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FACTORS INFLUENCING EYE INJURIES AMONG WELDERS IN ACCRA

BY

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DECLARATION

DECLARATION

I, Karl Kafui Kwaku Tetteh, declare that "Factors influencing Eye Injuries among Welders in Accra" is my own work as a student of University of Ghana, School of Public Health. All the sources that I have quoted have been acknowledged by means of complete references. This is submitted as a project work proposal to the School of Public Health, University of Ghana, in partial fulfilment of the requirement for the award of the Master of Public Health degree. This report has never been submitted either in whole or part for award of any degree in any other institution.

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Date: 22 - 07 - 2019

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Date: 22 - 07- 2019

DEDICATION

I dedicate this work to my family for the indefatigable support and love shown during this course.

ACKNOWLEDGEMENT

I thank God for the strength and provision to undertake this study. I am grateful for the motivation, encouragement and guidance of my supervisor, Dr. Seth Afagbedzi of the School of Public Health, Legon, which kept me going.

I appreciate the friendship and contributions of my fellow students which made this experience an enjoyable and fruitful one.

This course would not have been possible without the patience and commitment of all the lecturers.

ABSTRACT

Introduction

Eye injuries are one of the most common work-related injuries among certain occupations, including welders. The aim of this study was to determine factors associated with eye injuries among welders in Accra.

Methods

This was a descriptive cross-sectional study which was conducted among welders in Accra. Proportionate and systematic sampling was used to select 382 eligible welders from two welding sites in Accra Metropolis. Data was collected using a pretested questionnaire. The questionnaire was used to collect data on background information, history of eyes injuries, the use of eye personal protective equipment and factors influencing eye injuries. Microsoft Excel 2016 was used for data entry and STATA version IC 15.0 for Windows was used for analysis. Means and standard deviations were determined for continuous variables. Pearson chi-square test was used to determine the association between dependent and independent variables. Multiple logistic regression was used to determine the strength of association of factors associated with eye injuries. Reported p-values in this study were two-sided with significance levels < 0.05.

Results

Out of the 382 welders, 59.7% engage in electric/arc welding and 40.3% in gas welding. The prevalence of eye injuries was 47.9% with 33.3% of welders using eye personal protective equipment. Factors associated with eye injuries were engaging in gas welding (AOR=0.07; 95% CI: 0.03-0.15; p<0.001), higher monthly income (AOR=5.26; 95% CI: 1.72-16.09; p=0.004), non-use of eye PPE while working (AOR=1.86; 95% CI: 1.02-3.43; p=0.042) and no training on the use of eye personal protective equipment (AOR=2.17; 95% CI: 1.07-4.38; p=0.030).

Conclusion

Almost half of the welders have had a welding-related eye injury before. Majority of welders use electric welding in their activities. Those who use electric welding are more prone to eye injuries, as compared with those who use gas welding. Usage of eye PPEs is relatively low among welders for a variety of reasons, including the fact that usage of eye PPEs is not mandatory. The study found that the welders who do not use eye PPEs have a higher risk of eye injuries. Welders with monthly income above GHS1,000 had higher risk of eye injuries.

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ABBREVIATIONS

mm-Millimeters

MLE-Medium and Large scale Enterprises

MSE-Micro and Small-scale Enterprises

OHS-Occupational Health and Safety

OSHA-Occupational Safety and Health Administration

PI-Principal Investigator

PPE-Personal Protective Equipment

UV-Ultraviolet

UVR-Ultraviolet Radiation

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

The eyes are the third most common organ affected by injuries apart from the hands and feet (Mir et al., 2014). Eye injuries are common and constitute a major cause of preventable blindness. They are a common cause of visual morbidity occurring at workplaces worldwide (Prabhu, Rokhade, Chandra, & Kakhandaki, 2017). Above 2.5 million people succumb to eye injuries annually. Globally, more than 500,000 blinding injuries takes place annually (Ihekaire & Oji, 2017). Eye injuries do not occur as random events. There is empirical evidence that some individuals have increased risk of eye injuries as a result of exposure to hazards or their inability to avoid and detect hazards (Negrel, 1997). Majority of eye injuries have a direct link with occupation and the nature of activity at the time of the injury (Mir et al., 2014). In other words, some individuals have high risk of experiencing eye injuries because of their occupation. These individuals include small-scale and large-scale industrial workers. Welding is one of such occupations that poses an exceptional risk to the eye. Welders are an important occupational group particularly, in developing countries, owing to the advent of urbanization and industrialization which requires labour-oriented markets to change towards more automation and mechanization (Ganesh Kumar, Dharanipriya, & Kar, 2013).

The American Welding Society defines welding as the process of joining metals by heating and warming to a suitable temperature with or without the use of filter metal. It involves cutting metal objects, soldering and in some cases brazing (American Welding Society, 2008). A study on the evaluation of occupational injuries among welders in North West Iran showed that 92% of welders suffered eye problems (Amani et al., 2017).

The occupational eye injuries welders experience is because of exposure to ocular hazards. Ocular hazards are elements and circumstances which are a threat to the maintenance and

advancement of healthy, comfortable and wholesome vision (Ihekaire & Oji, 2017). These ocular hazards include welding flash burns, flying metal objects, harmful metal fumes, particulate matter and thermal burns (Fiebai & Awoyesuku, 2011; Prabhu et al., 2017).

Different studies have reported various risk factors associated with eye injuries among welders. A study conducted in Ethiopia stated that poor working conditions, long periods at work and inadequate safety precautions can lead to increased rates of ocular trauma and disease (Addisu, 2011). A study in India on occupational related eye injuries reported that workers who were partially trained or have no training when exposed to welding were four times more likely to experience eye injuries compared to a trained worker (Ganesh Kumar et al., 2013).

It has been documented that, the use of appropriate eye protection among welders prevents an estimated 90% of eye injuries. Additionally, the use of appropriate protective eye wear during the welding process has been reported to reduce the harmful effects of infrared, visible and ultraviolet radiation. Protective eye wear also provides some form of mechanical protection for the eye from weld splatter. Additionally, they reduce the intensity of visible light to improve protection during welding (Ajayi, Adeoye, Bekibele, & Onakpoya, 2011; Pabley & Keeney, 1981). Thus, the benefits of eye devices cannot be overemphasized.

There is a paucity of information regarding the prevalence of eye injuries and factors that influence eye injuries among welders in Ghana. A study conducted in Cape Coast on ocular health and safety assessment focused on mechanics and reported eye injuries in 39.5% of mechanics (Abu et al., 2016). Auto-welding mechanics had the highest risk of developing eye injuries.

It is against this background that this study seeks to determine factors that influence eye injuries among welders in Accra.

1.2 Problem statement

Globally, injuries cause significant economic loss. Per the Occupational Safety and Health Administration (OSHA), occupational eye injuries cause an economic loss of around $300 million each year (Prabhu et al., 2017).

The welding process is one which is prone to occupational injuries. Welding produces fumes, sparks, radiations and metal debris which may be hazardous to the eyes. Lombardi and colleagues in their study reported that welding increases the risk of eye injuries by four fold (Lombardi et al., 2005). Eye injuries among welders are of public health concern (Ghimire, Budhathoki, Niraula, Shrestha, & Pokharel, 2018). Eye injuries are a major cause of visual impairment and preventable blindness in the world. The use of eye personal protective equipment plays a significant role in ensuring the safety and welfare of welders. Despite the availability of these PPEs, eye injuries among welders still linger on.

In Nigeria, it was reported that the prevalence of eye injuries was 60.2% among welders in Port Harcourt. It was also reported that only 15.3% of welders were using eye PPEs at the time of the eye injury. The study also concluded that the main source of these injuries were metal chips and arc rays which could have been prevented by the use of eye PPEs (Fiebai & Awoyesuku, 2011).

Ghana has a large informal sector which makes up 70% of its workforce (Clarke, 2012). Welding activities generally fall under the informal sector in Ghana. In Ghana, welders are vulnerable to occupational injuries and accidents because workplace safety is at a very low level due to lack of regulation and inspections, informal management structures and lack of organizational safety culture (Clarke, 2005). Thus, injuries associated with this profession could be damaging to the society and economy of the country as these informal sector workers help to mobilize capital and human resources.

Research efforts in relation to occupational health and safety issues in Ghana have been focused on mechanics (Abu et al., 2016), woodworkers and the timber industry (Dwomoh, Owusu, & Addo, 2013). There is dearth of research on injuries, particularly eye injuries among welders in the country. Additionally, these eye injuries among welders are not regularly reported. Furthermore, anecdotal information indicates welding sites have poor working conditions and insufficient use of eye PPEs though there is significant continuous exposure to hazards from this occupation. Currently, not much is known about the prevalence and factors that influence eye injuries among welders in Accra. In addition, little is known about the prevalence of the use of eye PPEs among welders. This study, therefore, seeks to address these identified gaps in research on eye injuries among welders in Accra. Considering the relatively high prevalence of eye injuries reported in some studies, this study is important to identify factors associated with eye injuries among welders in Accra.

1.3 Justification

There exists occupational hazards and safety problems in every workplace. Thus, it is important safety systems are put in place to safeguard the welfare, health and safety of the worker. The challenging economic and jobs climate in the country has led to increase in informal sector work. Most works in the informal sector, especially welding, are injury prone. These injuries, especially eye injuries associated with welding, can be prevented if appropriate measures are taken. However, welders fall primarily under the informal sector where implementation of safety practices is perceived to be low or non-existent. The establishment and implementation of safety practices in this sector may be primarily dependent on the private owners of these small-scale businesses or the knowledge and safety practices of freelance welders. This situation could potentially result in the upsurge of preventable eye injuries among welders. There is paucity of documentation regarding eye injuries and the use of eye PPEs by welders in Ghana.

Hence, this study on factors that influence eye injuries among welders in Accra will provide baseline information on the prevalence of eye injuries among welders. It will identify factors which positively or negatively influence eye injuries so that appropriate recommendations would be made to improve the health and safety of welders in Accra. This study will also provide information on occupational health and safety practices among welders with regards to the use of eye PPEs. Additionally, this study will serve as a basis for advocacy regarding the reduction of eye injuries suffered by welders through welders' education, safety training and welfare about eye care; this will mitigate the economic and social impact that eye injuries will have on the nation, communities and families.

1.4 Objectives

1.4.1 General objective

The aim of this study is to determine factors that influence eye injuries among welders in Accra.

1.4.2 Specific objectives

1. To determine the prevalence of eye injuries among welders in Accra
2. To determine the proportion of welders who use the different welding types
3. To determine the proportion of welders who use eye personal protective equipment
4. To identify factors influencing eye injuries among welders in Accra

1.5 Research questions

1. What is the prevalence of eye injuries among welders in Accra?
2. What proportion of welders use the different welding types?
3. What is the prevalence of personal protective equipment usage among welders?
4. What are the factors that influence eye injuries among welders in Accra?

1.6 Conceptual Framework

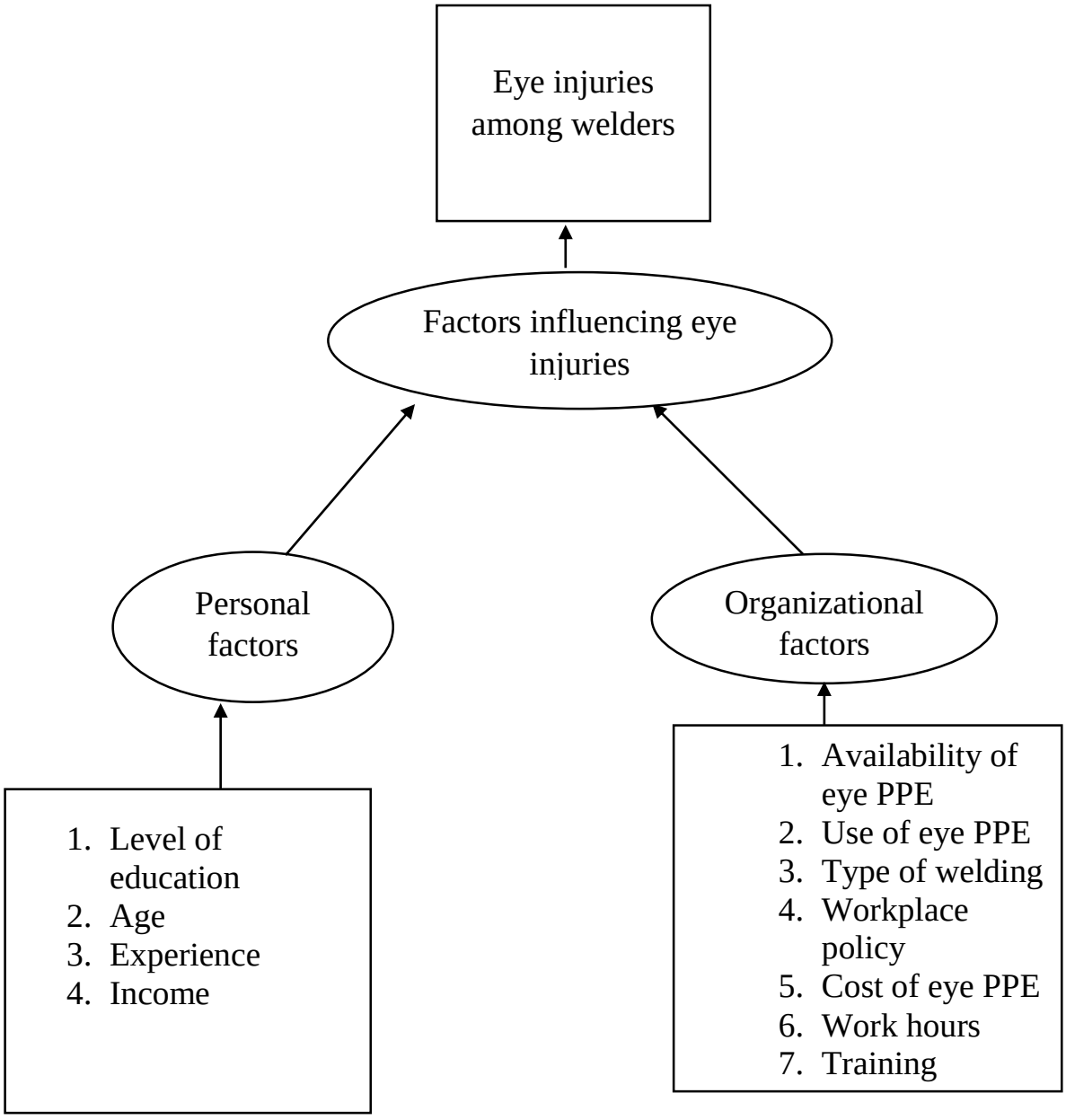

Figure 1: Conceptual Framework of Factors influencing Eye Injuries among welders in Accra

1.6.1 Narrative of conceptual framework

Personal factors influence eye injuries among welders, as indicated in Figure 1. A welder's level of education is expected to impact the incidence of eye injuries; welders with higher level of education may have more knowledge about safety and prevention of injuries, leading to lower levels of eye injuries. Age is also expected to influence the number of eye injuries, with younger welders expected to have more injuries. The number of years of experience as a welder could also influence the occurrence of eye injuries. Welders who have been on the job for a long time may be less likely to suffer from eye injuries compared to those who are new to the occupation due to lessons learnt over the years. Higher income may lead to more eye injuries; in their quest to make more income, welders take on more jobs and hurry through the jobs, predisposing them to more eye injuries.

Additionally, organizational factors such as type of welding, availability of PPEs, the use of eye PPEs, the cost of these eye PPEs and workplace policies may also influence eye injuries. The occurrence of eye injuries among welders is influenced by the type of welding technique employed at their workplace, as shown in Figure 1. The type of welding a worker engages in influences the occurrence of eye injuries because some welding types are perceived as less hazardous as compared to others. Vecchia et al. (2007) reported that arc welding is the most hazardous. The use of eye PPEs reduces the risk of eye injuries. The availability of eye PPEs may reduce the occurrence of eye injuries among welders. However, availability of PPEs does not necessarily translate into use. This is because some welders may still not use eye PPEs even though they may be available. The cost of eye PPEs may also play a role in the occurrence of eye injuries because welders may not acquire them if the cost is prohibitive to them. Training on the use of eye PPE leads to a reduction in eye injuries. Working for long hours increases the risk of eye injuries due to fatigue.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.0 Introduction

This chapter reviews literature in areas relevant to this study. It elaborates more on the various types of welding and welding techniques used by welders in Ghana and the proportion of welders who adhere to the use of eye personal protective equipment (PPE) during work. The chapter finally looks at factors influencing eye injuries among welders and the relationship between eye injuries and PPE use among welders.

2.1 Prevalence of eye injuries among welders

Welders are a high risk group for eye injuries due to their occupational exposures to metals and ultraviolent radiations. Traumatic eye injury is one of the most common and significant occupational health and safety concerns for welders (Bhumika, Thakur, Jaswal, Pundir, & Rajwar, 2014). The welding process emits a wide spectrum of radiations ranging between 200 to 1400 millimeters (mm). These radiations include ultraviolet (UV) rays (200 to 400 mm), visible light (400 to 700 mm) and infrared rays (700 to 1400 mm) (Fich, Dahl, & Fledelius, 1993; Voke, 1999). They have the tendency of causing damage to the eye when absorbed by the cornea and lens (Kumah et al., 2011). It has been reported that the intensity of light emitted from welding arcs causes damage to the retina. Also, infrared radiation may cause damage to the cornea, consequently leading to the development of cataracts. In addition, exposure to ultraviolet light from welding arcs, even for a very brief period of time, causes blight eye (American Welding Society, 2008). Long term exposure to ultraviolet radiation is associated with eye conditions such as pingueculae, pterygia, and keratopathy. In addition, thermal burns from hot metals can also occur during welding which contribute to the risk of developing skin and ocular damage (Ajayi & Omotoye, 2012).

According to Nartey et al. (2017), there are two categories of eye injuries based on their mode of cause: mechanical and non-mechanical. The former is further classified as closed globe injury and open globe injury depending on the intensity of damage caused to the cornea of the eye. Non-mechanical injuries are injuries incurred as a result of exposure to chemicals or radiations. It is classified into the following: chemical injuries, photo-radiation injuries, thermal injuries and electrical injuries (Nartey et al., 2017). Chemical ocular injuries are as a result of an acidic or alkali substance getting into the eye while photo-radiation ocular injuries are injuries caused by either ultraviolet or infrared radiation. Thermal ocular injuries are frequently caused by fire, or by hot fluids (Nartey et al., 2017).

Mechanical damage occurs from being struck by flying particles and chipped slag, radiation and photochemical burns from ultraviolet radiation (UVR), infrared radiation, and intense blue light. Irritation and chemical burns from fumes and chemicals are also associated with eye injuries among welders (Ngo & Leo, 2008). Ngo & Leo (2008) indicated that 71.3% cases of superficial corneal foreign body is associated with welding. Another study conducted on corneal injuries in a mechanic village in Nigeria reported that about 48% of study participants had diverse corneal injuries such as corneal opacity and photo keratitis (Ihekaire & Oji, 2017). Injuries to the cornea can be particularly troubling and may result in symptoms such as impaired vision, eye discomfort, burning sensation, swollen lids, and photophobia, among others (Yanoff & Cameron, 2011). Ihekaire & Oji (2017) indicated that mechanic welders sustain this injury by retaining extra ocular foreign bodies, blunt trauma, and penetrating and perforating injuries.

A cross sectional study was conducted in Nigeria to determine the prevalence and pattern of ocular injuries among industrial welders and the rate of use of protective eyewear. The results of the study showed that 60.2% of the workers experienced work related eye injury (Fiebai, & Awoyesuku, 2011). Another cross sectional study was carried out in rural communities in

Nigeria among welders. The research sought to determine the prevalence and pattern of eye injuries and the rate of eyewear among welders. The findings of the study demonstrated that 84.5% of the welders had ocular injury (Nwala et al., 2014). The results from the study conducted by Fiebai and Awoyesuku (2011) is lower than what was reported by Nwala and colleagues. The differences in the prevalence could possibly be due to the fact that one study was carried out in the rural areas while the other study used both rural and urban areas. The results of a study carried out in Bayelsa, Nigeria among welders showed that, the prevalence of eye injury was 43.4% with the commonest reported eye injury to be burns, foreign body and cuts (Douglas & Koroye-Egbe, 2018). A cross sectional study conducted among welders in the metal industry in India indicated that 75% of the welders had eye injury (Ganesh Kumar, & Dharanipriya, 2014). A cross sectional study conducted among welders in South Africa indicated that 61% of the welders had eye injury and the eye symptoms reported were foreign body sensation, persistent after images and watery eyes (Sithole, Oduntan, & Oriowo, 2009). A study of corneal injuries associated with ocular hazards in the welding industries in Nigeria revealed that 48% of the welders had diverse cornea injuries (Ihekaire, & Oji, 2017).

Adherence to strict rules and regulations with regards to occupational health and safety has been reported to reduce work related accidents (Alli, 2008; Peate, 2007; OSHA, 2016). Awareness and regulatory measures with respect to adherence to safety precautions exists in developed countries. However, in developing countries, it is in the incipient stage of development. In Ghana, welding activities generally fall under the informal sector. Welders and mechanics in Ghana constitute 11.5% of the human resource (Puplampu & Quartey, 2012). Low level of skills and technology affects the level of production among informal sector workers in Ghana. These workers employ rudimentary manual and traditional technologies and processes. They have been reported to be either ignorant about occupational health and safety issues in their fields of work or they simply cannot bear the cost of appropriate protective

gadgets. Thus, most workers in the informal sector are exposed to unpleasant environmental and hazardous conditions that pose a threat to their health and safety (Osei-Boateng & Ampratwum, 2011). The main reasons for these observations could be low level of education of informal sector workers, inadequate knowledge on health hazards as well as unavailability of preventive measures (Ganesh Kumar et al., 2013). In addition to these factors, safety precautions are not rigorously implemented in the informal sector. Thus, eye injuries among this group of people could be significant and detrimental to the economy of the country. In conclusion, previous studies indicate that the prevalence of eye injuries among welders are generally relatively high and hence this study will determine the prevalence of eye injuries among welders in Accra.

2.2 Type of welding and welding techniques used by welders in Ghana

Welding is a metal fabrication process in which metals are joined by the application of heat or pressure which leads to the melting of the metal at the joint and solidification (Tenkate, 2012). Welding processes differ in the manner in which temperature and pressure are combined and achieved. Based on energy source, welding processes can be classified as follows: gas welding, arc welding, resistance welding, solid state welding, thermo- chemical welding and radiant energy welding (Khan, 2007). Ihekaire & Oji (2017) indicated two basic types of welding: electrical welding and gas welding. The electrical welding is done with the use of welding arc which transforms electrical energy to heat energy. In gas welding, there is controlled combustion of acetylene and oxygen to achieve a flame temperature of 3,300°C.

Though there are many types of welding, gas and arc welding are the commonest types of welding practiced in developing countries (Ajayi & Omotoye, 2012). According to a study in Nigeria by Ajayi & Omotoye (2012), 67.9% were electric/arc welders and 22.5% were gas welders. In Ghana, the arc welding process is the most widely used (91%) welding process by industries (Adu, 2011; Adu & Danquah, 2016). Nartey et al. (2017) also indicated that the arc

welding process is the most widely used (91.0%) welding process by industries in Ghana whilst 43% of these industries use a combination of both arc and gas welding. Arc welding is the most frequently used type among welders in Ghana due to its flexibility and cost effectiveness (Adu & Danquah, 2016). Within the arc welding group, the largest percentage of the firms (77.35%) use the shielded metal arc welding only (Adu, 2011).

Occupational hazards associated with welding have been categorized into two; chemical and physical damaging factors. The chemical factors are dependent on the techniques of welding, the metal used, the metallic elements of the welding electrodes, whether working in open or closed environments and proper ventilation. The physical damaging factors include effects of gases, welding fumes and vapor which depend on exposure time, the type of welding process, protection practices and working conditions (Amani, Bahadoram, & Hazrati, 2017).

According to Edusa (2013), welding activities in Ghana fall under two sectors: the formal and the informal sector. The formal welding sector is made up of companies functioning under the metal production and manufacturing industries in Ghana; these companies are categorized as medium and large scale enterprises (MLEs) (Akpakpavi, 2015). Adu & Danquah (2016) also indicated that the formal sector is made up of companies that are registered with the Registrar-General's Department; they include governmental institutions, such as educational, health, research, mining, refineries and agro-processing institutions that have welding shops with trained or qualified welders. However, the informal welding sector is made up of enterprises which are not functioning under the metal production and manufacturing industries in Ghana and are categorized as micro and small scale enterprises (MSEs). The level of sophistication and formal expertise in the informal sector is low, although welders may benefit from several years of experience. The predominant tasks done in this sector include production of plate and sheet metals, construction of metal products, and maintenance and repairs of metallic products (Akpakpavi, 2015). In conclusion, welding activities practiced in Ghana have therefore been

focused on the use of the afore- mentioned welding processes and welding techniques.

2.3 Proportion of welders utilizing Eye Personal Protective Equipment (PPE).

The employment of safety measures and practices among welders are potential ways of reducing health hazards associated with this occupation. One of the proven ways to improve occupational health among welders, is the use of personal protective equipment (PPE). Most of the eye injuries welders suffer in the course of their work can be prevented via the use of appropriate eye personal protective equipment (PPE), particularly safety googles, helmets and face shields (Lombardi, Verma, Brennan, & Perry, 2009).The use of PPE is reported to be an important strategy for preventing exposure to hazards that could result in injuries and illnesses among workers across various industries including those in motor vehicle repair sector (Kumah et al., 2011). Most common PPEs for ocular protection are goggles, safety glasses and helmets. Goggles, for instance, provide better protection of the eye from impact, dust and radiation hazards (Puplampu & Quartey, 2012). Despite the widely acknowledged benefits of PPE use, only few workers wear PPE on regular basis. Budhathoki et al. (2014) reported that only 47.7% of welders used eye PPE. A study by Abu et al. (2016) in Cape Coast Metropolis in Ghana among mechanics reported that 72.5% of workers did not use eye PPE. A study conducted by Woo & Sundar (2006) indicated that protective eyewear were available for 48.6% of workers in a welding firm; however, only a fifth, representing 19.4%, wore the device. In parts of Singapore, it was found that 43.7% of workers had not used protective eyewear at the time of injury even though it was available to them while 34.6% had not been provided with any PPE at all (Voon et al., 2001). In the same country, it was found that 32.0% of reported cases of injury among welders was due to non-provision with eye PPEs while 38.7% had not used PPEs that was made available to them (Voon et al., 2001). In the Eastern Province of Saudi Arabia, it was reported that more than a third of those workers injured were not wearing eye protection devices made available to them at the time of injury, and that 76.6% of accidents were as a

result of projectile foreign bodies (Woo & Sundar, 2006).

These reports indicate that in many settings across the globe, even when workplace regulations are established and eyewear is made available, availability does not always result in usage and that negligence on the part of some workers may result in eye injuries. The stated reasons for the non-use of PPES include low perception of risk, poorly maintained lenses, discomfort, having to wear prescription lenses underneath, and vanity (Rodriquez, 2015). While the use of eye PPEs can protect the wearer's face, including the eyes, from a variety of hazards such as particles, light, heat, wind blast, (Sukati, 2014), only a few welders wear PPE. According to Sukati (2014), the use of alcohol and illicit drugs has been suggested to be a contributor to the non-use of PPE in the workplace. Other reported factors are inconvenience, cost, inappropriateness for the task and interference with prescription glasses (Lombardi et al., 2009). Lack of knowledge about the importance of protective devices is also a factor contributing to the non-usage of PPE (Meallet, 2008). According to Purslow & North (2009), the circumstances under which people work define which type of PPE they need to use and the importance attached to using them. Koffuor et al., (2012) also indicated that the setting in which an industry is placed has a bearing or an effect on the oculo-visual function. Therefore, there is variation in the rate of use of PPE among welders in different parts of the world. Undoubtedly, eye protection practices among welders appear to be inadequate and unsatisfactory to prevent injuries; hence, this study will determine the proportion of welders who use eye PPE while welding.

2.4 Factors influencing eye injuries among welders

Eye injuries account for one-quarter of all welding injuries, making them by far the most common injury among welders (Braun, 2007). The high incidence of eye injuries is attributed to a wide range of factors; some may be personal, environmental or organizational. According

to Ganesh Kumar & Dharanipriya (2014), age is a significant predictor of eye injuries, with the younger welders of less than 30 years old having a much higher prevalence (48.9%) than those above 50 years old. This study also reported a higher prevalence of eye injuries among welders with relatively lower education between grade 1 and 7 (53.2%). It was also reported in Nigeria that old age and a history of eye injuries were factors that influenced the development of cataract among metal arc welders (Megbele, Lam, & Sadhra, 2012). A study done in India by Chepkener (2013) among metal workers, including welders, reported that higher income may be linked to more eye injuries; workers, in their quest to make more income, take on more jobs which makes them hurry and more vulnerable to eye injuries. The use of eye PPE has the potential to reduce eye injuries among welders in their workplaces. Lombardi et al. (2009) indicated that work-related eye injuries may be reduced by at least 50% by using eye PPEs. Ihekaire & Oji (2017) conducted a descriptive study in parts of Nigeria on corneal injuries associated with ocular hazards in the welding industry. It was found that about 1.3% of eye injuries occurred among regular users of PPE, 46.1% among occasional users, and 38.1% among non-users. It was concluded that eye injuries occur because of non-usage of eye PPEs. In a cross-sectional study conducted on work related injury among welders, it was revealed that more than 95% of welders used at least one personal protective equipment; however, more injuries were seen among welders not using PPE at work (Ghimire et al., 2018). Budhathoki et al. (2014) indicated that welders who reported using PPE during welding were two times more likely to have been aware of hazards and hence, their likelihood of getting exposed to hazards was lower compared to their counterparts not putting on PPE. It was found in a study conducted in Cape Coast Metropolis of Ghana that eye injuries were reported in 39.5% of mechanics probably due to the non-compliance in the usage of eye protective devices (Abu et al., 2016). According to Sukati (2014), despite the existence of rules and regulations for eye protection in workplaces, injuries continue to occur mostly because of non-compliance with existing

guidelines and not issuing protective eye devices. Some authors indicated that the main drivers of eye injury among some welders are the use of cheap quality personal protective eyewear, lack of enforcement or low management priority of safety guidelines, laziness, rushing around, feeling of invincibility and lack of awareness of hazards (Lombardi et al., 2009; Meallet, 2008). Welding type has an influence on eye injuries. Vecchia et al. (2007) reported that arc welding is the most hazardous. According to Ajayi & Omotoye (2012), some eye conditions, like corneal opacity, are significantly higher among electric/arc welders as compared to gas welders. Gas welding poses less hazard because of lower ultraviolet emissions and reduced intensity of the flame (Davies, Asana, Nku, & Osim, 2010). In conclusion, this study will assess factors that influence eye injuries among welders in Accra.

CHAPTER THREE

3.0 METHODS

3.0 Introduction

This chapter provides description of how this study determined factors influencing eye injuries among welders in Accra. It contains a description of the study sites, methodological design/study type, the target population, detailed sample size calculation, sampling procedure, data quality, data management and analysis and ethical concerns involved in this study.

3.1 Study type

The study was a descriptive cross sectional survey which was conducted in March 2019 to determine factors associated with eye injuries among welders in Accra. Semi-structured questionnaires were administered to consenting participants to assess history of eye injuries, usage of eye PPEs, and factors influencing eye injuries.

3.2 Study site description

The study was conducted at Agbogbloshie and Darkuman Cable and Wireless because they are very busy hubs for informal sector welding activities. These study sites are located in Accra, the capital of Greater Accra Region, Ghana.

Accra is the economic hub of the Greater Accra region and the rest of the country. It is described as one of the fastest growing cities in Africa (Amoako & Frimpong Boamah, 2015). The city has a total of 778,267 migrants with an annual growth rate of 4.3%. According to the Ghana Statistical Service, it has a total population of 1,665,086 representing 42% of the region's total population. Greater Accra Region is the second largest region in Ghana in terms of population. Majority of the population (51.9%) are females and reside in urban areas (Ghana Statistical Service, 2014). It also has a household population of 1, 599, 914 with a total number of 450, 748 households. Approximately 70.1% of the population aged 15 years and older are economically active and 93% are employed whiles 7% are unemployed. Out of the employed

population, 1.7% are involved in skilled agriculture, forestry and fishery, 38.5% in service and sales, 20.1% in craft and related trade and 17.2% are managers, professionals and technicians (Ghana Statistical Service, 2014). The private sector employs the largest number of people in the country, accounting for 93% of jobs. About 86.1% of the economically active population aged 15 years and older are employed in the private informal sector.

Darkuman is a community located in the Okaikoi South Sub-Metro in the Accra Metropolitan Area of the Greater Accra Region. The population of Okaikoi South represents about 3% of the population of the Greater Accra Region (Ghana Statistical Service, 2014). Darkuman Cable & Wireless is a mixture of residential buildings, wholesale and retail shops, formal and informal offices and workshops, and open expanses of informal activity including welding.

Agbogbloshie is a neighborhood located in Central Accra. It is located in the Ashiedu Keteke Sub-Metro in the Accra Metropolitan Area of the Greater Accra Region. The population of Ashiedu Keteke represents about 2.9% of the population of the Greater Accra Region (Ghana Statistical Service, 2014). Agbogbloshie is an informal settlement with considerable overlap between industrial, commercial and residential zones. It is known as the hotspot of e-waste recycling (Grant & Oteng-Ababio, 2012). Agbogbloshie is separated by Abossey-Okai Road and is an extended community as well as one of Ghana's largest urban slums (Daum, Stoler, & Grant, 2017). It serves as home for informal workers and families.

3.3 Study population

The study was made up of "welders" of all ages and sex in selected sites in Agbogbloshie and Darkuman Cable and Wireless.

3.4 Inclusion Criteria

The study included welders of all types irrespective of age and sex working in the study site and willing to participate in the study. A welder in this study was defined as anyone who joins or brazes pieces of metal and has been involved in this activity for not less than six months.

3.5 Exclusion criteria

The study excluded welders who did not give consent.

3.6 Variables

3.6.1 Dependent variable

The dependent variable in this study was eye injury. This referred to whether the respondent has had any welding-related eye injury, defined as any eye trauma, discomfort or impaired vision as a result of welding activities.

3.6.2 Independent variable

Independent variables are partly responsible for the occurrence of dependent variable. In this study, independent variables included; age, sex, religion, number of years of working as a welder, income, highest level of education, history of eye injury, welder type, the use of eye PPE while working and work place policies concerning the use of eye PPE.

3.6.3 Study variables

Table 1: Study Variables

Variable	Operational Definition	Scale of Measurement
Eye Injury	Whether or not the respondent has experienced a welding-related eye injury	Nominal
Age	Age at last birthday	Continuous
Gender	Sex of respondent	Nominal
Religion	Religious affiliation	Nominal
Marital Status	State of being in marital union	Nominal
Level of education	Highest level of education	Ordinal
Average monthly income	Average monthly income from welding activities	Continuous
Years of working experience as a welder	Number of years as a welder	Continuous

Number of hours of work in a day	Number of hours of welding activities engaged in	Continuous
Type of welder	Type of welder at post	Nominal
Type of welding	Type of welding engaged in	Nominal
Extent of injury	Severity of eye injury sustained	Ordinal
Eye PPE use at time of injury	Whether or not welder used eye PPE at the time of injury	Nominal
Train eye PPE	Whether or not welder has had training on use of eye PPE	Nominal
Use eye PPE	Use of eye PPE during welding activities	Nominal

3.7 Sample size calculation

The required sample size was determined using a formula obtained from an article authored by Cochran (1977). Assumptions were based on; reliability coefficient (z) of 1.96 at 95% confidence level, margin of error (e) of 5 %, and the proportion of 60.2% (Fiebai & Awoyesuku, 2011). These figures were substituted into the formula to determine a minimum sample size for the study. The minimum sample size that was obtained was increased by a non-response rate of 5% based on Cochran (1977) proportion of population effect.

$\mathbf{N = Z^2pq/e^2}$ (Cochran, 1977)

N= sample size	N=?
Z= Z-score	z=95%=1.96
P= prevalence	p=0.602 (Fiebai & Awoyesuku, 2011)
q= 1-prevalence	q=0.398
D= Margin of error	d=0.05

$$\frac{(1.96)^2 \times (0.602 \times 0.398)}{(0.05)^2} = \frac{0.92043}{0.0025} = 368.17$$

Non response rate of 5% (0.05) gives: 0.05 x 369 = 18.45

Adding 19 to the sample size (n) of 369 gives, ***(i.e. 19+ 369= 388).*** Hence, the sample size desired for the study was **388.**

3.8 Sampling procedure

Simple random sampling was used to select two study sites in Accra; Agbogbloshie and Darkuman Cable and Wireless. The two study sites were randomly selected in order to achieve the minimum sample size required for the study. Proportionate sampling was used to determine the number of welders required at each site to achieve the required sample size. To do this, the total population of welders of the New Korley Lagoon Association of Welders (Agbogbloshie), and National Artisans and Traders Union of Ghana (NATUG), Darkuman Cable and Wireless branch was used.

Table 2 Proportionate Sampling for study sites

Sampling Site	Population size of welders	Sampling size
Agbogbloshie	500	162
Darkuman Cable & Wireless	700	226
Total	1200	388

To ensure sample representativeness, sampling interval *k* was calculated using *N/n* where N = population size, and n = sample size. For Agbogbloshie, *k*=3; after a random start, every third welder was selected until the calculated sample size was reached. For Darkuman Cable & Wireless, *k*=3; after a random start, every third welder was selected until the calculated sample size was reached. In order not to be interviewed more than once, respondents were advised to refuse repeat offers to participate in this study.

3.9 Data collection

Data was collected by 2 trained Research Assistants. A pre-tested semi-structured questionnaire was used to obtain information on the socio-demographic characteristics, history of eye injury, welding types, the use of personal protective equipment during welding activities, and factors influencing eye injuries. Data was collected through face to face interviews. This process was conducted in either English language or the local language of participants. Eligible participants were asked to give informed consent and allowed to participate in the study only

after appending their signature to two copies of consent forms. One was in the custody of the researcher whiles the other was in the custody of the participant as a sign of voluntary participation. Interviews were conducted in a private area away from other individuals.

3.9.1 Safety Considerations

During data collection it was anticipated that some participants may feel minor emotional distress especially if an eye injury has been suffered in the past; participants were reassured when such circumstances were encountered.

3.9.2 Data processing

Questionnaires from the field were coded. All questionnaires were checked by the Principal Investigator (PI) for consistency before passing on for data entry. Microsoft Excel 2016 was used for data entry. There was double data entry by different data entry clerks to ensure data consistency. After consistency checks was done, the entered data was exported to Stata version 15.0 (Stata Corporation, Texas, USA) for cleaning and analysis.

3.10 Data analysis

The primary analysis for the study was the proportion of welders admitting having suffered eye injuries. Secondary endpoint analysis was focused on age, sex, educational level, number of working years, income, welding type and the use of eye PPE. (independent variables). Descriptive statistics was used for background characteristics of welders. Differences in proportions were analysed using the Chi-Square test. This was to test for association between dependent and independent variables. Univariate and multiple logistic regression analyses were used to determine the strength of the association after adjusting for multiple collinearity through factor analysis. Risk factors identified during univariate analysis were fitted in logistic regression models to further determine strength of association. All reported p-values were two-sided with significance level < 0.05. The data analysis conducted in this study was adapted from a study risk of cataract in Nigerian metal arc welders (Megbele, Lam, & Sadhra, 2012).

3.11 Quality control

Before data collection, data collection tools were pretested outside the study sites, in a similar work environment. The purpose of this was to identify inconsistencies that may be encountered in the actual data collection process. Similarly, it offered research assistants an opportunity to familiarize themselves with data collection tools before the actual data collection. For the purpose of quality data, alphanumeric codes identifiable by location were assigned. The Principal Investigator was involved in actual data collection. He was responsible for supervision to ensure that Research Assistants adhere to guidelines. At the end of each data collection session, debriefing was done. This was to help identify challenges that were identified during the data collection process and how best to address them. Also, the Research Assistants validated each questionnaire for data quality and completeness.

3.12 Ethical consideration

Ethical approval for the study was obtained from the Ghana Health Service Ethics Review Committee (GHSERC: 036/02/19). Permission was also obtained from the New Korley Lagoon Association of Welders (Agbogbloshie), and National Artisans and Traders Union of Ghana (NATUG), Darkuman Cable and Wireless branch. Each respondent was informed prior to the interview that they are under no obligation to take part, they could withdraw at any time and that all answers were treated with paramount confidentiality. All welders who agreed to be part of the study were required to sign an informed consent form before being interviewed.

3.13 Limitations of the study

Some respondents had difficulty in recalling some information. Due to time constraints, eye screening was not performed to identify eye injuries and further validate findings. The study was cross-sectional and assessed the prevalence of eye injuries and factors influencing eye injuries at a point in time.

CHAPTER FOUR

4.0 RESULTS

Introduction

This chapter presents the analysis of the data collected. The aim of this study was to determine the factors that influence eye injuries among welders in Accra.

4.1 Demographic characteristics

Three hundred and eighty-two (382) welders were involved in this study. The mean age of study participants was 32.6 ± 10.96 (Table 4.1). Almost half of participants (42.9%) were aged between 20-29 years. Less than a third (27.0%) were aged 30-39 years with 7.1% being in the 50-59 years' age group. Individuals aged above 60 years were the least (2.9%). A large proportion of the participants (97.9%) were males with 2.1% being females (Table 4.1). Only 8.1% of welders had no formal education (Table 4.1). The rest indicated they had varying forms of education; primary (67.8%), secondary (21.7%) and tertiary education (2.4%). Close to a third of participants (30.1%) indicated they had been in the profession for 1 to 5 years while 27.2% stated they had been welding for 6 to 10 years and 5.2% had been working as welders for less than a year. Based on type of welder, close to half (45.3%) were masters and 33.8% were apprentice, with 20.9% being workers (Table 4.1). The most common welding type used in this study was electric/arc welding (59.7%) followed by gas welding (40.3%). More than half of participants (55.2%) stated they work more than 12 hours daily, with 44.8% working less than 12 hours daily. Similarly, close to half of the welders (42.7%) stated they earned between GHS 100 and 500 per month with 18.1% earning more than GHS 1000 per month. Based on religious affiliation, most of the welders (72.0%) were Christians while 28.0% professed Islam. With respect to marital status, over half of the welders (53.9%) were single, with 46.1% being married.

Table 4.1 Demographic characteristics of respondents

`	Numbers	Percentage (%)
Mean age (SD)	**32.6(10.96)**	
Age (years):		
< 20	23	6.0
20-29	164	42.9
30-39	103	27.0
49-49	54	14.1
50-59	27	7.1
60+	11	2.9
Sex:		
Male	374	97.9
Female	8	2.1
Education:		
No formal education	31	8.1
Primary	259	67.8
Secondary	83	21.7
Tertiary	9	2.4
Working experience (years):		
< 1	20	5.2
1-5	115	30.1
6-10	104	27.2
> 10	143	37.4
Type of welder:		
Apprentice	129	33.8
Worker	80	20.9
Master	173	45.3
Welding type:		
Electric/Arc Welding	228	59.7
Gas Welding	154	40.3
Daily working hours:		
< 12 hours	171	44.8
> 12 hours	211	55.2
Monthly income (GHS):		
< 100	66	17.3
100-500	163	42.7
600-1000	84	22.0
> 1000	69	18.1
Religion:		
Christianity	275	72.0
Islam	107	28.0
Marital status:		
Single	206	53.9
Married	176	46.1
Total	382	100

4.2 Prevalence of eye injuries

Out of the 382 welders, 47.9% (95% CI:42.8%-53.0%) stated they had experienced an eye injury while 52.1% stated otherwise, as shown in Figure 2.

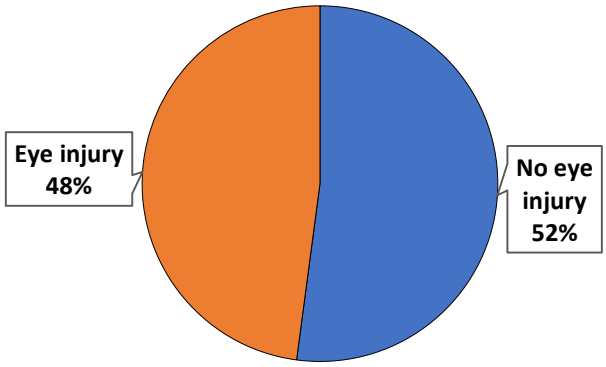

Figure 2 Prevalence of eye injuries

4.3 Distribution of eye injuries among welding types

The most common welding type used in this study was electric/arc welding (59.7%) (95% CI: 54.6%-64.6%) followed by gas welding (40.3%) (95% CI: 35.4%-45.4%). Among those who used electric/arc welding, most suffered eye injuries (73.7%), with only 9.7% of gas welders reporting eye injuries, as shown in Figure 3.

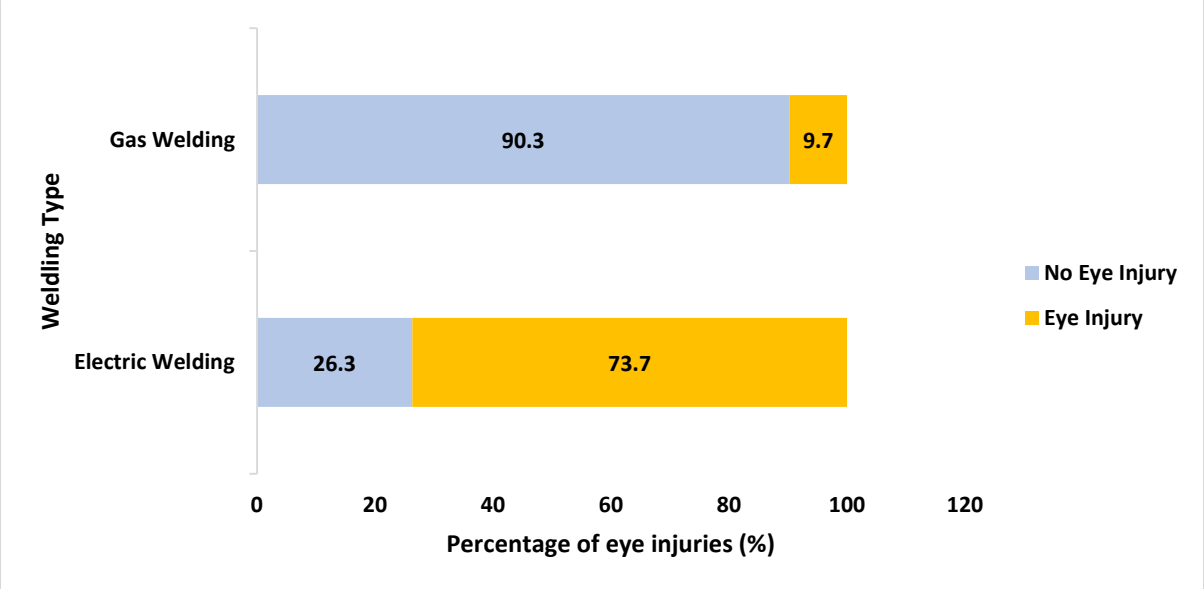

Figure 3 Proportion of eye injuries by welding type

4.4 Characteristics of eye injuries

Among those who experienced eye injuries, a large proportion of the injuries (95.6%) occurred less than a year ago. Furthermore, a few (3.3%) indicated they had eye injuries one to three years ago. Most of the injuries sustained (59.9%) occurred in the evening while only 18.7% occurred in the morning. With respect to the duration of eye injury, a greater proportion of the welders (95.6%) stated the injuries they sustained lasted less than a month. Only 4.4% indicated they suffered injuries for more than a month. Majority of the participants (83.6%) reported the injuries they sustained affected both eyes.

Table 4.2 Characteristics of eye injuries

Variable	Numbers	Percentage (%)
Time of last eye injury (years):		
< 1	174	95.6
1-3	6	3.3
3-5	1	0.5
> 5	1	0.5
Time of last eye injury:		
Morning	34	18.7
Afternoon	39	21.4
Evening	109	59.9
Duration of eye injury:		
< 1 month (short term)	175	95.6
>1 month (long term)	8	4.4
Number of eyes affected:		
One eye	30	16.4
Both eyes	153	83.6

4.5 Eye PPE Use

The prevalence of the use of eye PPE is summarized in Figure 4 with 66.7% (95% CI: 61.8%-71.5%) not using eye PPE at the time of the study.

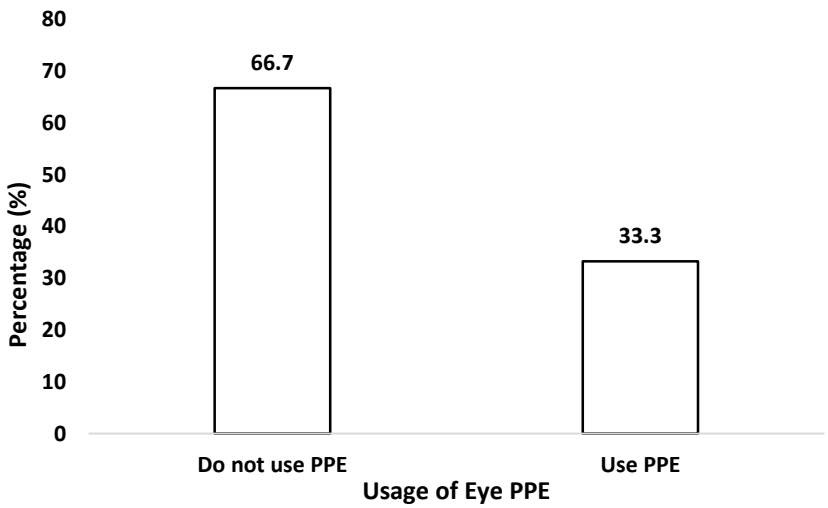

Figure 4 Prevalence of Eye PPE Use

4.6 Reasons for non-use of Eye PPE

Among welders who did not use eye PPE, various reasons were given. As shown in Figure 5, more than half (57.0%) indicated they did not use eye PPE because it was not mandatory with only 22.1% stating the use of eye PPE reduces productivity. Other reasons stated include low risk of task (8.4%), being uncomfortable and being in a hurry (3.2%) as well as short duration of task (1%).

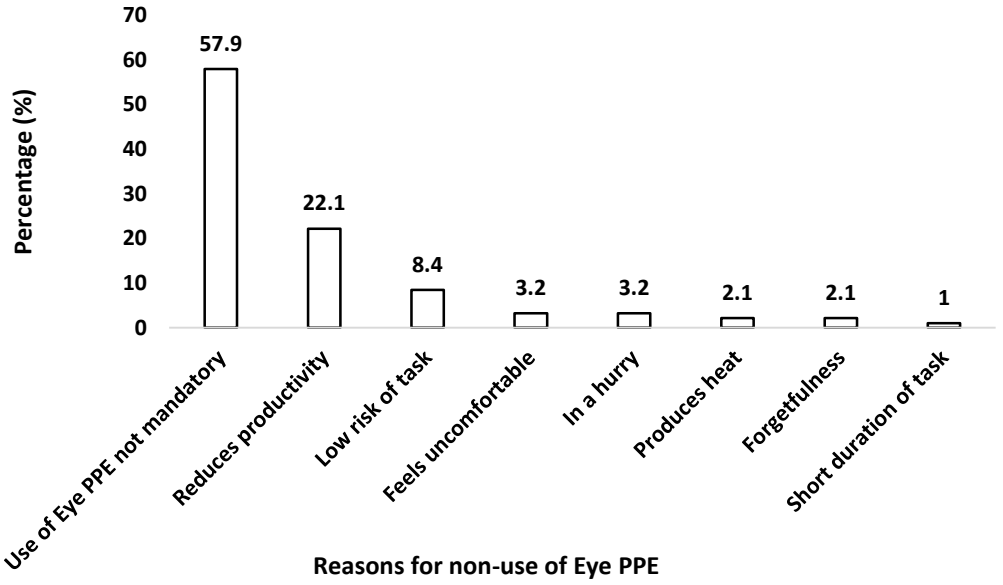

Figure 5 Reasons for non-use of Eye PPE

4.7 Commonly used Eye PPE

As shown in Figure 6, the commonly used eye PPE reported in this study were glasses (44.8%), goggles (40.1%) and eye shields (11.2%).

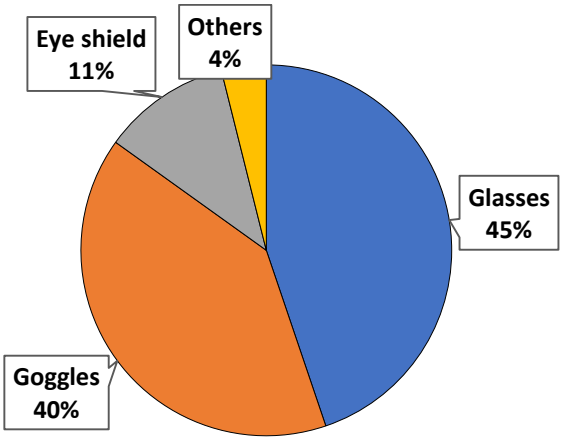

Figure 6 Commonly used Eye PPE

4.8 Ownership of eye PPE

Most of the welders (74.0%) indicated that they own eye PPE (Figure 7).

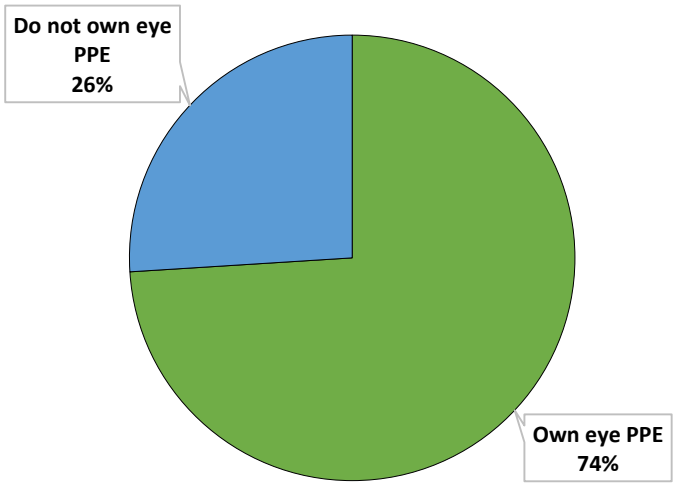

Figure 7 Ownership of eye PPE

4.9 Use of eye PPE of appropriate standards

Almost a third of welders (27.6%) who use eye PPE indicated that they never use eye PPE of appropriate standard (Figure 8).

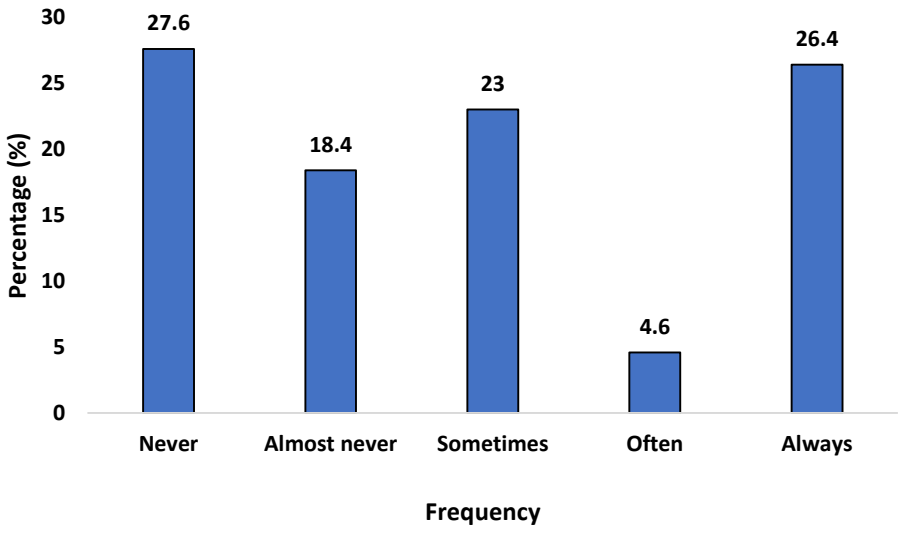

Figure 8 Use of eye PPE of appropriate standards

4.10 Safety training at work

Regarding safety training at work, most of the welders (61.2%) stated that they had never had any training (Figure 9).

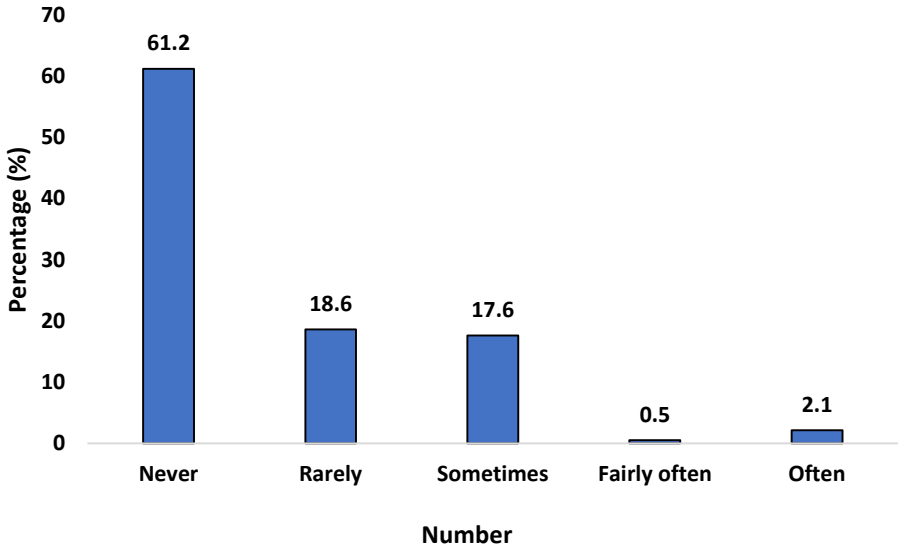

Figure 9 Safety training at work

4.11 Association between eye injury and demographic characteristics

Table 4.3 shows there was a statistically significant association between the type of welding type and eye injuries (χ^2 =15.4, p<0.001, α=0.05). However, no statistically significant difference was observed between eye injuries and age (χ^2 =5.27, p=0.384, α=0.05), work experience (χ^2 =1.66, p=0.646, α=0.05) and education (χ^2 =1.46, p=0.691, α=0.05).

Table 4.3 Association between eye injury and demographic characteristics

	Eye injuries		
Variable	**No eye injury n (%)**	**Eye injury n (%)**	**χ^2 (p-Value)**
Age (years):			5.27 (0.384)
< 20	14 (7.0)	9 (4.9)	
20-29	83 (41.7)	81 (44.3)	
30-39	61 (30.6)	42 (22.9)	
49-49	23 (11.6)	31 (16.9)	
50-59	13 (6.5)	14 (7.6)	
60+	5 (2.5)	6 (3.3)	
Sex:			0.01 (0.905)
Male	195 (98.0)	179 (97.8)	
Female	4 (2.0)	4 (2.2)	
Education:			1.46 (0.691)
No formal education	18 (9.0)	13 (7.1)	
Primary	134 (67.3)	125 (68.3)	
Secondary	41 (20.6)	42 (22.9)	
Tertiary	6 (3.0)	3 (1.6)	
Working experience (years):			1.66 (0.646)
< 1	12 (6.0)	8 (4.4)	
1-5	59 (29.6)	56 (30.6)	
6-10	58 (29.2)	46 (25.1)	
> 10	70 (35.2)	73 (39.9)	
Type of welder:			0.07 (0.997)
Apprentice	67 (33.7)	62 (33.9)	
Worker	42 (21.1)	38 (20.8)	
Master	90 (45.2)	83 (45.4)	
Welding type:			15.4 (<0.001)
Electric/Arc Welding	60 (30.1)	168 (91.8)	
Gas Welding	139 (69.9)	15 (8.2)	
Daily working hours:			3.50 (0.061)
< 12 hours	119 (59.8)	92 (50.3)	
> 12 hours	80 (40.2)	91 (49.7)	
Monthly income (GHS):			4.53 (0.210)
< 100	34 (17.1)	32 (17.5)	
100-500	81 (40.7)	82 (44.8)	
600-1000	52 (26.1)	32 (17.5)	
> 1000	32 (16.1)	37 (20.2)	
Religion:			0.03 (0.953)

Christianity	143 (71.9)	132 (72.1)	
Islam	56 (28.1)	51 (27.9)	
Marital status:			0.93 (0.336)
Single	112 (56.3)	94 (51.4)	
Married	87 (43.7)	89 (48.6)	

4.12 Association between eye injury and workplace characteristics

There was no statistically significant difference between the use of eye PPE while working and eye injuries (χ^2 =2.90, p=0.088, α=0.05). The use of eye PPE during last welding activity was also not statistically significant with eye injuries among welders (χ^2 =3.39, p=0.065, α=0.05), as shown in Table 4.4.

Table 4.4 Association between eye injury and workplace characteristics

	Eye injuries		
Variable	**No eye injury n (%)**	**Eye injury n (%)**	**χ^2 (p-Value)**
Use of Eye PPE while working:			2.90 (0.088)
Use eye PPE	74 (37.2)	53 (29.0)	
Do not use eye PPE	125 (62.8)	130 (71.0)	
Health policy at work:			1.12 (0.289)
Present	4 (2.0)	7 (3.8)	
Absent	195 (98.0)	176 (96.2)	
Use of Eye PPE in last activity:			3.39 (0.065)
Used eye PPE	96 (82.1)	162 (89.5)	
Did not use eye PPE	21 (17.9)	19 (10.5)	
Training on use of Eye PPE:			1.41 (0.235)
Had training	30 (15.7)	37 (20.4)	
Had no training	161(84.3)	144 (79.6)	
Eye PPE policy at work:			10.58 (0.001)
Present	1 (0.5)	12 (6.6)	
Absent	196 (99.5)	170 (93.4)	
Use eye PPE with appropriate standards:			7.32 (0.026)
Never	34 (54.8)	6 (24.0)	
Sometimes	13 (21.0)	7 (28.0)	
Often/Always	15 (24.2)	12 (48.0)	
Safety training at work:			0.42 (0.811)
Never	159 (79.9)	142 (77.6)	
Sometimes	32 (16.1)	34 (18.6)	
Often/Always	8 (4.0)	7 (3.8)	
Use eye PPE in good working condition:			10.0 (0.007)
Never	33 (52.4)	4 (16.0)	
Sometimes	12 (19.1)	7 (28.0)	
Often/Always	18 (28.6)	14 (56.0)	

Exposure to nearby welding activities:			17.27 (<0.001)
Never	9 (4.5)	3 (1.6)	
Sometimes	20 (10.1)	2 (1.1)	
Often/Always	170 (85.4)	178 (97.3)	

4.13 Demographic predictors of Eye injuries

Binary logistic regression was performed to determine risk factors associated with eye injuries in Table 4.5. Welding type and monthly income were demographic factors significantly associated with eye injuries. The model predicted that welders who engage in gas welding had 93% reduced odds of experiencing eye injuries as compared to welders who do electric/arc welding (AOR=0.07; 95% CI: 0.03-0.15; p<0.001). Increasing monthly income increased the odds of eye injuries. Welders who earn more than GHS1000 monthly were 5 times more at odds of eye injuries compared to those who earn less than GHS100 (AOR=5.26; 95% CI: 1.72-16.09; p=0.004).

Table 4.5 Demographic predictors of Eye injuries

	COR		AOR	
Variable	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
Age (years)	0.92 (0.77-1.09)	0.325		
< 20				
20-29				
30-39				
49-49				
50-59				
60+				
Sex	0.92 (0.23-3.72)	0.905		
Male				
Female				
Education	0.97 (0.80-1.19)	0.805		
No formal education				
Primary				
Secondary				
Tertiary				
Working experience (years)	0.92 (0.74-1.14)	0.462		
< 1				
1-5				
6-10				

> 10				
Type of welder	1.00 (0.80-1.26)	0.993		
Apprentice				
Worker				
Master				
Welding type	21.16 (11.82-37.87)	<0.001		
Electric/Arc Welding			Ref	Ref
Gas Welding			0.07 (0.03-0.15)	<0.001
Daily working hours	0.68 (0.45-1.02)	0.062		
< 12 hours				
> 12 hours				
Monthly income (GHS)	1.01 (0.82-1.24)	0.939		
< 100			Ref	Ref
100-500			1.27 (0.60-2.70)	0.529
600-1000			1.49 (0.58-3.79)	0.407
> 1000			5.26 (1.72-16.09)	0.004
Religion	1.01 (0.65-1.58)	0.953		
Christianity				
Islam				
Marital status	0.82 (0.55-1.23)	0.336		
Single				
Married				

4.14 Workplace predictors of Eye injuries

With respect to workplace related characteristics, the use of eye PPE while working as well as training on the use of eye PPE were predictors of eye injuries. The logistic regression model predicted that welders who do not use eye PPE while working were almost two times more at odds to experience eye injuries compared to their counterparts who use eye PPE (AOR=1.86; 95% CI: 1.02-3.43; p=0.042). Furthermore, welders who did not have any training on the use of eye PPE were also 2 times more at odds to experience eye injuries (AOR=2.17; 95% CI: 1.07-4.38; p=0.030).

Table 4.6 Workplace predictors of Eye injuries

	COR		**AOR**	
Variable	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
Health policy at work	1.94 (0.56-6.73)	0.297		
Present				
Absent				
Use Eye PPE while working	0.69 (0.45-1.06)	0.089		
Yes			Ref	Ref

No			1.86 (1.02-3.34)	0.042
Use eye PPE in last activity	1.86 (0.95-3.64)	0.068		
Yes			Ref	Ref
No			0.88 (0.36-2.14)	0.786
Training on use of Eye PPE	1.38 (0.81-2.35)	0.236		
Yes			Ref	Ref
No			2.17 (1.07-4.38)	0.030
Eye PPE policy at work	9.60 (1.74-52.89)	0.009		
Present				
Absent				
Use eye PPE with appropriate standards	0.47 (0.27-0.83)	0.010		
Never				
Sometimes				
Often/Always				
Safety training at work	0.92 (0.63-1.36)	0.690		
Never				
Sometimes				
Often/Always				
Use eye PPE in good working condition	0.42 (0.23-0.75)	0.003		
Never				
Sometimes				
Often/Always				
Exposure to nearby welding activities	0.33 (0.17-0.66)	0.002		
Never			Ref	Ref
Sometimes			0.08 (0.06-1.07)	0.057
Often/Always			1.22 (0.21-6.94)	0.825

CHAPTER FIVE

5.0 DISCUSSION

5.1 Prevalence of eye injuries

This study shows the prevalence of reported eye injury among welders in Accra to be 47.9%. The findings of this study is similar to the results obtained in the study conducted by Ihekaire and Oji (2017) in Nigeria who found the prevalence of eye injury to be 48% among welders. The prevalence of eye injury observed in this study is lower compared to studies conducted by Fiebai and Awoyesuku (2011) in Nigeria, Nwala and colleagues in rural Nigeria, Ganesh Kumar and Dharanipriya (2014) in India and Sithole, Oduntan and Oriowo (2009) in South Africa. Those studies found the prevalence of eye injury to be 60.2%, 84.5%, 75% and 61% respectively among welders. However, the prevalence in this study is higher compared to a study carried out by Douglas and Koroye-Egbe (2018) in Nigeria who found the prevalence of eye injury among welders to be 43.4%. The differences in the prevalence as obtained from other studies as compared to this study could possibly be as a result of differences in geographical, environmental, occupational structures and systems, sociocultural factors, and the methodology used.

Almost half of welders were found to have suffered eye injuries. This could have serious socioeconomic consequences for their families, communities and the country as a whole especially if these injuries are severe and/or permanent, affecting the income generating capability of the welder.

5.2 Welding type among welders

This study identified electric arc welding as the dominant welding type used by welders in Accra (59.7%). A similar pattern was observed in other studies where arc welding was the most common welding type used compared to gas welding (Adu & Danquah, 2017; Nartey et al.,

2017). The popularity of arc welding observed in these studies could be attributed to its cost effectiveness, its availability and ease of use.

Among electric welders, 73.7% of them experienced eye injuries, while only 9.7% of gas welders suffered eye injuries. This agrees with a study by Vecchia et al. (2007) which found electric welding to be more hazardous. This may be due to the nature of electric welding since it emits higher ultraviolet light and a brighter flame (Davies, Asana, Nku, & Osim, 2010).

5.3 Usage of Personal Protective Equipment (PPE) among welders

This study found that only 33% of welders used eye PPE while working. This is in agreement with studies conducted by Sukati (2014) and Tanko & Anigbogu (2012). Ajayi & Omotoye (2012) also reported low usage of eye PPE, as did Abu et al. (2016). This study reported a higher usage of 33% as compared to that reported by Abu et al. (2016) of 27.5%. However, this is lower than 47.7% usage of eye PPE which was reported by Budhathoki et al. (2014). Interestingly enough, 74.1% stated that they own eye PPEs. Ownership of eye PPE does not necessarily translate into usage of eye PPE. This is also seen in a study by Ajayi et al. (2011) which reported that while 45.9% of welders possessed eye PPE, only 9.6% use eye PPEs all the time. Low use of eye PPE could be attributed to a variety of reasons. Reasons for non-use identified in this study was unavailability of policies, reduction in productivity, inconvenience, production of excessive heat, forgetfulness, short duration of task, anticipated low risk of task and time factor. Some of these reasons are similar to what was reported by Lombardi et al., (2009). These reasons may be categorized broadly as; perceptions of hazard and risks, barriers to PPE usage, and enforcement and reinforcement. Another possible factor could be limited knowledge about the importance of PPE. The observed pattern of PPE use among welders in this study suggest an increased risk of eye injuries among welders in Ghana. This is because it has been reported that, unsafe occupational acts such as non-use of PPE are widely associated

with injuries (Ogundipe, Owolabi, & Olanipekun, 2018; OSHA, 2016). This observation warrants government institutions responsible for OHS to enforce mandatory use of PPE to ensure welders are more attentive towards personal safety. Without enforcement, eye PPE use is left to the discretion of the employer and employee. Enforcement should be accompanied by positive reinforcement from supervisors and colleagues to ensure the sustainability of eye PPE use. Also, better acceptance of safety procedures will be gained by involving all stakeholders, including workers, in how work tasks should be performed and the tools necessary to achieve it (Lombardi et al, 2009).

5.4 Factors influencing eye injuries among welders

Industrialization is desirable for all countries. It assures higher standard of living for the citizenry. The welding industry is among the many establishments engaged in the business of producing goods and services. However, welders are susceptible to varied occupational health hazards. Welders form a high risk group for eye injury as a result of exposure to metals and ultraviolet radiations (Nwala et al., 2014). These exposures are considered to be major risk factors for eye disorders (Megbele, Lam, & Sadhra, 2012).

This study identified a significant association between the non-use of eye PPE, welding type, monthly income greater than GHS1000 ($188.67), no training on the use of eye PPE, and eye injuries among welders. There was an increase in odds of eye injuries among welders with monthly income greater than GHS1000 ($188.67), non-use of eye PPE and no training on eye PPE. Welders who often indulge in gas welding had 93% reduced odds to develop eye injuries.

Regarding non-use of eye PPE, these findings agree with a study in Nigeria by Ihekaire & Oji (2017), in which it was reported that non-use of eye PPE was significantly associated with eye injuries. This was also similar to a study by Ghimire et al. (2018). Regarding welding type, these findings agree with a study by Vecchia et al. (2007) which reported that electric/arc welding is more hazardous than gas welding.

Regarding no training on eye PPE, these findings are similar to what was found in India where welders with institutional training on eye PPE were less likely to develop eye injuries (Ganesh Kumar & Dharanipriya, 2014). The reason for the reduced odds among welders who have had training on eye PPE could be attributed to increased awareness and knowledge about health safety (Prabhu, Rokhade, Chandra, & Kakhandaki, 2017).

Regarding welders with higher income who have an increased risk of eye injuries, these findings are similar to a study in Kenya among workers, including welders, which reported that higher income workers take on more jobs and in their haste to perform these jobs, develop more eye injuries (Chepkener, 2013). Also, the higher risk of eye injuries among welders with high monthly income of more than GHS 1000 ($188.67) may be because they undertake more challenging and riskier tasks to earn more money.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Almost half of the welders have sustained eye injury before. Most of the eye injuries affected both eyes. Majority of welders use electric welding in their activities. Those who use electric welding are more prone to eye injuries. Usage of eye PPEs is relatively low among welders for a variety of reasons, including the primary reason that usage of eye PPEs is not mandatory. The study found that the welders who do not use eye PPEs have a higher risk of eye injuries. Almost a third of welders who do use eye PPEs do not use eye PPEs of appropriate standard. Also, most welders have no form of safety training at work. Welders with monthly income above GHS1,000 had higher risk of eye injuries.

6.2 Recommendations

- Considering the importance of eye PPEs in the prevention of eye injuries, the use of eye PPEs by welders should be increased through education and training on the use of eye PPE, and making the use of eye PPE mandatory. These should be implemented through the relevant welder associations and the Accra Metropolitan Authority.
- Welding associations should prioritize interventions to reduce eye injuries particularly among electric welders since they form the majority of welders who suffer more eye injuries.

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APPENDICES

Appendix 1 Informed Consent forms

CONSENT FOR A STUDY ON FACTORS INFLUENCING EYE INJURIES AMONG WELDERS IN ACCRA

Section A- **BACKGROUND INFORMATION**

Title of Study:	FACTORS INFLUENCING EYE INJURIES AMONG WELDERS IN ACCRA
Principal Investigator:	KARL KAFUI KWAKU TETTEH
Certified Protocol Number	

Section B– **CONSENT TO PARTICIPATE IN RESEARCH**

General information about the study

The eyes are the third most common organ affected by injuries apart from the hands and feet. Eye injuries are common and constitute a major cause of preventable blindness. They are a common cause of visual morbidity occurring at workplaces worldwide. Majority of eye injuries have a direct link with occupation and the nature of activity at the time of the injury. Welding is one of such occupations which can directly or indirectly cause eye injuries. However, eye injuries associated with welding can be reduced via the use of Personal Protective Equipment (PPE), particularly eye PPEs among welders. Therefore, understanding the importance of the use of eye PPEs, will help reduce the burden of eye injuries among welders

Findings from this study will provide information to the New Korley Lagoon Association of Welders (Agbogbloshie) and National Artisans and Traders Union of Ghana (NATUG), Darkuman Cable and Wireless branch, on the most common eye injuries welders in the

association suffer. It will also provide evidence of eye PPE use among these welders. It is therefore important to identify factors which influence eye injuries among welders in Accra.

This study is a Master of Public Health degree project work for the principal investigator (PI). It has the support of the University of Ghana and Ghana Health Service to be carried out. You have been selected to participate in this study because, you are a welder and could experience eye injuries while working. You will be required to spend about 25 minutes in participating in this study.

What we have planned to do

We have planned to include 388 welders who work in Accra in this study. This study will be a onetime engagement where data will be collected from you via a structured questionnaire which will be administered to you.

Participation

You will be required to give responses to questions related to your demographic characteristics, occupational health and safety issues, eye injuries, your use of PPEs.

Benefits/Risks of the study

Potential risks

This study will not collect any sensitive information. However, anonymity will be highly maintained by discrete capturing of information by ensuring that, no identifying information collected from participants can be linked to them.

Potential benefits

Despite the potential risk that may be involved, the information obtained will be beneficial to the principal investigator for the purpose of obtaining his Master of Public Health degree. Furthermore, this study will provide baseline knowledge for further research which could lead to social interventions to reduce eye injuries among welders.

Confidentiality

All information related to you taking part in this study will be kept confidential from any other person except those who are directly involved in the study. The information will be kept under lock and key in a file cabinet. Also, the softcopy of the data will be stored on a computer and encrypted with password known to the PI alone. The information received on you during the study will be available only to the research assistants and only stakeholders responsible to act on recommendation and other concerns arising from the study. Data analysis will be done without showing your identity by using ID numbers. Your identity will not be revealed in any reports or publications resulting from this study. We will make the outcome of this information collected from available to you any time you request to know anything about yourself concerning this study. Any stakeholder who will like to use the results of the study to implement a recommendation will sign a consent to keep sensitive part of the reports confidential and is ready to face any sanction should it be that be revealed and confidential information in the process of using the results.

Compensation

You will not receive any material thing for participating in the study. You will not be given any cash for your participation in the study because, this work is solely for academic purpose. However, I thank you for your time spent giving your responses.

Withdrawal from study

You have the right not to participate or withdraw from the study at time they you feel uncomfortable without any penalty and this does not have any link with the service and care receive at the health facilities. Information collected from you before you decided to withdraw will not be included in the final analysis of the data.

Withdrawal from the study by the investigator

The investigator may decide that you discontinue with this study if it happens that you are not able to communicate clearly with the research assistant during the interview or could not provide the needed information needed for this study.

Contact for Additional Information

If you want any more information at any time during the study please contact:

1. The principal investigator Karl Kafui Kwaku Tetteh at the School of Public Health of the University of Ghana. Contact number: 0244093041
2. ……., Supervisor. Contact number:
3. …… who is the Administrator of the Ghana Health Service Ethics Review Committee. Contact number:

Section C- **PARTICIPANT AGREEMENT**

"I have read or have had someone read all of the above, asked questions, received answers regarding participation in this study, and am willing to give consent for me, my child/ward to participate in this study. I will not have waived any of my rights by signing this consent form. Upon signing this consent form, I will receive a copy for my personal records."

_____

Name of Participant

_____

_____

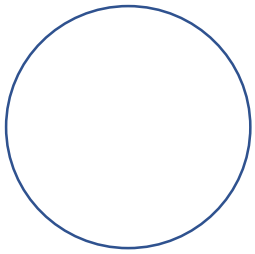
Signature or mark of Participant Date

If participant cannot read and or understand the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

_____

Name of witness



_____

Signature of witness / Mark

_____

Date

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____

Name of Person who Obtained Consent

_____ _____

Signature of Person Who Obtained Consent Date

Appendix 2 Study Questionnaire

Questionnaire for Factors Influencing Eye Injuries Among Welders in Accra

Questionnaire Code: …… Date of interview …… **Section 1: Bio-Data of Participant**		
1. Age of welder (in years)		…… ……
2. Gender	1. Male 2. Female	
3. Religion	1. Christian 2. Muslim 3. Traditional 4. Other, Specify	
4. Marital Status	1. Never married 2. Married 3. Separated 4. Divorced 5. Co-habiting 6. Widow/widower	
7. Level of education	1. No formal education 2. Primary 3. JHS/Middle school 4. SHS/Technical 5. Tertiary	
8. Average monthly income (GH Cedi)	……	
9. How long have you been working as a welder?	……..	
10. Which welder type are you?	1. Apprentice 2. Worker 3. Master	
11. Which type of welding?	1. Electric/Arc 2. Gas	

	3. Others (specify)	
Section 2: Eye Injuries		
12. Do you know there are hazards associated with welding?	1. Yes 2. No	
13. Have you ever sustained any eye injury while welding?	1. Yes 2. No	
14. If Yes, when did your last injury occur?	1. Less than 1 year ago 2. 1 to 3 years ago 3. 3 to 5 years ago 4. Over 5 years ago	
15. If Yes, at what time of day did the last injury occur	1. Morning 2. Afternoon 3. Evening	
16. If Yes, what was the extent of the injury?	1. Mild injury (no first aid needed) 2. Moderate injury (first aid needed) 3. Severe Injury (Hospital/clinic visit needed)	
17. If Yes, was the last injury short term or long term?	1. Short term (less than or equal to 1 month) 2. Long term (more than 1 month)	
18. If Yes, did the last injury affect 1 or 2 eyes?	1. One eye 2. Both eyes	
19. If Yes, were you wearing any eye PPE at the time of your last injury?	1. Yes 2. No	
20. If Yes, what was the nature of the last injury?	1. Mechanical 2. Chemical 3. Radiation 4. Thermal	

	5. Electrical	
21. Do you have any policy/policies on employee's health issues?	1. Yes 2. No	
22. If Yes, what does the policy/policies say?		…… …… …… …….. …… …… ……
Section 3: Use of eye Personal Protective Equipment (PPE)		
23. Do you use any eye PPE when working?	1. Yes 2. No	
24. If No, why don't you use any eye PPE?	1. Feels uncomfortable 2. Feels too much heat 3. Reduced productivity 4. Don't know how to use it. 5. Use of PPE not mandatory 6. Short duration of task 7. Low risk of task 8. In a hurry 9. Forgetfulness 10. Others (specify)……	
25. Specify the name of eye PPE used		…… ……
26. Did you use an eye PPE during your last work activity?	1. Yes 2. No	

27. Do you have the following eye PPEs available?	1. None 2. Glasses 3. Goggles 4. Eye shield 5. Other……	
28. Do you have your own eye PPE?	1. Yes 2. No	
29. If No, why not?	1. Too expensive 2. Not necessary 3. I don't know where to get one 4. Others (specify)	
30. How often do you remove your eye PPE while working??	1. Never 2. Almost never 3. Sometimes 4. Often 5. Always	
31. If Yes, what is your reason for removing your eye PPE?	1. Feels uncomfortable 2. Feels too much heat 3. Reduced productivity 4. Don't know how to use it. 5. Use of PPE not mandatory 6. Short duration of task 7. Low risk of task 8. In a hurry 9. Forgetfulness 10. Others (specify)	
32. Have you ever had any training on the use of eye PPEs?	1. Yes 2. No	
33. Whose responsibility do you think it is to	1. Employer 2. Employee 3. Government 4. Other…….	

provide eye PPE at workplace?		
34. Do you have any policy here on eye PPE?	1. Yes 2. No	
35. If yes, what does the policy state?		……
Section 4: Eye injury factors		
36. How often do you use eye personal protective equipment?	1. Never 2. Rarely 3. Sometimes 4. Often 5. Always	
37. How often do you use eye PPEs that meet the appropriate standards?	1. Never 2. Almost Never 3. Sometimes 4. rarely 5. Always	
38. How often do you use electric/arc welding?	1 Always 2 Often 3 Sometimes 4 rarely 5 Never	
39. Number of years of experience working as a welder	1. <1 2. 1-3 3. 4-6 4. 7-9 5. >9	
40. How often do you have safety	1. Never 2. rarely 3. Sometimes	

training at work?	4. Fairly Often 5. Often	
41. What is the average time in hours spent welding each day?	1. >12 hours 2. 10-12 hours 3. 8-10 hours 4. 6-8 hours 5. <6 hours	
42. Do you have working fire extinguishers readily available at your workplace?	1. Never 2. rarely 3. Sometimes 4. Often 5. Always	
Thank you		

Name of interviewer:…….. Time …….

Appendix 3 Ethical Clearance

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.

MyRef.ghs/rdd/erc/Admin/App//amend/GHS-ERC036/02/19
Your Ref. No.

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
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Email: ghserc@gmail.com
18th July, 2019

Dr. Kafui Kwaku Tetteh
University of Ghana
School of Public Health
Legon

RE: REQUEST FOR PROTOCOL AMENDMENT

Reference is made to your letter dated 14th on the above subject matter.

The Ghana Health Service Ethics Review Committee (GHS-ERC) has reviewed the documents submitted, and the rationale for the request for amendment. The GHS-ERC has given approval for the amendment to be implemented.

GHS-ERC Number	**GHSERC: 036/02/19**
Project Title	Factors influencing eye injuries among welders in Accra
Effective Date for Approval of Amendment	17th July, 2019
GHS-ERC Decision	**Amendment Approved**

The approval covers the following only:

- Changes in the age groups of respondents participating in the child cognitive games.
- Study site: Addition of '**Darkuma Cable and Wireless**" to the old site "**Agbogloshie**"
- Change of the dependable variable "Risk of Eye injuries" to "**Eye Injuries**"
- Change of protocol title from **"**Factors influencing risk of eye injuries among Welders in Agbogbloshie" to "**Factors influencing eye injuries among Welders in Accra"**

The following applies:

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC).
- Renewal of ethical approval if the study lasts for more than 12 months.
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report **after completion** of the study.
- Informing ERC if study is discontinued and reasons why.

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- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol.

SIGNED.....

Professor Moses Aikins
for (GHS-ERC Chairperson)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra