

**OCCUPATIONAL HEALTH AND SAFETY PROBLEMS OF
WELDING WORK AMONG SMALL SCALE WELDERS IN
DAR ES SALAAM, TANZANIA**

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**Occupational Health and Safety Problems of Welding Work among Small Scale
Welders in Dar Es Salaam, Tanzania**

By

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**A Dissertation Submitted in Partial Fulfilment of the Requirements for the
Degree of Master of Public Health of the
Muhimbili University of Health and Allied Sciences
October 2020**

CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled: “*Occupational Health and Safety Problems of Welding Work among Small Scale Welders in Dar Es Salaam, Tanzania*” in Partial Fulfilment of the Requirements for the Degree of Master of Public Health of the Muhimbili University of Health and Allied Sciences.

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DEDICATION

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LIST OF ABBREVIATIONS

CAG	Controller and Auditor General
ILO	International Labour Organization
IRB	Institutional Review Board
KIs	Key Informants
LBP	Low Back Pain
ME	Micro Enterprises
MUHAS	Muhimbili University of Health and Allied Sciences
OHS	Occupational Health and Safety
OSHA	Occupational Health and Safety Authority
PPE	Personal Protective Equipment
SME	Small and Medium Scale Enterprises
SSI	Small Scale Industries
WAHSA	Work and Health of South Africa
WHO	World Health Organisation

DEFINITIONS OF KEY TERMS

Occupational Health and Safety: Is the discipline, which deals with health and safety of the people due to their jobs.

Occupational health hazard: Is anything that may cause danger to health of a person as result of his job and cause diseases.

Occupational safety hazard: Is anything that may cause danger to the safety of a person at his workplace and result into accident or injury.

Occupational death: Is loss of life because of an exposure to a certain risk factors arising from work activity of a particular person.

Occupational injury: Is a personal injury contracted because of an exposure to a certain risk factors arising from work activity of a particular person.

Occupational disease or illness: Is a disease or ill condition contracted because of an exposure to a certain risk factors arising from work activity of a particular person.

Welder: Is a person who performs the welding activities (use gas, electricity and electrodes to join metals plates or iron and form other products).

Welding: Is an art, which involves joining metal plates or iron by using different methods that produces heat at the joints and result into fusion to produce final products or repair damaged parts.

Small scale Industry: Is defined as workplace, which is unregistered/unlicensed and employs less than ten (10) people, and not covered, by formal stringent regulatory procedures such as registrations, regular inspection or audits by the government authorities of the country.

Small and Medium Scale Enterprises: These are enterprises which are small and consist of between 5 and 10 people with higher capital of up to 20 million (TRA).

Micro Enterprises: The type of enterprise with less than five people and capital of less than five million Tanzania shillings with less technological equipment.

Personal Protective Equipment: An equipment, materials or cloth that a person wears or uses as a barrier between himself or herself and the hazardous agent.

Informal sector employee: Is defined as a person working in unregistered/unlicensed enterprise employing less than 10 people and not covered by formal stringent procedures of the country.

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ABSTRACT

Background: Work related deaths, injuries, illnesses and accidents among small-scale welders have been increasingly reported in developing countries Tanzania included. Inadequate knowledge on health-associated hazards, problems and PPE has been associated with increased rate of fatalities following low use of PPEs and enforcement by the responsible authorities. Therefore, many people suffer from their job though there are few studies in Tanzania on the health and safety problems experienced by small-scale welders and so limited information is available.

Aim: To determine occupational health and safety problems of welding work among small-scale welders of Dar Es Salaam, Tanzania.

Materials and methods: This was a community based cross sectional study, conducted in June 2020 at Toangoma ward in Temeke Municipality. The study involved 227 small-scale welders who were purposively selected from their workshops. The semi-structured pre-tested questionnaire was used to collect demographic information of the study subjects, form of training they attended, literacy level, awareness on welding health and safety hazards, health problems, and the use of personal protective equipment (PPE). Previous history of health problems for each welder and, use of PPE during welding and factors for use of PPE were also collected. The data were analysed by using Statistical Package for Social Sciences (SPSS) version 25.0.

Results: The study revealed that lower back pain is the most commonly reported health problem (95%) followed by skin burns (93%) and body cuts (89%), among small-scale welders. Moreover, difficult breathing (82%) and eyes irritation (87%) are also among the prevalent health problems. The use of PPE was reported high for eye protective gears followed by dust mask and overcoat. However, the use of recommended PPEs is a big challenge. Majority of the welders (69%) are aware of at least one health and safety hazard, health problem (77%) and PPE (91%).

Conclusion and recommendation: This study revealed that working environment for the small scale welders in Dar Es Salaam is very poor and pose high health risk to welders themselves and even the community surrounding the workshops as they are both exposed to the hazards continuously.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Metal welding is a process of joining two metal parts permanently by applying intense heat or pressure or both at the base of the joints or ends of items to be joined. This heat may come from an electric arc, flame, friction or pressure. However, the common source of heat is electric arc which causes melting of the metal ends and mix thoroughly by fusion when they cool down.(1) In addition, welding is just a component of metal fabrication process, which involves the designing of various metal structures, cutting, bending, and joining metal parts. Grinding, polishing and final coating or painting of the produced metallic products is the important aspects of this process.

Generally, welding industry is one of the big industry in the world with wide range of applications such as in aerospace manufacturing, marine equipment such as boats and ship, land transportation industry such as rails, trains trucks, buses, petrochemical industry, mining and civil engineering structures.(2) In addition, manufacturing of domestic and hospital furniture's such as hospital beds, dinning and studying tables, chairs, doors, windows, roofs, entry gates and many more including repair and fixing of the broken metal parts of the motors like vehicles.(3) So far there are two commonly methods used in metal welding especially in small-scale industries. (2) The type is particularly dependent on the source of heat or fuel used to produce heat and melt the joined ends of the objects such as using gas as a fuel or electricity driven metal welding.(4).

However, all the two methods have serious health effects to the welders and to the people in the surrounding community as the process produces nearly similar products. Such products include metal fumes and gases, which can be inhaled. Highly intense UV light and flying fine metal chips, which can cause eye, damage either immediately or with time as a chronic health effect. Also extreme noise during grinding ,extreme heat as well as uncomfortable postures have been experienced just to mention few.(5)

Work-related diseases are the main cause of death at work in all world regions and most of these work-related deaths and nonfatal occupational accidents occur in low- and middle-income countries.((6)). Reports show that developing countries experience a high burden of occupational related accidents and deaths as compared to developed countries. (6).

This is because of differences in the initiatives and strategies for OHS, which are put in place between the developed and the developing countries.

Due to the limitations of national data collection systems in many countries, there are no consistent global figures on work-related injuries and diseases.(6).

Also where such data is available, they are gathered from different sources such as social security and insurance institutions, labour inspectorates, occupational health services or other authorities and bodies all of which their main focus is people employed in a formal sector. Therefore, majority of developing countries lack the standard system of monitoring work related accidents and health effects especially in self-employed people who fall out of the formal system. In fact, many developing countries do not even possess social security systems and where such systems do exist, they do not cover the informal sector, which together with small and medium-sized enterprises (SMEs) provides the majority of employment .(6). In addition, ill health reporting and recording is often poor for SMEs. Therefore, the existing and provided figures by the authorities is always underestimate the real situation and so less resources may be allocated to support the initiatives and strategies for occupational health and safety of the people. As a result, negatively affect workers' safety and welfare, productivity and even financial and economic loss due to cost of healthcare and decreased workforce due to injuries, illnesses and deaths.(6)

In Tanzania, there is no mechanism of identifying and tracking the welding workshops in most African countries including Tanzania and their operations are not regulated at all. As a result, there is no clear data and information for the country on welding related health and safety incidents, even though welding works have become popular particularly in Tanzania. People's interests and influences on metal products have increased in the past decade over the wooden domestic furniture's and construction materials. This includes domestic furniture such as windows, doors, beds, entry gates, and motor spare parts and repair.

According to report by National bureau of Statistics (NBS), Dar es Salaam population is approximately 5.1 million, which is almost 9.8% of the entire country population with majority employed in informal sector.(6)

The informal sector in this context includes, small business people, farmers, SMEs, and MES such as food vendors, welders, barbershops, carpenters, shoemakers and repair, second hand clothes sellers, wood workers, aluminium profile makers, painters, motor repairs and many other more.(7)

Reports indicate that, SMEs are responsible for over 50 per cent of the new jobs created globally. Moreover, in most developing and emerging countries, they also employ more people than large enterprises do.(6) However most of them especially those in developing countries like Tanzania, are less utilised because working conditions are less safe and posing greater risks to the health of workers than larger enterprises due to poor system of OHS management.(6)

Recent publications indicate that, welding in Tanzania is a third small scale industry (12.6%) behind food vending industry (26.4%) and carpentry (13.8%).(7) However, because welders are left out of the formal system, their health and safety issues are given less attention though are life threatening and therefore there is the need for local context studies to be regularly conducted to inform the authorities so that appropriate strategies can be formulated and implemented. Following low uptake of graduate's school leavers in the formal employment sector, then welding as one of informal sector employs majority of young people despite the poor working condition and infrastructure for health and safety protection.

It is like for many other developing countries, Tanzania has limited information on the health and safety problems of welding works and when such information is available, it is underestimated because the governance authorities are much focused on formal sectors. Due to this, the real picture on the magnitude of the problem and its effects is not well understood by majority and so the public is less informed and takes the matter of less priority and allocate few resources for OHS, which forms a continuous vicious circle as indicated in the figure 1 below. (6) Understanding the real situation on the magnitude of the OHS is very crucial in bringing public awareness and enable setting up appropriate interventions to improve health and safety condition of the people at their workplaces. Therefore, this study is conducted to help determine the magnitude of the problem, and the associated factors so that public may be informed and take action.

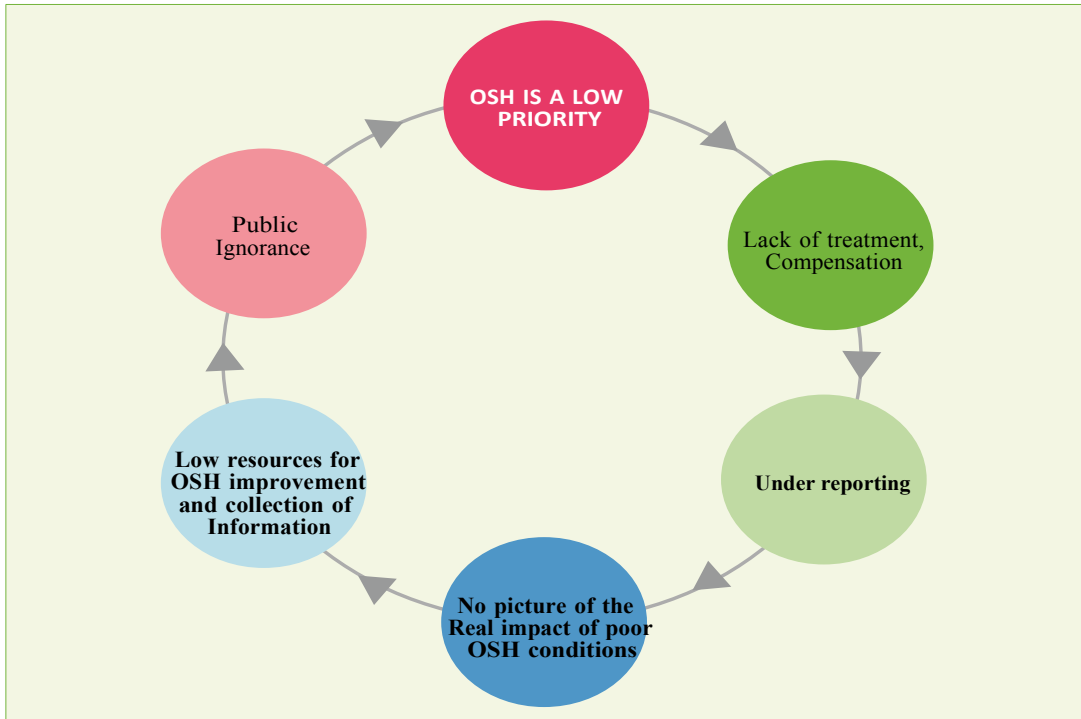


Figure 1: OHS Vicious circle (International Labour Office, 2013b)

1.2 Problem statement

It is estimated that more than 2.3 million occupational accidents and work related diseases fatalities are reported globally annually. Out of which over 2 million are due to work related diseases and more than 320,000 are due to occupational accidents.(8) Moreover, approximately 264 million cases of non-fatal occupational accidents and work related illnesses are reported each year that imposes up to 3 days absenteeism from work.

About 900,000 workers die from exposure to hazardous substances each year.(8) Approximately 860,000 occupational accidents and illnesses occur every day, which cause government to incur USD 2.8 million as overall cost of illness worldwide either directly or indirectly because of occupational problems.(6)

Employees in informal sector particularly those self-employed are vulnerable to these problems because their practices and operations are either not regulated or poorly regulated. This is contributed by lack of rules and guidelines for informal workers, most of the existing laws have put more concentration on workers in the formal sector.(9) In developing countries including Tanzania, the risk of getting work related accidents or occupational diseases ranges from 10 to 20 higher than in developed countries.(10)

According to the study conducted by Meena et al., the prevalence of respiratory tract condition among welders due to metal fumes is 88%. However, the study did not go further for other welding related health problems and the associated factors. Tanzania is like for any other developing countries there is a big information gap on welding occupational hazards, level of awareness and use of safety measures including personal protective gears as well as prevalence of welding related health problems among welders.(10)

Studies show that in Tanzania every year, more than 1million young people get into the employment market from schools, colleges and universities and the employment uptake by public sector is very low compared to demand.(6) Improving health and safety environment for welding work could attract more young people into the sector. Therefore, information on magnitude of health problems of welding work is crucial in understanding the extent and magnitude of the problem and may help a lot in designing group specific interventions and strategies, which aims at promoting and improving good working environment as well as good health and safety practices in this important working group. That why this study was conducted.

1.3 Conceptual Framework

This conceptual framework explains the relationship between various factors that influence the use of personal protective gears in welding works, which ultimately results into reduced occurrence of work related health effects.(11) Level of understanding on occupational hazards, form of training one attended and work experience are the main independent factors, which jointly influence the use of PPE. Therefore, the use of PPE ultimately determines prevalence of the occupational injuries as a dependent factor. The increased occurrence of occupational accidents in most of the work areas is due to poor adherence to good health and safety practices among welders.(10)

In addition, poor use of personal protective gears is contributed by low level of understanding on health and safe welding measures, work experience of a person and prolonged working hours, which finally lead to increased prevalence of work-related accidents, injuries and diseases and inadequate law enforcement by regulatory entities.

The information on people's awareness on health and safety hazards, personal protective gears and magnitude of health and safety problems or accidents and injuries of the welding work is needed so that appropriate interventions can be set and implemented. Figure 2 below indicates a schematic presentation of the concepts in relation to the study main outcome (Conceptual framework) which shows the link between the input variables and the output variables.

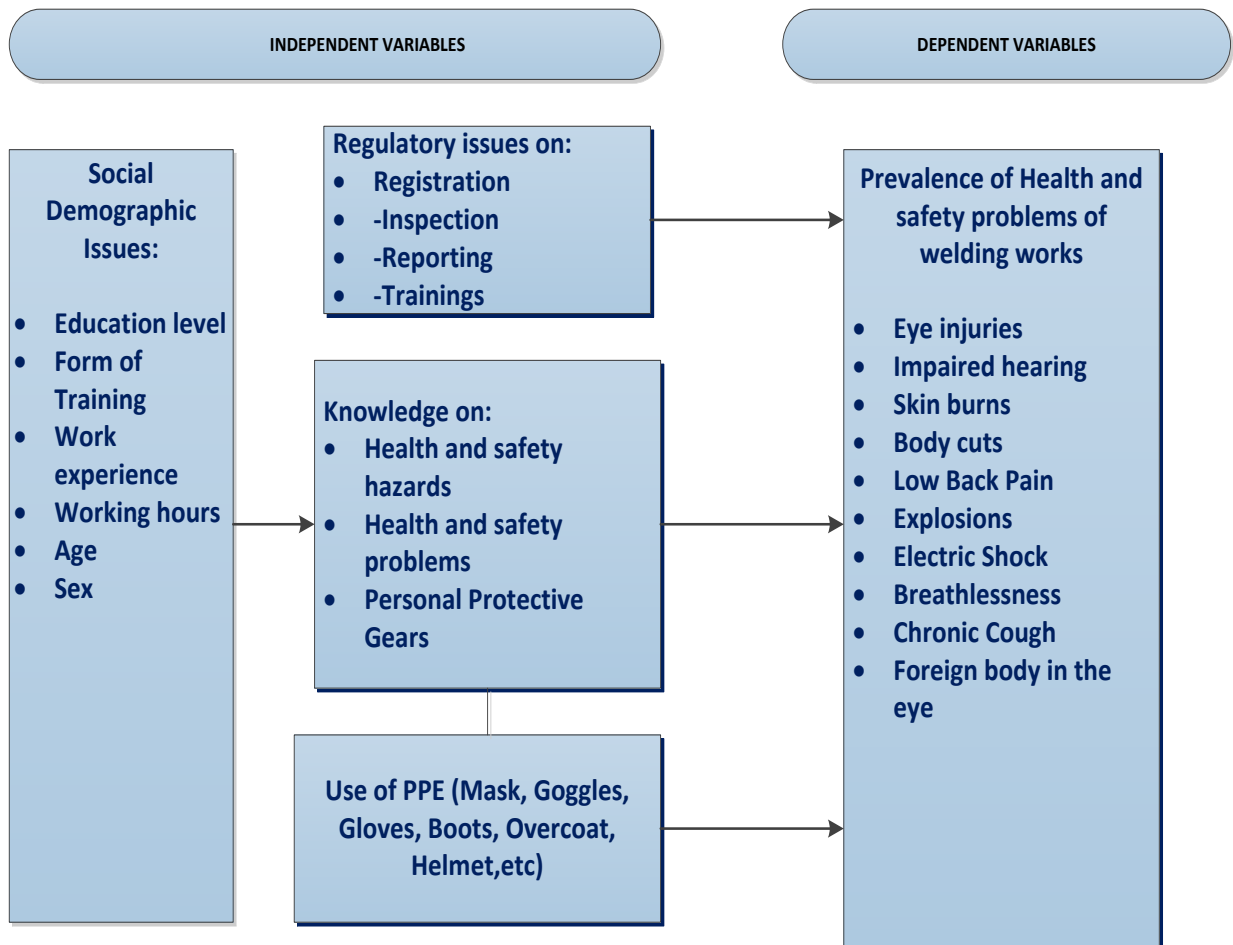


Figure 2: Conceptual framework for understanding factors associated with welding health problems

1.4 Rationale of the study

It is well understood that in many developing and low-income countries like Tanzania, occupational health and safety services is limited to formal sector workers.(9) This results into limited information on the occupational accidents, illness, injuries and even deaths related to occupations from informal sector. Thus making difficult for group specific interventions, policies and plans to be set which will help to improve occupational health services and work environment to the small-scale welding workers. This study has closed the information gap between the authorities, stakeholders and government in general on welding occupational hazards, level of awareness and adherence to health and safety measures, as well as prevalence of occupational health problems among these small scale-welding workers in the country. The information generated from this study will definitely enable the government to have an understanding on the magnitude of the problem in the country and will use it to plan and design specific interventions and strategies for improving occupational health system for small-scale welding workers in the country.

1.5 Research Questions

1.5.1 General Research Question

What is the prevalence of welding related health problems among small-scale welders in Dar es Salaam, Tanzania?

1.5.2 Specific Research Questions

1. What is the level of knowledge on welding health and safety hazards, health and safety problems and the personal protective gears among small-scale welders on Dar es Salaam?
2. What is proportional of small-scale welders of Dar es Salaam who use at least one PPE and clothing, during their works?
3. What is the prevalence of welding related health problems (respiratory tract conditions, eye problems, low back pain, body cuts and burns) among small-scale welders of Dar es Salaam?
4. What are the factors associated with use of personal protective gears among small-scale welders of Dar es Salaam?

1.6 Study Objectives

1.6.1 Broad Objective

This study aims to determine the prevalence of welding related health problems among small-scale welders of Dar es Salaam, Tanzania.

1.6.2 Specific Objectives

1. To assess knowledge level of small-scale welders of Dar es Salaam on occupational health and safety hazards, health and safety problems and the personal protective gears for welding works.
2. To determine proportion of small-scale welders of Dar es Salaam who use at least one PPE and clothing during their works
3. To determine prevalence of welding related health problems (respiratory tract conditions, eye problems, low back pain, body cuts and skin burns) among small-scale welders of Dar es Salaam, Tanzania
4. To determine factors associated with the use of personal protective gears among small-scale welders of Dar es Salaam.

CHAPTER TWO

2.0 Literature Review

2.1 Knowledge on welding health and safety hazards, health and safety problems and PPEs

Welding process releases many products to the environment, which may cause acute and chronic health effects to the welders and those living around the compounds. These products include metal fumes like aluminium, cadmium, chromium, copper, fluorides, iron, lead, manganese, magnesium, molybdenum, nickel, silica and titanium and zinc. Gases such as carbon dioxide, carbon monoxide, nitrogen oxide and nitrogen dioxide from the welding smoke are also released which are inhaled through nose or mouth if protective equipment are not used during welding.(12)

Intensive light from the applied welding arc, which may be in form of visible light or non-visible like ultraviolet rays (UVR) and infrared radiations are commonly known health hazards from welding works. In addition, excessive heat from welding reaction; flying metal chips, fires and explosions from the compressed gas used during the process, vibrations and uncomfortable posture are some of the health hazards, which are associated with welding professional and electric shock, which may result to instant death of a person.(13) Continuous exposure to these hazards, may results to acute and chronic health problems and accidents to the people who are directly involved in the welding works and even those surrounding the workshop.(3)

The common health problems experienced by welders range from acute conditions such as eye damages, chest pains, difficult breathing and chronic cough, body cuts and injuries of the toes and fingers, skin burns, electric shocks, conjunctivitis, temporarily hearing loss, partial loss of eye sight/visual ability, muscle pain including low back pain. It may also lead to chronic health problems such as permanent loss of hearing, permanent loss of visual ability, lung cancer, loss of body parts or death, and permanent disability.(3, 14) Majority of the workers especially in informal sector have a good understanding on occupational hazards to their health on the jobs they do. Those hazards include those, which are clearly visible and detectable like noises, heat, light, vibrations, sharps and flying metal particles. However, they take less seriously action in ensuring appropriate

protective measures are used to minimise the risk of contracting work-related accidents, injuries, disease or other health problems.(15)

Table 1 below highlights the commonly, health and safety hazards in welding works, their potential sources, health effects in short term and long term as well as a the recommended personal protective equipment.(14)

Table 1: Welding Hazards, their source, health effects and related personal protective equipment (PPE)

Welding hazards	Source of hazard	Acute health effects	Chronic health effects	Recommended Welding PPE
Fumes and gases	Welding smoke	Metal fume fever		
	(Composition dependent on: base metal welded; filler rod materials; coating, paint or grease on surface of work piece; and shielding gases involved). Grinding activities Environmental dust	Irritation of the eyes, nose, chest and respiratory tract. - Transient effect on lung function	Bronchitis, asthma, pneumonia, decreased lung capacity and pneumoconiosis/fibrosis. Associated with lung cancer, skin sensitization	-Respirators -Face masks -Safety goggles

Intense light(UV light)	-Welding arc	Conjunctivitis: welders' eye or arc flash. Skin burns (i.e. sunburn effect)	Loss of eye sight Conjunctival degenerative disorders, Associated with skin cancer	Welding helmet, Hand shield, Welding goggles, safety clothing for skin protection
Excessive Noise	-Welding process including allied activities i.e. hammering, grinding and drilling.	Temporal hearing loss Stress, annoyance, irritability - Associated with hypertension	-Permanent hearing loss -Associated with increased risk of cardiovascular diseases	-Ear muffs
				-Ear plugs
Electrocution/ electric shock	-Welding machine	- Burns	-Long term sequelae of electrical injuries including:	-Insulated gloves -Rubber soled safety shoes
	-Other electric powered tools i.e.		Neurologic, psychological and ocular effects	
	Grinder and drilling machine.			

Excessive Heat	Welding process Direct sunlight especially for outdoor workshops	Burns on exposed skin. Eye injuries due to hot and flying sparks, slag or metal chips. Burns in the ear due to hot slag or sparks. etc.	-Long term sequelae like scaring and reduced vision as a result of prolonged exposure.	-Fire resistant clothing and aprons, Ear plugs/muffs, face shield or goggles
Fires and explosions	-Heat, flames and sparks resulting in combustion of flammable materials (i.e. gas, solvents, paper, and wood, plastic). - High pressure gas cylinders (i.e. in gas welding).	Burns, Physical injuries due to blows from cylinders.	Long term effects as a result of exposure to explosion gases and fumes, physical injury and/or psychological trauma.	Fire resistant clothing and aprons, Insulated gloves, Rubber soled safety shoes

- Machinery, Vibrations, Compressed Air, Ergonomic	All machinery with fast moving parts e.g. grinders, drillers and cutters. Poor working posture, heavy lifting, and poor housekeeping, and leakages in compressed air or open electric cables	Cuts, lacerations, stab by sharp edges. Injections of flying particles into the eyes or skin, musculoskeletal complaints such as back pain, muscle fatigue and injuries, and explosions	-Hand arm vibration syndrome (HAVs), back pain, injuries or death and electric shock	Fire resistant clothing and aprons, Insulated gloves, Rubber soled safety shoes,
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In Nepal, the awareness level on welding health hazards is very high where majority of the welders (90.7%) are aware of at least one health hazard associated with welding works.(16) In Zambia, there are evidences that only 50% of the welders are aware of at least three hazards, which are light, fume and smoke and the sharp pieces of metal, or particles while around one third are not aware about any hazard.(14) In addition, majority of the welders (98%) are aware of at least one welding health hazard (98%) and only few (2%) do not know anything about welding hazards.(17) These figures imply that, a lot has to be done to ensure people are aware of the hazards associated to their job, health problems and the appropriate PPE so that they can take the appropriate actions.

A study conducted in Lideta, Ethiopia indicates that there is a high level of awareness on welding hazards. Majority of the welders (86.5%) are aware of the occupational hazards associated with welding.(18) A similar study conducted in Nigeria demonstrates a high level of awareness (90.6%). These findings show that people are aware of welding health hazards though the use of protection devices has been challenging in most of the

developing countries.(19) Despite all the evidences on level of awareness on occupational health hazards, it is very unfortunate that, this does not reflect to the level of PPE utilization.

In Uganda, majority of the welders (83%) understand that their job is hazardous to their health and may lead to serious health problems if protective measures are not in place. They are aware of different types of hazards associated with welding works.(20) Unfortunately, with all these published information, there is no published information in Tanzania and therefore level of awareness to welding health hazards is so far unknown. This study therefore intends to find out that piece of information.

The use of personal protective gears proves to reduce the exposure to health hazards by up to 30%. However, adequate understanding on the requirement of PPE and clothing and their uses has been very key in ensuring people utilise them effectively during their works. Several studies indicate that, in some setup, people are much aware just for some of the PPE and are not familiar about other types and therefore, this may affect PPE utilization level. For example, a study conducted in Zambia indicates that majority of welders (87%) are aware of safety boots but very few (10%) are aware of the ear protection PPEs such as ear muffs and plugs.(14) With this observation, it is obvious to find majority of the small-scale welders using safety boots but no one use earmuffs or plugs to protect their ears from excessive noises because they do not know about it.

Small scale welders have been found to be more competent in performing their basic welding jobs but lack knowledge on health hazards relating to their works and the PPE which they need to use in order to protect them from exposure to hazards.(21) Some PPE are commonly used than the other such as goggles, mask and boots because majority of the welders know them well but some other protective gears are not used for example respirator mask.

Since this has not been explored in our context, it is therefore expected that results from this study will reveal the real situation on the ground with regarding level of understanding of the small-scale welders on various health and safety hazards related to their job and the likely health effects they may encounter as welders.

2.2 Utilization of PPE and Clothing among welders and the associated factors

According to Occupational Health and Safety best practices, use of personal protective equipment (PPE) is the last option in controlling health hazards among workers. The best option is eliminating the source of hazard, followed by separation of the hazard from workers by designing. Furthermore, substitution of the hazardous component from the work and replace with safe component; and administratively control measure through minimising exposure frequency and duration among involved personnel such as duty shift and minimal working hours.(22)

Lastly, when not all options are possible then PPE and clothing are encouraged to provide a barrier between the hazard and the person doing the work and reduce the chance of exposure.(23) In other words, it comes between the hazard and welder so that a person is not directly exposed to the hazard and thus minimise the effects or reduce likelihood of health problems or safety issues to happen or may happen with little impacts.

PPEs and clothing are always specific to body site and special for each type of hazard, which is to be controlled. Therefore, to be safe, one has to use more than one PPE or clothes if he works in a highly hazardous job such as welding to protect every body part.(14) Due to these, welders are required to wear goggles, safety shield or welding helmet to protect their eyes and face from direct exposure to intensive UV light and radiations generated during welding process.(24) Additionally, facemask or respirators must be used to prevent inhalation of metal fumes, gases and dust particles that may enter the respiratory tract and cause health problems shortly or in long run of the welder.(24) Earmuffs or plugs should also be used to cover the ears to control the excessive noise from welding or cutting process that may damage the ear and lead to temporary or permanent hearing loss.(21)

Moreover, safety boots, insulated hand gloves and overcoat or leather apron have to be dressed throughout the work to prevent the body from mechanical injuries such as falling objects, cuts and burns due to excessive heat or fire and explosions from the gas during welding.(17, 25)

Adherence to proactive health and safety measures such as using right PPE all the time among workers is believed to lower the risk of contracting work-related health problems by up to 30%.⁽⁸⁾ Therefore, there is a greater need to put more emphasis on the effective use of PPE as well as working according to the recommended safe environment and healthy measures.

Some studies from India, show that a large percentage of welders (89%) use personal protective gears during welding though not throughout and in full set.⁽²⁶⁾ In fact, there is a problem on utilization of PPE whereas some welders use at least one PPE; some do not use PPE. For examples in Nepal where, more than 95% of the welders use at least one PPE, but that does not mean one is safe from exposure to hazards.⁽¹⁶⁾ However, in some countries such as India the level of utilization is very low (37%) despite high level of understanding (95%) on occupational health hazards and on the importance of using PPE. ⁽²⁷⁾ Therefore, since there is no existing information on PPE utilization among Tanzania small-scale welders, this study intends to bridge that gap. Figure 3 below illustrates the recommended personal protective equipment for welding works.

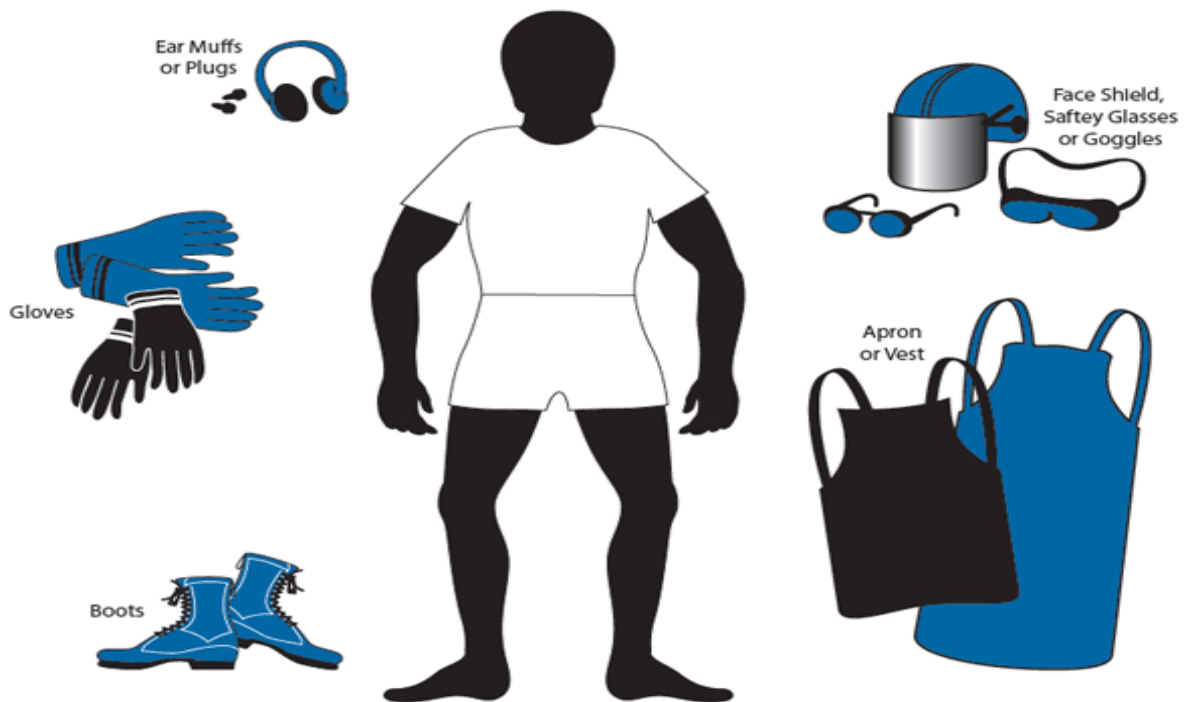


Figure 3: Personal Protective Equipments used in welding works
(<https://steelhub.wordpress.com>)

2.3 Prevalence of occupational health and safety problems among small-scale welders

Occupational accidents and work related diseases cause about 2.3 million fatalities annually in which over 2 million are due to work related diseases and more than 320,000 are due to occupational accidents. Approximately 264 million cases of non-fatal occupational accidents and work related illnesses lead to up to 3 days absence from work while around 900,000 workers die from exposure to hazardous substance each year.(6)

Non formal sector particularly small and medium enterprises (SMEs) and self-employed people have become more victim of the problems due to the fact that their measures are either not regulated at all or poorly regulated as most of the existing laws have put more concentration on workers from formal sector.(28) WHO reports reveal that there are about 250 million cases of work related injuries worldwide per year and welding is one of the jobs contributing to this number especially in developing countries like Tanzania. Furthermore, it is estimated that about 18,000 workers die every year from work related accidents in southern Africa region while more than 13 million workers are injured in accidents and 67,000 people contract work related diseases in each year.(29)

The prevalence of occupational accidents, injuries and diseases in welding works is higher especially in developing countries like Tanzania as compared to developed countries where there are very strong regulatory systems and very good health and safety implementation plans and strategies.(28) However, the magnitude of the problem by specific body system or body part and respective hazard type is alarming, because some body parts are much involved in almost every part of the process and thus gets higher frequency of exposure to hazards for example eyes, hands, and the skin.(29)

Recently, studies have confirmed that eye is the third body part frequently exposed and affected behind the arms and limbs in welding works followed by lower back due to heavy lifting and unconducive postures.(29) Flying metal chips and the emitted radiations are the main causes of the ocular injuries reported in different countries. For example in Nigeria, about 68% of the ocular injuries are due to metal chips.(4) The problems are increasing due to continuous exposure to intensive light and flying metal chips or particles that cause immediate or long-term damage to the eyes especially when proper eye protection devices are not used.(1)

Further studies demonstrate that burns account for 46% of the occupational injuries in welding.(29) In Tanzania, the prevalence of acute respiratory health condition due to metal fumes from welding works is estimated to be 88.2%.(12) This rate is higher than other forms of welding health problems reported in the region in which burns for example is estimated to have 46% rate. Recently published study from Ethiopia indicates the decreased prevalence of eye defects, body cuts, skin burns and respiratory conditions among people working in large metal industries of 49.9% as compared to those in small-scale industries.(30).

Studies from Canada report prevalence of injuries of 36.5%, which is slightly lower, compared to other countries such as India.(1, 30) These studies indicate that there is big difference in findings with regard to prevalence of health problems basing on the country such as developed or developing and middle-income country especially basing on the interventions and plans on health and safety within respective countries. In addition, the type and size of the industry has an impact on the rate of accidents and injuries reported among its workers. For example, small-scale industries have higher prevalence of reported work related accidents and injuries as compared to large or medium industries.(1) This is because; small and medium industries are less regulated or not regulated at all.(6, 9) In addition, the authorities register and regulate large and medium workshops while small-scale industries are mostly self-regulated and not registered or licensed by responsible authorities.

In Tanzania, the prevalence of respiratory tract condition because of exposure to metal fumes is reported to be 88.2% from the study conducted by Meena et al. However, the magnitude for other health problems is not known so far.(12). Therefore, this study determines the prevalence of all selected health problems among the small-scale welders because of exposure to different hazards so that appropriate interventions can be developed and implemented.

2.4 Factors associated with use of personal protective gears among small-scale welders

2.4.1 Regulatory factors associated with use of PPE among small-scale welders

The rate of use of PPEs in Africa is reported to be very low as compared to developed countries, for example in Namibia only 10% of industries were found to use PPE and majority do not use as required by the Occupational Health and safety legislations.(31) Poor regulation of non-formal sector, unsafe work environment and condition; and low awareness on health hazards and inadequate training on OHS, among the work group has been greatly linked to increased health and safety problems in the informal sector.(6, 10) In particular, the welding work is associated with a number of health and safety hazards, such as metal fumes and gases, intense light, extreme noises, uncomfortable postures, sharp objects, flying metal chips, fires and explosions, electric shock, vibrations, extreme heat, dust and many others all of which a welder is exposed to on routine basis.(3) Tanzania laws and policies on occupational health and safety, including its health services in general such as workers compensation schemes and health insurance schemes provide high protection and much consideration to the people working in formal sector than in non-formal sector. This implies that, those working in small-scale welding workshops and many others are left out of the existing frameworks like farmers and many others who are excluded in several aspects.(9)

Studies show that, occupational health and safety services is accessed by less than 5% of the working population with the main focus to those employed in government entities and those employed in formal private sectors while greatly excluding non-formal and self-employed people.(9) The Ministry of Works, Youth, Employment and People with disability through Occupational Safety and Health Authority (OSHA) is responsible to oversee occupational health and safety issues in the country. OSH Act of 2003 and the National Occupational Health and Safety Policy of 2008 and later workers' compensation Act of 2008 give power to this entity to oversee health and safety issues in the country. It ensures all employers and workplace owners comply with the stipulated requirements of the OHS Act and the National Health and Safety Policy but very unfortunate, informal sector and the self-employed people are left out.(3, 9)

These Policy and Acts provide a clear road map through which the occupational health and safety of the people working in various sectors in the country will be controlled and monitored. These documents also give workplace owners and employers the responsibility of ensuring that Occupational Health and Safety legislations and standards are observed and complied to.(32)

Among the critical issues addressed by the OHS Act includes inspection of all workplaces before operations start, and subsequent registration of those workplaces by OSHA and get Health and Safety Compliance Certificate.

Additionally, Section (51) of the act provide a requirement for all accidents and incidents occurring at workplace to be documented, investigated and reported to the authority within 24 hours of the incident by the employer.

It further clarifies that there should be first aid services, provision of utility services, provision of protective equipment to people exposed to hazardous works as well as continuous health and safety trainings. Regular health check for employees and effective system of monitoring and evaluating Health and Safety measures including good housekeeping in work places, among all employers across country in general are among the key issues emphasized by the law.

Further to that, there is Workers Compensation Act (2008) which provides a framework for handling settlement and payment of benefits as compensation for the death or injury contracted by employee during delivering his or her duties. The Act enabled the establishment of the fund, The Workers Compensations Fund (WCF), which collects funds through contribution from employers and employees to cover compensation when employees contract death, diseases, illness, sustained injuries or accident during their work productivity, and affect economic sustainability of many countries.

The problem is big in informal sector especially in SMEs like those self-employed in street welding workshops, carpentry, vehicle repairs, mechanics, and many others.(9, 22) OSHA focuses much on large-scale enterprises and public entities. The existing system of OHS surveillance reaches mostly public and big private institutions and leave non-formal sector lying on the disadvantaged side.(9) According to the Controller and Auditor General

(CAG) report of OSHA performance for 2013, there is inadequate coverage of health and safety services in the country due to inadequate human resources and infrastructures.(33)

In Tanzania, the records on the magnitude of work-related accidents and injuries are not available especially for self-employed people working at small-scale level like welding workshops.(33)

The situation is much contributed by lack of well-coordinated national system of licensing and recognizing non-formal sector workers, and the way of reporting and monitor accidents in among the non-formal sector workers and workplaces across the country.(12, 33)

Considering the expansion of the welding small-scale industries in the country and the hazardous nature of the profession, this group was expected to receive a wide coverage of OHS service but it has been opposite. Welding workers especially self-employed have been continuously exposed to severe health hazards with the associated severe health effects of which some are temporary and some are lifetime and still the system leave them aside.(12, 34). Despite these serious health effects, the group and other non-formal sector workers are not covered by the OSHA services as required by the existing legal frameworks.(9)

It is very unfortunate that the entire laws target employed people in government system or private companies and have excluded the large group self-employed people such as the small-scale welders, farmers, mechanics and carpenters. These workplaces are neither inspected for compliance to minimum safety requirements nor registered for certification. The accidents, illnesses, diseases and injuries occurring to this group of people are not reported, investigated and compensated in any way.(9) In other words, these laws protects much people who work in formal sector than those working in non-formal sector such as small scale metal fabricators, farmers, and many other who are involved in motor repair, carpentry and building.

OSHA has managed to register only 6599 workplaces out of 27, 500 workplaces, which is only 24% and per urban and remote areas being the main victim of unregistered workplaces.(33) This implies poor coverage of occupational health and safety services

across the country in which the coverage and access to occupational health services is less than 20% with small-scale informal sector and self-employed category being highly neglected in the services.(9)

2.4.2 Individual factors associated with use of PPE among small-scale welders

Some scholars considers individual factors such as attitude towards PPE use, knowledge on health hazards and PPE, willingness to use PPE and influence from other people are among the key factors, which may influence use of PPE.(31) Therefore lack of adequate knowledge on welding health and safety, PPE and hazards relating to welding and how to use PPEs ,have been highly linked to poor utilization of the recommended PPE and hence increased rates of occupational accidents and injuries.(15, 35) However, this is contrary to the study conducted in Nepal, which confirmed that being aware on the hazards is not associated with PPE utilization.(16) Furthermore, it was revealed in Uganda that higher level of awareness on occupational hazards and PPE does not guarantee effective use of PPE among small-scale welders.(20)

That means people may be aware of the potential hazards and all precaution measures but still may not use the recommended PPEs during work.

Several individual factors have been associated with the peoples decision to use an appropriate PPE and so increase the rate of work-related accidents and injuries among small-scale welders globally and in the region.(36, 37) Such factors include substance abuse like alcohol or marijuana, which may impair decision and make a welder less attentive and less serious hence fail to adhere to appropriate use of personal protective gears.(26, 38) Poor attitude towards PPE use, low knowledge on PPEs and hazards and willingness to use PPE as well as influence from other friends or colleagues at work.

Studies reveal that effective adherence to OHS measures depends on workers understanding on health and safety hazards related to their job and how they can be eliminated from work place or controlled from happening and reduce workers exposure to the associated hazards by using PPE.(15, 16, 35)

2.4.3 Economic and financial factors associated with use of PPEs among welders

In addition, failure to use PPE due to individual factors like low understanding on the importance of the PPE with regard to protective power, low accessibility and unavailability of the PPE due to economic constraints, have also been associated.(39)

Sometimes people have been working continuously without resting and therefore become very tired to the extent that, they fail to observe some health and safety rules in their workplaces and thus contribute to injuries. In Ghana it was observed that, among other factors, are failure to observe the set safe working procedures, unsafe behaviours and practices of the welders, not using the right and appropriate PPE and sometimes due to using defective or unmaintained equipment which may result into electric shock or explosion and fire.(17)

Most of these occupational accidents and deaths are preventable but low level of adherence to preventive health and safety practice is the main obstacle. As a result, people die from work related problems, suffer from permanent disability, get sustained injuries and chronic disease conditions, and thus decrease work productivity.

For the enterprises and formal government institutions, PPEs are purchased by the employer and distributed to staff, but it is different for self-employed and small-scale workers such as welders who have to purchase at their own. Studies reveal that people fail to use PPEs because they could not afford to buy a full pair of PPE and so decide to work in an unsafe condition.(20).

CHAPTER THREE

3.0 MATERIALS AND METHODS

Defined research design as the roadmap of a research, which is comprised of various tasks including framing the research question and its further adequate refinement to be a researchable question, formulating aims and objectives of the study, methodology i.e. how data was collected and analysed in complete coherence to address the research question/s.(40) With this in mind, this study followed a descriptive methodology in order to determine the magnitude of occupational health effects of welding works experienced by small-scale welders among small-scale welders in Dar es Salaam, Tanzania.

3.1 Study design

This was a descriptive cross-sectional study design to determine prevalence of occupational health problems (welding relating accidents, injuries and diseases) among small-scale welders. The study considered exposure factors such as knowledge on welding health hazards, knowledge on welding health problems, knowledge on PPE and use of PPE while the prevalence of welding health problems was the outcome variable, among small-scale welders.

The study also assessed variables like sex, age, level of education, form of training attended to become a welder, work experience and cigarette smoking as one of the confounder variable for respiratory tract symptoms. Choice of the study design considered the duration and cost of the study. Cross sectional study is quicker and easy to conduct, and slightly cheaper compared to other study designs.

3.2 Study area

The study was conducted in Temeke municipal, Dar es Salaam region, Tanzania. This municipal is among the five municipalities of the region. Other municipals include Ilala, Kinondoni, Ubungo, and Kigamboni. The municipal was selected through multistage sampling approach followed by purposive sampling method to pick the welders. The second stage is selection of Toangoma administrative ward from twenty-one wards of Temeke municipal, through random sampling method. The Toangoma ward has fourteen administrative streets including Mzingo A, Mzingo B, Kongowe, Goroka A, Goroka B, Toangoma, Masaki, Malela, Masuliza, Ponde, Mwapemba, Mikwambe, Changanyikeni and

Vikunai. This ward is bordering Kibada ward from Kigamboni municipal in the eastern and Mwanenge ward from Mkuranga District on its southern part while Mbagala ward on its northern side and western part. According to the 2012 population census, the Toangoma ward covers 37.5 km² with a total population of 44,578 in which 21, 292 (47.8%) males and 23,286 (52.2%) females.

Other administrative wards of Temeke municipal include Azimio, Buza, Chamazi, Chang'ombe, Charambe, Keko, Kiburugwa, Kijichi, Kilakala, Kurasini, Makangarawe, Mbagala, and Mbagala Kuu. In addition, there are Mianzini, Miburani, Mtoni, Sandali, Tandika, Temeke, and Yombo Vituka wards (**Figure 2**).

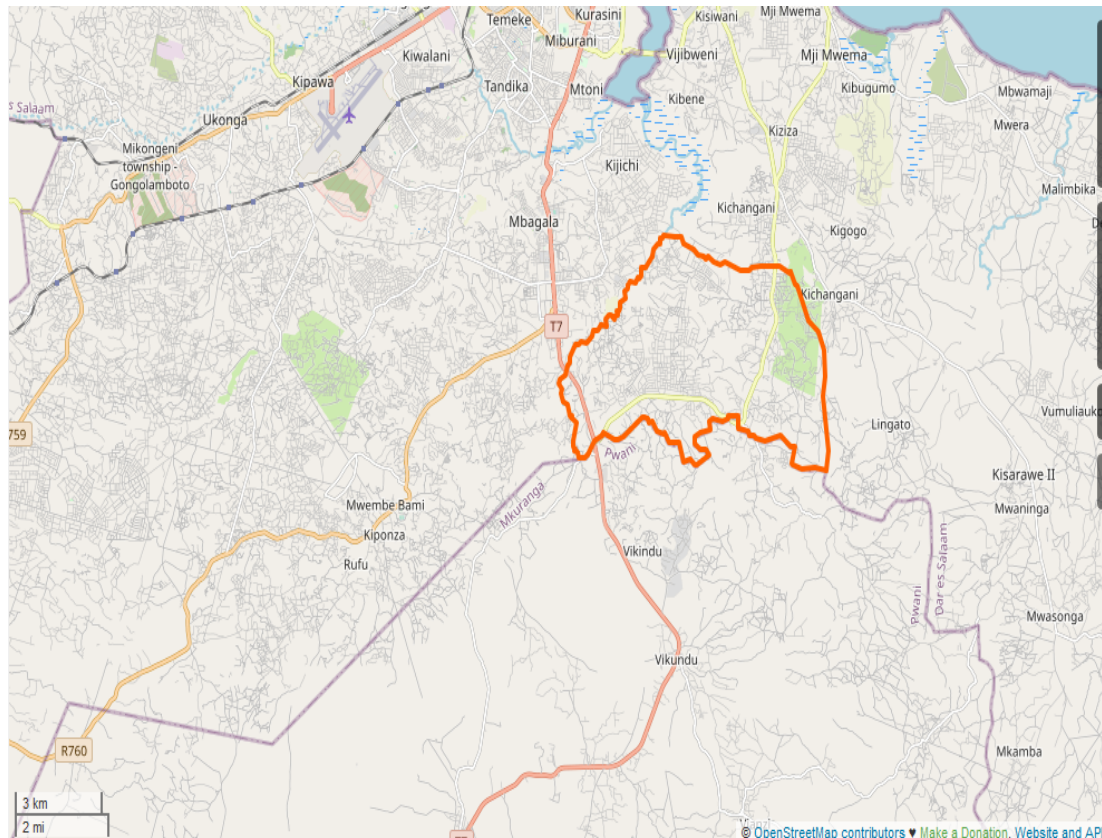


Figure 4: A google map showing the location of Toangoma ward (Red bordered) and the neighboring wards in Temeke Municipal.

3.3 Study population

The target population for this study was all small-scale welders found working in the home based welding workshops, roadside or market places and outdoors during the day of visit. All these were included in the study with exception of those who were not doing welding works parse especially in the workshops with combined activities such as wood works, aluminum works and metal works, and others who refused to take the consent form for participation.

3.4 Inclusion and Exclusion Criteria

Since the study sample was purposively selected, inclusion and exclusion criteria were not applicable and therefore everybody who was working in the workshop on the day of visit was selected for the study.

3.5 Research Variables

3.5.1 Independent Variables

1. Social demographic variables (age, sex, form of training each participant has attended to become a welder, highest level of education attained, use of PPE during working).
2. Knowledge of participants on occupational hazards, welding related health problems such as accidents, injuries and diseases, and PPE for welding.
3. Utilisation of PPEs (dust mask, goggles, shield guard, earmuffs, overcoat, and insulated gloves) for welding work

3.5.2 Dependent Variables

The outcome variable for this study is prevalence of welding health and safety problems (eye injury, eye foreign body, explosions, electric shock, skin cuts, burns, low back pain, chronic cough, breathlessness, and hearing problem) for the past six (6) months.

3.6 Sample size for the study

From the previous study conducted in Tanzania, on similar topic reported the prevalence of acute respiratory health conditions (ARHC) to be 88% and the other study published in 2014 revealed the lowest proportional of 9.9% for hearing loss among welders.(12) Therefore, researcher considered and used the lowest proportion of 9.9% to estimate the sample size for all other health problems with non-response rate of 10% and the design

effect of 1.5 from the target population. The used confidence interval was 95% with 5% margin of error.

Therefore sample size of 227 was calculated as per formula described by Ravindrya for infinite population.(32)

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

$$n = \frac{1.96^2 \times 0.099(1 - 0.099)}{(0.05)^2}$$

$$n = 137$$

Where E = acceptable margin of error (MoE) which is 5% at 95% confidence interval.

Assuming the non-response rate (r) of 5% the actual sample size was;

$$n' = n / (1 - r)$$

$$n' = 137 / (1 - 0.1)$$

$n' = 151$, with design effect of 1.5,

Then actual sample size was 227 participants.

3.7 Sampling Technique

The planned 227 welders to participate in the study were purposively selected from their work sites situated along the roadsides, public markets, bus stands, outdoors or homes, across Toangoma ward depending on the expertise they had on welding works.

The workshops from 14 streets of Toangoma ward which were covered during the study include Mzinga A, Mzinga B, Kongowe, Goroka A, Goroka B, Toangoma, Masaki, Malela, Masuliza, Ponde, Mwapemba, Mikwambe, Changanyikeni and Vikunai until the sample size was attained in which the researcher was referred and directed to the next welding workshop by the welders themselves as they know each other very well.

During the study, workshops from each street were visited. All welders who were present on the day of visit were requested to participate in the study. Those who agreed signed consent forms and invited for the interview. The interviewer completed the questionnaire until the sample size of 227 welders was attained.

3.8 Data collection and Management

The research assistant was trained on the study topic, data collection tools and oriented to the study area. The data collection team comprised of the principal investigator (PI), research assistant and the member of street health committee from each visited street in the ward. The team visited the selected workshops, and introduced each other to the workshop supervisor or the in charge. The PI explained in details the purpose of the study to the study subjects. Moreover, the entire process and procedure was explained to the workshop supervisor before starting the interview. The workshop supervisor then explained to other welders in the workshop and asked them to feel free to participate in the study and cooperate. Those who agreed to participate signed consent forms. The PI and the research assistant collected data from the 62 visited workshops.

3.8.1 Data Collection tools, validity and reliability issues

Semi structured questionnaire

The used questionnaire was primarily developed in English and later translated to Kiswahili the National language and consisted of five major parts to gather general information and in response to research questions (Appendix 2A&B). The tool was adopted from the study by Z'gambo who did similar study and was slightly modified to fit our purpose and context. The first part captured social demographic characteristics of the participants i.e. age, sex, an education status (i.e. drops out, failure, completed, and never attended). The second part explored training history of the participant (formal or informal training).

The third part assessed the general awareness on occupational hazards, health problems, accidents and injuries related to welding works (common hazards, injuries, accidents and frequency of accidents) and PPEs for welding works. The fourth part assessed the utilization of PPE. Lastly, there was a question to assess the prevalence of health problems by type experienced by welders (burns, cuts, eye injury, low back pain, respiratory conditions) and finally the participant's recommendations.

Consent form

This document was used to seek permission and willingness of a respective study participant to participate in this study. This consisted of the brief introduction of the topic, researcher, purpose of the study, confidentiality issues and any clarification like incentives for participation in the study (Appendix 1A & 1B). Lastly, they were asked to put their signature or finger stamp for acceptance to participate.

Validity and reliability of data

The obtained data were reliable and valid due to the fact that, the collection tool was pre-tested at Kibada among welders before the actual exercise and issues were corrected accordingly to enable production of reliable information which can be analysed and answer the research questions. Factors that may influence the intended outcomes in anyway were taken care. For instance, cigarette smoking could also cause respiratory tract conditions like breathlessness or coughing. Therefore, cigarette smokers were not analysed for respiratory conditions.

3.8.2 Data Collection and Processing

Data collection was done using pre tested open and close-ended questionnaire based on demographic details, literacy level, and form of training one has attended, awareness of welding related hazards, welding health and safety problems, and PPE and clothing. In addition, details on use of personal protective equipment and clothing as well as frequency of use and self-reports on history of eye injuries, respiratory conditions, cuts, burns, low back pain and hearing loss were also captured. Furthermore, information on the factors for increased rates of welding related health problems and proposed strategies to reduce rate of welding related health problems among small-scale welders.

Interview and Completion of Questionnaire

After the full introduction of both teams, and explanation on the purpose of the study and the procedure for data collection; and obtain permission from the supervisor, each welder was privately asked to participate in the study. Those who agreed to participate in the study were given a consent form (Appendix 1A&1B) to read or for those who were unable to read, the researcher read consent form to them. The participants were free to withdraw

from the study at any time during the study. However, no participants who withdrew from the study.

All questions were clearly read to the participants in the language selected by the participant though all participants preferred Kiswahili language, and then investigator completed the questionnaire form as per response from the participants., Researcher provided clarification to participant on any issue, which was found to confuse respondents. In addition, all participants were free at any time to stop continuing with the study, and the partially completed questionnaires were discarded and the new participants were enrolled.

All completed survey forms were assigned serial numbers for traceability, and all responses clearly validated and then get compiled together before leaving so that if anything is not clearly recorded then correction were done immediately.

3.9 Data Management and Analysis Plan

Data were collected on daily basis for five consecutive days in which the completed questionnaires were crosschecked every day evening for any errors on accuracy and completeness. All completed and crosschecked questionnaire were serially numbered and after finishing the data cleaning, they were all entered in SPSS version 25.0 software ready for analysis. The generated details were saved in the computer and flash disk as back up and the used questionnaire forms were safely archived. The collected quantitative data were processed and analysed by using Statistical Packages for Social Sciences (SPSS) software version 25.0 in which univariate and bivariate analysis were done to establish both frequency and association between variables, and chi-square test was used to assess statistical significance of the association between the analysed variables of the study. For each research objective, the study variables were analysed separately and displayed accordingly using different methods as per plan explained here under.

3.9.1 Data Analysis for Social demographic characteristics and general information

Participant's characteristics and general details were analysed using simple descriptive analysis and presented in distribution tables, indicating the proportion of participants with each character of interest. The characters of interests included age at groups of under 18 years, between 18-24, 25-34, 35-49 or above 50 years. Sex of the participant as a male or female, education level attained or literacy level as either primary education, secondary

education, college education, drop out or never attended at all. Another variable is form of training, which a participant has attended to become a welder as either through formal vocational education training or through attachment to the workshops (Traineeship).

Work experience and working duration of a participant are other variables, which was studied to explore how long a person has been working as a welder given as a range from less than a year, 1-2 years, 3-5 years, 6-10 years or more than 10 years. Duration of work for at least 8 hours in a day or more than 8 was also analysed. The researcher went further to assess whether there is any relationship between form of training, level of education and work experience on use of PPEs.

3.9.2 Data Analysis for knowledge on health hazards, problems and PPEs for welding works

Level of knowledge among participants was assessed by testing the ability of welders to mention the hazards, which are associated with welding works, health problems associated with the job, and PPEs used in welding work (Appendix 2A&B). The levels were categorised into three groups basing on the number items listed for each aspect of the question. It was expected that welders would mention at least 8 items in each of the asked aspect. Those who mentioned from 0-2 were considered to have little knowledge; those who mention from 3-5 issues were considered to have moderate knowledge while those who mentioned 6-8 issues were considered to have high knowledge. Again, each mentioned item was then analysed to check for the commonly known health hazard, or problem or PPE among the study participants.

For instance, in first question welders were asked to mention health and safety hazards in welding works. Therefore, we expected them mention metal fumes, intense light (UV), extreme noise, heavy lifting, extreme heat, uncomfortable posture, flying metal chips, sharp objects, electricity, explosion of compressed gas cylinder and vibrations.

In addition, participants were asked to mention health and safety problems associated with welding works, and they were expected to list respiratory problems such as difficult breathing, chest tightness, chest pain and chronic cough, visual problems such as complete loss of sight, eye irritation, objects in the eye, and hearing problems such as loss of hearing or earaches.

Ergonomic problems such as low back pain, also skin burns, body cuts, electric shock and exploded by compressed air cylinder.

Lastly, they were asked to mention the PPEs required in welding works and therefore we expected them to list eye PPEs such as goggles, face shield, welding helmet. Also respiratory tract protection PPEs such as fume respirator mask, and dust masks. Feet, hands and general body protection PPEs such as Safety boots, safety gloves, coverall or apron were also expected.

3.9.3 Data Analysis for Use of PPEs among study participants

Every participant was assessed for Use of PPEs for eyes and face, nose, respiratory tract, general body, hands, legs, and ears will be measured by two questions for each PPE type. The obtained responses were “Yes” or “No” for using of each PPE for a specific body part. These responses were then analysed as descriptive statistics to determine the proportion of participants using each PPE type as well as those who do not use PPE or use ordinary clothing and materials for protection.

3.9.4 The prevalence of selected welding health and safety problems among participants

Proportion of eye injuries, eye foreign objects, hearing loss, body cuts, skin burns, chronic cough, breathlessness, electric shock, explosions, and low back pain were measured by self-reports from each participant through “Yes” or “No” questions which were asked against each selected health effects from welding works. The participants were required to recall and provide a response as whether experienced any symptom for each health problem for the past six months to one year. The proportion of participants experienced each health and safety problem were analysed by descriptive analysis.

3.9.5 Factors associated with Use of PPE among Small Scale welders

Firstly, proportion of each factor as per category (individual, regulatory and economic) was established using descriptive analysis methods and then their association was examined using cross tabulation and chi square tested for statistical significance at 95% CI (P value 0.05) and then logistic regression analysis (multivariate) was done to determine the level of association among factors (individual, regulatory and economic).

Crude odds ratio (COR) and adjusted odds ratios (AOR) was used to test the significance levels at 95% confidence intervals.

3.9.6 Association between social demographic factors and use of welding PPE

Three social demographic characteristics of the participant including education level, form of training, and work experience were analysed using bivariate analysis model to check for presence of any association with the decision to use personal protective gears among study participants. The association was then statistically tested further for significance level at P value of less than 0.05 using Chi square method for the association to be considered statistically significant.

3.9.7 Association between Use of Eye protective gears and the prevalence of Eye problems

The association between the history of using PPEs for eye, respiratory tract, and overall among the prevalence of the respective health and safety problems experienced by participants was also assessed by using cross tabulation analysis. The results were tested for statistical significance by using Chi square method at 95% confidence interval p-value of less than 0.05 or less for the association to be considered as statistically significant.

3.10 Ethical issues

In the process of adhering with ethical issues during the study, ethical clearance was obtained from the Institutional Review Board of the Muhimbili University of Health and Allied Sciences. In addition, secondary permit was requested from Municipal Executive Director though reply was not received timely but relevant local government authorities in the respective wards, streets and workshop owners and supervisors were consulted for permission before start of data collection.

Before data collection starts, the study and purpose of the study was explained in their local language, which is Kiswahili to all participants, and then each individual participant was asked to sign a consent form or put a thumb stamp as a proof of their acceptance to participate in the study. However, for participants under the age of 18years, and considering the nature of the study (Low risk) the participants were asked for permission to

participate verbally, and the consent was signed by their workshop supervisors after they accepted.

However, any unethical practices at the workshops during the study such as child labour, gender discrimination and violence, were reported to local government authority representative for immediate intervention in their plans but also education was provided to the respective people.

In addition, people who were found at workshop working while are severely sick the researcher gave them advice to stop working and visit health facility for immediate medical services **38 (16.7%)** participants who were below 18years old, the researcher informed the local government officials and advised them to work under close supervision of the senior technicians.

Participants' information was handled confidentially, their responses undisclosed to any person and remained confidential between a researcher and the participants, and no piece of the information was used contrary to the purpose of this study.

In addition, all provided information from respondents through the completed questionnaires would be discarded after the final report is submitted to the university. In addition, to ensure confidentiality all names and participant particulars were disclosed during data collection as part of this study and the shared information were strictly for this study only. Since this study did not involve any invasive procedures or intervention, therefore no any participant who faced any physical or medical problem due to their involvement in the study.

CHAPTER FOUR

4.0 Data Analysis and Results

4.1 Background information of the study

This study was conducted in June 2020 and 227 participants were included, which is 100% participation. These participants were purposively selected from sixty-two (62) workshops of Toangoma wards in fourteen streets. Majority of the workshops were in open space (outdoor) situated along the roadsides of Mbagala Rangi Tatu to Mikwambe via Mzinga, Kongowe, Goroka, Toangoma Masuliza, Ponde, and some workshops were situated within the households of Vikunai, Malela, Masaki, Mwapemba and Vikunai area. Local leaders supported the research team to identify the workshops in their respective streets. The research team in support with the local leaders identified the welders from different workshops in each administrative street and requested them to participate in the study. The research team recruited those who were willing to participate (**Table 1**).

Table 2: Distribution of streets and the number of welders from workshops selected in the ward

Street	Selected participants (n)	Proportion (%)
Mzinga A	20	9
Mzinga B	18	8
Kongowe	24	11
Goroka A	10	4
Goroka B	16	7
Toangoma	30	13
Masaki	9	4
Malela	16	7
Masuliza	8	4
Ponde	13	6
Mwapemba	14	6
Mikwambe	25	11
Changanyikeni	15	7
Vikunai	9	4

4.2 Social demographic characteristics and general information of the participants

All 227 recruited subjects were male and participation rate was 100%. Majority of the participants 189 (83.3%) had age above 18 years in which 100 (44.1%) were predominately between 24-35years and 38 (16.3%) were below 18 years. Most of the street welders 174 (77%) completed primary school education and above in which 86 (38%) completed primary school education as their highest level of education. Those who attained secondary school education were 51 (22%) while college graduates were 37 (16%); school dropout were 30 (13%) and 23 (10%) never attended school (**Table 2**).

The study also found that a significant number of participants 190 (84%) received their training through hands on apprenticeship to other workshops where they worked with experienced welders for some times and the rest 37 (16%) attended formal Vocational Training Education colleges. Most of the welders 225 (99.1%) have work experience of more than 1 year and the remainder have less than a year of working experience (**Table 2**).

Analysis show that most of the welders 122 (54%) reported to work for long hours more than 8 hours and some 57 (25%) work for 8 hours. Others welders 48 (21%) reported to have no specific working duration. About the welding method, most welders 224 (98.7) reported to use electric welding and the rest use gas method (**Table 2**).

Table 3: Social demographic and general information of the study Population (N = 227)

Characteristics	Frequency	Proportion (%)
Sex		
Male	227	100
Age Group		
<18	38	16.7
18-24	53	23.3
25-34	100	44.1
35+	36	15.9
Education level attained		
Never attended school at all	23	10
Secondary School Drop Out	30	13
College education	37	16
Secondary education	51	22
Primary school education	86	38
Form of training attended		
Attachment/Apprenticeship	190	84
Formal vocational training	37	16
Experience in welding work (in years)		
<1	2	0.9
1-2	129	56.8
3-5	46	20.3
>6	50	22.0
Working duration (in hours)		
>8	122	54
8	57	25
No specific duration	48	21
Welding method/type		
Gas	3	1.3
Electricity	224	98.7

4.3 Knowledge of small scale welders on health and safety hazards, problems and PPE

4.3.1 Analysis of knowledge level on hazards, problems and PPEs among welders by categories

When participants assessed on their level of knowledge on health hazards, health problems and Personal protective gears, it was found that less than a half of the participants 110 (48%) reported to have moderate understanding on hazards associated with welding works, and 70 (31%) reported to have little understanding while 47 (21%) were reported to have high understanding. In addition, 90 (40%) of welders reported to have moderate understanding on welding associated health and safety problems and 85 (37%) reported to have high understanding, whereas 52 (23%) reported to have little understanding (**Table 3**). Furthermore, more than half of the welders (56%) reported to have moderate understanding on PPEs and clothing for welding works and 79 (35%) reported to have high understanding while 20 (9%) reported to have little understanding. Therefore, from collective analysis, it was found that high proportion of welders 157 (69%) have moderate and high level of understanding on health and safety hazards, 175 (77%) on welding associated health and safety problems and 2017 (91%) on PPE used in welding works (**Table 3**)

Table 4: Level of Understanding of Small-scale welders on Health and Safety hazards, Health and Safety Problems and Personal Protective Gears (N = 227)

Aspects of study	Level of understanding	Frequency (n)	Proportion (%)
Health and Safety Hazards	Little	70	31
	Moderate	110	48
	High	47	21
Health and Safety Problems	Little	52	23
	Moderate	90	40
	High	85	37
Personal Protective Gears	Little	20	9
	Moderate	128	56
	High	79	35

4.4 Use of Personal Protective Equipment and Clothing among small-scale welders

The study found that the most commonly used PPE by welders was coverall reported by 87 (38%) welders followed by face mask 79 (35%) and safety goggles (22%) and safety boots (18%) (Table 7. PPEs for ears and hand protection were reported to have the lowest proportion of use by the welders in which only six people (3%) reported to use earmuffs and just three people (1%) reported to use leather gloves, which mean there is little protection provided, by welders to their ears and hands during their works. The study also found that majority of welders use personal protective gears and clothing, which are not recommended, and therefore the level of protection they provide is minimal compared to the standard PPEs that are recommended. For instance, 186 welders (82%) reported to wear ordinary shoes instead of the safety boots, 126 (56%) use sunglasses as eye protection device, 125 (55%) use ordinary clothes instead of overcoat to protect their bodies and others 69 (30%) use cloth mask. (Table 4).

Table 5: Use of Personal Protective Gears and Clothing among small scale welders (N=227)

Type of PPE	frequency (n)	Proportion (%)
Eye Protection		
Welding shield/face shield	40	18
Safety goggles	49	22
Sunglasses	126	56
Welding helmet	12	5
Ear Protection		
Ear muffs	6	3
Ear plugs	0	0
Respiratory Tract Protection		
Dust Mask	79	35
Respirators	3	1
Cloth Mask	14	6
Hands Protection		
Leather Gloves	3	1

Rubber Gloves	79	35
Foot protection		
Safety Boots	41	18
Ordinary shoes/sandals	186	82
General Body Protection		
Overall	87	38
Ordinary Clothes	125	55
Apron	15	7

These welders in the figure below were observed in one of the visited workshops in which they both work without recommended PPEs. They have just put on, ordinary clothes with bare feet and hands sunglasses, and a piece of cloth around mouth, and nose.



Figure 5: Some of the observed welders working without recommended PPEs in one of the workshops (Photo by a researcher)

4.5 Prevalence of selected welding health and safety effects of welding works among welders

This study found that the most common health problems reported by small-scale welders 216 (95%) were low back pains which is due to heavy lifting and poor posture, followed by skin burn from fire particles reported by 210 welders (93%) caused by extreme heat and fire particles especially on the hands and feet; while body cuts reported by 201 welders (89%). Additionally, majority of welders 198 (87%) reported to experience eye irritation, objects in the eye reported by 196 (86%) welders, difficult breathing reported by 186 (82%) and chronic cough and chest pains reported by 169 welders (74%). In addition, few welders 48 (21%) reported to have lost hearing or pains in the ears and 28 welders (12%) got electric shock due to using open electric cables and welding equipment in the workshop (**Table 5**).

Table 6: Prevalence of Health and safety effects of welding works among participants (N = 227)

Experienced Health Problems		Frequency (n)	Proportion (%)
Difficult breathing	Yes	186	82
	No	41	18
Chronic Cough/Chest pain	Yes	169	74
	No	58	26
Loss of vision/Eye itching	Yes	198	87
	No	29	13
Object in the Eye	Yes	196	86
	No	31	14
Loss of hearing/Pain in ears	Yes	48	21
	No	179	79
Body Cuts	Yes	201	89
	No	26	11
Skin Burn	Yes	210	93
	No	17	7
Low Back Pain	Yes	216	95
	No	11	5
Electric shock	Yes	28	12
	No	199	88
Explosion	Yes	0	0
	No	227	100

4.6 Factors associated with the use of personal protective gears among small-scale welders

4.6.1 Individual factors associated with use of PPE

Descriptive analysis was conducted to establish the proportion of each individual factor, which is associated with the use of PPE among the small-scale welders. The factors studied included willingness to use PPE, knowledge on use of PPE and substance abuse such as alcohol usage. The results in **Table 5** show that knowledge on PPE is the leading factor with high proportion (85%) followed by willingness to use PPE had proportion (83%), and lastly substance abuse which is 37%. Therefore, individual knowledge on PPE is higher among the welders, and willingness to use PPE is high while use of substances like alcohol is very low. It means that, majority of welders (85%) have high knowledge on PPEs and their uses.

Table 7: Individual factors associated with the Use of PPEs

Individual factor(s)	Frequency (N = 227)	Percentage (%)
Willingness to use PPE (Whether they are willing to Use PPE)		
Yes	188	83
No	39	17
Knowledge (on PPE)		
Yes	192	85
No	35	15
Substance Use (Whether they use drugs or alcohol)		
Yes	84	37
No	143	63

4.6.2 Regulatory and Economic factors associated with Use of PPE

The study identified the regulatory factors as well as economic factors, which are associated with use of PPE among small-scale welders. These factors included availability of PPE, accessibility of PPE, presence of guidelines and policies regarding use of PPE in their local language and lastly the economic position of an individual (affordability).

The majority of the respondents (79%) also reported that they could not afford to purchase sufficient and recommended PPEs for their work. This means that the individual economic position is not good enough for them to purchase the recommended PPEs and use them accordingly. The results also reveal that availability of PPE is not a big problem because 86% confirmed that PPEs are available and accessible but guidelines on PPE use are not available.

This study revealed that there are no guidelines or policies regarding the use of PPE among small scale and so only, few people (15%) confirmed to have guidelines on PPE. Therefore, absence of these guidelines and policies is contrary to the Occupational Safety and Health Act.(41) (Table 7).

Table 8: Regulatory and economic factors associated with use of personal protective equipment among small-scale welders

Regulatory and economic factors		Frequency (N=227)	Percentage (%)
Whether the PPEs are easily accessed and available	Yes	195	86%
	No	32	14%
Whether the presence of policies and guidelines on the use of PPE in local language	Yes	192	85%
	No	30	15%
Whether the PPEs are affordable to small scale welders	Yes	47	21%
	No	180	79%

4.6.3 The relationship between individual, regulatory, and economic factors on Use of PPEs

Bivariate analysis was also conducted to determine the relationship between the individual factors and regulatory factors on the use of PPEs. Then Pearson Chi square analysis at bivariate analysis level was conducted to determine the level of association between the individual factors as well as economic and regulatory factors and the Use of PPE. The results were presented as indicated in **Table 8**.

Table 9: Results for the individual and regulatory factors associated with use of personal protective equipment among small-scale welders

Individual factors		Proportion of using PPE			P-Value
		Yes (%)	No (%)	Total	
Willingness to use PPE	Yes	128 (68)	60 (32)	188	0.006
	No	20 (51)	19 (49)	39	
Knowledge of use of PPE	Yes	130 (68)	62 (32)	192	0.007
	No	12 (34.0)	23(65.0)	35	
Substance abuse	Yes	39 (46.40)	45(53.4)	84	0.08
	No	69 (48.3)	74 (51.70)	143	
Regulatory and Economic factors					
Availability and accessibility of PPE	Yes	101 (73.5)	94(26.5)	195	0.009
	No	10 (50.0)	22 (50.0)	32	
Presence of guidelines/policies regarding use of PPE	Yes	26 (80.0)	9 (20.0)	35	0.007
	No	57 (30)	135 (70)	192	
Economic situation of an individual (Affordability)	Yes	35 (74.5)	12 (24.5)	47	0.0083
	No	69 (38)	111(62)	180	

The table above indicates that the selected individual factors such as willingness to use PPE and knowledge on the use of PPE are significantly associated with use of personal protective equipment at bivariate analysis level while substance abuse is not.

The use of personal protective equipment is the highest among welders that reported willingness to use PPE (68%), knowledge on use of PPEs (68%) while the proportion was the lowest to the welders who reported substance abuse (46.40%).

Regulatory factors such as availability of PPE, presence of guidelines and policies on use of PPEs and affordability of PPEs are significantly associated with the use of personal protective equipment. From these findings, the use of personal protective equipment is the highest among welders who reported availability and accessibility of PPE (63.1%) and those who reported availability of guidelines and policies regarding use of PPEs (74.2%) as well as those who reported affordability (74.5%).

4.6.4 Multivariate analysis of the relationship between factors associated with use of PPE

Both individual, regulatory and economic factors were analysed to establish the level of significance of factors on the use of PPE. Therefore, all the variables both individual and regulatory factors which were statistically significant in bivariate analysis were subjected to multivariate analysis using the binary logistic regression. The adjusted odds ratios (AOR) and crude odds ratio (COR) for each of the factors considered were processed at a 95% confidence level to conclude on the association of the factor on the use of PPEs. The results are presented in **Table 9**.

Table 10: Multivariate results of the factors associated with use of Personal Protective Equipment

	Proportion of PPE use		COR (95%CI)	AOR (95%CI)
	Yes (%)	No (%)		
Willingness on use of PPE				
Yes	128 (68)	60 (32)		
No	20 (51)	19 (49)	4.412 (1.347-14.448)	4.118 (1.063-15.955)
Knowledge of use of PPE				
Yes	130 (68)	62 (32)		
No	12 (34.0)	23(65.0)	4.219 (1.392-12.788)	2.013 (0.401-10.094)
Availability and accessibility of PPE				
Yes	101 (73.5)	94(26.5)		
No	10 (50.0)	22 (50.0)	2.774 (1.054-7.303)	1.710 (0.010-0.130)
Affordability of PPE				
Yes	35 (74.5)	12 (24.5)		
No	69 (38)	111(62)	6.207 (2.138-18.016)	13.195 (0.714-243.737)
Availability of guidelines and policies on PPE use				
Yes	26 (80.0)	9 (20.0)		
No	57 (30)	135 (70)	3.683 (1.553-8.735)	0.683 (0.165-2.827)

Individual factors

Willingness of an individual on using PPE: The binary analysis indicate that willingness of individuals on the use of PPE use is statistically associated with the proportion of use of the personal protective equipment (COR = 4.412; 95% CI = 1.347-14.448; p = 0.008). When this is subjected to a multivariate analysis, willingness of the individual welder on using PPE use, similarly showed a significant association (AOR = 4.118; 95%CI = 1.063-15.955; p = 0.039). This means that welders who reported high willingness proportion on PPE use are 4.118 more likely to use the personal protective equipment than those who reported less willing to use PPEs.

Knowledge on use of PPE: This study shows that knowledge on the use of PPE was significantly associated with the use of PPEs (COR = 4.219; 95% CI = 1.392-12.788; $p = 0.006$). Thus, welders who had knowledge on the use of PPEs were four times more likely to use PPEs than those who reported to have no knowledge on use of PPEs. This implies that knowledge is among the key individual factors on decision to use or not to use a recommended PPE among welders. However, these results were opposite when subjected to multivariate analysis where there was no statistically significance association between knowledge on PPE and the subsequent use of PPEs, (AOR = 2.013; 95% CI = 0.401-10.094; $p = 0.42$). This implies that having knowledge on PPE use do not guarantee that a welder will use the recommended PPE.

Regulatory and economic factors

PPE availability and accessibility: Bivariate analysis showed that easy availability and accessibility to the recommended PPE among small-scale welders were significantly associated with the use of PPEs (COR = 2.774; 95% CI = 1.054-7.303; $p = 0.034$). It was also observed that welders who reported availability of PPEs were 2.774 times more likely to use PPEs than those who reported limited availability of PPEs.

However, when subjected to multivariate analysis, it was revealed that the availability of PPE has minimal influence on welders decision to use a recommended PPE (AOR = 1.710; 95% CI = 1.054-7.303; $p = 0.121$).

Presence of guidelines and policies on the use of PPEs in their local language: The presence of guidelines or policies on the use of PPEs was found to have statistically significant association with the proportion of use of the PPE at bivariate analysis level (COR = 9.500; 95% CI = 3.678-24.540; $p = 0.000$). In addition, this association was also significant when subjected to a multivariate analysis, (AOR = 8.354; 95% CI = 2.445-28.546; $p = 0.001$). The welders who reported availability of guidelines or policies regarding the use of PPEs were 6.423 times more likely to use the PPE than those who did not report availability of guidelines or policies regarding use of PPEs.

PPE Affordability: Affordability of the recommended PPEs among small-scale welders, was found to have statistically significant influence on the use of PPEs at bivariate analysis

level (COR = 6.207; 95% CI = 2.138-18.016; p = 0.083). This relationship was also statistically significant at multivariate analysis level (AOR=13.195; 95%CI=0.714-243.737; p=0.0037). Therefore, welders who reported affordability of PPEs were 13.195 times more likely to use PPEs than those who reported unaffordable.

4.7 The association between selected social demographic characteristics and use of welding PPE

The association between education level, form of training and work experience on use of PPE was analysed and then statistically tested to check for significance level at P value of less than 0.05 using Chi square. From the analysis, it was revealed that the proportional of welders using at least one recommended PPE was significantly higher in welders with primary education and higher as compared to those who never attended any school at all and the school dropouts (p value = 0.01). In additional the proportional of welders reported to use at least one PPE was significantly higher among welders who attended formal vocational training as compared to those trained through attachment (p value = 0.02). Furthermore, the proportion of welders reported to use at least one PPE was lower to welders having work experience of more than 3 years as compared to those with less experience (Chi square test, p = 0.01) implying that as welders get more experienced they tend to ignore use of PPE.

Table 11: Association between selected social demographic characteristics and use of welding PPE

Participants Characteristic	Welders Using at least one recommended PPE			
	Frequency (n)	Proportion (%)	Total	p-value
Education level				
Primary	33	38	86	
Secondary	29	56.9	51	
College	21	56.8	37	0.01
Drop Out	10	33	30	
Never attended	8	34.8	23	
Form of training				
Attachment	70	41	190	
Formal training college	31	84	37	0.02
Work Experience (Yrs.)				
<1	2	100	2	
1-2	65	50.4	129	
3-5	18	39	46	0.01
>6	16	32	50	

4.8 Association between selected social demographic characteristics of participants and reported health problems among welders

Lower back pain was reported to be more prevalent health effect of welding work and therefore further analysis was done on the association of the problems to social demographic characteristics. The proportion of welders reported to have experienced lower back pain was lower to the youngest participants (<18 years), and was increasing significantly as age increases (Chi square test, $p = 0.02$, **Table 10**). In addition, welders who reported to work for more than 8 hours had higher proportion of lower pain (Chi square test, $p = 0.042$, **Table 11**)

Table 12: Association between age and work duration and the prevalence of lower back pain

Characteristic	Frequency (%)	Total	P value
Age Group			
<18	33(87)	38	0.00
18-24	50(94)	53	
25-34	97(97)	100	
35+	36(100)	36	
Working duration			
>8	119(97)	122	0.01
8	52(91)	57	
No specific duration	45(94)	48	

Note: P values were calculated using Chi square test and significant at level of 5%

4.9 Association between welder's knowledge on welding personal protective gears and the use of appropriate PPEs

Analysis was conducted on the association between levels of knowledge on personal protective gears required for welding work and the uses of respective personal protective gears among participants. It was found that, welders with high knowledge on PPEs had also high proportion of using the respective PPEs as compared to those with moderate and low knowledge. This was observed for all analysed chosen PPEs as face/eye PPEs (Chi square test, at p value = 0.01), general body PPEs (Chi square test, at p value 0.002), feet

PPEs (Chi square test, at p value 0.001), and respiratory tract PPEs (Chi square test, at p value = 0.04) (Table 12).

Table 13: Knowledge level and the use of selected PPEs among study participants

Knowledge Levels	Use of Eye/face PPEs		Total	P value
	Used PPE (%)	Not Used PPE (%)		
Low	4(20)	16(80)	20	0.01
Moderate	32(25)	96(75)	128	
High	65(82)	14(18)	79	
Total	101	126	227	
Use of Body PPEs				
Low	2(10)	18(90)	20	0.02
Moderate	40(31)	88(69)	128	
High	60(76)	19(21)	79	
Total	102	125	227	
Use of Foot PPE				
Low	2(10)	18(90)	20	0.01
Moderate	10(8)	118(92)	128	
High	29(37)	50(63)	79	
Total	41	186	227	
Respiratory tract PPE				
Low	1(5)	19(95)	20	0.04
Moderate	33(26)	95(74)	128	
High	48(61)	31(39)	79	
Total	82	145	227	

CHAPTER FIVE

5.0 Discussion

5.1 Knowledge of welders on welding health and safety hazards, problems and PPEs

From this study, majority of welders had high knowledge on welding related hazards, problems and PPE. The results from this study are in agreement with the findings reported in the study conducted in Zambia by Z'gambo et al, which revealed that majority of the welders (98%) were aware of at least one welding related health and safety hazard and PPE for welding works. In that study it was also found that majority of welders had moderate level of understanding on PPE (71%, n = 305), and health and safety hazards (63%, n = 271). Similar findings were also reported in the study conducted by Okuga and colleagues in Uganda on small-scale industrial welders in Jinja Municipality on awareness of occupational hazards and Use of Safety measures in which they found that majority of welders (83%) were aware on hazards, health problems and PPEs.(42) Budhathoki et al, in Nepal found that majority of welders (90.7%) are aware of at least one welding hazard and the same proportion is aware of at least one PPE.(16) Awosan et al, and colleagues in their study conducted in Nigeria found that 70.4% of 280 welders had good knowledge on both chemical and physical hazards associated with welding works.

5.2 Use of Personal protective equipment and Clothing among small scale welders

The study aimed at finding out the use of personal protective gears for welding and it was found that all study subjects use eye protective gears but very few subjects use the recommended PPE type such as welding helmet, safety goggles and helmet while more than half of the welders use ordinary sunglasses and not safety goggles. The study also found that more than half of welders use ordinary clothes (55%, n = 125) compared to those using overcoat or aprons (45%, n = 102). Ordinary shoes were also used by majority of welders (82%, n = 186%) compared to safety boots (18%, n = 41). A significant number of welders used dust mask (35%, n = 79) and cloth masks (30%, n = 65), over (1%, n =) reported to use metal fume respirator mask and the rest do not use any kind of mask at all (44%, n = 76). These results are in agreement with the previous study conducted by Z'gambo et al. in Zambia, where majority of welders reported to use personal protective

gears, which are not recommended.(14) In Zambian study it was also found that 327 (76%) welders used sunglasses, 225 (52%) used ordinary shoes and 221 (51%) used ordinary clothes. The study conducted by Okuga and colleagues in Uganda showed similar findings. According to the study conducted by Meena et al, people who did not use respiratory PPEs were 5 times more likely to develop respiratory health conditions and so argued on the importance of strict adherence to the use of PPEs.(12)

In this study 98% of the welders had goggles, out of these only 6 welders (2.8%) had recommended goggles and the rest had ordinary sunglasses.(20) Findings of this study agree with the findings of other Tanzania study conducted by Meena et al. who reported 95% of the welders used PPE where 109 welders (99.1%) used goggles and 2 welders (1.8%) used appropriate metal fumes respirator, 29 (26.4%) used dust mask and 76 (66.4%) did not use any form of PPE for respiratory pathway.(12) Prabhu et al, their study also found that eye protective gears such as goggles and face shield to be most commonly used PPE in their study where 73.3% of the welders use goggles. (26).This is inconsistent with the study conducted by Budhathoki et al, which indicated that the most commonly used PPE is mask (45%).(16) On the other hand the results contravenes what was found in Nepal by Budhathoki et al, in which the use of PPE was very low among welders (47.7%) despite high awareness level on the hazards and PPE required.(16) This low level of PPE use may be contributed by different factors, such as affordability and uncomfotability on various types of the recommended types of PPEs, which are needed for their job.

5.3 Occupational health and safety problems of welding works among small scale welders

This study aimed at assessing occupational health and safety problems of welding work among small-scale welders of Dar es Salaam and it was revealed that lower back pain is the most prevalent health problem (95%) among small-scale welders. The results of this study are in agreement with results from the study conducted by Z'gambo et al. in Zambia, where skin burn which was among the most commonly reported health and safety problem associated with welding works (87%), followed by eye problems (85%). Foreign objects in the eye was also reported in 78% (n = 335) of the welders.(14) Another study conducted in Uganda by Okuga and colleagues reported burns and cuts to account for 73% of the work related accidents in welding works with backache, and chest pain accounted for 14%

contrary to this study where backache is the mostly common reported health problem.(20) . The difference in proportion may be contributed by several reasons such as work duration of the participants as in this study majority of welders work for more than 8 hours every day and so get little time for resting but also they might be using machineries in lifting heavy objects during works.

5.4 Factors associated with use of PPE among small-scale welders

The study reveal that use of the personal protection equipment among small-scale welders is influenced by willingness of individual person, presence of guidelines on PPE uses and PPE affordable cost for people to purchase the recommended PPEs. This finding is in agreement with studies conducted in Uganda where the majority of the small-scale welders reported affordability in terms of cost of PPE as the leading factor for low use of the recommended PPE and some reported difficult in using PPE.(20) In addition, Budhathoki et al, found that knowledge on PPE use do not directly influence the use of PPE type instead other factors such as cost may apply.(16) In a study conducted in Nigeria by Adewoye et al, they had opposing results in which they found that use of PPEs is greatly influenced by level of knowledge ($p=0.0000$) and enforcement by the authorities and therefore poor knowledge results into low use of PPE as well as low enforcement.(43). In addition, another study conducted by Awosan et al, at Kaduna Nigeria revealed that poor utilisation on PPE is due attributed by non-availability of PPE, which has also been found a significant. Availability of work regulation was found associated with PPE use (AOR: 0.06 (0.02, 0.21), according to the Ethiopian study conducted by Berhe Beyene Gebrezgiabher et al.((44))

5.4 Study limitations and mitigation

This is purely a descriptive study and the findings are for descriptive purpose as well. Therefore, findings cannot establish causal effect relationship between exposures to hazards and the experienced health outcomes or problems among the study participants. This is because the study focused only on the descriptive features of the variables under the study. For example, this study cannot tell how level of education attained or form of training one has attended influenced the level of adherence to health and safety measures

or influenced utilization of PPE, or influenced reduction of occupational health problems. Being a cross sectional study it only focused at the snapshot of the small-scale welding workers' problems and its various contributing factors at that particular time of the study and therefore only those who were there during the time of visit got a chance to participate and respond to questions.

In addition, recall bias was also faced among the participants. This is because the study intended to gather health problems experienced by the people in the past six months. Thus, there is a great chance to some people forgot what they experienced in the past. Therefore, participants were asked questions on health and safety problems they have ever experienced, for a period of up to period of six months.

In ensuring validity and reliability of data and results, data collection tools such as questionnaire were pre-tested in eight selected workshops from Kibada area in Kigamboni municipality just few kilometers away from the study area to check for their suitability in gathering participants' information.

Again, COVID-19 outbreak was another limitation for my study, as I had to purchase adequate PPEs including disposable facemask for the data collectors and the participants during workshops visiting to avoid contacting the virus.

CHAPTER SIX

6.0 Recommendations and Conclusions

Conclusion

Majority of small-scale welders of Dar es Salaam attended hand on apprenticeship training to become welders and most of them attained primary school education and work for more than eight hours a day therefore need to be boosted up with formal training on health and safety practices so that their work becomes more safe and healthier. In addition, it was found that there are people under the age of 18years working in some workshops which is not allowed according to the law(Child labour),and so authorities are argued to make very close follow up in the small scale industries practices in order to end mulpractices.

Most of welders have knowledge on welding related health and safety hazards, health problems and PPEs required for welding works. However, this is not translated to practical use of PPEs. Willingness to use PPE, knowledge on the use of PPE and cost of PPEs have been associated with the use of PPE among small scale welders and therefore more emphasis should be made to ensure people are willing to use PPE also make the PPE affordable to all small scale welders .

Majority of welders use PPEs below the recommended standards and therefore they do not get high level of protection as they expect because they use less effective materials. For example, PPE for eye protection is the most commonly used items but majority are sunglasses and not safety goggles. Therefore, the educational promotion materials must be provided to them on different appropriate PPEs and their importance so that they can be fully utilised.

This study also found that, majority of welders have experienced low backache, skin burns, body cuts on various parts, objects in the eyes, respiratory conditions such as difficult breathing, chest pain and tightness. Thus, a lot has to be done starting from improving and transforming the awareness on hazards and health problems to effective use of the PPEs to protect the welders. We recommend further clinical studies to be conducted on these people so that the severity of these reported health conditions can be determined and required health services provided.

Recommendations

Based on the findings and since majority of the workforce in developing countries including Tanzania is employed in private sector particularly non-formal sector, this study shows just a small group of small-scale welders in the informal sector and how they experience health problems due to their job. There are many more groups of people facing the same challenges which have impact on the families and the country economy because some people becomes permanently disable or die. Therefore, from the findings of this study, the researcher recommends several things to the government authorities, stakeholders, research community and the welders themselves to address the situation.

1. Occupational Health and Safety Authority (OSHA)

As the overseer of the health and safety compliance in the country, in collaboration with parent ministry (Ministry of Labour, Employment, Youth Development and People with Disability) should organise and conduct refresher trainings and regular assessments to the small-scale welders in the country as they do for the formal sector employee. This will help give more knowledge and skills on the best ways, which people may follow and work safely and improve their level of awareness for both hazards, problems and PPE considering that most of them did not attend formal college training. In addition, OSHA has to develop the guidelines and policies for the small-scale sector and information education and communication Materials in their local language, which will be easily understood by these welders'. For example, information Education and Communication materials on hazards, health problems and PPEs in Kiswahili and freely distributed to the street welding workshops. Furthermore, there is the need to push for policy and law change so that the coverage of Occupational Health and safety is expanded to include the self-employed and small-scale sector workers as welders. This will ensure the compliance is adhered to both sectors and benefit from health insurance schemes.

2. Individual Welders themselves

The study found that, majority of welders are aware of the hazards associated with welding works and how they can be controlled by using appropriate PPEs but do not use recommended PPEs. Therefore, it is recommended that welders should seek appropriate

skills and knowledge on health and safety for their job. They should also, change their minds on PPE and be willing to use them continuously. This is in order that they can lower the chance of contracting the hazard and subsequent health problems. Therefore, it is the duty of welders themselves to make sure they comply. In addition, all welders must collaborate with government authorities in identifying the designated areas for welding workshops, registration or licensing of welders and even formulate an entity or union, which will help identify the profession and ensure compliance to health and safety practices and improve the work environment.

3. Stakeholders and researchers

Researchers are highly encouraged to work on further research especially in studying the causal effects of awareness and level of education and form of training, and the association between use of PPE and increased rate of welding health problems among small-scale welders. Stakeholders are also required to collaborate with the government authority on supply of low cost PPEs and clothing. In addition, all stakeholders should take note that everyone is responsible for improving health and working environment for these small scale group through promotion of good practices and support education campaign for safe working environment so that every person may enjoy the job.

References

- 1.Kumar SG, Dharanipriya A. Prevalence and pattern of occupational injuries at workplace among welders in coastal south India. Indian journal of occupational and environmental medicine. 2014;18(3):135.
- 2.Timings R. Fabrication and welding engineering: Routledge; 2008.
- 3.Rongo L, Barten F, Msamanga G, Heederik D, Dolmans W. Occupational exposure and health problems in small-scale industry workers in Dar es Salaam, Tanzania: a situation analysis. Occupational Medicine. 2004;54(1):42-6.
- 4.Isah E, Okojie O. Occupational health problems of welders in Benin City, Nigeria. J Med Biomed Res. 2006;5(1):64-9.
- 6.International Labour Organization (ILO , Safety and health at work : a vision for sustainable prevention: XX World Congress on Safety and Health at Work 2014: Global Forum for Prevention,. <http://www.ilo.org/publns>. 2014;24 - 27 August 2014, Frankfurt, Germany / International Labour Office. - Geneva: ILO, 2014.
- 7.Muhanga M. Informal sector in urban areas in Tanzania: some socio-demographic, economic and legal aspects. 2017.
- 8.Amponsah-Tawiah K, Mensah J. Occupational health and safety and organizational commitment: Evidence from the Ghanaian mining industry. Safety and Health at work. 2016;7(3):225-30.
- 9.Mrema EJ, Ngowi AV, Mamuya SH. Status of occupational health and safety and related challenges in expanding economy of Tanzania. Annals of global health. 2015;81(4):538-47.
- 10.Mersha H, Mereta ST, Dube L. Prevalence of occupational injuries and associated factors among construction workers in Addis Ababa, Ethiopia. Journal of public health and epidemiology. 2017;9(1):1-8.
- 11.Jilcha K, Kitaw D. A Literature Review On Global Occupational Safety And Health Practice & Accidents Severity. International Journal for Quality Research. 2016;10(2).
- 12.Meena GG. Assessment of occupational exposure to metal fumes and associated respiratory health symptoms among small scale welders in Dar es salaam: Muhimbili University of Health and Allied Sciences; 2017.

- 13.Christopher TM. The Effects of ARC Welding Hazards To Welders and People Surrounding The Welding Area. *International Journal of Mechanical Engineering and Technology*. 2017;8(3).
- 14.Zgambo J. Occupational hazards and use of personal protective equipment among small scale welders in Lusaka, Zambia: The University of Bergen; 2015.
- 15.Eze BI, Okoye O, Aguwa EN. Awareness and Utilization of Welders' Personal Protective Eye Devices and Associated Factors: Findings and Lessons From a Nigerian Population. *Workplace health & safety*. 2015;63(4):170-8.
- 16.Budhathoki SS, Singh SB, Sagtani RA, Niraula SR, Pokharel PK. Awareness of occupational hazards and use of safety measures among welders: a cross-sectional study from eastern Nepal. *BMJ open*. 2014;4(6):e004646.
- 17.Appiah SO. Workplace Safety and Accidents among Artisans at Kokompe-Accra, Ghana: University of Ghana; 2014.
- 18.Tadesse S, Bezabih K, Destaw B, Assefa Y. Awareness of occupational hazards and associated factors among welders in Lideta Sub-City, Addis Ababa, Ethiopia. *Journal of Occupational Medicine and Toxicology*. 2016;11(1):15.
- 19.Ajayi IA, Adeoye AO, Bekibele CO, Onakpoya OH, Omotoye O. Awareness and utilization of protective eye device among welders in a southwestern Nigeria community. *Annals of African medicine*. 2011;10(4).
- 20.Okuga M, Mayega R, Bazeyo W. Small-scale industrial welders in Jinja Municipality, uganda. *Afr Newslett*. 2012;22(2):35-6.
- 21.Sanda M-A, Nugble J, editors. Welders' Knowledge of Personal Protective Equipment Usage and Occupational Hazards Awareness in the Ghanaian Informal Auto-mechanic Industrial Sector. *International Conference on Applied Human Factors and Ergonomics*; 2019: Springer.
- 22.Quinlan M. The effects of non-standard forms of employment on worker health and safety: ILO Geneva, Switzerland; 2015.
- 23.Reese CD. Occupational health and safety management: a practical approach: CRC press; 2015.
- 24.Popović O, Prokić-Cvetković R, Burzić M, Lukić U, Beljić B. Fume and gas emission during arc welding: Hazards and recommendation. *Renewable and Sustainable Energy Reviews*. 2014;37:509-16.

25. Personal Protective Equipments used in welding works 2016. (<https://steelhub.wordpress.com>).
26. Prabhu M, Rokhade R, Chandra KP, Kakhandaki A. A study of awareness and use of personal protective eyewear among welders in a tier 2 city in South India. *Indian Journal of Clinical and Experimental Ophthalmology*. 2017;3(3):356-60.
27. Bhumika T, Thakur M, Jaswaf R, Pundir P, Rajwar E. Occupational injuries and safety measures adopted by welding workers: A cross sectional study in South India. *Global J Med Public Health*. 2015;3.
28. Rantanen J, Lehtinen S, Valenti A, Iavicoli S. A global survey on occupational health services in selected international commission on occupational health (ICOH) member countries. *BMC public health*. 2017;17(1):787.
29. Mokaba M, Malema R, Oduntan O, Mothiba T. The health effects of welding on welders in the Capricorn District, Limpopo Province, South Africa. *African Journal for Physical Health Education, Recreation and Dance*. 2013;19(Supplement 1):222-34.
30. Benti A. *Assessing the Prevalence of Occupational Injury and its Association With Utilization of Personal Protective Equipment Among Workers in Large Scale Metal Manufacturing Factories, Addis Ababa, Ethiopia: Addis Ababa University; 2017.*
31. Mutekanga D. Determinants of Employee Use of Personal Protective Equipment, the Case of Spedag Interfreight Uganda Limited, Kampala *J Environ Sci Public Health* 2019. 2019.
32. RABA, Kumar S. *Sample Size Estimation in Prevalence Studies. The Indian Journal of Pediatrics*. 2012.
33. Audit N. *A Performance Audit Report on the Management of Occupational Health and Safety in Tanzania*. 2013.
34. Mwombeki F, editor *Occupational health and safety challenges in construction sites in Tanzania. The W99 Triennial International Conference, Rethinking and Revitalizing Construction Safety, Health, Environment and Quality; 2005.*
35. Kumar SG, Dharanipriya A, Kar S. Awareness of occupational injuries and utilization of safety measures among welders in coastal South India. *Int J Occup Environ Med (The IJOEM)*. 2013;4(4 October):252-172-7.

- 36.Nenonen N, Saarela K, Takala J, Manickam K. Global estimates of occupational accidents and work-related illnesses 2014. Singapore: Workplace Safety & Health Institute; 2014.
- 37.London RGLaL. Global Occupational Health: Current Challenges and the Need for Urgent Action
Icahn School of Medicine at Mount Sinai *Annals of Global Health* 2014;80:251-256. 2014.
- 38.Kheni NA, Gibb AG, Dainty AR. Health and safety management within small-and medium-sized enterprises (SMEs) in developing countries: Study of contextual influences. *Journal of construction engineering and management*. 2010;136(10):1104-15.
- 39.Mushi L. Factors Affecting Adherence to Occupational Health and Safety Rules and Regulations in Improving Public Health in the Informal Sector Workers in Mabibo-Dar es Salaam. 2019.
- 40.Green J, Thorogood N. *Qualitative methods for health research*: Sage; 2018.
- 41.Ministry Of Labour Eay, Development. *National Occupational Health And Safety Policy*. 2009.
- 42.Okuga M. *Awareness of occupational hazards and use of safety measures among roadside welders in Jinja Town*: Makerere University; 2011.
- 43.Adewoye KR, Awoyemi AO, Ibirongbe DO, Babatunde OA, Ibrahim T. Knowledge on the health effects of welding smoke, use of ppe among electric-arc welders in ilorin south, north central Nigeria. *Journal of Asian Scientific Research*. 2013;3(9):924-32.
- 44.Berhe Beyene Gebrezgiabher DT, and Tesfaye Yetum. *Awareness of Occupational Hazards and Utilization of Safety Measures among Welders in Aksum and Adwa Towns, Tigray Region, Ethiopia, 2013*. *Journal of Environmental and Public Health*. 2013;Volume 2019:7

Appendices

Appendix 1A: Informed Consent - English



Dear Participant,

Request for Participation in a Research Project Study with **titled: Occupational Health and Safety Problems of welding work among small-scale welders of Dar es Salaam, Tanzania.**

Background and Purpose

This is a request for you to participate in a research study that intends to gather information about Occupational Health and Safety Problems of welding works among small-scale welders of Dar es Salaam, Tanzania. We are looking for people who are working in welding workshops and we hope that, you can provide us with the information that will help in understanding the topic in question. Twahiri Magoolo, a postgraduate student at Muhimbili University of Health and Allied Sciences pursuing Masters in Public Health, conducts this study.

Procedures

If you agree to participate in this study, we will give you a guided questionnaire to provide your demographic characteristics, work activities, materials and equipment that you use, the personal protection equipment that you use as you work and some of the health problems that you have encountered and experienced for the last six months to one year as a result of your welding work. At any point if you find any question that you do not want to answer or you don't remember the answer, just let us know and we will assist to clarify or skip and go on to the next question. Your honesty in providing the answers to the questions will be appreciated. The questionnaire and discussion will take 20 minutes at the most and the filled questionnaire will be collected immediately after the discussion is over.

Confidentiality

All the information that will be provided by you as response to questionnaire will be kept confidential and will not be shown to any other person. Identification will be by means of ID numbers that will be assigned to all participants. It will not be possible to identify you in the results of the study when these are published. All the questionnaires with their information will be destroyed at the end of this study after the final presentation is done to the University.

Voluntary Participation

Participation in the study is voluntary. There are no monetary benefits to you; we hope the information you will provide may be useful in improving your work. You can withdraw your consent to participate in the study at any time during the interview without stating any particular reason. If you later on wish to withdraw your consent or have questions concerning the study, you may contact the following:

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Declaration by Study Participant

I have read/listen and understood the consent form and I am willing/Not willing to participate in the study (Delete which is not applicable).

(Name and Signature of the study participant and date)

Declaration by Data Collector

I confirm that I have given information about the study to the best of my knowledge and nothing was left unclarified to the participant.

(Name and Signature of Data Collector and Date)

Appendix 1B: Consent Form – Swahili Version



Mpendwa Mshiriki,

Ombi la Kushiriki kwenye utafiti juu ya kichwa: Madhara ya Kiafya na usalama ya kazi ya ucholemeaji kwa wachomeleaji wadogo wa Dar es Salaam, Tanzania

Utangulizi na dhumuni

Hii ni kukuomba ushiriki katika utafiti wetu huu unaolenga kukusanya taarifa kuhusu kazi ya ucholemeaji na athari za kiafya zinazowakumba wachomeleaji wadogo wadogo waliojiajiri jijini Dar es Salaam, Tanzania. Tunahitaji watu ambao wanafanyakazi katika karakana za ucholemeaji na tuna imani utatupatia taarifa zitakazotusaidia kuelewa somo husika kwenye tafiti hii.

Utaratibu wa kufuata

Kama utakubali kushiriki kwenye utafiti huu, tutakupatia dodoso lenye maswali yanayolenga kufahamau Taarifa zako za makazi, shughuli za kazi yako, , vifaa kinga unavyovitumia katika kazi yako, na athari za kiafya ulizo kutana nazo kwa kipindi cha hadi miezi sita au mwaka mmoja uliopita yatokanayo na kazi yako ya ucholemeaji. Kama itatokea umekutana na swali lolote ambalo usingependa kulijibu ama haukumbuki jibu lake basi utatujulisha ili tukupe ufafanuzi au tuliache na kuendelea na maswali mengine. Ukweli wako katika kutupatia majibu tutayafurahia nakukushukuru.sana Maswali

yanatarajiwa kuchukua takribani dakika 20 kwa uchache na karatasi za maswali zitakusanywa papo hapo mara baada ya kukamilika kujazwa.

Usiri wa taarifa

Tambua kuwa, taarifa zote utakazozitoa pindi unajibu dodoso letu zitabaki kuwa siri na hazitaoneshwa kwa mtu yeyote asiye husika na utafiti huu. Utambulisho wako utakuwa na namba ya utambulisho utakayopatiwa na hatutatumia jina lako mahali popote. Haitawezekana kukutambua pindi matokeo ya utafiti huu yatakapotoka na kuchapishwa. Pia madodoso yote yaliyojazwa yataharibiwa mwisho wa utafiti huu na mara baada ya kufanya wasilisho la mwisho kwa chuo.

Hiari ya Kushiriki

Ushiriki katika utafiti wetu ni wa hiari. Hakutokuwa na faida yoyote kifedha ambayo utaipata kutokana na ushiri wako na tunatarajia taarifa utakazozitoa zitasaidia sana kuboresha kazi yako. Pia unaweza kuamua kujitoka kwenye utafiti wakati na saa yoyote bila sharti wala kutoa sababu yoyote. Kama baadae utapenda kujiondoa au una swali lolote kuhusiana na utafiti wetu unaweza kuwasiliana na wafuatao:

Twahiri Magoolo – Mtafiti Mkuu

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Tamko la Mshiriki

Nimesoma/nimesikiliza na kuelewa fomu hii ya maridhiano na nimeridhia kushiriki katika utafiti huu.

(Jina, sahihi ya mshiriki na tarehe)

Tamko la mkusanya taarifa

Nathibitisha kuwa nimetoa taarifa kuhusiana na utafiti huu kwa mshiriki na hakuna swali la mshiriki limeachwa bila ya kujibiwa au kufafanuliwa.

(Jina, sahihi ya mkusanya taarifa na tarehe)

Appendix 2A: Questionnaire – English Version



Occupational Health and Safety problems of welding work among small scale Welders in Dar es salaam, Tanzania

A postgraduate student researcher from Muhimbili University of Health and Allied Sciences to ask few questions concerning WELDING WORKS, which is your routine professional job, developed this questionnaire. The purpose of the questionnaire is to enable us obtain the information, which will help to understand the occupational health and safety problems that are experienced by small-scale welders of Dar es Salaam in Tanzania.

It is my hope; this information will give us a real situation on your understanding on health hazards relating to your job, the health problems you are facing and the associated factors so that we can set appropriate actions for improving health of small-scale welders in Tanzania.

The survey will take few minutes to complete and give it back to me. If you would like to know the results of this study, please provide your email address or mobile phone number _____

All answers you will provide will be strictly confidential between you and researcher and you will not be disclosed or identified anywhere for any reason.

Thank you!

Part A: Demographic and General Information (Circle the appropriate response)

SN	Questions	Response Choices
1	Your Age (Years) is?	a. <18 years b. 18-24 c. 25-34 d. 35+
2	Sex	a. Male b. Female
3	What is the highest level of education you have completed?	a. Primary school b. Secondary School c. Graduate/College d. Drop Out e. Never attended
4	For how long have you been working as a welder (Years)?	a. <1 b. 1-2 c. 3-5 d. >6
5	Which form of training did you attended to become a welder?	a. Technical college b. Traineeship/Attachment
6	Have you ever attended any Health and safety training in your life?	a. Yes b. No
7	For how long have been working hours in a day?	a. 8hours b. >8hours c. No specific time
8	Do you have history of using tobacco?	a. Yes b. No
9	Have you ever heard about Occupational Health and Safety Authority (OSHA)	a. Yes b. No
10	Among the two commonly applied welding methods Which one do you use?	a. Gas welding b. Electric welding c. Both

Part B: Participant knowledge on welding health hazards, health problems and Personal Protective Equipment (PPE):

	QUESTIONS	Parameter of the assessment
Participant knowledge on welding health hazard (0-8)		
1	Tell us, which welding health and safety hazards do you know?	<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
Knowledge on health problems associated with welding works (0-8)		
2	Which health problems do you think a welder may acquire/get because of his job?	<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
Knowledge on personal protective equipment used welding works (0-8)		

3	What are the common Personal Protective Equipment, which are used in metal welding works?	

Part C: Experienced health problems among welders for the past six months.

Have you ever experienced any accidents, injuries or illnesses/diseases below for the past six (6) months? Tick (√) the appropriate response from the provided List.

Responses	Breathlessness	Chronic cough/Chest pains	Foreign body in the eye	Eye injury/Loss of sight	Impaired Hearing/Pains	Body Cuts/injured by sharps	Skin Burns	Low Back Pain	Electric shock	Explosions
Yes										
No										

Part D: Use of PPE and their frequency of utilisation:

What type of PPE have you been using to protect yourself from exposure to welding hazards such as light, heat, fumes, noise, dusts, etc.? Tick (√) the appropriate response from the provided List.

	Welding helmet	Hand shield/Goggles	face mask/Mask	Work suit/coverall	Ear muffs/ear plugs	Safety shoes	Insulated gloves
Yes							
No							

Part E: Factors associated with use of personal protective equipment and clothing among Small Scale Welders in Dar es Salaam, Tanzania.

From your understanding, what do you think are the main factors influencing the use of personal protective gears and clothing among small-scale welders of Dar es salaam?				
SN		Yes	No	Not sure
1	Affordability/Cost of the PPEs			
2	Knowledge on the use of PPEs			
3	Willingness of welders to use PPE			
4	Presence of Guidelines on PPE Use			
5	Substance abuse such as alcohol			
6	Availability and accessibility			

Thank you!

Appendix 2B- Questionnaire – Kiswahili



Mada: Madhara ya Kiafya na usalama ya kazi ya uhomeleaji kwa wachomeleaji wadogo wa Dar es Salaam, Tanzania

Dodoso hili limeandaliwa na mtafiti mwanafunzi wa shahada ya uzamili katika Chuo Kikuu cha Afya na Sayansi Shirikishi cha Muhimbili ili kuuliza maswali machache kuhusiana na kazi ya uhomeleaji ambayo ni kazi yako ya siku zote. Dhumuni la dodoso hili ni kutuwezesha kupata taarifa ambazo zitasaidia kutambua matatizo ya kiafya na usalama yanayowakabili wachomeleaji wadogo wa Dar es Salaam, Tanzania ili mikakati stahiki ya kuboresha eneo hili iweze kuchukuliwa.

Ni tumaini langu kuwa taarifa hizi zitatupatia hali halisi juu ya matatizo ya kiafya yanayowakabili wachomeleaji wadogo kutokana na kazi yao ya kuhomelea, kadhalika na kutambua kiwango cha uzingatiaji wa misingi ya usalama na afya mahala pa kazi ili kulinda afya na mazingira ya kazi.

Kujaza dodoso hili, litakuchua takribani dakika 20 hadi 30 nalitajazwa kwa usaidizi wa mtafiti mkuu ama msaidizi wake na baada ya kukamilika litakusanywa.

Kama utahitaji kufahamu matokeo ya utafiti huu hapo baadae, unaombwa kuweka mawasiliano _____ yako _____ hapa chini. _____

Majibu na Taarifa utakozitoa zitabaki kuwa siri kati ya mtafiti na mshiriki.

Asante kwa kuamua kushiriki!

Sehemu A: Taarifa za kimakazi na za jumla za mshiriki (Zungushia jibu linalofaa/sahihi)

SN	Swali	Machaguo ya Majibu
1	Umri wako (Miaka) ni?	a. <18 b.18-24 c.25-34 d.35+
2	Jinsia yako ni?	a. Mme b. Mke
3	Kiwango juu cha elimu ulichofikia ni?	a. Elimu ya msingi b. Elimu ya sekondari c. Mhitimu wa chuo d. Uliacha shule e. Haukusoma kabisa
4	Una uzoefu wa miaka mingapi katika kazi yako (Miaka)?	a.<1 b.1-2 c.3-5 d.>6
5	Ulijifunza kwa mfumo gani ufundi wako wa kuchomelea?	a. Chuo cha ufundi b. Kujishikiza kwa mafundi
6	Ulishawahi kuhudhuria mafunzo yoyote ya usalama na afya katika elimu yako?	a. Ndio b. Hapana
7	Unafanya kazi masaa mangapi kwa siku?	a.Masaa 8 b.Zaidi ya 8 c. Hakuna muda maalum
8	Ulishawahi kutumia aina yoyote ya tumbaku?	a. Ndio b. Hapana
9	Ulishawahi kusikia kuhusu Mamlaka ya Usalama na Afya mahala pa kazi(OSHA)	a. Ndio b.Hapana
10.	Katika aina kuu mbili za njia za uchomeleaji,wewe unatumia ipi?	a. Gesi b. Umeme d. Zote

Sehemu C: Matatizo ya kiafya na kiusalama yanayokukuta kutokana na kazi yako ya ufundi :

Swali: Ni matatizo gani ya kiafya na kiusalama kama vile ajali, majeraha au magonjwa umekabiliana nayo kutokana na kazi yako ya ufundi uhomeleaji vyuma kwa kipindi cha mwaka mmoja uliopita? Weka alama ya vema (√) kila tatizo husika kwenye kisanduku hapo chini.

Responses	Kupumu kwa shida	Kukohoa sugu/Kif	Kibanzi cha jicho	Kutoona/macho kuwasha	Kutosikia/Maumivu va sikio	Kujikata	Kiuno/m gongo	Kupigwa shoti/ume	Kulipukiwa na	Kuungua
Ndio										
Hapana										

Sehemu D: Matumizi na Kiwango cha utumiaji wa vifaakinga wakati wa kuchomelea vyuma:

Swali: Huwa unatumia vifaa kinga gani kujikinga na majanga ya kiafya na usalama kama vile mwanga, joto, moshi na hewa, kelele, vumbi, n.k katika kazi yako ya uhomeleaji? Weka alama ya vema (√) kwenye kisanduku chenye jibu ulilochagua.

	Kofia ngumu	Ngao/Mawani ya mwanga	Mask ya uso/Mask	Koti la kufunika mwili	Viziba masikio	Viatu vya usalama	Soksi nzito za mikono
Ndio							
Hapana							

Sehemu E: Mambo yanayohusiana na matumizi ya vifaa kinga na mavazi kwa wachomeleaji wadogo wadogo wa Dar es salaam:

Swali: Kwa uelewa wako, unadhani ni mambo gani makubwa yanayochochea kuongezeko kwa matatizo ya kiafya na kiusalama kwa mafundi wachomeleaji wadodwadogo wa Dar es salaam?


Sn		Nakubali	Sikubali	Sina uhakika
1	Gharama ya vifaa kinga			
2	Uwelewa juu ya umuhimu wa vifaa kinga			
3	Utayari wa wachomeleaji kutumia vifaa kinga			
4	Uwepo wa miongozo ya matumizi ya vifaakinga			
5	Matumizi ya vileo			
6	Upatikanaji wa vifaa kinga			

Asante Sana kwa muda wako!

Appendix 3: Ethical Clearance Approval

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

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



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

Ref. No. HD/MUH/T.517/2017
IRB#: MUHAS-REC-04-2020-236

03rd May, 2020

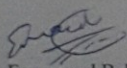
Twahir S. Magoolo,
MPH-Distance Learning,
School of Public Health and Social Sciences,
MUHAS.

RE: APPROVAL OF ETHICAL CLEARANCE FOR A STUDY TITLED: " OCCUPATIONAL HEALTH AND SAFETY PROBLEMS OF WELDING WORKS AMONG SMALL SCALE WELDERS OF DAR ES SALAAM, TANZANIA."

Reference is made to the above heading.

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

The ethical clearance is valid for one year only, from **03rd June, 2020 to 02nd June, 2021**. In case you do not complete data analysis and dissertation report writing by **02nd June 2021**, you will have to apply for renewal of ethical clearance prior to the expiry date.


Dr. Emmanuel Balandya
ACTING: DIRECTOR OF POSTGRADUATE STUDIES

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

Appendix 4: Permission letter to Municipal

EXECUTIVE DIRECTOR,
TEMEKE MUNICIPAL COUNCIL,
P.O. BOX 46343
DAR-ES-SALAAM,
Email: temeke@temekemc.go.tz

4th June 2020

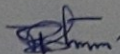
**RE: PERMISSION TO CONDUCT PUBLIC HEALTH RESEARCH AT TOANGOMA
WARD IN TEMEKE MUNICIPALITY FROM 8TH-14TH JUNE 2020**

I am a student pursuing a Master of Public Health degree at Muhimbili University of Health and Allied Sciences (MUHAS) with registration number **HD/MUH/T.517/2017** and currently required to conduct a research as a partial fulfillment of my Master's degree. The title of my study is **Occupational Health and Safety Problems of Welding Work among Small Scale Welders in Dar Es Salaam, Tanzania.**

I have secured ethical clearance approval from the university, with reference Number IRB: MUHAS-REC-04-2020-236 on 3rd June 2020 and therefore permitted to proceed for next step of data collection.

With this letter, I kindly your good office to consider my request and allow me conduct a study in a mentioned area for five days from 8th – 14th June 2020 so that I interact with small scale welders and obtain the required data information for my analysis.

It's my hope that, my request will be positively considered.



Twahiri Saidi Magoolo