RESPIRATORY SYMPTOMS, LUNG FUNCTION AND CONTRIBUTING FACTORS AMONG IRON FOUNDRY WORKERS IN DAR ES SALAAM, TANZANIA

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By

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A Dissertation Submitted in (Partial) Fulfillment of the Requirement for the Degree of Master of Science in Environmental and Occupational Health of Muhimbili University of Health and Allied Sciences

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CERTIFICATION

The undersigned certifies that she has read and hereby recommended for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled; ***Respiratory Symptoms, Lung function and Contributing factors among iron foundry workers in Dar Es Salaam,*** in a (partial) fulfillment of the requirements for the Degree of Master of science in Environmental and occupational Health of the Muhimbili University of Health and Allied Sciences.

_____

SH Mamuya, PhD

Supervisor

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Date

DECLARATION AND COPYRIGHT

I, **Gift G. Mbise,** Declares 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.

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DEDICATION

*I dedicate this dissertation to my heartfelt parents **Godson** and **Grace Mbise**.*

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ABBREVIATIONS

CDC	Centre for disease control
COLD	Chronic obstructive lung disease
COPD	Chronic obstructive pulmonary disease
COPS	Chronic obstructive pulmonary Symptoms
FEV	Forced expiratory volume
GDP	Gross domestic product
ILO	International labor organization
IOM	Institute of Occupational Medicine
MSDS	Material safety data sheet
OEL	Occupational exposure level
OSHA	Occupational health and safety authority
PEF	Peak expiratory flow
PEL	Permissible exposure level
PPE	Personal protective equipment
SIDO	Small industrial development organization
TLV	Threshold limit value
WRLRS	Work-related upper respiratory symptoms
WRURS	Work-related lower respiratory symptoms

DEFINITIONS

Foundry: In this study refers to industries that deal with metal, iron and steel activities. It involves cutting, melting, shaping, molding, welding etc.

Occupational hygiene: The discipline (science and art) of anticipating, recognizing, evaluating and controlling health hazards in the working environment with the objective of protecting worker health and well-being and safeguarding the community at large.

Peak expiratory Flow rate: refers to is a person's maximum speed of expiration.

Confounding: A confounder is a factor which is associated with both the exposure variable and the disease outcome variable. It is not intermediate pathway between exposure and disease. I.e. smoking

Recall bias: This refers to systematic error due to differences in completeness of recall to memory of past experience.

Dysponea: An abnormal condition in a person's respiratory system causing difficulty in breathing.

Emphysema: Inflammatory response in the lungs resulting in narrowing of the small airways and breakdown of lung tissue

Bronchitis: Is an inflammation of the mucous membranes of the bronchi (the larger and medium-sized airways that carry airflow from the trachea into the more distal parts of the lung.

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: Common activities in foundry such as welding, heating, cutting, molding etc expose workers to dusts, gases and fumes which as a result lead to respiratory symptoms like wheeze and dyspnea on acute. Prevalence of respiratory symptoms have been studied in different areas like in coffee, sisal, coal and spray painting none has been done on iron foundry industry in Tanzania. This study focused on respiratory symptoms, lung function and contributing factors among iron foundry workers in Dar es Salaam.

Method: **Analytical cross-sectional study was conducted. A purposive non random proportionate to sample size was used to obtain 300 iron foundry workers from three iron foundries, who were interviewed, measured peak flow rates and dust sampling.**

Results: Proportion of respiratory symptoms highly reported were Wheezing 39% (n=117) and Cough 32.3% (n=97), SoB 21.7 %(65) and phlegm25.3 % (76). Workers who did not get on job training have shown high odds of getting shortness of breath 1.265(0.548-2.917. After adjusting for age iron foundry workers who did not get job training showed odds of 1.188(0.588-2.400) of developing wheeze symptom. Workers who did not get on job training showed odds of 1.112 (0.521-2.372) of developing phlegm. Iron foundry workers with no on job training showed odds of 1.320 (0.647-2.691) of developing cough symptom. The mean peak expiratory flow rates for iron foundry workers was 440.55 ± 107.66 less than predicted mean peak flow rates 606.12 ± 42.27. Dust measument in Industry A= 1.1041mg/m^3, industry B= 2.2894mg/m^3 and industry C= 0.5398mg/m^3. Dust measurements among job categories were Furnace 2.1858mg/m^3, raw mill was 0.530mg/m^3 and Loading was 0.573mg/m^3. Dust measument results could not show statistical significant association with the respiratory symptoms.

Conclusion and recommendations: Prevalence of respiratory symptoms highly reported were wheeze and cough, there was significant decreased in lung functioning due to decreased in peak expiratory flow rates. Observed contributing factors were lack of on job training, cigarettes smoking and long working experience, poor use of dust filters, and job tasks. Recommended cigarette smoking cessation, job trainings, job rotation and work shifts, use of protective gears, and further cohort studies in iron foundry.

CHAPTER ONE

1.0. INTRODUCTION

1.1. Introduction

Respiratory symptoms are indication of disorder in the functioning of lungs and heart. This is mainly due to exposure to external components which in most cases are contaminants or irritants that are hazardous and affect the proper functioning of heart and lungs(Kuo, Chang, Liang, & Chung, 1999). Lungs are the main route of exposure through inhalation of noxious particles and gases. Occupational exposure to dust, gases and fumes contributes to the increase in the prevalence of respiratory symptoms and affect the ability of lung functioning(Gomes, Lloyd, Norman, & Pahwa, 2001).

Common causes of respiratory symptoms **among iron foundry workers,** are the exposures to contaminants such as breathing fumes during welding, heating and cutting of galvanized metals. These activities expose workers and lead to respiratory symptoms such as chills, nausea, fever, fatigue, muscle ache and joint pains (Ahsan, Lackovic, Katner, & Palermo, 2009).

Other causes of respiratory symptoms include exposures during processes of melting and casting processes of steel products. This lead to susceptibility to narrowing of airways, lead to respiratory symptoms such as dysponea, sputum, cough, wheezing as well as altering pulmonary functioning indices(Hamzah, Tamrin, & Ismail, 2015).Respiratory disease occur due to exposure to numerous emissions at workplaces. Common respiratory disease in foundry activities include pulmonary fibrosis, chronic obstructive lung diseases, lung cancer, asthma syndrome(Voisin et al., 1996).

Foundry industry is characterized by low level of occupational hygiene as well as poor implementation of pollution control methods(Gomes, Lloyd, & Norman, 2002). Foundry workers are exposed to numerous emissions at workplaces(Low & Mitchell, 1985).

Nature and level of contaminants may be influenced by the designs of building, ventilation, size of operation, electric current at use where the main route of exposure is through inhalation(Voisin et al., 1996).

Apart from respiratory symptoms and disease observed in the foundry industry other indication for respiratory problem is lung function impairment. Exposure to dust in workers has been highly associated with the reduction in forced vital capacity and FEV. The combined effect of gases, fumes and dust has been observed to reduce the peak expiratory flow rates(Gomes et al., 2001).

In small scale industries exposure to hazards is severe due to the poor designing, poor ventilation and maintenance, workers become vulnerable to respiratory disorders such as COPD, lung diseases, due to their chemical, physical nature, dose exposure conditions and host factors (Nemery, 1990).

Severity of respiratory disease due to foundry activities is of serious concern. High prevalence of chronic obstructive pulmonary diseases. Poor use of protective equipment makes workers vulnerable to respiratory diseases, and lower preventability of occupational diseases this makes this study of major public health impact (Halvani, Zare, Halvani, & Barkhordari, 2008),

Considering high prevalence 2010, respiratory diseases had grown by 6%,lower respiratory infections also grown to 5% (CDC, 2014). Poor working conditions in the small scale industry where occupational health and safety procedures are often overlooked, continous expose workers to various hazards like metal dusts, fumes and harmful gases. **Similar studies on respiratory symptoms have been done in different parts of Tanzania on sisal, coffee, coal and spray painting. None has been done in the iron foundry industry. The growing rate of industrialization and investment in Tanzania rise a demand to have stringent operating standards for the protection of workers. This study aims at exploring magnitude of respiratory symptoms, lung functionality and contributory factors among iron foundry industries in Dar es Salaam.**

1.2. Problem Statement

Foundry Industry comprises of metal, iron and steel works where several activities take place. Such activities are welding, heating, cutting galvanized metals, melting and casting of unfinished products(Ahsan et al., 2009). Others are molding, pour cast shakers, finishing and sand reclamation(Kuo et al., 1999). These activities expose workers to elements such

as aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lithium, manganese, mercury, uranium, titanium, zinc, etc (Kusaka, Sato, Suganuma, & Hosoda, 2001). Through activities like welding, heating and melting there is high decomposition of elements in iron, steel or metal (from extracted ore). Release of metal fumes, dusts, and harmful gases due to foundry activities cause a serious exposure to workers causing negative impact to the health of workers, inhalation being a primary route of exposure.

Prevalence of respiratory symptoms goes along with the reduction in forced vital capacity due to reduction of PEF (Gomes et al., 2001).Poor use of personal protective equipments due to several reasons one among being difficult tropic climatic conditions, whereby its quite hard to use the PPE's at these areas as they are not modified to suit the climatic conditions(Gomes et al., 2002). Growth of respiratory diseases is of major public health impact(Halvani et al., 2008).

Studies in respiratory symptoms have been done in different parts of the world. In Tanzania similar studies have been done in different occupational settings like a study on sisal showed shortness of breath (37%), cough(65%)(Kayumba, 2008), Studies on coffee reported cough 23%, chest tightness 27%(Sakwari, Bråtveit, Mamuya, & Moen, 2011). Study on street sweepers reported cough (54.9% , wheezing (32.4% , phlegm (39.2 %(Stambuli, 2012). Although respiratory symptoms have been studied in different occupational settings none has been done in the iron foundry.

A need to conduct a study in our settings is very essential given the fact that iron foundry industry is a quick growing one in Tanzania. The growth rate is 5.6 percent per annum and Its GDP is 6.9 percent. However it provides plenty of employment opportunities to youth. This study aims at exploring magnitude of the respiratory symptoms, lung function, and their contributory factors among iron foundry workers in Dar es Salaam.

1.3. Conceptual Framework

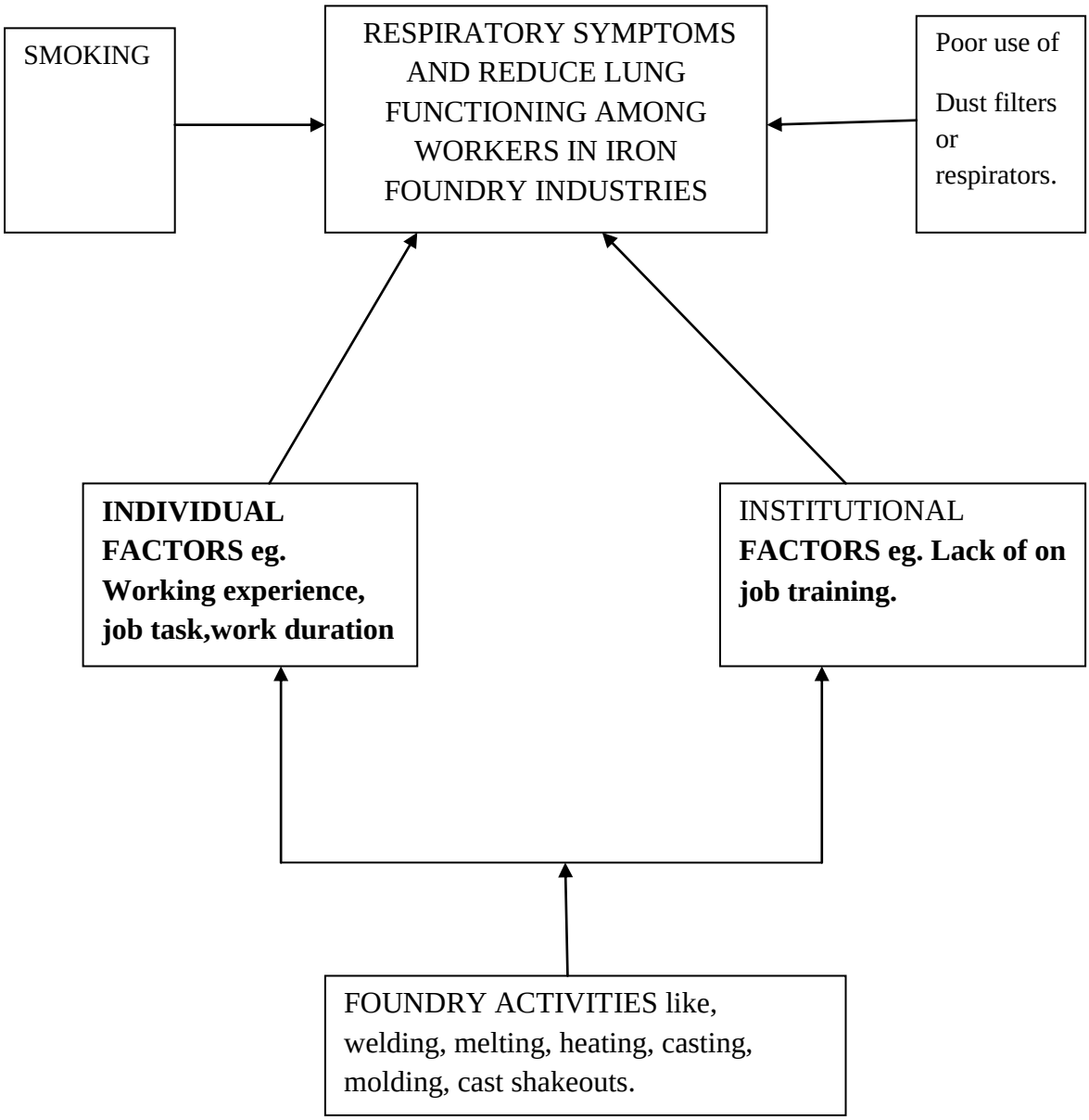


Figure 1.1*: conceptual framework*

The framework as presented in figure 1 above conceptualizes the factors that influence occurrence of respiratory symptoms as outcome variable. The framework having classes of independent variables being *individual factors and institutional factors indicates* that these factors interact with each other to influence the outcome variable. The outcome variables interact and influence occurrence of most individual factors to in turn facilitate occurrence of the outcome variable.

For instance young workers are mostly inexperienced and have poor understanding of work processes and how to limit their exposure to air pollutants, which predisposes them to respiratory problems(Yoon & Ahn, 2014). Similarly lack of health and safety training (as an institutional factor) as well as inadequate workplace inspection services (as a regulatory factor) leads to poor worker awareness and understanding of work conditions and dangerous behaviours like not using PPE can accelerate the outcome variable(OSHA, 2012). Smoking behavior separately influence increased respiratory symptoms and reduced lung function(Bidoli et al., 2015).

1.4 Research Questions

i. What is the prevalence of respiratory symptoms among iron foundry workers in Dar es Salaam?
ii. **What are the conditions of lung functioning among iron foundry workers in Dar es Salaam?**
iii. **What are associating factors to occurrence of respiratory symptoms among iron foundry workers in Dar es Salaam?**

1.5 Objectives

1.5.1. Main Objective

To assess respiratory problems, lung functionality and contributory factors among iron foundry workers in Dar es Salaam.

1.5.2. Specific Objectives

i. To determine the prevalence of respiratory symptoms among iron foundry workers in Dar es salaam.

ii. To determine Peak Expiratory flow rates of iron foundry workers in Dar es Salaam
iii. To identify factors associated to the occurance of respiratory symptoms among iron foundry workers in Dar es Salaam.

1.6. Significance of the study

This study has addressed the magnitude of the respiratory problem and lung function among iron foundry workers; also has assessed contributory factors like smoking habit and long work experience. The study has added knowledge to the foundry owners on the necessity to implement on job trainings.

To the regulating agency responsible in overseeing occupational hygiene at work places the findings of this study provides a clear image of the situation at foundry places in response to inspections being conducted. Improvement, enforcement and adherence to the guidelines should be stringent. This study also provides information helpful in the need to reviews policies and operation standards in iron foundry places.

1.7: Literature Review

Global Situation of iron foundry Industry.

Foundry industry use old age technology, workers gain skill as they practise. The foundry industries are associated with great air pollution due to emission by the melting furnaces which lead to emission of flue gases to the atmosphere dangerous to health(Howrah & Das, 2008).Exposure at the iron foundry occur at every stage of production in foundry example exposure to silica occurs during removal or repair of lining refractory materials at the furnance(Dust, 2012).

On follow up to diseases that worker acquire and which are known to relate to work exposure various statutory bodies are established to enable worker to seek for the compesation(IIAC, 2011).Workers are required by law to participate into instruction and training programs provided by employers or competent authorities so as to acquire knowledge and understanding of safety and health measures on the job(ILO, 2005). Employees in scrap metal industry are exposed to a range of safety hazards associated with material handling methods and metal themselves(U.S. Department of Labor, 2008).

Various studies on iron foundry revealed that occupational exposure to iron arises with the generation of metal dust and other exposures like metal fumes however findings did not indicate that occupational diseases encountered are due to iron(Palmer & Coggon, 1997). Also quartz and silica in metal dust are known to be main toxic components in metal dust associated with many occupational diseases(Scholz, Slavin, & Rowntree, 2007). Cohort studies have been related with the occurance of occupation cancer among iron foundry workers(Sorahan, Faux, & Cooke, 1994).

Respiratory symptoms in Foundry industry

Prevalence of respiratory symptoms determines the quality of working conditions and health of working environment. Respiratory diseases are a result of un attended respiratory symptoms. In different studies in foundry there have been recurrent episodes of respiratory symptoms among workers such as cough, wheeze, chest tightness, dysponea, shortness of breath at rest. A study in Turkey on assessment of occupational asthma and prevalence of respiratory symptoms in foundry workers had findings of prevalence of cough 14.98%, phlegm 71%, breathlessness 8.06%, chest tightness 4.03%, and wheeze 2.01%. these findings explain the severity of respiratory diseases in iron foundry(Kayhan, Tutar, Cinarka, Gumus, & Koksal, 2013).

However a study in America on the burden of non malignant respiratory disease due to occupational airborne exposures showed the evidence of existence of mortality and morbidity rates where about 386,000 (Asthma, 38000), COPD 318,000, Pneumoconiosis 30,000 due to exposure to occupational airborne particles (Steenland, Leigh, Driscoll, & Nelson, 2005). These findings highlight the contribution of dust in the disorder of respiratory health.

Another study on the prevalence of respiratory abnormalities among male workers in Taiwan showed existence of pneumoconiosis 8.8%, among Furnance workers, 16.3% among after process workers, and 2.5% among administrative workers(Kuo et al., 1999). These findings explain the need to study prevalence of respiratory symptoms among foundry workers, as deaths in foundry industry are a result of respiratory symptoms due to workplace exposures.

In Tanzania, studies on respiratory symptoms in coal mine showed the existence of workers with dry cough 45.07%, breathlessness 34.8%, blocked nose 23.09% (Mamuya, Bråtveit, Mashalla, & Moen, 2007) . A study in dust exposure and chronic respiratory symptoms among coffee curing workers in Kilimanjaro showed cough with sputum 23%, chest tightness 27%(Sakwari et al., 2011). A study on work environment and respiratory health among sisal Processors in Tanzania showed existence of sneezing 4.2(95%CI; 1.6–11.1), dry cough 2.9 (95%CI; 1.3–5.4), stuffy nose 3.1 (95%CI; 1.4–7.0). A study on occupational respiratory health symptoms and associated factors among street sweepers in Dar es Salaam found out cough 54.9%, phlegm 39.2%, wheezing 32.4%, nose irritating 35.8%, sneezing 63.7% found out street dust being a main cause to such respiratory symptoms(Stambuli, 2012). Information on prevalence of respiratory symptoms in foundry in Tanzania is lacking.

Lung functioning Impairment.

Pulmonary functioning impairment occurs as a result of adverse health effects in the foundry industry. Peak expiratory flow rate measures air flow through the bronchi. This defines the functionality of lung capacity. It tells that airway systems have incurred constriction. Very useful in occupational studies to determine severity of asthma, and in treatment options.

A study in Srilanka among brass workers found out that while cough, phlegm, chronic bronchitis and dysponea were significantly highly reported ventilation capacity was significantly lower in all indicators of FEV_{10} and PEFR than they were measured(Jayawardana, De Alwis, & Fernando, 1997).

Another study in Taiwan reported findings of PEFR (l/min) among male foundry workers in two groups of smokers in their respective roles of Administrative 6.26±2.02, After processing 6.05±2.07, Molding 6.82±2.11, and Furnance 5.64±1.95. Non smokers in their respective roles of Administrative 6.29±2.09, After processing 6.25±2.04, Molding 6.44±1.96, and Furnance 6.75±1.57. The results showed pulmonary function tests of non smokers had better test results than smokers while smoking group in Furnance had poorest results(Kuo et al., 1999).

A study by Gomes on dust exposure and lung impairment at a small iron foundry in a rapidly developing country showed that combined occupational exposure to dust, gases and fumes reduces peak expiratory flow rates (PEF) and other pulmonary function tests like FEV(Gomes et al., 2001).

A study in Tanzania on work environment and respiratory health among sisal workers found that ventilation capacities among sisal workers showed significant reduction of 6.4%, 3.9% and 1.7% in the mean cross shift PEF, FEV_1 and FVC. Sisal workers showed highest decline of PEF and FEV_1 with PEF cross shift of 6.4% and 55l/min among symptomatic workers(Kayumba, 2008).

Factors associated with occurance of respiratory symptoms

a) **Personal dust exposure**

In a study between soft drink bottling and iron foundry workers it was found to be exposure to dust was higher among the iron foundry workers, and among these general, fur nace, rolling mill, and fabrication workers had higher exposures to dust than did workers in continuous casting, the mechanical workshop, and the bottling plant. Exposure to dust were significant predictors of lung function(Gomes et al., 2001).

Also a study in Tanzania on dust exposure and chronic respiratory symptoms among coffee curing workers in Kilimanjaro found out personal total dust exposure in the coffee factories were significantly higher than in the control group (beverage factory). (Geometric mean (GM) 1.23 mg/m3, geometric standard deviation (GSD) (0.8) vs. 0.21(2.4) mg/m3)(Sakwari et al., 2011).

A study on metal dust exposure and respiratory symptoms among steel workers in Malaysia found out Metal dust concentration values (Co, Cr, and Ni) among steel workers. The highest mean concentration for cobalt was found in caster (0.19 mg/m3) while the highest mean concentration for chromium and nickel was found in welder (0.19 mg/m3 and 0.67 mg/m3 respectively). The highest cumulative respirable exposure for cobalt was found in melter (11.84 mg/m3) while the highest cumulative respirable of chromium and nickel were found in refractory man (5.43 mg/m3) and caster (16.64 mg/m3) respectively.

A study in Korea on cases of lung cancer in foundry workers showed that a grinding and blasting worker who worked for 33 years in foundry and diagnosed for cancer was exposed to highest levels of respirable quartz 0.412mg/m^3 also a forklift driver who worked in foundries for 39 years was exposed to the levels of respirable quartz 0.223mg/m^3.The lung cancer was due to occupationally related exposures(Jeong et al., 2013).

b) Utilization of PPE's

Occupational hygiene is sporadically emerging in developing countries like Tanzania facing challenges including incomplete information about the past history of workers, utilization of PPE's etc this leads to failure to trace actual exposure impact of workers and the associated factors(Checkoway & Eisen, 1998).

A study in South Tehran on prevalence of respiratory symptoms among workers in industries found out the highest percent of respiratory symptoms with prevalence of cough32.6%, phlegm56.6%, chest tightness34.6%, dyspnea50.4% and nose irritation29.2% were those employees who had an exposure with harmful material(Ghasemkhani, Kumashiro, & Rezaei, 2006).

A study in Tanzania on respiratory symptoms among street sweepers found Availability and wearing of mouth/nose mask was reported 70.6% and 61.8%. General availability of PPEs 41.2% responded once after three months and wearing of PPEs 47.1% responded did not wear frequently because not available at any time which did not make them motivation of frequently wearing of PPEs during street sweeping(Stambuli, 2012).

A study on respiratory abnormalities among male foundry workers in central Taiwan found out one among risk factor is the poor quality or lack of personal protective equipment worn by the workers. Only about 30% of molding and furnace groups included in this study wore a mask while working. Masks typically worn were made of cloth and did little to filter out airborne dust particles. Only about 20% reported wearing protective aprons which may pre- vent workers from carrying harmful dust materials home on their clothes(Kuo et al., 1999).

A study on prevalence of occupational asthma and respiratory symptoms in foundry workers in Turkey found out that workers who used protective masks all the time had a

lower prevalence rate of respiratory symptoms and occupational asthma than those not using them those who use protective equipment 24.7% had respiratory symptoms, 10.6% had occupational asthma, whereas those who did not use protective equipment 36.5% had respiratory symptoms, 27.8% had occupational asthma(Kayhan et al., 2013).

c) Smoking

Smoking is the most observed confounder in the respiratory studies. Several studies on respiratory symptoms found that the interaction of smoking and various occupational exposures accelerates high risks and become predominant cause of COPD (Bala & Tabaku, 2010).

In a study on Survey of the Respiratory Health of the Horkers of a Talc Producing Factory in . smoking was positively and significantly related to this increase 10 out of 11 pneumoconiosis cases were radiological findings showed new images were from smokers(Wild, Rwfregier, Auburtin, Carton, & Moulin, 1995).

A study on Prevalence of Respiratory Symptoms among Workers in Industries of South Tehran , Iran found cigarette smoking has been identified as the most important cause of pulmonary diseases(Ghasemkhani et al., 2006).

A study on respiratory abnormalities among male foundry workers in central Taiwan found that Furnace and molding workers had the highest percentage of smokers (both over 60%) and the highest pack-year values (> 26), 25.7% and 30.2%, respectively. Respiratory symptoms for the four groups of furnace, after casting, molding and administrative revealed significant differences between smokers and non-smokers. The prevalence of respiratory problems was higher among smokers(Kuo et al., 1999).

A study on Prevalence of Occupational Asthma and Respiratory Symptoms in Foundry workers found out that smoking also increased the risk of occupational asthma in foundry workers. It is found that smokers were more frequent among asthmatics (p: 0.021), and degree of smoking (pack/year) was higher than that of non asthmatics (p:0.037) Cigarette smoking was observed to adversely affects the lung function of the workers in this study(Kayhan et al., 2013).

A study on Respiratory Diseases Among Dust Exposed Workers found that smoking can aggravate the symptoms of silicosis and increase the risk of lung cancer(Chen, Liu, Huang, & Rong, 2012)

A study on Evaluation and Comparison of Respiratory Symptoms and Lung Capacities in Tile and Ceramic Factory Workers of Yazd showed that smokers WRLRS 20.7%,WRURS 18.9%, COPS 24.5% where as non smokers WRLRS 17%, WRURS 16.3%, and COPS 19.5%(Yoon & Ahn, 2014).

d) Health worker effect

Healthy worker effect is a bias due to preferential selection of relatively healthy persons for employment in many industries. The initial selection of relatively healthy individuals at time of hire and the survival of the healthiest individuals that permits long- term employment.

Health worker effect referred to as the healthy worker survivor effect has been attributed to the tendency for the least healthy workers to leave the active workforce. Leaving employment may occur either non differentially or differentially with respect to exposure, and may result in biased exposure-response estimates depending on the relation between survival and exposure

A third source of healthy worker effect bias is the tendency for the least healthy workers to transfer from higher to lower ex- posed jobs within the same workplace, when the exposure is recognized as a contributor to impaired health (Checkoway & Eisen, 1998).

In a study on Cause-specific mortality due to malignant and non-malignant disease in Korean foundry workers found out the foundries which have more than one hundred workers occupied less than 10 percent among 208 foundries of this cohort. Working environment is poor and work load is too heavy to endure foundry works just healthy workers can endure it just healthy workers can endure it(Yoon & Ahn, 2014).

In a study on Chronic Obstructive Pulmonary Disease in Iron-Steel and Ferrochrome Industry Workers Cumulative exposure to dust and increasing working years in specific jobs have been associated with a steeper decline in forced expiratory volume. Although

workforce-based studies allow an accurate measure of occupational exposures but selection bias is more likely to occur due to the healthy worker effect(Bala & Tabaku, 2010).

CHAPTER TWO

2.0: METHODOLOGY

2.1. Study Design

Analytical cross-sectional study was conducted among iron foundry workers in selected industries.

2.2. Study Area

Dar es Salaam City as a business centre in Tanzania containing a high concentration of trade, manufacturing and other services compared to other parts of Tanzania was purposively selected for this study. It is the capital of Dar es Salaam region with a population of 4 364 541 people as reported in 2012 official national census and comprises three Administrative Districts; northern KINONDONI, central ILALA and southern TEMEKE. The study was conducted in selected iron foundry industries in the two districts of Temeke and Kinondoni except Ilala where there was no iron foundry industry.

2.3. Study Population

Major study variable is respiratory symptoms and the main interest is to determine its prevalence among all Dar es Salaam iron foundry workers. Therefore, the target population was all iron foundry workers in Dar es Salaam from which a representative sample was drawn to constitute the study population.

2.4. Study Sample size

Sample size was calculated using the formula adopted from Kish and Lisle formula (1965) below;

$$n = \frac{Z^2 P(1-P)}{\varepsilon^2}$$

Where

n: is minimum sample size

Z: confidence interval at 95%

P: **Expected proportion of the study with characteristic of interest** was assumed to be 50% and ε is margin of error which is 5% at 95% confidence interval

$$n = \frac{1.96^2 * 50(100-50)}{5^2}$$

Adjusting for 10% non response rate the sample size n= 426 was suggested to be used.
The minimum sample size of respondents to participate in the study was 426 iron foundry workers from selected industries.

2.5. Sampling procedure

A total of 300 workers in iron foundry industries from the production section who have been working for at least a year participated in the study. Dar es Salaam was purposively selected.
A Purposive non random sampling was used to select districts and wards with iron foundry industries. Simple random sampling proportionate to size allocation was conducted to select number of study participants in the iron foundries after giving the consent.

2.6. Inclusion Criteria

All iron foundry workers with a minimum of one year duration working with iron foundry industry and who gave consent to participate in the study.

2.7. Recruitment of research assistants

Three research assistant were recruited from among university graduates in the field of public health. They were trained on the data collection tools basing on general and specific objectives of the study, and how to take PEF measurements and height.

2.8. Data Collection Technique and tools.

Data was collected using a structured questionnaire which was administered face to face by trained research assistants. The questionnaire included questions on demographic information, occupational history, respiratory symptoms, smoking habits, use of PPE, measurement of peak flow rates as well as prevention and control measures at the working

place. These questions focused on the corresponding variables as presented in the conceptual framework. The British Medical Council questionnaire prepared in English and translated to Swahili and then back to English to verify the translation was adopted to assess for respiratory symptoms. The questionnaire was reviewed for the study and necessary modifications were made to suit the need of this study. Severity of respiratory symptoms was categorized into dysponea I when a respondent agreed to shortness of breath when walking or hurrying on level ground. Dysponea II when a respondent agreed to shortness of breath when walking with other people of the same age on level ground. Dysponea III when a respondent agreed to stop of breath when walking on level ground(William Reddan, Dennis Flaherty , Anastasios Tsiatis, Mary E. Peters, 2010).

Measurement of Peak Flow rate

Data on the peak expiratory flow rate were collected using special equipment Vitalograph Peak Flow Meter model ENSO23747 (Vitalograph Ltd., ennis, Ireland). The peak expiratory flow (PEF), also called peak expiratory flow rate (PEFR) is a person's maximum speed of expiration, as measured with a peak flow meter; a small, hand-held device used to monitor a person's ability to breathe out air. It measures the airflow through the bronchi and thus the degree of obstruction in the airways. A participant would stand up, hold the peak flow meter, insert a small portion of the mouth piece in his mouth and try as much as possible to fill his lungs through inspiration then expire with maximum force through the peak flow meter and readings were taken from the attached scale of the device. The participant was required to take three (3) measurements, the best of which was selected as taking only one measurement could be a limitation if the participant did not blow enough into the meter. Peak expiratory flow rate test was measured at pre shift and post shift sessions until the collected sample size was obtained. The other measurement variables that were taken are height and age. Height was measured using a tape measure with accuracy of 0.1 cm. Readings collected were analyzed and comparison made between the measured values and the predicted values in accordance to the occupational exposure limit values. Peak expiratory flow rates were equated according to the formula;

$$PEF_{male}\ (l/min) = e^{(0.544*\ln(Age))-(0.0151*Age)-(74.7/Height)+5.48)}$$

PEF_{female} (l/min) = $e^{(0.376*\ln(Age))-(0.012*Age)-58.8/Height+5.63)}$ PEF (L/min) where H being Height in centimeters and A being Age in years (Nunn & Gregg, 1989).

Dust Measurement

Dust at different sites in the factories was measured by use of Side Kicks dust sampling pumps. The pumps were charged and calibrated using Rotamitor calibrator at the site daily. The pumps were used with IOM sampler fitted with Polyvinyl Chloride where support pads had a thickness of 37millimeter diameter and 5micrometer pore size. Personal sampling pumps equipped with IOM sampler were loaded with PVC supporting pads and were put on workers' breathing zones during a working shift. At the end of this time the pumps were removed and IOM samplers carrying dust samples were topped and stored carefully and transported to the physiology laboratory in Muhimbili University of Health and Allied Sciences. The IOM sampler were refrigerated for 24 hours and being desiccated for further 24 hours before weighing the dusts amount using a Mettler Toledo Equipment that weighed pre weight of filters before going to the field and post weight after field work to get the actual weight inhaled by a worker. During the activities of weighing pvc pads the room temperature was recorded to be around 25 degree centigrade and relative humidity using Thermo hygro equipment was 42% for best results. Raw data were quantitatively analyzed. Mean dust amount in mg/m^3 were calculated to each of the industry and to each job category in the factories. Dust concentration was computed with three categories of low concentration, medium and high dust concentrations. Basing on working sections of Furnace, Raw mill and Loading. Results obtained were compared to the recommended OEL (Scholz et al., 2007). A total of 70 samples were taken from nine work stations of Furnance, raw mill and loading sections.

2.9. Pretesting

Pretesting was conducted after obtaining ethical clearance. The purpose of the pre-test was to verify whether the tool would collect the desired information as well as assuring the consistency of questions. Necessary modifications were made before data collection.

2.10. Data Analysis.

Data obtained from the questionnaire and the readings out of peak expiratory flow and readings of dust measurements were analyzed by use of Statistical Package for Social Sciences (SPSS) version 16.0. Preliminary data was checked for missing entries and outliers. Descriptive statistics were done to determine the proportion of respiratory symptoms. Data from peak expiratory flow meter were manipulated basing on the given formula and t test was run to find a mean difference between measured values and predicted values, dust readings from laboratory were converted and manipulated to obtain readings in (mg/m3). The degree of association between the dependent and independent variables were tested by using Pearson chi square test for categorical variables. Factors with p-value less than 0.2 were selected. Symptoms with three independent variables and above with less than 0.2 were selected for univariate analysis.

Univariate logistic regression was conducted for every single respiratory symptom then followed by a multivariate logistic regression for different predictor of respiratory symptoms, while adjusting factor of age. A value of $p<0.05$ at 95% confidence interval was considered to be statistically significant.

2.11. Reliability and validity of the tools

The tool used was a questionnaire adapted from British Medical Research Council which has been extensively used in many studies of the same kind. The questionnaire was modified and adopted to meet the needs of this study.

Peak expiratory flow meters were checked thoroughly before performing any functionality. The pef meters were calibrated by zeroing before taking a fresh reading. The study participants were trained on how to use a hand held peak flow meter for peak flow rate measurement.

Dust sampling pumps were charged, pre and post calibrated effectively at the site every morning before performing any functionality and after end of the work during the whole study period. The pumps were calibrated by using Rotamitor.

Close follow up by the principal investigator was ensured so as to obtain quality data.

2.12. Variables

2.12.1. Dependent variables

- Respiratory problems and lung function.

2.12.2. Independent variable

- ***Individual Factors:*** Age, sex, level of education, work experience, Job task, utilization of PPE's i.e. respirators, smoking habit, past illness.
- ***Institutional factors;*** On job trainings i.e. the use of ppe's, the use of MSDS, workplace supervision, personal dust.

2.13. Ethical Clearance

Ethical clearance was obtained from Institutional Review Board of Muhimbili University of Health and Allied Sciences. Introduction letter together with ethical clearance were sent to the director generals of the industries randomly selected. Swahili oral consent explaining the aim of the study, after explaining the purpose and contents of the study were sought from the respondent to participate in the study, after acceptance they preceded with the study. Codes were used for identity in the questionnaire instead of names to ensure confidentiality. The study was conducted in comfortable places and confidentiality was assured.

CHAPTER THREE

3.0 RESULTS

3.1 Socio-demographic characteristics

The present study enrolled a total of 300 participants. Participants were recruited from three factories of Dar es Salaam city, two factories in Temeke 160 (53.33%), and one factory in Kinondoni 140(46.67%). Overall, the mean age was 32.05 years (SD=9.39). Majority (46%) were aged between 21 to 30 years. On marital status, about 168(56.0%) of workers reported to be married 118 (39.3%) of its participants reported being single. About 296(98.7%) of workers were male. 199(66.3%) of all workers had primary school education level. Table 1 summarized the findings.

Table 3.1: Socio-demographic characteristics of the study population (n=300)

Character	**Iron foundry workers n=300**	
	n	%
Age (years)		
Less than 20	18	6
21 to 30	138	46
31 to 40	90	30
41 to 50	42	14
Marital status		
Single	118	39.3
Married	168	56
Education Level		
Primary	199	66.3
Secondary	90	30
Certificate	7	2.3

3.2 Proportion of respiratory symptoms among iron foundry workers.

In table 2, the proportion of respiratory symptoms is shown. Wheezing 39% (n=117) and Cough 32.3% (n=97) were found to be most prevalent Respiratory symptoms. The least reported respiratory symptom was chest illness 17.1% (n = 51).

Table 3.2: Proportion of respiratory symptoms among Iron foundry workers (n=300)

Symptom	Frequency (n)	Percent (%)
Shortness of breath (SoB)	**65**	**21.7**
• **Sob after a run**	**65**	**21.7**
• **Sob walking on level ground**	**28**	**9.3**
• **Sob walking with others**	**29**	**9.7**
Wheezing	**117**	**39**
• **Wake up with wheeze**	**81**	**27.7**
• **Sleep broken by wheeze**	**45**	**15.4**
• **Wheeze after run/climb stairs**	**69**	**23.7**
Cough	**97**	**32.3**
• **1st thing in the morning**	**55**	**19**
• **During day or night**	**64**	**22.1**
Phlegm	**76**	**25.3**
• **1st thing in the morning**	**63**	**21.7**
• **During day or night**	**55**	**18.9**
Cough and phlegm	**80**	**26.7**
• **Past three months**	**79**	**27**
• **Experienced more than one episode**	**54**	**70.1**
Chest illness	**51**	**17.1**

3.3. Severity of Respiratory symptoms

Severity of Shortness of Breath among iron foundry workers was assessed; proportionally, 9.7% (n=29) of interviewed Iron foundry workers reported to experience shortness of breath while walking with other people of their same age on a level ground. However 9.3% (n= 28) reported that they had to stop for breath while working on a level ground. About 21.7% (n=65) of interviewed iron foundry workers reported to experience shortness of breath after a run. whereas shortness of breath when walking on level ground is dysponea I, shortness of breath when walking with other people of same age on level ground is dysponea II and stop of breath after run is dysponea III (Table3.2).

About 23.7% (n=69) of iron foundry workers reported to experience wheezing after a run or stairs climb whereby 15.4% (n= 45) reported to experience their sleep being broken by wheezy and 27.7% (n=81) experienced Wheezing after a morning wake-up (Table 3.2).

Proportionally, about eight one iron foundry workers (52.3%) reported to experience the improvement of respiratory symptoms like wheezing and Sob on weekends. Fifty five iron foundry workers (19%) reported to experience cough first thing in the morning whereas sixty four (22.1%) reported to experience cough during the day or at night. About sixty three (21.7%) of iron foundry workers reported to experience phlegm first thing in the morning whereas 55 (18.9%) had experienced phlegm during the day or at night (Table 3.2).

Among the past respiratory disease and condition(s) which might confound the relationship between dust and respiratory symptoms assessed among Iron foundry workers; Chest problems 17% (n=50) was highly reported followed by regular asthma 6.5% (n=19), pneumonia 5.5 % (n=16) and heart trouble 4.8% (n=14) and the least was any injury on chest 17% (n=50). Table 3.3 summaries the findings.

Table 3.3: Proportion of Past Respiratory diseases (n=300)

Disease / conditions	Frequency (n)	Percent (%)
Chest operation/Injury	5	1.7
Heart Trouble	14	4.8
Pneumonia	16	5.5
Asthma	19	6.5
Chest problems	50	17

3.4 Peak expiratory flow rate among iron foundry workers

Values for peak expiratory flow rate for iron foundry workers. The measured mean value was 440.55 L/min ± 107.66 compare to the predicted mean value was 606.12 L/min ± 42.27. The observed difference in mean was found to be statistically significant ($p<0.01$). (Table 3.4) below summarizes.

Table 3.4: **Difference in peak expiratory flow rate values among iron foundry workers**

variable	Mean Value ± SD (L/min)	*p-value	Mean	Sig(2-tailed)
Measured pef	440.55 ± 107.66	<0.01	165.56±104.09	0.000
Predicted pef	606.12 ± 42.27			

* *Independent sample t-test*

3.5 Dust measurements among iron foundry workers

Dust levels were measured among three industries of iron foundries in three job sections. Table 10 below summarizes the findings.

Table 3.5: Results of dust levels in three Iron foundries and within job categories

Industries	**Dust level in (mg/m^3)**
A	1.1041
B	2.2894
C	0.5398
Job Categories	
Furnance	2.1858
Raw mill	0.530
Loading	0.573

3.6 Factors associated with occurrence of respiratory symptoms among iron foundry workers in Dar es Salaam.

Factors associated with occurance of respiratory symptoms under study include the independent variables which are Age, job task, work experience, job training, use of dust mask, and smoking behavior. Below is the association table.

Iron foundry workers with smoking behavior showed high proportion of acquiring shortness of breath (32.7%), where as workers who had shortness of breath but without smoking had proportion (19.5%) the association showed no statistical significance (p=0.098) (Table 3.6). Workers who had on job training had lower proportion of shortness of breath compare workers with on job training respectively (18.0%, 24.8%). The result showed no statistical significance (p=0.16) (Table 3.6).

Table 3.6: Association between Shortness of breath symptom and covariates.

Variable	**Shortness of breath (Sob)**		**P value**
Age of respondent	Yes(N=65)	No(N=235)	0.371
<20	3 (16.7%)	15 (83.3%)	
21-30	26 (18.8%)	112 (81.2%)	
31-40	20 (22.2%)	70 (77.8%)	
41-50	11 (26.2%)	31 (73.8%)	
>50	5 (41.7%)	7 (58.3%)	
Job Categories	Yes (N=47)	No (N= 176)	0.271
Furnance	17 (24.6%)	52 (75.4%)	
Raw mill	8 (13.1%)	53 (86.9%)	
Loading	22 (24.2%)	69 (75.8%)	
Smoking behavior	Yes (N=64)	No(N = 230)	**0.098***
Yes(N=52)	17(32.7%)	35 (67.3%)	
No (N=241)	47(19.5%)	194(80.5%)	
On job training	Yes (N=63)	No (N=226)	**0.16***
Yes(N= 128)	23 (18.0%)	105(82.0%)	
No (N= 161)	40 (24.8%)	121(75.2%)	

Iron foundry workers working in loading section had high proportion of cough symptoms (42.9%) followed by workers in Furnance section (31.9%). The association of occurance of cough symptom showed no statistical significance (p=0.116) (Table 3.7).

Iron foundry workers who did not use dust filters/ face masks showed high proportion of cough symptoms (39.1%) compare to workers who used dust filters but acquired cough

symptoms (25.4%). The association of occurance of cough symptom showed statistical significance (p=0.036) (Table 3.7).

Iron foundry workers who did not have on job training showed high proportion of cough symptoms (39.1%) compare to workers who had cough symptoms and who did not have on job training (24.2%). The association of occurance of cough symptom showed no statistical significance (p=0.007) (Table 3.7).

Table 3.7: Association between Cough symptom and covariates

Variable	**Cough**		**P value**
Age of respondent	YES(N= 97)	NO(N= 203)	0.364
<20	6(33.3%)	12 (66.7%)	
21-30	44(31.9%)	94(68.1%)	
31-40	24(26.7%)	66(73.3%)	
41-50	17(40.5%)	25(59.5%)	
>50	6 (50.0%)	6(50.0%)	
Job Category	Yes (N= 77)	No (N= 146)	**0.116***
Furnance	22(31.9%)	47(68.1%)	
Raw mill	16(26.2%)	45(73.8%)	
Loading	39(42.9%)	52(57.1%)	
Use of Dust filters and Dust Masks	Yes (N =95)	No (N = 196)	**0.036***
Yes(N= 134)	34(25.4%)	100(74.6%)	
No (N= 156)	61(39.1%)	95(60.9%)	
On job training	Yes (N=94)	No (N= 195)	**0.007***
Yes(N = 128)	31(24.2%)	97(75.8%)	
No (N= 161)	63 (39.1%)	98 (60.9%)	

Iron foundry workers with age 50 years and above show high proportion of occurance of phlegm (50%) followed by workers with age group between 41 and 50 years who have proportion of (33.3%). Workers with least proportion of phlegm symptoms were those at the age group of less than 20 years who showed prevalence (22.2%). The association of age category and occurance of phlegm symptoms showed no statistical significance p=0.187. (Table 3.8)

Iron foundry workers who had smoking behavior had high proportion of phlegm compare to workers who got phlegm symptom but who donot smoke respectively (40.4%, 22.8%). The association of smoking behavior and occurance of phlegm symptom showed statistical significance p=0.027. (Table 3.8).

Iron foundry workers who did not get on job training had high proportion of phlegm (28.6%) whereas workers who had phlegm and who had on job training had lower prevalence of (21.9%). The association of on job training and occurance of phlegm symptom showed no statistical significance p=0.079. (Table 3.8).

Table 3.8: Association between Phlegm symptom and covariates

Variable	Phlegm		P value
Age of respondent	YES(N= 76)	NO(N= 224)	**0.187***
<20	4(22.2%)	14 (77.8%)	
21-30	31(22.5%)	107(77.5%)	
31-40	21(23.3%)	69(76.7%)	
41-50	14(33.3%)	28(66.7%)	
>50	6(50%)	6(50%)	
Smoking	Yes (N =76)	No (N= 218)	**0.027***
Yes(N = 52)	21 (40.4 %)	31(59.6%)	
No (N= 241)	55(22.8 %)	186(77.2 %)	
On job training	Yes(N= 94)	No (N =195)	**0.007***
Yes(N= 128)	31(24.2%)	97(75.8%)	
No (N= 161)	63(39.1%)	98(60.9%)	

Iron foundry workers working in loading section had high proportion (45.1%) of wheeze symptom followed by workers in Furnance who had proportion (44.9%). Whereas workers in raw mill had low proportion of (27.9%). Association of job category and occurance of wheeze symptom showed no statistical significance p- value = 0.080 (Table 3.9)

Iron foundry workers who smoke and who had wheeze symptoms had high proportion of 55.8% compare to workers who had wheeze but who did not smoke (36.5%). Association of smoking behavior and occurance of wheeze symptom showed statistical significance p-value = 0.026 (Table 3.9).

Iron foundry workers who had no on job training had high proportion (43.5%) of wheeze symptoms where as workers who had wheeze symptoms and who had on job training had lower proportion (32.8%). Association of on job training and occurance of wheeze symptom showed no statistical significance p- value = 0.065 (Table 3.9).

Table 3.9: Association between Wheeze symptom and covariates

Variable	Wheeze		P value
Age of respondent	YES(N= 117)	NO(N= 183)	0.551
<20	7(38.9%)	11(61.1%)	
21-30	49(35.5%)	89(64.5%)	
31-40	36(40%)	54(60%)	
41-50	21(50%)	21(50%)	
>50	4(33.3%)	8(66.7%)	
Job Categories	Yes (N= 89)	No (N= 134)	**0.080***
Furnance	31(44.9%)	38(55.1%)	
Raw mill	17(27.9%)	44(72.1%)	
Loading	41(45.1%)	50(54.9%)	
Smoking behavior	Yes (N =117)	No (N= 177)	**0.026***
Yes(N =52)	29(55.8%)	23(44.2%)	
No (N =241)	88(36.5%)	153(63.5%)	
On job training	Yes (N=112)	No (N= 177)	**0.065***
Yes(N= 128)	42(32.8%)	86 (67.2%)	
No (N= 161)	70 (43.5%)	91(56.5%)	

Iron foundry workers who had smoking behavior had high proportion of getting cough and phlegm symptoms (38.5%) compare to workers who had cough and phlegm symptoms and who did not smoke. The association of smoking behavior and occurance of cough and phlegm symptom showed no statistical significance p- value =0.114 (Table 3.10).

Iron foundry workers who had no external inspection had high proportion of getting cough and phlegm symptoms (33%) whereas workers who had cough and phlegm symptoms and

who had external inspection had lower prevalence (24.1%) of cough and phlegm symptoms. The association of external inspection and occurrence of cough and phlegm symptom showed no statistical significance p- value =0.104 (Table 3.10).

Table 3.10: Association between Cough and phlegm and covariates

Variable	Cough and Phlegm		P value
Age of respondent	YES(N= 80)	NO(N= 220)	0.437
<20	5(27.8%)	13(72.2%)	
21-30	35(25.4%)	103(74.6%)	
31-40	22(24.4%)	68(75.6%)	
41-50	12(28.9%)	30(71.4%)	
>50	6(50%)	6(50%)	
Smoking behavior	Yes (N=80)	No (N= 214)	**0.114***
Yes(N=52)	20(38.5%)	32(61.5%)	
No (N=241)	60(24.9%)	181(75.1%)	
Inspection by regulatory bodies	Yes (N=79)	No (N= 212)	**0.104***
Yes(N = 191)	46(24.1%)	145 (75.6%)	
No (N= 100)	33(33%)	67(67%)	

Iron foundry workers who had smoking behavior had high proportion (26.9%) of chest illness symptoms compare to workers who were not smoking but who had chest illness symptoms (15.4%). The association between occurance of chest illness and smoking behavior showed no statistical significant association p= 0.122 (Table 3.12).

Iron foundry workers who did not use dust filters/ masks had high proportion (21.2%) of getting chest illness compare to workers who got chest illness while using dust filters/ masks (11.9%). The association between occurance of chest illness and the use of dust filters/ masks showed no statistical significant association p=0.102 (Table 3.12).

Table 3.11: Association between Chest illness and covariates

Variable	Chest illness		P value
Age of respondent	YES(N= 51)	NO(N= 249)	0.745
<20	2(11.1%)	16(88.9%)	
21-30	27(19.6%)	111(80.4%)	
31-40	15(16.7%)	75(83.3%)	
41-50	6(14.3%)	36(85.7%)	
>50	1(8.3%)	11(91.7%)	
Smoking behavior	Yes (N=51)	No (N= 243)	**0.122***
Yes(N=52)	14(26.9%)	38(73.1%)	
No (N=241)	37(15.4%)	204(84.6%)	
Use of Dust filters and Dust Masks	Yes (N=49)	No (N = 242)	**0.102***
No (N = 156)	33(21.2%)	123(78.8%)	
On job training	Yes (N=49)	No (N= 240)	0.591
Yes(N = 128)	20(15.6%)	108(84.4%)	
No (N= 161)	29(18%)	132(82%)	

3.7 Univariate analysis of factors associated with occurance of respiratory symptoms.

Factors associated with occurance of respiratory symptoms under study include the independent variables which are Age, job task, work experience, job training, inspection by regulatory bodies, use of dust mask, and smoking behavior.

Age among iron foundry where the odds of those workers with age 50 years and above had higher odds of developing shortness of breath compare to workers with 20 years and below (OR, (95% CI), 3.571, (0.659-19.341)) though not statistically significant. Age group 41years to 50 years showed high odds of developing shortness of breath compare to workers with age less than20 years and below (OR, (95% CI), 1.774, (0.430-7.323)) though not statistically significant.(Table 3.12)

Job category showed associating factor on occurance of shortness of breath among iron foundry workers where the odds of workers in loading section were high compare to those

in raw mill section (OR, (95% CI), 2.053, (0.848-4.969)) though not statistically significant. (Table 3.12).

The odds of workers in Furnance section were higher compare to workers in raw mill (OR, (95% CI), 2.166, (0.860-5.453)) though not statistically significant. (Table 3.12)

Lack of use of dust filters showed to be a determinant factor among iron foundry workers were as the odds of occurance of shortness of breath compare to workers who used dust filters was (OR, (95% CI), 1.009, (0.576-1.766)) though not statistically significant. (Table 3.12)

Table 3.12: Univariate analysis of Shortness of breath symptom

Shortness of Breath	***Un adjusted OR***	**95.0%C I for OR**		**P-value**
		Lower	**Upper**	
Age <20 **(Reference)**	1			
21-30	1.161	0.313-4.306		0.824
31-40	1.429	0.376-5.431		0.601
41-50	1.774	0.430-7.323		0.428
>50	3.571	0.659-19.341		0.140
Job Category				
Raw mill	1			
Furnance	2.166	0.860-5.453		0.101
Loading	2.053	0.848-4.969		0.111
Work experience				
5years and below	0.999	0.555-1.796		0.996
6years and above	1			
Job training				
Yes	1			
No	0.663	0.373-1.178		0.161
Dust Filters				
Yes	1			
No	1.009	0.576-1.766		0.975

Age among iron foundry workers shows to be a determinant factor on occurance of cough where as age group 41-50 showed higher odds (OR, (95% CI), 2.750, (0.809-9.354)), followed by age group greater than 50 years (OR, (95% CI), 1.870, (0.863-4.052)) but not statistically significant. (Table 3.13).

Iron foundry workers in Furnance section showed to be a determinant factor on occurance of cough compare to workers in raw mill section (OR, (95% CI), 4.92, (0.244-0.995)). This was statistically significant. (Table 3.13). Iron foundry workers with work experience 5 years and below had odds higher than those workers with 6 years and above (OR, (95% CI), 1.199, (0.719-2.002)). This was not statistically significant. (Table 3.13)

Iron foundry worker who did not use dust filters had higher odds of getting cough compare to workers who used dust filters (OR, (95% CI), 1.889, (01.140-3.129)). This was not statistically significant. (Table 3.13).

Table 3.13: Univariate analysis of cough symptom

Cough	Un adjusted OR	95.0%C I for OR		P-value
		Lower	Upper	
Age <20	1.375	0.464-4.072		0.565
21-30	1.287	0.715-2.319		0.400
31-40	1			
41-50	2.750	0.808-9.354		0.105
>50	1.870	0.863-4.052		0.113
Job Category				
Raw mill	1			
Furnance	4.92	0.244-0.995		0.048
Loading	0.648	0.337-1.245		0.193
Work experience				
5years and below	1.199	0.719-2.002		0.487
6years and above	1			
Job training				
Yes	1			
No	2.012	1.204-3.362		0.008
Dust Filters				
Yes	1			
No	1.889	1.140-3.129		0.014
Smoking				
Yes	1			
No	0.680	0.367-1.260		0.220

Iron foundry workers with age 41 to 50 years showed higher odds of getting wheeze compare to age group greater than 50 years(OR, (95% CI), 2.000, (0.522-7669)). Age group 31 -40 years had high odds (OR, (95% CI), 1.333, (0.3744.758)).Though not statistically significant. (Table 3.14)

Iron foundry worker in loading section had higher odds of getting wheeze compare to workers in raw mill section. (OR, (95% CI), 1.035, (0.553-1.936)). This was not statistically significant. (Table 3.14)

Iron foundry workers with no job training showed higher odds of getting wheeze compare to workers with job training (OR, (95% CI), 1.575, (0.972-2.553)). This was not statistically significant. (Table 3.14)

Iron foundry workers who did not use dust filters showed higher odds of getting wheeze compare to workers who use dust filters (OR, (95% CI), 1.393, (0.866-2.243)). This was not statistically significant. (Table 3.14)

Table 3.14: Univariate analysis of Wheeze symptom

Wheeze	Unadjusted OR	95.0%C I for OR		P-value
		Lower	Upper	
Age <20	1.273	0.276-5.873		0.757
21-30	1.101	0.316-3.843		0.880
31-40	1.333	0.374-4.758		0.658
41-50	2.000	0.522-7.669		0.312
>50	1			
Job Category				
Raw mill	1			
Furnance	0.490	0.245-0.980		0.044
Loading	1.035	0.553-1.936		0.915
Work experience				
5years and below	0.948	0.577-1.559		0.834
6years and above	1			
Job training				
Yes	1			
No	1.575	0.972-2.553		0.065
Ppe				
Yes	1			
No	1.393	0.866-2.243		0.172
Smoking				
Yes	1			
No	0.456	0.249-0.837		0.011

Iron foundry workers with age group greater than 50 years shows higher odds of getting phlegm symptom compare to workers with less than 20 years(OR, (95% CI), 3.500, (0.717-17.094)). Workers with 41-50 years showed high odds of getting phlegm symptoms compare to workers with less than 20 years old. (OR, (95% CI), 1.750, (0.485-6.314)).This was not statistically significant. (Table 3.15)

Iron foundry workers working in loading section had higher odds of getting phlegm symptoms compare to workers in raw mill section. (OR, (95% CI), 1.944, (0.903-4.185)).Followed by workers in Furnance section had high odds of getting phlegm

compare to workers in raw mill section. (OR, (95% CI), 1.667, (0.736-3.776)).This was not statistically significant. (Table 3.15).Iron foundry workers with 5 years and below had high odds of getting phlegm symptom compare to workers with 6 years and above. (OR, (95% CI), 1.310, (0.759-2.261)).This was not statistically significant.(Table 3.15)

Table 3.15: Univariate analysis of phlegm symptom

Phlegm	**Unadjusted OR**	**95.0%C I for OR**		**P-value**
		Lower	**Upper**	
Age <20	1			
21-30	1.014	0.311	3.303	0.982
31-40	1.065	0.316	3.586	0.919
41-50	1.750	0.485	6.314	0.393
>50	3.500	0.717	17.094	0.122
Job Category				
Raw mill	1			
Furnance	1.667	0.736	3.776	0.221
Loading	1.944	0.903	4.185	0.89
Work experience				
5years and below	1.310	0.759	2.261	0.332
6years and above	1			
Job training				
Yes	1			
No	0.700	0.408	1.202	0.196
Ppe				
Yes	1			
No	0.859	0.507	1.454	0.571
Smoking				
Yes	0.437	0.232	0.820	0.010
No	1			

3.8 Multivariate analysis of factors associated with occurance of respiratory symptoms.

Factors associated with occurance of respiratory symptoms under study include the independent variables which are Age, education level, job task, work experience, job training, inspection by regulatory bodies, use of dust mask, and smoking behavior. After univariate analysis was run age category variable was controlled so as to observe the behavior of other independent variables versus dependent variables respiratory symptoms SoB, wheeze, cough and phlegm.

After adjusting for age workers working in the foundry 5 years and below showed high odds of getting shortness of breath 1.194(0.484-2.941). Workers who did not get on job training have shown high odds of getting shortness of breath 1.265(0.548-2.917). Also iron foundry workers working in loading section showed significant high odds of getting shortness of breath 2.557(0.960-6.808) followed by workers in Furnance section who had odds of getting shortness of breath 2.077(0.753-5.728) **(**Table 3.16).

Variable in (table 3.12) show higher magnitude of odds ratio when in (Table3.16). This can be explained by the influencing character by other factors when put together in (Table 3.16). Whereas this effect is not observed when individual variable on causing respiratory symptoms. compare to when in (table 3.12). Also job category Furnance section show a decrease in magnitude of odds ratio in (table 3.16) compare to when in (table 3.12).

Table 3.16: Multivariate Analysis of SOB symptom

Variable	Adjusted OR*	95% CI for OR		Pvalue
		Upper	Lower	
Work experience				
5years and below	1.194	0.484	2.941	0.701
6years and above	1			
Job Training				
Yes	1			
No	1.265	0.548	2.917	0.582
Dust Filters				
Yes	1			
No	0.742	0.335	1.642	0.461
Smoking				
Yes	1			
No	0.603	0.262	1.386	0.233
Job Category				
Raw mill	1			
Furnance	2.077	0.753	5.728	0.158
Loading	2.557	0.960	6.808	0.060

Adjusted OR (Age)

After adjusting for age iron foundry workers who did not get job training showed odds of 1.188(0.588-2.400) of developing wheeze symptom, where as workers who did use dust filters showed odds of 1.138(0.577-2.245) of developing wheeze symptom. Iron foundry worker at the loading section showed higher significant odds of 2.150(1.011-4.569) followed by workers in Furnance section who showed odds of 1.827(0.835-3.999) of developing wheeze symptom.(Table 3.17).

Variable in (table 3.13) show higher magnitude of odds ratio when in (table3.17). This can be explained by the influencing character by other factors when put together in (table 3.17). Whereas this effect is not observed when individual variable on causing respiratory symptoms. However a variable on inspection by regulatory bodies showed to decrease in magnitude of odds ratio in (table 3.17) compare to when in (table 3.13).

Table 3.17: **Multivariate analysis for Wheeze Symptom**

Variable	Adjusted OR*	95% CI for OR		Pvalue
		Upper	Lower	
Work experience				
5years and below	0.766	0.364	1.611	0.482
6years and above	1			
Job Training				
Yes	1			
No	1.188	0.588	2.400	0.632
Dust Filters				
Yes	1			
No	1.138	0.577	2.245	0.710
Smoking				
Yes	1			
No	0.526	0.248	1.118	0.095
Job Category				
Raw mill	1			
Furnance	1.827	0.835	3.999	0.132
Loading	2.150	1.011	4.569	0.047

Adjusted OR (Age)

After adjusting for age iron foundry workers showed odds of 1.257 (0.648-2.438) of developing cough symptom. Iron foundry workers with no on job training showed odds of 1.320 (0.647-2.691) of developing cough symptom where as workers who did not use dust filters showed odds of 1.522 (0.764-3.034) of developing cough. Also iron foundry workers in loading section showed high odds of 2.125(0.990-4.560) of developing cough symptom. Followed by workers in Furnance section who showed the odds of 1.187(0.525-2.682) to develop cough symptom (Table 3.18).

Variable in (table 3.14) show higher magnitude of odds ratio when in (table3.18). This can be explained by the influencing character by other factors when put together in (table 3.18). Whereas this effect is not observed when individual variable on causing respiratory symptoms.

Table 3.18: Multivariate analysis for Cough symptom.

Variable	Adjusted OR*	95% CI for OR		Pvalue
		Upper	Lower	
Work experience				
5years and below	0.654	0.308	1.393	0.271
6years and above	1			
Job Training				
Yes	1			
No	1.320	0.647	2.691	0.445
Dust Filters				
Yes	1			
No	1.522	0.764	3.034	0.232
Smoking				
Yes	1			
No	0.866	0.401	1.868	0.713
Job Category				
Raw mill	1			
Furnance	1.187	0.525	2.682	0.681
Loading	2.125	0.990	4.560	0.053

Adjusted OR (Age)

After adjusting for age iron foundry works with 5 years and below showed odds of 1.067(0.476-2.396) of developing phlegm symptoms. Workers who did not get on job training showed odds of 1.112 (0.521-2.372) of developing phlegm (Table 3.19).

Workers who smoke showed significant odds of 2.196(1.017-4.744) of developing phlegm where as workers in loading section showed higher odds of 1.875(0.819-4.297) of developing phlegm followed by workers in Furnance section who showed 1.235 (0.513-2.958) of developing phlegm symptoms (Table 3.19).

Variables in (table 3.19) show high magnitude compare to when in (table 3.19). This may be due to the additive influencing character when these factors are joined up together. Compare to when they stand alone (table 3.19).

Table 3.19: Multivariate analysis of Phlegm symptom

Variable	Adjusted OR*	95% CI for OR		Pvalue
		Upper	Lower	
Work experience				
5years and below	1.067	0.476	2.396	0.874
6years and above	1			
Job Training				
Yes	1			
No	1.112	0.521	2.372	0.784
Dust Filters				
Yes	1			
No	0.867	0.421	1.784	0.698
Smoking				
Yes	2.196	1.017	4.744	0.045
No	1			
Job Category				
Raw mill	1			
Furnance	1.232	0.513	2.958	0.641
Loading	1.875	0..819	4.297	0.137

Adjusted OR (Age)

CHAPTER FOUR

4.0 DISCUSSION

4.1 Proportion of respiratory symptoms among iron foundry workers

This part discusses the findings of respiratory symptoms among iron foundry workers in Dar es Salaam in Temeke and Kinondoni districts. Various respiratory symptoms were assessed and findings showed high proportion of respiratory symptoms including wheeze (39%), cough (32.3%), cough and phlegm (26.7%) and chest illness (17.1%). This current study shows similar results as a study by Alexandra and colleges on respiratory symptoms among foundry workers done in Australia (1985) which revealed that wheeze and other respiratory symptoms have been widely reported among iron foundry workers as they are attributed to exposure to substances at work. That observation relates to actual situation observed in the field during data collection where wheeze and cough symptoms were highly reported. A study by Bala and Tabaku (2010) done in Albania to assess COPD disease among iron steel foundries revealed higher level of cough (40.1%)and higher levels of phlegm(46.3%) among iron and steel foundry workers. That study demonstrated higher prevalence compare to what was found in this current study.

However a study by Ghasemkhani and colleagues in Iran (2006) on determination of the prevalence of respiratory symptoms among workers in south Tehran, Iran revealed highly reported cases of phlegm (41.6%) and dysponea (41.7%) among industrial workers. Findings in the later and former study above have higher prevalence compare to what was found in this current study suggesting low level of occupational hygiene at foundries. Also policies on the OEL at foundries if not effectively enforced may result to such high prevalence of respiratory symptoms. Also a study by Kayhan and colleges in Turkey (2013) on Prevalence of occupational asthma and respiratory symptoms reported higher cases of phlegm (20.47%) and cough(14.98%) symptoms among production workers, other symptoms reported were chest illness and wheeze symptoms. The findings are lower compare to what is found in this current study, the reason may be advanced technology used in Turkey compare to technology in the foundry industries studied, effective use of Personal protective equipment, also stringent Implementation of OEL may be a reason for lower cases of respiratory symptoms.

In the findings of this study it was found that workers with age between 20- 30 years experienced respiratory symptoms more compare to other age groups. This can be explained by the concept of health worker effect, also a study by (Hamzah et al., 2015) explain findings by Azwan et al who reported 53.2% work-related respiratory symptoms were wheezing (30.2%), shortness of breath (44.2%), and chest tightness (30.3%), and cough (41.1%) were observed among this age group.

Apart from the observed prevalence of Shortness of Breath among iron foundry workers as reported. Severity of SoB symptoms were rated as Dysponea I, II and III. Severity is assessed if a worker has shortness of breath when walking with other people on a level ground describes dysponea I, if a worker has stop of breath when walking on a level ground describe dysponea II, when a worker get short of breath when run describe dysponea III.

The persistence of symptoms such as wheezing reported causing iron foundry workers to have their sleep broken and having woke up in the morning with wheeze. This indicates increased severity of reported symptoms however iron foundry workers reported improvement of respiratory symptoms during weekends which could explains the role of exposure in exacerbating respiratory symptoms.

4.2 Peak Expiratory flow rates among iron foundry workers

Peak expiratory flow rates measure personal ability to expirate which determines lung functionality of an iron foundry worker. Findings in this study revealed that mean value for peak flow rates measured was less compare to mean value for predicted peak flow rates as shown in table 7. The findings are proved to be statistically significant at $p<0.01$ according to students'T - test. These findings show relationship between occurance of respiratory symptoms and low lung functionality among iron foundry workers. A study by Elwood and colleges in Ireland on respiratory disability in ex flax workers (1986) revealed that the observed decrease in lung functionality was due to light smoking behavior. Another study by Gomes and colleges (2001) in United Arab Emirates revealed that a job setting at the iron foundry was a significant predictor to reduction of lung functionality. Another study by Johnson and colleges (1985) amongst other factors like smoking, height and age, long working experience when controlled work exposure was observed to be a

causative factor to reduced lung functionality. Low lung functionality as observed may be caused by continous exposure to the work environmental where exposure to fumes, gases and dust contributes to low lung functionality.

4.3 Personal Dust concentration among Iron foundry workers.

Iron foundry workers are exposed to several activities like scrap sorting, sand molding, sand reclamation, loading of end products, etc all of which expose workers to dust particularly metal dust. Findings in this study revealed that dust in Furnance was 2.1858mg/m^3 where as in raw mill was 0.53mg/m^3 and in loading was 0.573mg/m^3. This justify that activities in the furnace which are scrap sorting and melting expose workers highly to metal dust particularly iron dust. However activities in loading bay such as bending, tie and loading highly expose workers dust contributes to iron dust as a results influence respiratory symptoms among iron foundry workers. Analysis of respiratory symptoms versus the amount of dust exposure revealed that workers in the furnace had high cases of shortness of breath (24.6%) and cough and phlegm (33.3%) symptoms. Workers in loading bay showed high cases of wheeze (45.1%), cough (34.8%), Phlegm (33%), chest illness (25.3%). However the results showed no statistical significance basing on the Threshold limit value of iron dust 5mg/m^3(WHO). Similar finding in a study by Alexandra and colleges (1985) on respiratory diseases among foundry workers revealed that measurement of dust and fumes inhaled were less than recommended TLV. This could be related to improvement in ventilation in recent times and that higher prevalence observed are a result of past exposures responsible for the apparent sensitization of some workers. A study by Bala and Tabaku (2010) reveals that exposure to dust over a long working period in years in a specific job is associated with reduction in lung functionality. This is relative to the findings in this study whereas workers experience low lung functionality and high prevalence of respiratory symptoms.

However a study by Gomes (2001) and colleges on prevalence of respiratory symptoms reveals that dust inhaled in the foundry adversely affect lung functioning of workers. However poor use of Protective equipment contributes to greater exposure to dust. A study by Hamzah (2015) and colleges reveals that cumulative metal dust exposure elevates respiratory symptoms prevalence. A study by Higgins (1961) and colleges describes that

dust alone cannot account for the excess of respiratory symptoms several other factors must be involved to contribute. However the findings relates what was observed in this study where by though dust was observed yet it was not statistically significant there has been occurance of respiratory symptoms suggesting that other factors inline must be present to catalyze the occurance of respiratory symptoms. According to Industrial Injury Advisory Council IIAC (2011) explain that workers in furnace have high access to metal dust which is a contributing factor to respiratory diseases in the foundry.

4.4 Contributing Factors to respiratory symptoms in the iron foundry.

Findings in this study describe various factors observed of which are significant in prompting prevalence of respiratory symptoms and low lung functionality in selected industries. These factors among many were observed to be statistically significant at $p<0.05$.

4.4.1 Smoking habit

Smoking habit forms a common behavior among iron foundry workers. Smoking was evaluated as Current smokers 66(27.6%) and ex-smokers 27(59.3%). Smoking has been associated with reduction in peak expiratory flow rates as reported by many studies, however smoking accelerate prevalence of respiratory symptoms as much as risking a health of a worker to occupational lung cancer. Working environment in iron foundry exposes workers to dust, fumes, gases all of which contributes to occurrence of respiratory symptoms the use of cigarettes accelerate the effect and lead to respiratory diseases. A study by Hoyle and colleges (2002) on occupational lung diseases in iron foundry workers reveals that smokers were likely to report each symptom. That situation was observed also in this current study whereas all smokers had experienced respiratory symptoms. Also a study by Hamzah (2015) and colleges on metal dust exposure and respiratory symptoms showed smoking habit as a contributing factor to the occurance of shortness of breath symptoms. A study by kayhan (2013) and colleges suggest the cessation of cigarette smoking as it is associated with occurance of occupational asthma.

4.4.2 Work experience

In this study workers who worked five years and below formed two third of the study population. This clearly defines that longer working duration extend exposure period of a worker to the occupational hazards such as dust, fumes and gases of which lead to respiratory symptoms. A study by Ghasemkhani (2006) and colleges revealed that respiratory symptoms increased with employment years. Also a study by Halvani (2008) and colleges on evaluation of respiratory symptoms among ceramic factories reveals that working duration show important independent determinant for respiratory symptoms. A study by Kuo and colleges (1999) revealed long working duration has a contribution towards respiratory abnormalities.

4.4.3 Job Training

Job training refers to the introduction, familiarization to the work environment, hazards and risk associated with a particular job. It is necessary for workers to be effectively trained about exposures at the workplace and protective measures to be taken including the use of protective equipments based on acceptable standards. Findings in this study shows that job training is lowly given to workers and this contribute to increased prevalence of respiratory symptoms which is statistically significant. During this study most workers admitted to acquire apprentice rather than on job training. Apprentice is local and therefore only skill a worker but donot educate a worker on exposures that directly affect a worker's health. On job training if offered effectively will lower prevalence of respiratory symptoms. A study by Ghasemkhani (2006) and colleges revealed that if an industrial hygiene practice is not ensured there will be no awareness among workers on the workplace hazards to lower the risks of exposures. Also a study by Gomes (2001) and colleges revealed that poor use of personal protective equipment is mainly due to lack of knowledge of industrial hygiene.

4.4.4 Use of dust filters or respirators

Use of personal respirators during work is a necessary attempt to all workers in iron foundry. Though in most cases worker do not prefer working with protective gears due to several reasons but it this study revealed that a for use of dust filters/ respirators contributes to occurance of respiratory symptoms the use of personal protection is often

ignored in tropical countries because of the hot and humid climatic conditions, which make the use of these devices impractical(Gomes et al., 2002). A guiding manual from OSHA explain the need for every employer to ensure all workers are fully protected throughout work duration(U.S. Department of Labor, 2008). A study on sisal plantation revealed that lack of use of protective gears and contributed to increased risk of respiratory effects by inhalation of harmful substances(Kayumba, 2008).

Another study among street sweepers in Ilala Tanzania found that street sweepers rarely used PPEs while exposed to high level of dust which may contribute to increases the prevalence's of respiratory health symptoms(Stambuli, 2012).

Findings in a study on metal dust exposure and respiratory symptoms among steel workers revealed (36.4%) workers claimed that they used masks 'full time' during the working hours,(47.8%), subjects used masks 'most of the time', and (15.8%) were 'seldom' using masks(Hamzah et al., 2015). Personal protection equipment such as respirators is a good solution for short duration tasks (Chen et al., 2012).

4.4.5. Job Tasks

In this study it was revealed that workers in job categories of Furnance and loading sections showed higher odds ratio of occurance of respiratory symptoms compare to workers in raw mill section. A study on Lung Function and Respiratory Symptoms in Foundry Workers revealed that workers in finishing section showed higher concentration of inhalable dust(mg/m^3) compare to sections of core and melt(Woerfel & Cherry, 1997). In a study on respiratory diseases among dust exposed workers showed that workers in dusty work places require administrative measures to cutting short their working hours or job rotation(Chen et al., 2012). According to Code of Practice on Safety and Health in the Iron and Steel Industry from ILO, it is necessary workers being familiarized to their workplaces knowing the hazards in the work places so as to arrange for job rotation, work duration and management of hazards and risks(ILO, 2005). It has been observed that variability of exposure levels among workers with presumably the same jobs and work tasks may equal or exceed variability between workers with dissimilar jobs (Checkoway & Eisen, 1998).

4.5 Study limitation and mitigation

It may be difficult to generalize the findings obtained for the rest of other steel factories in Tanzania due to some factors like technology, age of the industries, regular operation and maintenance. **However the study involved 300(70%) respondents rather than 426 proposed due to the occupational settings, study design used and selection of three industries**. The study was held into Industries involving all sections and job categories thereby the findings of this study gives a real picture of the respiratory health problem and related factors. This was mitigated by ensuring each district that had iron and steel industries was included in the study except for one district that did not have any of these industries. Information from the sample might be prone to some few errors particularly when it comes from the portion of population of interest rather than the whole population. This was mitigated by explaining the aim of the study to the management and the kind of study participants required. The supervisors assisted in sorting out desirable participants daily before conducting a study. Structured prepared questions may also be prone to have recall bias since the information to be requested from the study participants might have occurred over a period of 12 months ago. This was mitigated by careful interviewing and repeating questions to ensure that participants capture their memories.

CHAPTER FIVE

5.0: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study explored the proportion of respiratory symptoms among iron foundry workers, findings showed existence of respiratory symptom highly reported symptoms were wheeze and cough. There has been observed reduction of lung function due to the reduced peak expiratory flow rates among iron foundry workers. However the study outlined cigarette smoking; longer work experience, on job training, poor use of dust filters, and job tasks as contributing factors in the development of respiratory symptoms among iron foundry workers in Dar es Salaam.

5.2 Recommendations

From the findings in this study the following are recommended;

- On job training to the workers by the industrial management is crucial for the health of workers.
- Cigarettes smoking cessation program should be conducted among iron foundry workers. Suggestive stringent laws and bylaws to be adhered.
- Use of respiratory protective gears such as respirators and masks should be encourage so that workers can work over a long period of time in a foundry at health conditions.
- Job rotation, limited working hours per day, familiarization of workers to the hazards in their working sections
- This study has just snapshot the situation at iron foundries suggestions to cohort studies in iron foundry is encouraged so as to get a big picture in the trends of the respiratory health among iron foundry workers

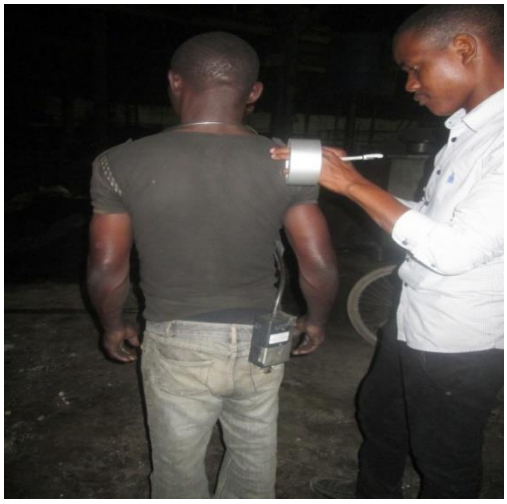




Figure 5.1: Dust measurement and coding exercise



Figure 5.2: Molding activities



Figure 5.4: Loading activities



Figure 5.3: Furnance activities



Figure 5.5: Calibration of side kick pumps



Figure 5.6 : Interviews in a special room



Fig 5.7: PEF Measurement

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APPENDICES

Appendix I: Questionnaire – English Version

RESPIRATORY QUESTIONNAIRE

Respiratory Questionnaire

Questionnaire base on the British Medical Research Council MRC (UK) Respiratory Questionnaire 1986, which has been extensively validated and modified to meet the intentions of this study. This questionnaire is intended to be completed by an interviewer rather than by the respondent. Additional questions have been added to cover clinical aspects of bronchial hyper responsiveness validated by the Department of Occupational and Environmental Medicine, National Lung Institute.

Preamble

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

If the subject is disabled from walking from any condition other than heart and lung disease, please begin questionnaire at **Question 5** and mark the adjacent box ☐

Title: **RESPIRATORY SYMPTOMS AND LUNG FUNCTIONALITY AMONG WORKERS IN FOUNDRY INDUSTRIES IN DAR-ES-SALAAM.**

Questionnaire number: ……

Name of small scale industry/Office: …….

SECTION A: DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

Question number	**Questions**	**Response**
A1	How old are you?	…… years
A2	Gender of respondent?	1. Male 2. Female
A3	What is your marital status?	1. Single 2. Married 3. Divorced/separated 4. Cohabiting
A4	What is your highest level of education?	1. Never been to school 2. Primary 3. Secondary 4. Certificate
A5	What is your area of practice?	1. Supervisor 2. Welder 3. Production 4. Others(Mention)
A6	How long have you worked at this position (mention)	

Shortness of breath (dysponea) and Wheezing

During the last month:

1. Are you troubled by shortness of breath when hurrying

On level ground or walking up a slight hill? Yes ☐ No ☐

If Yes to 1:

2. Do you get short of breath walking with other people of

your age on level ground? Yes ☐ No ☐

If Yes to 2:

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

Yes ☐ No ☐

4. If you run, or climb stairs fast do you ever

a. Cough? Yes ☐ No ☐

b. Wheeze? Yes ☐ No ☐

c. Get tight in the chest? Yes ☐ No ☐

5. Is your sleep ever broken…?

a. By wheeze? Yes ☐ No ☐

b. Difficulty in breathing? Yes ☐ No ☐

6. Do you ever wake up in the morning (or from your sleep if a shift worker)

a. With wheeze? Yes ☐ No ☐

b. Difficulty with breathing? Yes ☐ No ☐

7. Do you ever wheeze…?

a. if you are in a smoky room? Yes ☐ No ☐

b. if you are in a very dusty place? Yes ☐ No ☐

If Yes to Q5, Q6, Q7:

8. Are your symptoms better

a. at weekends (or equivalent if shift worker)? Yes ☐ No ☐

b. when you are on holidays? Yes ☐ No ☐

If **Yes** to **Question 8** please record details of any occupational exposure to respiratory hazards eg fumes, harmful gases, dust exposures etc.

Cough

9. Do you usually cough first thing in the morning

Yes ☐ No ☐

10. Do you usually cough during the day –or at night –

Yes ☐ No ☐

If Yes to Q9 or Q10. :

11. Do you cough like this on most days for as much as

Three months each year? Yes ☐ No ☐

Phlegm

12. Do you usually bring up phlegm from your chest first thing in the morning? Yes ☐ No ☐

13. Do you usually bring up any phlegm from your chest during the day – or at night? Yes ☐ No ☐

If Yes to Q12. or Q13 :

14. Do you bring up phlegm like this on most days for as much as three months each year? Yes ☐ No ☐

Periods of cough and phlegm

15. In the past three years, have you had a period of (increased) cough and phlegm lasting for three weeks or more? Yes ☐ No ☐

If Yes to Q15:

Q16. Have you had more than one such episode? Yes ☐ No ☐

Chest Illnesses

17. During the past three years, have you had any chest illness that has kept you from your usual activities for as much as a week? Yes ☐ No ☐

If Yes to Q17:

18. Did you bring up more phlegm than usual in any of these illnesses? Yes ☐ No ☐

If Yes to Q18:

19. Have you had more than one illness like this in the past three years? Yes ☐ No ☐

Past Illnesses

20. Have you ever had, or been told that you have had:

a. An injury, or operation affecting your chest? Yes ☐ No ☐

b. Heart trouble? Yes ☐ No ☐

c.. Pneumonia Yes ☐ No ☐

d. Asthma? Yes ☐ No ☐

e. Other chest trouble? Yes ☐ No ☐

Yes ☐ No

Tobacco Smoking

21. Do you smoke? Yes ☐ No ☐

If No to Q21:

Q22. Have you ever smoked as much as one Cigarette a day for as long as one year? Yes ☐ No ☐

If **No** to **Question 21 or 22**, omit remaining questions on smoking.

24a. Do (did) you smoke manufactured cigarettes? Yes ☐ No ☐

25. Do you smoke any other forms of tobacco? Yes ☐ No ☐

If Yes to Q25:

Record details under Additional Notes

For ex-smokers

Q26. When did you give up smoking altogether? Month _____Year _____

Use of Personal protective Equipment

Q27a. Do you use Dust filters/ Respiratory masks?(Observe). Yes☐ No☐

How often……

If yes to Q27a

Q27b. Are the ppe's in Q27a appropriate to your job task and enough to every worker (observe) Yes☐ No☐

Q28.Are there prevention and control measure towards exposures at your working section i.e. ventilation settings (observe) Yes☐ No☐

Q29. Are there on job trainings (how to use ppe's, how to operate with hazards at minimum risks, how to use msds, safety trainings, like fire control, dust, gaseous)

Yes☐ No☐

Q30. Do you have internal inspections? Yes☐ No☐ how often? …….

Q31. Do you get inspected by regulatory bodies like OSHA, Yes☐ No☐

How often……

Peak flow readings

Train the respondent to blow a mouth piece and record the readings out of the three blows. Respondent should stand upright while blowing, the direction of mouth piece should point away from anyone else's face, record the details of height and age.

Height (cm)……

Peak flow meter readings	**PRESHIFT**	**POSTSHIFT**
	1…….	1…….
	2…….	2…….
	3……	3……

Appendix II: Questionnaire – Swahili Version

DODOSO LAKASORO KATIKA MFUMO WA UPUMUAJI

Hili dodoso limetokana na dodoso lililotengenezwa na MRC(UK)1986 Ambalo limehakikiwa vyakutosha.Dodoso hili linatazamiwa kutumika na muhojaji/mtafiti na si mhojiwa. Maswali ya ziada yameongezwa kujumuisha taarifa nyingine muhimu dodoso hili limehakikishwa na idara ya afya ya mazingira ya mahala pa kazi.Pia dodoso limeboreshwa ili kutimiza malengo ya huu utafiti.

UTANGULIZI

Nitakuuliza maswali machache kuhusu matatizo katika mfumo wa upumuaji. Kama mhojiwa hawezi kutembea kutokana hali yoyote tofauti na ugonjwa wa mapafu na moyo tafadhali anzia na swali 5 na ujaze kisanduku cha pembeni.

DALILI ZA MAGONJWA KATIKA MFUMO WA UPUMUAJI NA KUPUMUA MIONGONI MWA WAFANYAKAZI WA SEKTA YA VIWANDA VYA VYUMA.		
	KIFUNGU A	
A1	Unao umri wa miaka mingapi?	……..
A2	Jinsia ya mhojiwa	1. Mume 2. Mke
A3	Hali ya ndoa ya mhojiwa?	1. Hajaolewa/hajaoa 2. Ameolewa/ameoa 3. Wameachana 4. Wanaishi pamoja bila ndoa
A4	Umefikia kiwango gani cha juu cha elimu?	1. Elimu ya msingi 2. Elimu ya sekondari 3. chuo
A5	Unafanya kazi gani katika kiwanda hiki?	5. Msimamizi 6. mchomeleaji 7. uzalishaji

		8. Nyingine…..Taja……..
A6	Kwa muda gani umefanya kazi hii?(Taja)	

KIFUNGU B:

KUSHINDWA KUPUMUA NA KUTOA SAUTI NYEMBAMBA WAKATI WA KUPUMUA KATIKA MWEZI MMOJA ULIOPITA

1.	Je unapata shida ya kupumua wakati wa kutembea kwa haraka kwenye ardhi tambare au au unapopanda kilima kifupi	NDIO	HAPANA

KAMA JIBU NI NDIO SWALI 1

2	Je unapata shida ya kushindwa kupumua wakati unapotembea na watu wengine wa umri wako kwenye ardhi tambarare	NDIO	HAPANA

Kama ndio kwa swali la 1 na 2

3	Je inakubidi usimame ili upumue wakati unapotembea katika mwendo wako katika ardhi tambarare	NDIO	HAPANA

4. Kama ukikimbia au kupanda ngazi kwa haraka je huwa unatokezewa na yafuatayo

	NDIO	HAPANA
a)kukohoa		
b)kutokwa na kisauti chembamba wakati wa kupumua		

c)unahisi kubanwa kifua		

5. Je usingizi wako huwa unakatishwa na

	NDIO	HAPANA
a) kutoa sauti ya mkwaruza(mlio) wakati wa kupumua		
b)kushindwa kupumua vizuri		

6. Je huwa ukiamka asubuhi (au kutoka usingizini kama ni mfanyakazi wa shift)

	NDIO	HAPANA
a) kutoa sauti ya mkwaruza(mlio) wakati wa kupumua		
b) kushindwa kupumua vizuri		

7. Je huwa una toa sauti ya mkwaruza au mlio wakati wa kupumua (wheeze)

	NDIO	HAPANA
a)kama uko kwenye chumba cha moshi		
b)kama uko kwenye vumbi sana		
c)Kama uko kwenye gesi hatarishi		

Kama jibu ni ndio kwa swali la 5,6,&7

8.Je dalili za matatizo ya mfumo wa upumuaji hupungua?

	NDIO	HAPANA
a)wakati wa wikiendi (wakati wa mapumziko kama ni mfanyakazi na shift)		

b)wakati upo likizo		

Kama jibu ni ndio kwa swali la 8 tafadhali rekodi taarifa kuhusu uwepo na visababishi vya matatizo ya mfumo wa upumuaji mahala pa kazi mfano gesi hatarishi , vumbi la vyuma na kadhalika

KIFUNGU C: KIKOHOZI

9.	Je huwa uamkapo tu asubuhi unakohoa	NDIO	HAPAN A
10	Je huwa unakohoa kipindi cha mchana au usiku		

Kama jibu ni ndio kwa swali la 9 au 10

11.	Je huwa unakohoa kama hivi karibu siku zote kwa muda karibu miezi mitatu kila mwaka	NDIO	HAPANA

KIFUNGU D: MAKOHOZI

12.	Je huwa unatoa makohozi mara tu uamkapo asubuhi	NDIO	HAPANA
13	Je huwa unatoa makohozi yoyote wakati wa mchana au usiku	NDIO	HAPANA

Kama jibu ni ndio kwa swali la 12 & 13

14.	Je huwa unatoa makohozi karibu siku zote kwa muda na karibu miezi mitatu kila mwaka	NDIO	HAPANA

KIFUNGU E: VIPINDI VYA KIKOHOZI NA KUTOA MAKOHOZI

15.	Katika kipindi cha miezi mitatu iliyopita. Umewahi kupata kipindi cha kuongezeka kukohoa na kutoa makohozi vilivyodumu kwa siku tatu au zaidi.	NDIO	HAPANA

KAMA JIBU NI NDIO KWA SWALI LA 15

16.	Je umeshawahi kupata hali hiyo kwa zaidi ya mara moja	NDIO	HAPANA

KIFUNGU G: MAUMIVU YA KIFUA

17.	Katika kipindi cha miaka mitatu iliyopitaje umewahi kupata kuumwa kifua ambacho kilikufanya usiende kwenye shughuli zako za kawaida kwa muda karibu na wiki .	NDIO	HAPANA
18	Je uliwahi kupata kutoa makohozi zaidi ya kawaida katika kipindi chochote cha kuumwa kwako		
19.	Je uliwahi kuumwa zaidi ya mara moja katika kipindi cha miaka mitatu		

KIFUNGU H: TAARIFA YA MAGONJWA YA MFUMO WA UPUMUAJI

21.	Je umewahi kumwa au kuambiwa kuwa unaumwa magonjwa kati ya haya	NDIO	HAPANA
	a)ajali au upasuaji unaoathiri kifua chako		
	b)matatizo ya moyo		
	c)Nimonia		
	d)Pumu		
	e)Matatizo mengine ya kifua		

KIFUNGU I: UVUTAJI SIGARA

21.	Je wewe unavuta sigara	NDIO	HAPANA
22.	Je umewahi kuvuta sigara angalau moja kwa siku kipindi cha angalau mwaka mmoja		

24a) Je unavuta sigara za kutengenezwa kiwandani?

NDIO	HAPANA

25.	Je unavuta aina nyingine ya tumbaku?	NDIO	HAPANA

Kama jibu ni ndio la swali la 1-25

Jaza maelezo kwenye kisanduku kifuatacho

……

26.Je ni lini ulicha sigara kabisa mwezi…….mwaka……

27(a).Je unatum maski ya kuzuia vumbi pindi uwapo kazini?

NDIO	HAPANA

27(b). Kama ndio 27(a) Je vifaa kinga hivi vinakidhi haja kulingana na majukumu yako? Na vinatosheleza wafanyakazi wote?(Chunguza)

NDIO	HAPANA

28. Kuna mfumo wa udhibiti na uzuiaji wa madhara yatokanayo na kazi mfano kichuja vumbi/ madirisha makubwa/ eneo kubwa kwa ajili ya mzunguko wa hewa(chunguza)

NDIO	HAPANA

29. Je unapatiwa mafunzo yoyote pindi muwapo kazini mfano jinsi ya kutumia vifaa kinga, msds,jinsi ya kuzima moto,madhara ya vumbi, moshi na gesi zitokanazo na kazi ambazo ni hatarishi kwa afya

NDIO	HAPANA

NDIO	HAPANA

31. Je mnafanyiwa ukaguzi wa mazingira ya kazi na uongozi wa kiwanda/ viongozi?

32.Je huwa mnatembelewa na wakaguzi wa OSHA ?

NDIO	HAPANA

Kipimo cha peak flow meter

Mwelekeze mhojiwa namna ya kupuliza bomba, rekodi kiwango kilichopulizwa katika mara tatu.Mhojiwa atatakiwa kupuliza akiwa amesimama wima, na atatakiwa kutokugeuza bomba kwenye uso wa mtu mwingine. Hakikisha kuchukua taarifa za urefu na uzito wa mhojiwa.

Urefu wa mhojiwa (cm) ……..

Kiwango cha PEF mita	**KABLA YA SHIFT**	**BAADA YA SHIFT**
1	…….	……
2	…….	……..……..
3	……	……

Appendix III: Informed Consent – English Version

Consent form

Title: Respiratory Symptoms and Lung functionality among workers in Foundry Industries in Dar es salaam, Tanzania.

Consent to Participate In the Study

Greeting! My name is Gift Mbise, a resident from Muhimbili University of Health and Allied Sciences. I am currently conducting a study titled "Respiratory Symptoms and Lung functionality among Workers in Foundry Industries in Dar es salaam, Tanzania".

Purpose of the Study

The study is intended to assess the presence of respiratory symptoms and lung functionality among foundry workers. The results obtained will determine extent, magnitude and way forward to deal with the observed situation among the foundry workers.

Benefits of the Study

Results from this study will be an important source of information to policy makers and reviewers, small scale industry workers, Industry owners and other stakeholders on the burden of exposures, respiratory symptoms and their determinants among SSI workforce. The information will also raise awareness to SSI workers on how they should behave while at work to get rid or reduce the levels of exposures. The Ministry of Health and Social Welfare and Occupational Safety and Health Authority are expected to use the information to set up possible solutions about the problem.

What participation involves

We ask for your participation in the study because you are among the SSI workers and you are regarded as a group at risk of exposures as a result of your job. If you agree to participate in the study you will be interviewed on your previous exposure status, your age, your job experience and other relevant information inherent in your current job in this Industry.

Confidentiality

All information obtained from you will be treated as confidential and will be used only for the intended purposes of this research. The research team will compile a report that will contain information about all industrial workers interviewed while maintaining confidentiality.

Potential Risks

We do not expect any harm to you as a result of your participation in the study.

Right to withdraw

You have the right to participate or not to participate in the study without giving any reason for your decision. When you have decided to participate you are also free to terminate your participation at any time in the course of the study.

Contacts

If you have any questions about this study you are free to contact, the principal investigator, Gift Mbise (0717 986808) or giftgodson@gmail.com.

If you have any questions/concerns about your rights as a participant you may contact Chairman of MUHAS Research and Publications Committee. P.O.BOX 65001 Dar es Salaam. Telephone number: 2150302-6 and Dr. S.H. Mamuya(0787721377).

If you agree to this interview, please sign this consent form.

I …… have read and understood the contents of the consent form and my questions have been answered adequately. I therefore consent for the interview regarding the study.

Signature of the interviewee …… Date. ……

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

Appendix IV: Informed Consent – Swahili Version

FOMU YA RIDHAA

Utafiti: Dalili za magonjwa ya kifua na uwezo wa mapafu kupumua miongoni mwa wafanyakazi sekta ya viwanda vya vyuma Tanzania.

Ridhaa ya kushiriki kwenye utafiti

Habari! Jina langu ni Gift Mbise, mtafiti kutoka chuo cha afya na sayansi shirikishi Muhimbili. Kwa sasa nafanya utafiti ili kutambua dalili za magonjwa ya kifua na uwezo wa mapafu kupumua miongoni mwa wafanyakazi katika sekta ya viwanda vya vyuma Dar es salaam Tanzania .

Lengo la utafiti

Matokeo ya utafiti huu yatakuwa ni rasilimali muhimu sana kwa watunga sera,waboresha sera, wafanyakazi wa sekta ndogondogo, wamiliki viwanda na wadau wengine kwa sababu matokeo haya yatatoa picha halisi juu ya ukubwa wa tatizo na sababu mbalimbali zinazopelekea matatizo haya kuwepo kwa wafanyakazi katika mazingira ya kazi.

Faida za kushiriki katika utafiti

Taarifa hizi zitaongeza uelewa kwa wafanyakazi wenyewe juu ya jinsi gani wajikinge na madhara ya kuumia kazini na hatimaye kupunguza tatizo au kulimaliza kabisa. Wizara ya Afya na Ustawi wa Jamii na Mamlaka ya Usalama na Afya Mahala pa kazi wanatazamiwa kutumia matokeo haya kuandaa mikakati thabiti kwa ajili ya kudhibiti tatizo hili.

Ushiriki

Tunaomba ushiriki wako katika utafiti huu maana wewe ni mmojawapo wa wafanyakazi wa sekta hii ambao ni kundi linalotambuliwa kuwa katika hatari ya kupata athari wakati ukiendelea na kazi katika mazingira ya kazini. Ukikubali kushiriki utaulizwa maswali kuhusu hali ya athari hapa kazini kwa kipindi kilichopita. Utaulizwa pia kuhusu umri wako na muda ambao umekuwa ukifanya kazi pamoja na taarifa nyingine kuhusiana na kazi yako.

Usiri

Taarifa zote utakazotoa zitakuwa siri na hazitatumika kwa matumizi mengine mbali na utafiti huu. Timu ya utafiti itachambua taarifa hizi na kutoa taarifa ambayo haitatoa siri yoyote kuhusu wewe kwa kuwa majina au taarifa inayomlenga mtu binafsi haitakusanywa katika utafiti huu.

Athari

Katika utafiti huu hatutegemei madhara yoyote kwa mhojiwa kwa kipindi chote cha utafiti au hata baada ya utafiti huu.

Haki ya kujitoa na mambo mbadala

Unao uhuru wa kushiriki katika utafiti huu au kutokushiriki pasipo kutoa sababu yoyote juu ya hatua utakayokuwa umechukua.Ukishakubali kushiriki katika utafiti huu na ukaona kwamba huwezi kuendelea unao uhuru wa kusitisha ushiriki wako muda wowote wa utafiti.

Mawasiliano

Kama utakuwa na swali lolote kuhusu utafiti huu unaweza kuwasiliana na kiongozi wa utafiti huu ambaye ni Gift Mbise. Simu- 0717986808 au barua pepe- giftgodson@gmail.com. Kama utakuwa na swali juu ya haki yako kama mshiriki unaweza kuwasiliana na, Mwenyekiti wa kamati ya utafiti na machapisho ya chuo cha afya Muhimbili kwa anuani S.L.P 65001 Dar es Salaam. Simu ya mezani: 2150302-6, pamoja na Dr. S.H. Mamuya(0787721377).

Kama umekubali kuhojiwa, tafadhali saini hapa:

Mimi ……., nimesoma na kuelewa kilichoelezwa kwenye fomu hii na maswali yangu yamejibiwa kiufasaha. Hivyo ninakubali kuhojiwa kwa ajili ya utafiti huu.

Sahihi ya mhojiwa …… Tarehe ……..

Sahihi ya mhoji …… Tarehe……