Hapana]

Appendix III: Meta fumes sampling worksheet

AIR SAMPLING WORKSHEET

Date_____

Personal Information			Sample ID	Cyclone No.	Pump No.	Nature of jointing metal pieces	Time start	Time stop	Sampling time	Flow rate start	Flow rate stop	Sampling volume	Lab. Results (mg/m^3)		
ID	Weight (Kg)	Height (cm)											Cd	Cr	Ni

Sample ID	Job description

Process description_____

Engineering control_____

Work practice_____

Ventilation status_____

Appendix IV: Observation Checklist

OBSERVATION CHECKLIST ON WELDERS RESPIRATORY PROTECTIVE EQUIPMENTS

Checklist ID _____

Welder ID _____

Name of welding workshop_____

Physical Address_____

Date_____

S/N	QUESTIONS	OBSERVATION 1. Yes 2. No	REMARK
5.	Is welder wearing any form of respiratory PPE?		
6.	Is respiratory PPE worn properly?		
7.	Is respiratory PPE worn suitable for protecting welder from metal fumes?		
8.	Is welding operations taking place in indoor environment?		
9.	Is there exhaust ventilation near the place where welder is working?		
10.	Is there any sign or symbols reminding welder to wear respiratory PPE?		

Appendix V: Ethical clearance for a study

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES
OFFICE OF THE DIRECTOR OF POSTGRADUATE STUDIES

P.O. Box 65001
DAR ES SALAAM
TANZANIA
Web: www.muhas.ac.tz

Tel G/Line: +255-22-2150302/6 Ext. 1015
Direct Line: +255-22-2151378
Telefax: +255-22-2150465
E-mail: dpgs@muhas.ac.tz

Ref. No. MU/PGS/SAEC/Vol. IX

18th April, 2017

Mr. Godfrey G. Meena
MSc. Environmental and Occupational Health
MUHAS.

RE: APPROVAL OF ETHICAL CLEARANCE FOR A STUDY TITLED "ASSESSMENT OF OCCUPATIONAL EXPOSURE TO METAL FUMES AND ASSOCIATED RESPIRATORY HEALTH SYMPTOMS AMONG SMALL SCALE WELDERS IN DAR ES SALAAM."

Reference is made to the above heading.

I am pleased to inform you that, the Chairman has, on behalf of the Senate, approved ethical clearance for the above-mentioned study. Hence you may proceed with the planned study.

The ethical clearance is valid for one year only, from 19th April, 2017 to 18th April, 2018. In case you do not complete data analysis and dissertation report writing by 18th April 2018, you will have to apply for renewal of ethical clearance prior to the expiry date.

Dr. E. Balandya
DEPUTY DIRECTOR OF POSTGRADUATE STUDIES

cc: Director of Research and Publication
cc: Dean, School of Public Health and Social Sciences

Appendix VI: Permission letter from Kijitonyama, Chang'ombe and Buguruni Wards

KINONDONI MUNICIPAL COUNCIL

ALL CORRESPONDENCES TO BE ADDRESSED TO THE MUNICIPAL DIRECTOR

Tel: 2170173
Fax: 2172606

In reply please quote:

Ref. KMC/F.6/5

MUNICIPAL DIRECTOR
KINONDONI MUNICIPAL COUNCIL
P. O. BOX 31902
2 MOROGORO ROAD
14883 DAR ES SALAAM

Date 03/05/2017

Godfrey G. Meena,
Muhimbili University mental of Health Allied Sciences,
P.O.Box 65001
DAR ES SALAAM.

RE: RESEARCH PERMIT

Refer to the above heading.

I am pleased to inform you that your above request has been considered by the Municipal Director, and has offered you a place to conduct your research from 7TH **May to 7TH June, 2017.**

Upon receipt of this letter, please report to the **Kijitonyama Ward Executive Officer,** for commencement of your research.

During the period of research you are required to obey the rules and regulations of the institution as they will be defined by the supervisor of the research.

Hoping to see you soon.

.....
L.Almas
For: **THE MUNICIPAL DIRECTOR**
KINONDONI

Copy : Director of Postgraduate Studies,
Muhimbili University mental of Health Allied Sciences,
P.O.Box 65001
DAR ES SALAAM.

TEMEKE MUNICIPAL COUNCIL

[All letters should be addressed to the Municipal Director]

Tell: +255 22-2851054
Fax: +255 22-2850640
E- mail: temekemanispaa@tmc.go.tz
website: www.tmc.go.tz

P.O.Box: 46343,
Mandela Road
DAR ES SALAAM,
TANZANIA.

Ref. No. TMC/MD/ U.21/30

Date: 3/5/2017

MALOTH
WEO CHANGOMBE

RE: RESEARCH PERMIT Godfrey G. Meena

Please refer to the heading above

This is to inform you that permission is granted to the above mentioned student/Researcher from MUHAS to conduct research on assessment of Occupational Exposure to Metal fumes and associated respiratory health Symptoms among small scale welders.

case study of ~~Occupational Exposure to Metal~~ Chang'ombe ward

This permit will effect from the date of this letter.

Please give with necessary assistance.

HABEL J. ULEDI
For: MUNICIPAL DIRECTOR
TEMEKE

MUNICIPAL DIRECTOR
TEMEKE

Copy to: - Student/Researcher Godfrey G. Meena

From MUHAS

HALMASHAURI YA MANISPAA YA ILALA

BARUA ZOTE ZIPELEKWE KWA MKURUGENZI WA MANISPAA

SIMU NA. 2128800
2128805
FAX NO. 2121486

OFISI YA MKURUGENZI
I MTAA WA MISSION
S.L.P 20950
11883 – DAR ES SALAAM

05/05/2017

KUMB. NA. IMC/AF.3/31

AFISA MTENDAJI
KATA YA BUGURUNI
DAR ES SALAAM

YAH: KUMTAMBULISHA.....GODFREY G. MFINA.....

Husika na mada tajwa hapo juu.

Halmashauri ya Manispaa ya Ilala imemruhusu Mwanachuo toka.....CHUO CHA AFYA MUHIMBILI.....kufanya juu Project/Field/Research ya...AFYA NA USALAMA KAZINI.....katika ofisi yako. **Project/Field/Research"** itaanza kuanzia tarehe .....7...../...5.....2017 hadi.....7...../.....7.....2017.

Tafadhali umpe Ushirikiano.

Nakutakia kazi njema.

R. Muna
Kny: MKURUGENZI WA HALMASHAURI
MANISPAA YA ILALA

Kny: MKURUGENZI
HALMASHAURI YA MANISPAA YA ILALA