# PREDISPOSING FACTORS TO NOISE INDUCED HEARING LOSS AMONG METAL WORKERS IN SELECTED JUA KALI SHEDS IN MOMBASA COUNTY, KENYA

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# Predisposing Factors to Noise Induced Hearing Loss among Metal Workers in Selected Jua Kali Sheds in Mombasa County, Kenya

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## DECLARATION

This thesis is my original work and has not been presented for degree in any other University.

Signature…………………………………….. Date: …………………………

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This thesis has been submitted for examination with our approval as university supervisors

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**TUM Kenya**

## DEDICATION

I dedicate this work to my parents Mr. Wilfred Kilinzo and Mrs Elizabeth Kilonzo for educating and teaching me hard work. To my Husband Peter Sang for believing in me and my son’s Kibet and Kimutai for supporting and encouraging me through my studies.

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## LIST OF ACRONYMS

| | |
|---|---|
| **ENE** | Excessive noise exposure |
| **ONIHL** | Occupational Noise Induced Hearing Loss |
| **OHSW** | Occupational Health Safety and Welfare |
| **OSHA** | Occupational Safety Health Administration |
| **EPA** | Environmental Protection Agencies |
| **TTS** | Temporary Threshold Shift |
| **TLV** | Threshold Limit Value |
| **dB** | Decibels (noise units) |
| **WHO** | World Health Organization |
| **ANISA** | American National Standards Institute |
| **ILO** | International Labor Organization |
| **NIDCD** | National Institute on Deafness and other Communicable Diseases |
| **ISO** | International Standard Organization |
| **HZ** | Hertz |
| **KH**Z | Kilohertz |
| **GDP** | Gross Domestic Product |
| **FKE** | Federation of Kenyan Employees |
| **CDC** | Center for Disease Control and Prevention |

| | |
|---|---|
| **HPD** | Hearing Protection Devices |
| **dB(A)** | A-weighted decibel |
| **DBHL** | Decibel Hearing Loss. |
| **LAeq, 8h** | Equivalent sound levels, measured over an exposure period of 8 hour |
| **PPD** | Personal Protective Devise |
| **PPE** | Personal Protective Equipment's |

## DEFINITION OF TERMS

**Age-related hearing loss** Loss of hearing that progresses with age, also known as Presbycusis.

**Audiometric** A test to measure an individual's hearing threshold levels.

**Buy-quiet policy** Policy to purchase equipment that is the quietest.

**Decibel** The unit used to indicate the relative magnitude of sound pressure level and other acoustical quantities, abbreviated as 'dB'.

**Effective noise control** An action, procedure or device to eliminate noise from the workplace or reduce noise to safe exposure levels.

**Hearing impairment** Hearing loss that causes some degree of disability.

**Hearing loss** Reduced ability in a person to detect sound.

**Hearing threshold level** The quietest sound a person can detect at a particular frequency relative to young people with normal hearing.

**Occupational noise** Noise experienced in the workplace.

**Personal hearing protectors** Devices worn over the ears or inserted into the ear canals with the aim of protecting a person's hearing against noise.

**Plant** Any tool, equipment, machinery or fitting used in the workplace.

**Prevalence** Number of cases of ONIHL at a defined point in time.

**Pure Tone Average** Hearing thresholds levels averaged across certain tested frequencies.

| | |
|---|---|
| **Self-efficacy** | The confidence a person has in their ability to take action on or deal with a specific issue. |
| **Sound pressure level** | The relative magnitude of sound pressure expressed in decibels referenced to 20 micropascals. |
| **Temporary threshold** | Temporary hearing loss, usually as a result of short-term exposure to loud noise. |
| **Tinnitus** | Ringing, buzzing or other noises in the ear or head in the absence of any external sound source |

## ABSTRACT

The "*Jua kali*" sector is an informal, unorganized small-scale enterprise employment in Kenya, and a source of livelihoods for many in most cities and towns. However, the sector is inadequately supervised and lacks occupational health services; the workers are characterized by little or no formal education, knowledge on occupational safety procedures, environmental safety requirements, and even the occupational health and safety laws and legislation making, them vulnerable to many occupational health hazards. This study assessed the noise levels in selected *"Jua kali"* metal sheds, the predisposing factors to hearing loss, the influence of knowledge, attitude and practice among the "*Jua kali*" metal workers in Mombasa County, Kenya. A structured questionnaire was used to collect socio-demographic information and work-related data while noise level measurements (noise mapping) were done randomly on selected participants using sound level meters. The audiometric test was done on the participants by use of clinical audiometer machine (measured at 4,000Hz) to determine the hearing levels. The data was analyzed using SPSS version 21.0. The mean noise level of 108.87dB (A) in the "*Jua kali*" metal shed was significantly higher (p=0.012) than the standard OSHA allowable levels of 85dB(A). Out a sample size of 204 respondents, 146(72%) participants involved in the study, 47.9% had moderate hearing loss while 2.7% had severe hearing loss. Significant association was found between hearing loss among the "*Jua kali*" workers and the following pre-disposing factors: age (p=0.000), gender (p=0.000), duration on the job (p=0.000), marital status (p=0.020), Position at work (p=0.040). Among the respondents 90.4% knew that the workplace produces high noise but 55.5% did not know that it could cause NIHL, 81.1% of the respondents did not use PPEs, and among those who used 43.2% did not know the correct type of PPE to use. Noise levels in study area were higher than 85 dB(A) which is the allowable level, factor such as age, gender, marital status, duration of work and position at work were found to predispose *"Jua kali"* workers to NIHL. Therefore, there is need to encourage safe work practices to minimize exposure time to noise, Train on proper use of PPEs, mount up signs to show that "*Jua kali*" metal work sheds are noisy work and tailor-made refresher course to create skill and knowledge on health and safety.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background information

Human beings are blessed with the five senses of touch, vision, hearing, taste and smell. These senses are very essential for living a normal life. Ability to hear is one of these important senses, through which communication with others can be done and enable enjoyment of day-to-day life. Unfortunately, some people may lose the hearing ability due to infection, head injury, aging, certain medications, birth defects, and tumors, problems with blood circulation or high blood pressure, and stroke (American Academy of Otolaryngology, 2014).

There may be total or partial loss of one or both ears but the level of hearing impairment can be mild, moderate or severe. Noise-induced hearing loss is the second most common form of sensorineural hearing deficit, after Presbycusis (age-related hearing loss) (Am Fam Physician, 2000). Prolonged exposure to noise at high intensity is associated with damage to the sensory hair cells of the inner ear and development of permanent hearing threshold shift, as well as poor speech in noise intelligibility and sleep disorder (Akande, 2001), headaches (Sataloff, 2006), high blood pressure (Willich, 2005), annoyance and stress (Nelson *et al*., 2005). Genetic factors may make someone more susceptible (Davis *et al*., 2003; Konings *et al*., 2009). There is also evidence that noise exposure frequently leads to tinnitus which might be due to alterations in the central auditory function (Henderson *et al*., 2011), one of the most serious health problems.

Other factors that have been linked with an increased risk of NIHL include smoking (Palmer *et al*., 2004; Wild *et al*., 2005), male gender, race, poor diet, cardiovascular disease (Daniel, 2007), and concomitant exposure to carbon monoxide or hydrogen cyanide (Fechter, 2004). Noise is probably the most common occupational health problem, especially in the manufacturing industries (WHO, 1997). It is easy to identify, not very difficult to measure, and is in most cases controllable, although noise abatement is sometimes quite costly. Hearing protection can be a satisfactory solution, as long as protectors are properly fitted, worn, and maintained (Joseph, 2004). Unfortunately, noise and hearing conservation problems do not always receive the attention they deserve because the effects of noise are not lethal (United States Technical Service, 2000). Also, like so many occupational health hazards, noise is insidious. Although traumatic noise exposure may cause an immediate hearing loss (American Hearing Research Foundation, 2009), individuals with noise-induced hearing loss may not become aware of the condition until it is of handicapping proportion; and by that time, it is permanent (United States Technical Service, 2000).

It has been estimated that as many as 500 million individuals worldwide might be at risk of developing NIHL (Alberti, 1998). The impact of hearing loss worldwide is manifestly under-appreciated, with studies suggesting that one in six adults are afflicted with some degree of physiologic hearing impairment (International Archives of Otorhinolaryngology, 2006). The estimated number of people affected by hearing loss worldwide increased from 460 million in 2018 (WHO, 2018) to 630 million worldwide in 2030

Exposer to excessive noise is a major cause of hearing disorders. Recent publications have postulated that excessive noise exposure (ENE) attributes to about16% of all causes of hearing loss (Nelson *et al*., 2005). Despite enhanced awareness of the hearing impact of ENE, and the increasingly-stringent focus on occupational noise-induced hearing loss (ONIHL) remains a significant source of potentially avoidable morbidity (Andrew, 2007).

Occupationally-acquired noise-induced hearing loss is a sub-categorization of acquired hearing impairment whereby workplace ENE can be rationally attributed to a quantifiably-reduced hearing capacity (WHO, 2004). Much of this impairment may be caused by exposure to noise on the job. The Centers for Disease Control (CDC) report of 2010 states that 15% of Americans between the ages 20 to 69 years have hearing loss that could be caused by exposure to noise at work or leisure activities (CDC, 2010). According to Verbeek *et al*. (2012), there were 9 million workers in the USA at risk of hearing loss due to regular exposure to sound of 85 dB or greater, 49% of the miners have hearing loss by the age of 50 years (NIOSH, 2001), and about 10 million have NHIL less than 25 decibels (USDOL-OSHA, 2002). In the European Union, 28% of workers surveyed were reported to at least one-fourth of the time occupationally exposed to noise loud enough (corresponding to approximately 85 - 90 dBA), that they would have to raise their voices to hold a conversation (EASHW, 2000). In Germany, 4−5 million people (12−15% of the workforce) are exposed to noise levels defined as hazardous by WHO (WHO, 2001). The situation is improving in developed countries as more widespread appreciation of the hazard has led to the introduction of protective measures.

Data for noise levels in developing countries are scarce. However, available evidence suggests that average noise levels are well above the occupational level recommended in many developed nations (Suter, 2000; WHO/FIOH, 2001). The average noise levels in developing countries may be increasing because industrialization which is not always accompanied by protection.

There is a good general agreement that daily average noise levels below 80 dB(A) are innocuous, and that noise levels above 90 dB(A) are hazardous (United States Technical Service, 2000). Individuals exposed to between 85 and 90 dB(A) need to be monitored because some of the more susceptible ones will develop a hearing impairment if they are exposed for sufficiently long durations (United States Technical Service, 2000).

OSHA allows 8 hours of exposure to 90 dB(A) but only 2 hours of exposure to 100 dB(A) sound levels. NIOSH would recommend limiting the 8-hour exposure to less than 85 dB(A). At 100 dB(A), the National Institute for Occupational Safety and Health (NIOSH) recommends less than 15 minutes of exposure per day (NIOSH, 1998). In Kenya, the Environmental Management and Control (EMCA) Act 1999, Occupational Safety and Health (OSH) Act 2007 and Noise and Excessive Vibration Pollution Control Regulation (NEBPCR) 2008, allow only 85dB(A) in eight (8) working hours (Laws of Kenya, 2012). However, this has not been ascertained in the "*Jua kali*" sector, despite increasing cases of hearing loss (Eardrop Kenya, 2011). It is against this backdrop that this study was planned.

## 1.2 Statement of the Problem

The "*Jua kali*" sector in the East African region has played a central role in the socio- economic sphere and is a source of 85% to 90% of all non-farming employment opportunities (Baiya, 2012). In Kenya today, the "*Jua kali*" industry accounts for Sh3. 4 trillion to Kenya's total output (MSME, 2016) nearly 28% of the GDP and comprise 90% of all businesses in the country (ILO, 2005). The "*Jua kali*" sector represents an enormous conglomeration of products in many towns and villages in Kenya (Maundu, 1992), hence large populations of Kenyans are working in this sector. Metal work constitutes hammering, welding, riveting which are relatively noisy activities.

The "*Jua kali*" sector in Kenya is usually services or business operation done either in the open or under temporary shelter (Maundu, 1992). The workers in this sector are characterized by little or no formal education, hence no knowledge on occupational safety procedure, environmental safety requirements, and even the occupational health and safety laws and legislation. Thus, they are predisposed to unsafe working conditions, noise being the most challenging environmental hazard (Rabinowitz, 2012).

Exposure to excessive noise is one major cause of hearing disorders. It has been estimated that as many as 500 million individuals might be at risk of developing NIHL worldwide (Alberti, 1998). The NIOSH estimates that more than 30 million workers (almost 1 in 10) are exposed to unsafe noise levels on the job (Michael *et al*., 2005).

In Kenya, about 84% of all workers in selected Industrial plants in Nairobi were exposed to noise above 85dB(A) (Muiruri, 2011). Retirement Benefits Authority in partnership with Operation Eardrop Kenya held "*Jua kali*" studies elsewhere have shown that these workers have disabling impairments (KNFJKA, 2012). In Mombasa, the study was held in 2011 and about 31.1% of the 779 "*Jua kali*" artisans assessed were found to have disabling hearing impairment (KNFJKA, 2012). which was way above what is found in the general population. Milikau *et al*. (2016) found noise levels in "*Jua kali*" sheds in Mombasa County to be above 90dB(A), with

NIHL at 59.6%. Most of these assessments did not consider metal work areas yet they are thought to be producing most of the noise in the "*Jua kali*" sheds. Hence, there is need to determine NIHL, level of noise, influence of social demographic factors and the influence of knowledge, attitude and practice of workers on NIHL in metal work *Jua kali* sheds in Mombasa County.

## 1.3 Objectives of the Study

### 1.3.1 General Objective

The objective of the study was to determine the predisposing factors influencing hearing loss among "*Jua-kali"* workers in Mombasa County.

### 1.3.2 Specific Objectives

i. To determine the intensity of noise within metal workplaces in "*Jua kali"* sheds within Mombasa County,
ii. To determine the level of hearing loss among the workers in "*Jua kali"* metal work sheds within Mombasa County,
iii. To determine the influence of socio-demographic and work-related factors on NIHL among the metal workers in "*Jua kali"* sheds within Mombasa County.
iv. To determine the influence of knowledge, attitude and practice of workers on NIHL in "*Jua kali"* metal work sheds within Mombasa County.

## 1.4 Research Questions

i. What are the prevailing noise levels in "metal workplaces in "*Jua kali"* sheds within Mombasa County?
ii. What is the level of hearing impartment among the workers in metal workplaces in "*Jua kali"* sheds within Mombasa County?
iii. What is the influencing socio-demographic and work-related factors on NIHL among the metal workers in "*Jua kali"* sheds within Mombasa County?
iv. What is the influence of knowledge, attitude and practice of workers on NIHL in "*Jua kali"* metal work sheds within Mombasa County?

## 1.5 Justification of the Study

The "*Jua kali"* industry in Kenya currently accounts for nearly 28% of the GDP and comprise 90% of all businesses in the country and contribute Sh3. 4 trillion to Kenya's total output (MSME, 2016). Employment in the sector has grown by 43% over the past five years to 7.0 million (Kenya Economic Survey, 2008), of which approximately 30-40% are employed in the manufacturing section. The "*Jua kali*" sector represents an enormous conglomeration of products in many towns and villages in Kenya (Maundu, 1992), hence a large population of Kenyans is working in this sector. There is therefore need to protect the workers to noise-related hearing losses. Information obtained is intended to be shared with the Mombasa County Department of Occupational Safety and Health (DOSH), and National Environment Management Authority (NEMA) officers, so as to safe guard the informal sector and plan for occupational safety and health talks and enforce effectively OSH act of 2007 and EMCA Act of 1999.

## 1.6 Scope of the Study

In this study, noise mapping in Mombasa County "*Jua kali*" metal sheds was done to measure the level of noise in the workplace. Audiometric tests were conducted on the sample metal workers within the "*Jua kali*" sheds to determine hearing loss among the workers and questionnaire developed collect primary data on other variables like age, sex, work duration, education background and personal protective equipment used. The study took place in Mombasa County-Kenya which is on the coordinate $4^0$03'S $39^0$ 40'E in Changamwe, Kisauni and Mombasa sub-County in February, 2018 to September, 2018.

## 1.7 Conceptual Framework

It is a sketched representation of the research variables relationship, the dependent variable being hearing loss NIHL, independent variable being socio-demographic and work-related factors, intervening factors in this research were use of PPE, and Noise levels.

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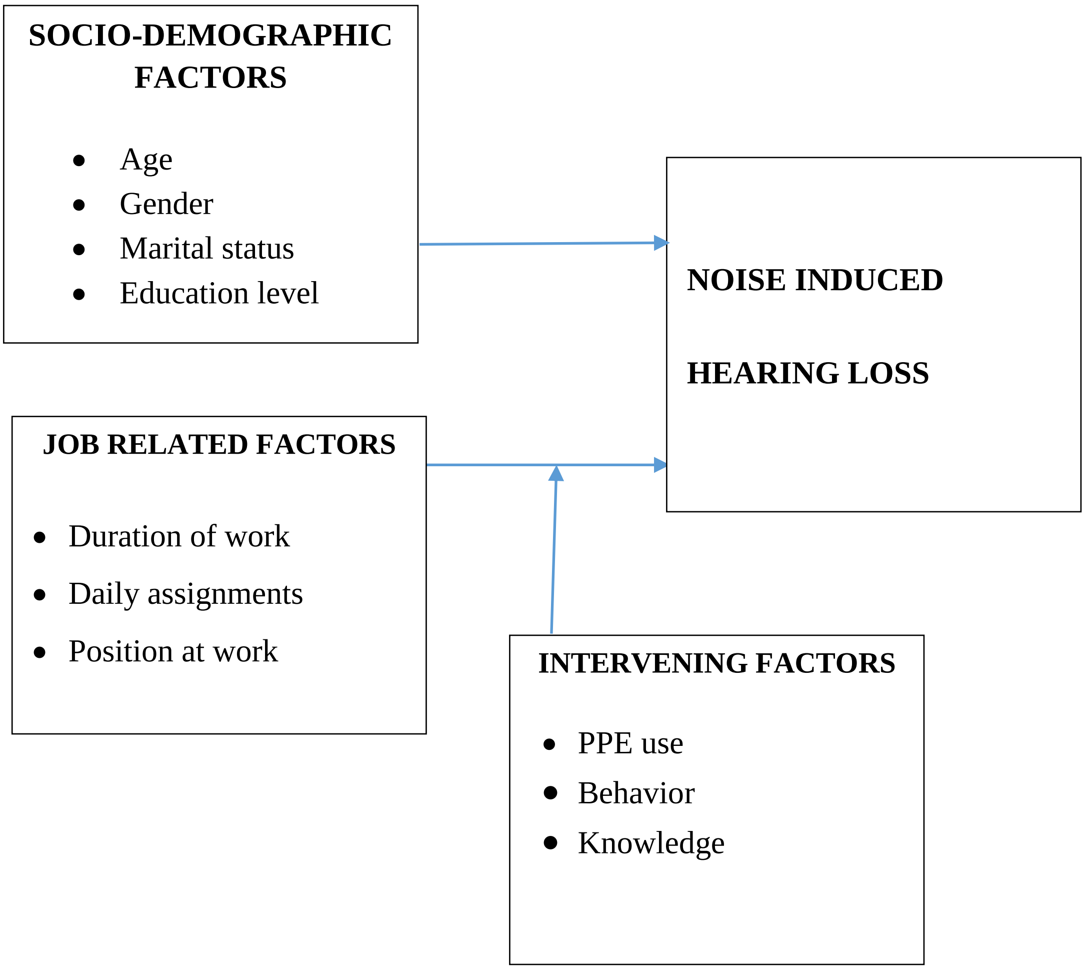


**Figure 1.1: Conceptual framework of the study**

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

The name "*Jua kali*" is a Kiswahili word for "hot sun"; this is an informal sector which is run by small scale industries mainly done in semi-permanent shelter or in the open (Maundu, 1992). In 2001, the sector employed 14.5million people and the numbers are increasing (Faria 2020) and institute of economic affai , 2016 .

The informal sector in Kenya has been growing faster than the formal sector and consequently providing more opportunities for employment. Over 80% of those working in the informal sectors are youth, aged between 18-35 years (Faria, 2020). Most "*Jua kali*" firms require workers with skills that school leavers do not have and therefore the sector is unlikely to solve Kenya's unemployment problems (Simiyu *et al*., 2016).The Kenyan informal sector according to Economic survey published in 2020 informal sector employed more workers 80% than the formal sector. In the informal sector, workers are exposed to occupational health hazards which includes physical hazards (noise, heat, dust and poor working platforms), chemical hazards, mechanical hazards (cuts, bruises), biological hazards and poor access to clean water and toilets (Langat, 2020). These workers in the informal sector are not covered by any insurance or Work Injury Benefit Act and therefore most of the victims of injury just leave the informal sector and the whole burden of treatment is borne by their families.

A study by Langat *et al*. (2020) showed that 90 % of the equipment in "*Jua kali"* industries in Kenya are improvised and therefore more time consuming and with a lot of hazards, noise been among the most common hazard identified. The survey showed that majority of the workers were not using personal protective equipment and workers were not aware of occupational health hazards they were exposed to. Another study carried out in Nairobi on strategy for improving occupational health and safety, working conditions and environment in metal working "*Jua kali"* sector in Nairobi (Simiyu, 2016, Langat 2020) identified noise as among the major hazards present.

## 2.2 Empirical Review

### 2.2.1 Sound and Noise

Sound is a vibration (a mechanical phenomenon whereby oscillations occur about an equilibrium point) that propagates as a typically audible mechanical wave of pressure and displacement, through a medium such as air or water. In physiology and psychology, sound is the reception of such waves and their perception by the brain (Grimshaw *et al.* 2017)**.** Sound is produced by vibrating objects and reaches the listener's ears as waves in the air or other media. When an object vibrates, it causes slight changes in air pressure. These air pressure changes travel as waves through the air and produce sound. To illustrate, imagine striking a drum surface with a stick. The drum surface vibrates back and forth. As it moves forward, it pushes the air in contact with the surface. This creates a positive (higher) pressure by compressing the air. When the surface moves in the opposite direction, it creates a negative (lower) pressure by decompressing the air. Thus, as the drum surface vibrates, it creates alternating regions of higher and lower air pressure. These pressure variations travel through the air as sound waves (Figure 2.1).

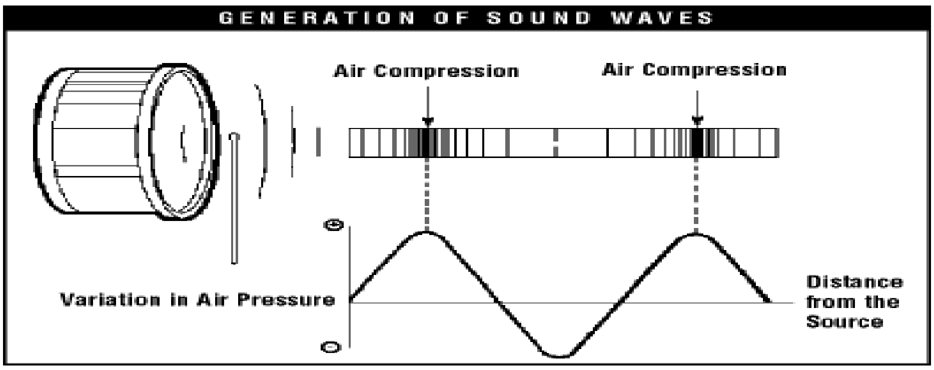


**Figure 2.1: General sound wave** (Source: Canadian Centre for Occupational Health and Safety, 2014)

A sound wave in a transmission medium causes a deviation (sound pressure, a *dynamic* pressure) in the local ambient pressure, a *static* pressure (Canadian Center for Occupational Health and Safety, 2014) Sound pressure, denoted *p*, is defined mathematically by;

$$p_{\text{total}} = p_{\text{stat}} + p,$$

Where: $p_{\text{total}}$ is the total pressure and $p_{\text{stat}}$ is the static pressure

Figure 2.1 below illustrates generation of sound pressure.

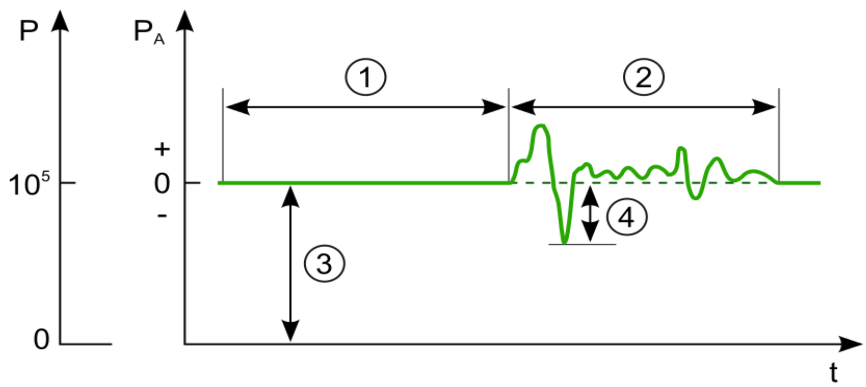


**Figure 2.2: Generation of Sound Pressure** (Source: ANSI S1.1-1994).

*1 Silence 2. Audible sound 3. Atmospheric pressure 4. Sound pressure.*

Sound that is perceptible by humans has frequencies from about 20 Hz to 20,000 Hz. In air at standard temperature and pressure, the corresponding wavelengths of sound waves range from 17 m to 17 mm. (ANSI/ASA, 2013). Sometimes speed and direction is combined as a velocity vector; wave number and direction are combined as a wave vector (ANSI/ASA, 2013). Noise is therefore unwanted sound and, is a random fluctuation in an electrical signal, a characteristic of all electronic circuits (Popelka, 1998). Noise generated by electronic devices varies greatly, as it can be produced by several different effects.

Noise is the most persistent physical contaminant in human environment, unlike other contaminant agents. The effect of noise may be unnoticed instantaneously and its accumulation can lead to an obvious physical, psychic and social deterioration (Sierra *et al*., 2017). It is the most common occupational health problem in manufacturing industries it is easily identified, not very difficult to measure and most of the time controllable (Resource Guide, 2000). Noise can be described in terms of intensity (perceive as loudness) and frequency (perceived as pitch). Both intensity and the duration of noise exposure determine the potential for damage to the ear (Peter, 2002). Noisy environments are hazardous to the hear (Minja *et al*., 2003) and increase the risk of accidents in the workplace (Marcos *et al.*, 2008).

### 2.2.2 Hearing Loss

When sound waves enter the ear, the vibrations impact the ear drum and are transmitted to the middle and inner ear. In the middle ear three small bones called the mellus (or hammer), the incus (or anvil), and the stapes (or stirrup) amplify and transmit the vibrations generated by the sound to the inner ear. The inner ear contains snail-like structure called the cochlea which is filled with fluid and lined with cells with very fine hairs. These microscopic hairs move with the vibration and convert the sound waves into nerve impulses-the result is the sound we hear. Exposure to loud noise can destroy these hair cell and cause hearing loss (OSHA Technical Manual, 2011).

When the ear is exposed to excessive sound levels or loud sounds over time the force exerted on the stereo cilia of the hair cells becomes damaging, producing abnormalities of the hair cells. Some of the abnormalities include metabolic exhaustion of the hair cells, structural changes and degeneration of structures within the hair cells. There are morphological changes of the cilia, ruptures of the cell membranes, complete degeneration of hair cells, neural cells and supporting cells (Gelfand, 2001).

### 2.2.3 Noise induced hearing loss

Noise induced hearing loss is a permanent hearing impairment resulting from prolonged exposure to high levels of noise (American Hearing Research Foundation, 2012). NIHL is the second most common form of sensorineural hearing deficit after Presbycusis (age related hearing loss) and begins at the higher frequencies of (3.000 to 6.000 Hz) developing gradually as a result of chronic exposure to excessive sound levels (Peter, 2001). It is also a sensory-neural process, which develops slowly as a result of exposure to continuous or intermittent loud noise 2wq1 (Mirza *et al*., 2018).

When noise is too loud, it begins to kill cells in the inner ear. As the exposure time to loud noise increases, more and more hair cells are destroyed. As the number of hair cells decreases, so does the hearing. Currently, there is no way to restore life to dead hair cells; the damage is permanent (American Hearing Research Foundation, 2012).

The damage caused by noise, called sensorineural hearing loss, can be caused by several factors other than noise, but noise-induced hearing loss is different in one important way – it can be reduced or prevented altogether (America Hearing Research Foundation, 2012). The National Institute for Occupational Safety and Health estimates that more than 30 million workers (1 in 10) are exposed to unsafe noise levels on job (Mirza, 2018). The National Institute for Deaf and other Communicable diseases states that 30 million Americans are exposed to hazardous noise of 85 dB(A) (OSHA, 2007). In developing countries, it is estimated that between 7% to 10% of the population have diminished hearing, and 50% of this is preventable (WHO, 2006). Most of the workplaces are noisy. A study by the USA department of labor indicated that more than half of industrial machines emit noise levels between 90dB(A) and 100dB (A) and approximately 50% of industrial work environments have noise levels between 85 and 95dB(A) and less than 6% of the machines surveyed produced noise levels less than 85dB(A) (WHO, 1999).

Sound can be measured scientifically in two ways; intensity and pitch. Both of these affect the degree to which sound (noise) damages hearing. The WHO grades of hearing impairments are show in Table 2.I below.

**Table 2.1: WHO grades of hearing impairment**

| Grade of impairment | Audiometric ISO values (average of 500,1000, 2000 4000 Hz | Impairment description |
|---|---|---|
| 0 (no impairment) | 25 dB HL or less (better ear) | No or very slight hearing impairment. Able to hear whispers. |
| 1 (Slight impairment) | 26-40 dB HL (better ear) | Able to hear words spoken by normal voice at 1 meter |
| 2 (Moderate impairment) | 41-60 dB HL (better ear) | Able to hear words spoken by raised voice at 1 meter |
| 3 (Severe impairment) | 61-80 dB HL (better ear) | Able to hear some word when shouted to the better hear |
| 4 (Profound impairment including deafness) | 81 dB HL or greater (better ear) | Unable to hear and understand even a shouted voice |

(Source: WHO, 1991)

### 2.2.4 Predisposing factors to NIHL

NIHL can be caused by a one-time exposure to an intense "impulse" sound, such as an explosion, or by continuous exposure to loud sounds over an extended period of time, such as noise generated in a workshop. (NIDCD, 2010). Genetic factors may make some individuals more susceptible (P Yu *et al*., 2018, T Ding*et al*., 2019). Other things that have been linked with an increased risk of noise induced hearing loss include smoking (Guo *et al*., 2017, Tavania *et al*., 2017), male gender, race, poor diet, diabetes, cardiovascular disease (Carrol *et al*, 2017).

#### 2.2.4.1 Intensity of Sound

Sound intensity, denoted as **I**, and measured in $W \cdot m^{-2}$ in SI units, is defined mathematically by;

$$\mathbf{I} = p\mathbf{v},$$

Where $p$ is the sound pressure; **v** is the particle velocity. (ANSI. 1994).

Intensity of sound is measured in decibels dB(A). The scale runs from the faintest sound the human ear can detect, which is labeled 0 dB(A), to over 180 dB(A), the noise at a rocket pad during launch. Decibels are measured logarithmically, being 20 times the log of the ratio of a particular sound pressure to a reference sound pressure. This means that as decibel intensity increases by units of 20, each increase is 10 times the lower figure. Thus, 20 decibels is 10 times the intensity of 0 decibels, and 40 decibels is 100 times as intense as 20 decibels. Sound intensity may be given in two different units. Persons interested in the actual physical quantification of sound use units of sound pressure level (SPL). SPL is calibrated to a constant sound pressure level that does not vary with frequency. On audiograms, however, sound intensity is calibrated in hearing level (HL), meaning that the reference sound is one that that just barely heard by a normal population. Thus, HL units are relative ones and do not generally correspond to SPL units. Higher intensity (dB) of sound causes more damage.

Many experts agree that continual exposure to more than 85 decibels may become dangerous. Table 2.2 illustrates some common sounds and their intensity.

**Table 2.2: Common sounds and their intensity**

| **Approximate Decibel Level** | **Example** |
|---|---|
| 0 dB | The quietest sound you can hear. |
| 30 dB | Whisper, quiet library. |
| 60 dB | Normal conversation, sewing machine, typewriter. |
| 90 dB | Lawnmower, shop tools, truck traffic; 8 hours per day is the maximum exposure (protects 90% of people). |
| 100 dB | Chainsaw, pneumatic drill, snowmobile; 2 hours per day is the maximum exposure without protection. |
| 115 dB | Sandblasting, loud rock concert, auto horn; 15 minutes per day is the maximum exposure without protection. |
| 140 dB | Gun muzzle blast, jet engine; noise causes pain and even brief exposure injures unprotected ears; maximum allowed noise with hearing protector. |

**(Source:** American Hearing Research Foundation, 2012).

#### 2.2.4.2 Sound pressure level (SPL) or acoustic pressure level

This is a logarithmic measure of the effective pressure of a sound relative to a reference value. Sound pressure level, denoted as $L_p$ and measured in dB, is defined by

$$L_p = \ln\left(\frac{p}{p_0}\right)\ \mathrm{Np} = 2\log_{10}\left(\frac{p}{p_0}\right)\ \mathrm{B} = 20\log_{10}\left(\frac{p}{p_0}\right)\ \mathrm{dB},$$

Where;

- $p$ is the root mean square sound pressure;
- $p_0$ is the *reference sound pressure*;
- 1 Np = 1 is the neper;
- 1 B = (1/2) ln (10) is the bel
- 1 dB = (1/20) ln(10) is the decibel.

The commonly used reference sound pressure in air is

$$p_0 = 20\ \mu\mathrm{Pa},$$

which is often considered as the threshold of human hearing. The proper notations for sound pressure level using this reference are $L_{p/(20\ \mu\mathrm{Pa})}$ or $L_p$ (re 20 μPa), but the suffix notations dB SPL, dB(SPL), dBSPL, or $\mathrm{dB}_{\mathrm{SPL}}$ are very common, even if they are not accepted by the SI (ANSI, 1994 ).

Most sound level measurements will be made relative to this reference, meaning 1 Pa will equal an SPL of 94 dBI (ANSI, 1994). The lower limit of audibility is defined as SPL of 0 dB, but the upper limit is not as clearly defined. While 1 atm (194 dB Peak or 191 dB SPL) is the largest pressure variation an undistorted sound wave can have in Earth's atmosphere, larger sound waves can be present in other atmospheres or other media such as under water, or through the Earth (ANSI, 1994).

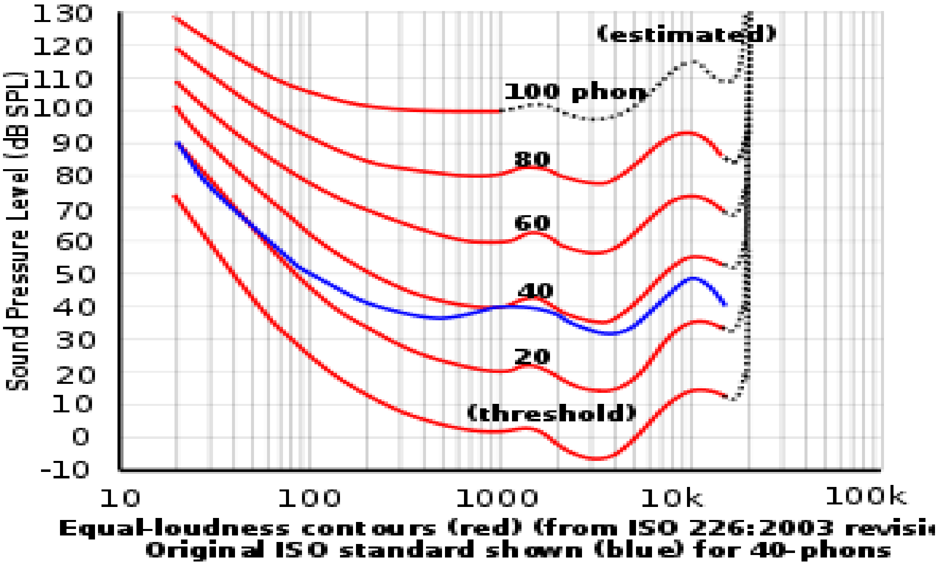


**Figure 2.3: Equal-loudness contours** (Source: ISO, 2003)

Ears detect changes in sound pressure. Human hearing does not have a flat spectral sensitivity (frequency response) relative to frequency versus amplitude. Humans do not perceive low- and high-frequency sounds as well as they perceive sounds near 2,000 Hz, as shown in the equal-loudness contour. Since the frequency response of human hearing changes with amplitude, three weightings have been established for measuring sound pressure: A, B and C, A-weighting applies to sound pressures levels up to 55 dB, B-weighting applies to sound pressures levels between 55 dB and 85 dB, and C-weighting is for measuring sound pressure levels above 85 dB (ISO 226:2003)

In order to distinguish the different sound measures a suffix is used: A-weighted sound pressure level is written either as $dB_A$ or $L_A$. B-weighted sound pressure level is written either as $dB_B$ or $L_B$, and C-weighted sound pressure level is written either as $dB_C$ or $L_C$. Unweighted sound pressure level is called "linear sound pressure level" and is often written as $dB_L$ or just L. Some sound measuring instruments use the letter "Z" as an indication of linear SPL. (ANSI S1.1-1994)

#### 2.2.4.3 Frequency

Pitch is measured in frequency of sound vibrations per second, called Hertz (Hz). Frequency is measured in cycles per second, or Hertz (Hz). The higher the pitch of the sound, the higher the frequency. A low pitch such as a deep voice or a tuba makes fewer vibrations per second than a high voice or violin. Generally, noise induce hearing loss occurs at a pitch of about 2000-4000 Hz (American Hearing Research Foundation, 2012). Frequency is measured in cycles per second, or Hertz (Hz). Young children, who generally have the best hearing, can often distinguish sounds from about 20 Hz, such as the lowest note on a large pipe organ, to 20,000 Hz, such as the high shrill of a dog whistle that many people are unable to hear (Ambrose, 2003).

Human speech, which ranges from 300 to 4,000 Hz, sounds louder to most people than noises at very high or very low frequencies (Meyer, 2020). There is considerable variation in the hearing range between individuals. Most young people can hear up to 18,000 Hz. Our ability to hear high frequencies declines with age. By the age of 55, some men can't hear above 5,000 Hz and some women can’t hear above 12,000 Hz. Women tend to have better hearing than men at high frequencies (Homans,2017). When hearing impairment begins, the high frequencies are often lost first, which is why people with hearing loss often have difficulty hearing the high-pitched voices of women and children.

Hearing impaired people often have difficulty detecting differences between certain words that sound alike, especially words that contain S, F, SH, CH, H, or soft C, sounds, because the sound of these consonant is in a much higher frequency range than vowels and other consonants (American hearing research Foundation, 2012).

#### 2.2.4.4 Duration

The duration (how long you are exposed to a noise) can affect the extent of noise induced hearing loss. The longer one is exposed to a loud noise, the more damaging it may be. Excessive noise is present in many situations for instance; every gunshot produces a noise that could damage the ears of anyone in close hearing range

(American Academy of Otolaryngology, 2005). Large bore guns and artillery are the worst because they are the loudest (Jacob, 2012). Even cap guns and firecrackers can damage your hearing if the explosion is close to the ear (American hearing Foundation 2012). According to the American Hearing Research Foundation (2012). Anyone who uses firearms without some form of ear protection risks hearing loss. Some of the more common situations of excessive noise include occupational noise (machinery, among others), loud music, and non-occupational noise (such as lawn mowers, snow blowers, among others).

### 2.2.5 Socio-demographic factors affecting NIHL

Many factors may influence hearing loss; including age, gender, education, marital status.

Age, also called age-related hearing loss or presbycusis results from degeneration of the inner ear structure occurs over a period of time, hence it comes gradually. Most people lose hearing at middle age which worsens at old age (Reshman, 2008) due to the damage of hair cells within the cochlea, hence ineffective transmission of signals (Mathew *et al.*, 2003).

Gender influences development of sensorineural hearing impairment; male gender is the most affected by NIHL (Minja, 2003). NIDCD, (2018) suggested that men are twice likely to experience hearing loss than women. Men have a higher noise exposure due to their high percentages in noisy environment (Golz, 2001), genetically predisposed to NIHL (Gao *et al.,* 2020)

Education level is one of the most important factors to personal success in society today (Clemson, 2014).  Most educated people are less effects by work place hazards. A lower risk was observed for workers with some education (Boini *et al*., 2017). This is because educated people tend to make better decisions, hence a safe work place (Salem *et al*., 2010).

The culture of safety is influenced greatly by the behavior and attitude of workers. The cultural theory of risk, indicates that people tend to perceive danger and respond to risk in different ways and that these different ways tend to encourage the development of different social structures (Rayner, 2009). A health and safety culture is key factor when it comes to determining the effectiveness of a safety system. Culture is based on behavior, every day actions, and decisions and goes far beyond health and safety policies (Sawanga, 2016).

Head trauma, that can be caused by accident or head injury, leads to traumatic brain injury which can lead to hearing loss due to injury of auditory path way (Chiasson, 2015). After head injury, eardrum or ossicular chain damage may occur which interferes with intralabyrithine fluid and nerve, hence hearing loss (Timothy *et al*., 2021).

Sudden deafness has been associated with viral diseases such as mumps, rubella, the respiratory and herpes groups of viruses, and hantavirus and Lassa virus (Pitkaranta, 1999). The inner ear structure can be damaged by viral infection or increase susceptibility to bacterial infection which leads to hearing loss (Cohen, 2014).

Inherited hearing loss is classified as autosomal recessive from X-linked or dominant which is mitochondrial-related. The autosomal recessive hearing loss is caused by pathogenic variants in both alleles where the child inherits them from both parents. Autosomal dominant inheritance occurs when variants in one single allele are able to cause hearing loss (Moza *et al.,* 2019). Genetic inheritance may run in the family and occur due to change in the inner ear and auditory nerve (NIDCD, 2018) about 80% of deafness is genetic (Shearer, 2017).

## 2.3 Critique of Existing Literature

Workers in both formal and informal sector have been exposed to noise (Baumann *et al*., 1995). In the formal sector, the Ministry of Labor, through Director of Occupational Safety and Health (DOSH), ensures that the occupational safety and health regulations are enforced unlike in the informal sector. Minja *et al*. (2003) studied noise induced hearing loss among industrial workers in Dar es Salam and found that noise levels were above the safe limit of 85 dB(A). In Kenya, most of the research has been conducted research on occupation noise exposures but only in the formal sector. Anino *et al*., (2010) studied occupational noise induced hearing loss among workers in Jomo Kenyatta International Airport, Nairobi. Kengen (2006), studied noise emission levels around Olkaria geothermal power project, while Jorge. (2014) studied occupational noise levels in Mumias sugar. The informal "*Jua kali*" sector accounts for nearly 18% of the GDP and comprise 90% of all businesses in the country (ILO, 2005) yet no information is available about the workplace and workers for the regulation authorities to work with.

## 2.4 Legal frame work

It is the right of every Kenyan to inhabit a conducive environment, (Article 69(1) g of the Kenyan constitution which agrees with the EMCA (1999) and OSHA (No 15 of 2007). Factory and other Places of Work (Noise prevention and control) rules 2005, prohibit production of any loud, unreasonable, unnecessary or unusual noise which annoys disturbs, injures or endangers the comfort, response, health or safety of others and the environment.

The NEMA (Noise and excessive vibration rules (2009), prescribe the maximum permissible noise levels from a facility or activity to which a person may exposed to as 85 dB for eight working hours.

## 2.5 Summary

Occupational noise exposure and hearing loss contribute to the risk of industrial accidents and for many occupational health and safety professionals this makes a compelling argument to reduce noise exposure in the workplace. However, the evidence supporting this rationale is limited. Cohen (1973), states that noise is the most common occupational health problem, especially in the manufacturing industries. It is easy to identify, not very difficult to measure to measure, and in the most cases controllable, although noise abatement is sometimes quite costly (Resource Guide, 2000). Hearing protection can be satisfactory solution, as long as protection are properly fitted, worn, and maintained. Unfortunately, noise and hearing conversation problems do not always receive the attention they deserve because the effect of noise is not lethal. Also, like other occupational health hazards, noise is insidious. Individuals suffering noise induced hearing loss may not be aware of the condition until it is of handicapping proportion and by that time it is permanent (Canada Technical Service, 2000).

In the formal sector, the occupational safety and health regulations are enforced unlike in the informal sector. Most of the researches that had been carried out on occupational noise exposure had been carried out in the formal sector; NIHL in Jomo Kenyatta International Airport Nairobi (Muiruri. 2012), NIHL in industrial plants in Nairobi Anino (2010). The literature reviewed opened up many areas of research in the informal sector. The informal sector workers like any other workers in the formal sector requires to be protected from occupational noise induced hearing loss. No research has yet been conducted on occupational noise induced hearing loss in the informal sector metal fabrication, although similar research has been conducted in the formal sector in construction by (Neitzel *et al*., 1999) and steel rolling mills by (Foluwasayo *et al*., 2005). This research study aimed at getting the actual situation in *"Jua kali"* sector Mombasa Sub County.

**2.6 Research Gaps**

The "*Jua kali"* sector in the East African region has played a central role in socio-economic sphere and is a source of 85% to 90% of all non-farming employment opportunities (Baiya, 2012). In Kenya, the "*Jua kali"* sector is one of the largest informal sectors in Kenya (Maundu, 1992) and accounts for nearly 18% of the GDP and comprise 90% of all businesses in the country (ILO, 2005). "*Jua kali"* is a major employer in Kenya and yet very little information is known about the work place conditions and the Occupational hazards that the workers are exposed to. The objective of this study is to determine the contributing and predisposing factors to occupational noise to hearing loss among workers in "*Jua kali"* sheds in Mombasa County.

# CHAPTER THREE

# MATERIALS AND METHODS

## 3.1 Research Design

Cross-sectional research design was used in this study. A cross sectional study design is a quantitative study which involved gathering data that describes events and then organizes, tabulates, depicts and describes the data collected (Watson, 2015). The study aimed at collecting information from the respondents on personal information (age, sex, years of work) and medical background information (ear disease suffered) using a questionnaire. It also involved measurement of noise levels (noise mapping) and hearing ability of the respondents, classification, analysis, comparison and interpretation of data.

## 3.2 Study Area and Population

The study population was among "*Jua kali*" workers in Mombasa County. Mombasa County is one of the 47 Counties in Kenya. Mombasa County lies in the Coastal line of Kenya and Indian Ocean. There are six sub counties: Mvita, Changamwe, Likoni, Jomvu, Nyali and Kisauni. Mombasa island is the headquarters of the county with an area of 14.1 square kilometers and between coordinates $4^{o}$03'S and coordinate $39^{o}$40'E. Due to rural urban migration it had the population of 1.3 million people a 3.35% increase from 2019(KNBS, 2020), leading to job scarcity and most young people venturing into self-employment. (Appendixes Viii)  Mombasa county map.

## 3.3 Sampling Frame

The study was conducted in Mombasa subcounty, Mombasa County, "*Jua kali"* sheds between January 2017 to July 2017. The study was focused on the "*Jua kali"* workers at the "*Jua kali"* sheds who were directly dealing with metal works, blacksmiths and metal engineering. The workers who had less than one year in the venture were not be included since NIHL develops over a period of time.

### 3.4 Sample and Sampling Technique

#### 3.4.1 Sample Size Determination

The number of persons involved in metal work only was determined from the local register available with the workers' representatives. The number of workers was Buxton = 248 workers, Changamwe = 72 workers, and Nyali = 97 workers. The total number of registered "*Jua kali*" metal workers in the three clusters Mombasa was 417.

The sample was determined using the formula (Slovin's formula)

$$n = \frac{N}{1+N(e)^2}$$

Where;

n = sample size of the proportion of interest,

N= Total population

e = Level of precision sample error $^{+}_{-}$ 0.05

$n = 417/\ 1+417(0.05)^2$

= 204.1617

=204 workers

The number of responded that actively participated in the research was 146 which is 71.56% which is within the acceptable range (Guo, 2013).

**Table 3.1: Distribution of respondent I the study**

| Daily assignment | Hammering | Riveting | Welding | Food vendors | Total |
|---|---|---|---|---|---|
| Nyali (Kongowea) | 7 | 8 | 4 | 2 | 21 |
| Buxton(Mvita) | 63 | 18 | 8 | 11 | 101 |
| Changamwe | 9 | 9 | 3 | 3 | 24 |
| Total | 79 | 36 | 13 | 16 | 146 |

### 3.4.2 Sampling Technique

The selected metal "*Jua kali*" sheds was found in the following places in Mombasa County; Changamwe, Buxton and Nyali, because the other work places were not enclosed and noise was not concentrated.

Simple random sampling technique was used to select workers in each "*Jua kali*" shade, random sampling is a set of individuals randomly selected to represent entire population (Lauren, 2020) Simple random sampling ensures reduction of potential for human biasness in selection of cases included in the sample (Taherdoost, 2016).

## 3.5 Research Instruments

### 3.5.1 Data Collection Tools

Data on noise effects was collected by use of a structured questionnaire (Appendix III) which consisted of three sections. Section I consisted of question on Socio-demographic characteristics. These were questions that gave information about the correspondents and included characteristics of age, sex, level of education, and marital status. Section II consisted of NIHL related questions which led to determining awareness of correspondents to noise hazards. Section III consisted of questions that led knowledge on prevention of NIHL and illness of the ears, and general questions relating to occupational and other relevant areas. The questionnaire was administered to all identified participants who met the inclusion criteria.

### 3.5.2 Noise Mapping Equipment

Noise mapping to determine the noise levels in the area of study were conducted, Audiometric tests (pure tone audiometry) was also done on the selected subjects to determine the hearing ability.

The following materials and instruments were used;

#### 3.5.2.1 Sound level meter

A sound level meter (SLM) (Appendix V) is a noise mapping device used to make frequency-weighted sound pressure level measurements which are displayed in dB(A) (Katalin, 2018). SLMs feature an omnidirectional measurement quality condenser microphone, a mic preamp, frequency weighting networks, an RMS detector circuit, averaging circuits, the meter display, AC and DC outputs used to feed other measurement devices or for recording.

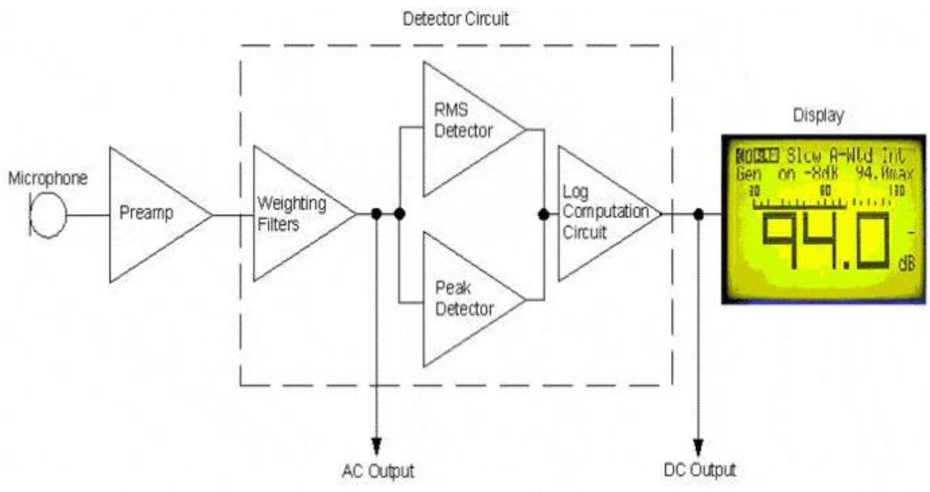


**Figure 2.4: Functional drawing of a basic SLM** (Source: Park, 2012)

#### 3.5.2.2 Audiometer

This is an instrument for determining the hearing ability (Appendix VI). The audiometer measures hearing acuity for variations in sound intensity and pitch and for tonal purity, involving thresholds and differing frequencies. The audiogram obtained from audiometer may be used to describe the hearing of a person for the various frequencies tested. It may be used to calculate the amount of hearing handicap a person has, and may be used as a tool to determine the cause of a person's hearing loss (Ensink, 2017).

### 3.6 Data Collection Procedure

The details of the workers were obtained from the workers register. The data was collected in three stages.

Stage one involved noise measurement in various locations within the *"Jua kali"* sheds, Stage two involved gathering information using structured questionnaires.

Stages three involved carrying out of Audiometric tests.

#### 3.6.1 Preliminary Field Visits

Site visits were done to the identified study area (metal "*Jua kali*" sheds) to get acquitted with the activities and processes that were carried out, and to identify the hazards that the workers were exposed to. Meetings were conducted with the workers to sensitize them about noise in their work place, effect of noise to their health and the intended research study, including how it was beneficial to them. A list of the workers (respondents) was obtained from the leaders and the date and time set for commencement of the research work.

#### 3.6.2 Evaluation of hearing ability

Evaluation of hearing ability was done in three stages (Ensink, 2017) in the morning before the workers started their daily chores.

In Stage 1, the participants were informed about the evaluation process in order to give informed consent. A structured questionnaire (Appendix III) for collection of hearing related data was then administered to the participants. They were then assisted to fill in the questionnaire.

In Stage 2, the participants were then taken through an auditory examination which included general examination and specific examination of the ear. Examination on the ears was carried using an otoscope; where wax found in the participant was removed then ear audiometric tests was done.

Lastly, in Stage 3, the participants were ushered into a quiet room where ambient sound pressure levels of 38.9 dB(A). A subjective Audiometric test were carried out using Integrated sound level meter Type 2225 (Briie & Kjaer, 2001). The audiometric exam tests how well a person's hearing functions. The test covered both intensity and tone of sounds to determine how well a person can hear. The degree of hearing loss was classified as mild, moderate and severe.

### 3.6.3 Noise level measurement

An environmental noise survey was conducted to determine the noise in the workplace. This was done using Integrated sound level meter Type 2225 (Briie & Kjaer, 2001) (Appendix V). The work area was divided in to three work stations according to the work done and two measurements were done on each section (during the peak of activity and during no activity), the noise level was recoded and average calculated.

Briie and Kjaer, (2001) with omnidirectional microphone set at a slow response was used in measuring the environmental noise at the workplace. The instrument was calibrated using an Acoustic Cirrus calibrator model CR: 515, Serial No. 46701, at 93.9dB(A) and 1000 Hz. The calibration was used to check the sensitivity of the instrument immediately before and after the measurement period. The sound meter level was set to measure the A-weighted noise level which varied with the frequency intensity like the sensitivity of the human ear. The sound level meter was held at 1 meter from the ground and the Leq (the continuous equivalent sound pressure level) sample measurements taken at various sheds. The Leq is indicative of average noise levels over a given period. Where noise levels were found to be above 85dB(A) a 30-frequency analysis were done to determine at what frequency the level of high noise was resulting from.

### 3.6.4 Use of protective devices

The Occupational Safety and Health Act of 2007, Part XI Section 101 states that, all workers in any workplaces with processes involving exposure to injurious or offensive substance should use adequate, effective and suitable protective clothing and appliances. Protective clothing/appliances (PPE) are equipment that protect the user against health or safety risks at work**.** Questionnaire (Appendix III). Section III

## 3.7 Pilot Test

Pilot test is a small-scale preliminary study conducted in order to evaluate feasibility, time, cost, adverse effect and size (Laxmi, 20018). It provides opportunities to validate, understand, supply additional data and acts as a rehearsal (Bokrantz elal.,, 2018). In this study pilot test was be done in Likoni metal "*Jua kali"* workers, South of the study area. A sample of 10 workers was taken for the pilot test.

### 3.7.1 Validity of Research Instrument

Validity is defined as the accuracy, truthfulness and meaningfulness of inferences that are based on the data obtained from the use of a given tool or scale for each construct or variable in the study. Validity is an estimate of how accurately the data obtained from the use of a tool in a study represents a given variable or construct in the study (Mohajan, 2017). In this study pilot testing was an important step in making the instrument valid for the purposes of the study.

During pilot testing vague questions and unclear instructions were revealed. Important suggestions and comments were captured from the respondents which enabled improvement and efficiency of the instrument. The responses from different participants analyzed to get a generalized position which stood the validity test. The items were structured in simple English, which respondents found easy to respond to.

### 3.7.2 Reliability of Research Instrument

Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. It is influenced by random error. As random error increase's reliability decreases random error is defined as the deviation from a true measurement due to factors that have not been addressed by the researcher. Errors may arise from coding, fatigue and bias (Mugenda & Mugenda, 1999). Cronbach alpha technique was used to determine the reliability of the questionnaire where a value greater than 0.7 is considered reliable (Tobar, 2018). In this study, Cronbach alpha was determined by SPSS version 21 and found to be 0.83 hence, the tool was reliable.

### 3.7.3 Control group

This was a base line group that was not exposed to working conditions (noise levels) as those of the experimental respondent. A group of people who vended food to the "*Jua kali*" workers in Mombasa County was the control group since they did not engage in noisy assignment thou they worked in a noisy environment.. They underwent audiometry test and answered the questionnaire.

## 3.8 Data Processing and Analysis

Quantitative data analysis was done by descriptive statistics Frequency, mean and standard deviation. Comparison of means was using t-test and ANOVA to check significance relationships of variables: NIHL significance relationship with socio demographic and work-related factors. NIHL significant relation with sound levels, towards achieving the objective of determining the predisposing factors of NIHL in worker in the "*Jua kali"* sheds. Chi-square test of association was also used for analysis. Statistical Software for Social Sciences (SPSS) Version 21.

## 3.9 Ethical consideration

Approval for the study was sought from (JKUAT), the Ethical Review Committee of Pwani University (Appendix VII), and DOSHS Mombasa County.

Participation was conducted on voluntary basis with informed consent from individuals. No incentives were given to participants. This was achieved by ensuring that individuals received sufficient information, which could be easily understood, and ensuring that appropriate strategies were in place to protect participants from potential adverse consequences of the research.

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.1 Results

### 4.1.1 Response rate

The total number of respondents was 146 out of a sample size of 204 the response rate in this study was 71.57%. Mugenda and Mugenda (1999), stated that the response rate of 55% is good enough for statistical reporting. It confirms the correctness of response and it allows one to make deductions.

### 4.1.2 Socio-demographic characteristics of the respondents

The results of Social demographic characteristics of the respondents are presented in Figures 4.1 to Figure 4.4 below.

Most (52.1%) of the metal "*Jua kali"* workers were aged 20-35 years (Figure 4.1). Majority of the respondents (81.5%) were male

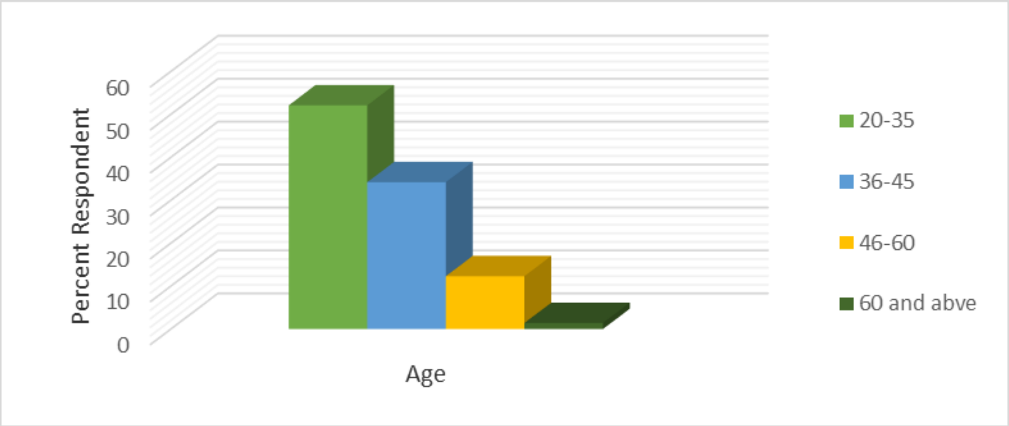


**Figure 4.1: Age distribution among the respondents in metal work "*Jua kali*" shed in Mombasa County-Kenya, 2018**

On marital status, majority (65%) of the respondents were married, meaning that most of the respondents had families (Figure 4.2).

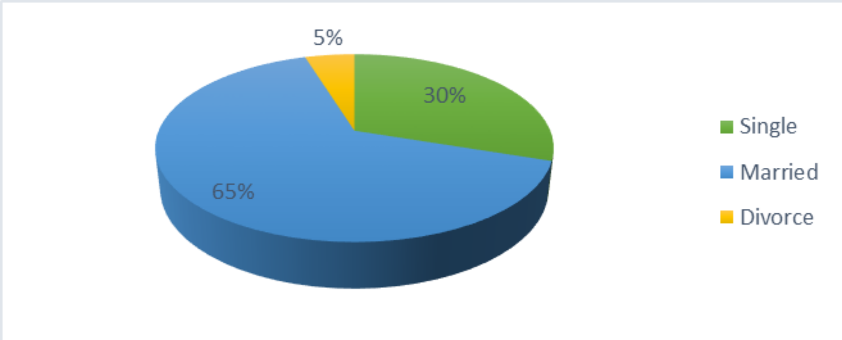


**Figure 4.2: Marital status distribution among the respondents in metal work "Jua kali" shed in Mombasa County-Kenya, 2018.**

On education level, 60.3% had Primary school education, 4.1% had no formaleducation, and 4.1% had Tertiary school education (Figure 4.3). This is an indication that most of the respondents had low or lacked formal education.

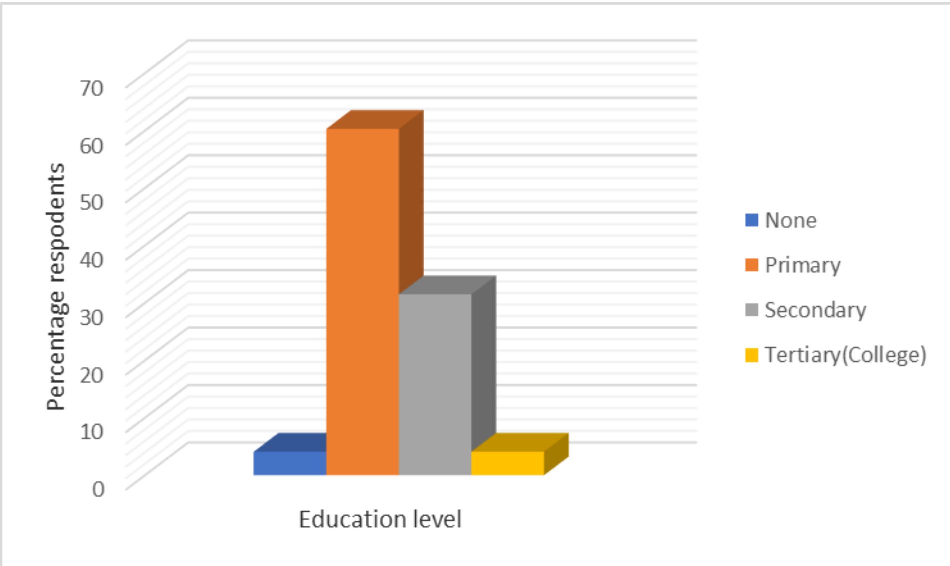


**Figure 4.3: Education level distribution among the metal workers in "Jua kali" shed in Mombasa County-Kenya, 2018**

### 4.1.3 Intensity of noise within metal workplaces in Jua Kali sheds in Mombasa county- Kenya

Table 4.1 below shows results of noise measurement done in all locations and in working zones.

**Table 4.1: Noise level measurements in dB(A) in metal working areas in "*Jua kali"* sheds, Mombasa County- Kenya, 2018**

| Location | Working zone | Noise level | | | | |
|---|---|---|---|---|---|---|
| | | High | Low | Area Mean | Location means | Overall Mean |
| Buxton | Hammering | 134 | 112 | 123 | | |
| | Riveting | 127 | 90.4 | 108 | | |
| | Welding | 123 | 104 | 113.5 | | |
| | Food Vending | 103 | 96 | 99.5 | 109.6 | |
| | Marketing | 112 | 99 | 104 | | |
| Changamwe | Hammering | 122 | 103 | 112.5 | | |
| | Riveting | 110 | 98 | 104 | | |
| | Welding | 119 | 95 | 214 | | |
| | Food Vending | 96 | 76 | 86 | | |
| | Marketing | 90 | 70.7 | 80.35 | | |
| | | | | | 119.37 | |
| Kongowea | Hammering | 125 | 102 | 113.5 | | |
| | Riveting | 107 | 97 | 102 | | |
| | Welding | 117 | 94 | 105 | | 108.67 |
| | Food Vending | 94.4 | 75 | 84.7 | 97.04 | |
| | Marketing | 89 | 71 | 80 | | |

Changamwe metal work "*Jua kali"* shed had the highest level of noise (119.4 dBA) follwed by Buxton (109.6 dBA) and Nyali (Kongowea) had the least noise (87.6 dBA) (Figure 4.4).

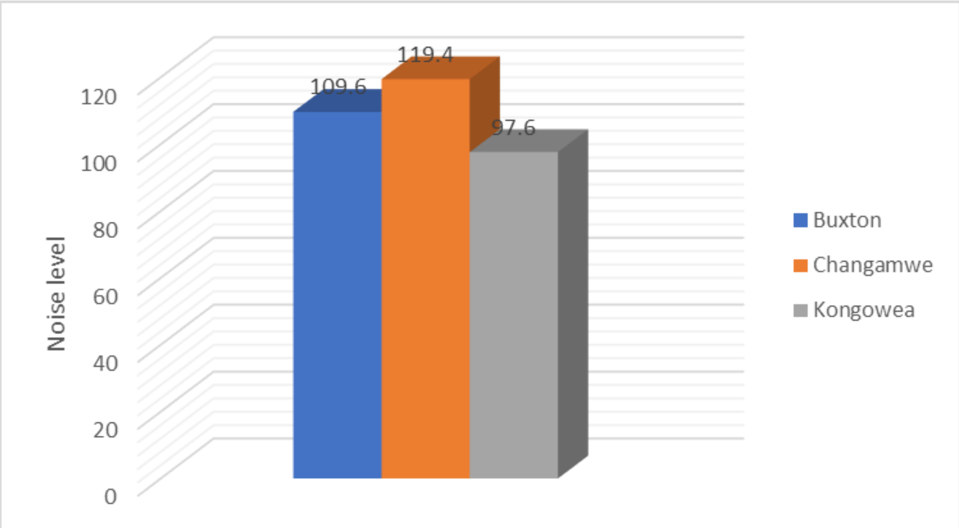


**Figure 4.4: Intensity of noise in *Jua kali* metal work shades with Mombasa County-Kenya, 2018**

The mean noise level in all metal *Jua kali* sheds in Mombasa County was 108.87 ± 8.2312 decibels which is higher than the maximum recommended value of 85 decibels as shown in table 4.4 above.

A *t*-test statistical at ($p = 0.05$) for noise levels in metal *Jua kali* sheds showed a significant difference ($p = 0.012$) between the average noise level (108.87) in metal *Jua kali* sheds in Mombasa County and the recommended level of 85 dBA.

However, analysis of variance (ANOVA) on the mean noise level in the three locations (Changamwe, Buxton and Nyali (Kongowea) showed no significant differences ($p = 0.594$).

Considering the working zones (various assignments), the mean noise level was highest (144.166 dBA) among those doing hammering, noise levels were high compared to the given standards (OSHA 2007 and NEMA 1999). (Figure 4.5).

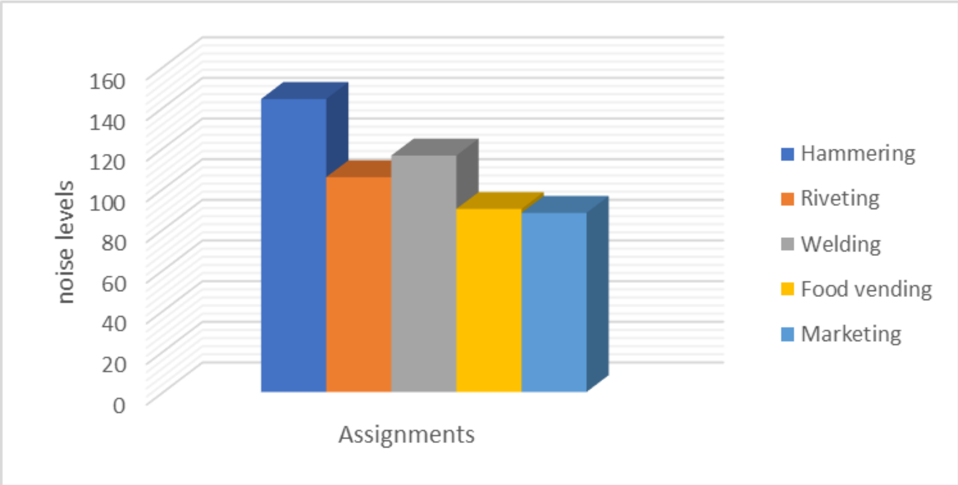


**Figure 4.5: Noise levels in deferent assignments in metal *Jua kali* sheds in Mombasa County- Kenya, 2018**

### 4.1.4 Level of hearing loss among the workers in *Jua kali* metal work sheds within Mombasa County-Kenya

The second objective of the study was to determine the number of people with hearing loss at metal *Jua kali* sheds in Mombasa County. To meet this objective, an audiometry test was administered to all the respondents, and the following results was computed. Figures 4.6 below shows that the proportion of workers with no hearing loss was 49.3%, those with moderate hearing loss were 47.9% and 2.7% had severe hearing loss. NIHL had developed in 2.7% of the respondent, 47.9% had been acquire some level of NIHL while 49.3% did not show evidence of acquiring NIHL.

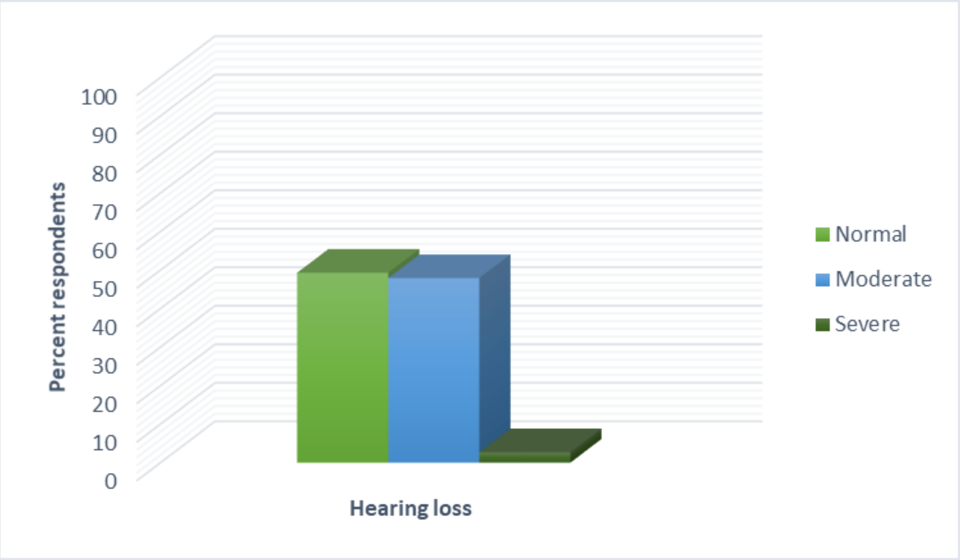


**Figure 4.6: Level of hearing loss among the respondent in metal "*Jua kali*" sheds in Mombasa County-Kenya, 2018**

### 4.1.5 Influence of socio-demographic and work-related factors on NIHL among the metal workers in "*Jua kali*" sheds within Mombasa County-Kenya

#### 4.1.5.1 Influence of socio-demographic characteristics on NIHL

Chi square test was done to check for association between hearing loss and socio-demographic factors among the metal *Jua kali* workers. This was achieved through determining the association between trouble hearing after work, hearing loss and set of socio demographic factors namely; age, gender, duration, education and marital status. The results are shown in Table 4.2 below.

A significant association was found between age (p=0.00), gender (p=0.00) and marital status (p=0.020) with NIHL.

**Table 4.2: Chi square association of social demographic factor and NIHL among the respondents in metal "Jua kali" shed in Mombasa County-Kenya 2018**

| Socio-demographic characteristic | | Hearing loss Normal | Moderate | Severe | $\chi^2$value (exact) | Df | P value |
|---|---|---|---|---|---|---|---|
| Age | 20-35 years | 51 (67.1) | 25 (32.9) | 0 (0) | 51.064 | 6 | 0.000 |
| | 36-45 years | 17 (34) | 33 (66) | 0 | | | |
| | 46-60 years | 4 (22.2) | 11 (61.1) | 3 (16.7) | | | |
| | 60 and above | 0 (0) | 1 (50) | 1 (50) | | | |
| Gender | Male | 49 (41.2) | 66 (55.5) | 4 (3.4) | 17.134 | 2 | 0.000 |
| | Female | 23 (85.2) | 4 (14.8) | 0 | | | |
| Level of education | None | 4 (66.7) | 2 (33.3) | 0 | 5.535 | 6 | 0.477 |
| | Primary | 38 (43.2) | 46 (52.3) | 4 (4.5) | | | |
| | Secondary | 27 (58.7) | 19 (41.3) | 0 | | | |
| | Tertiary | 3 (50) | 3 (50) | 0 | | | |
| Marital status | Single | 28 (63.6) | 16 (36.4) | 0 | 11.634 | 1 | 0.020 |
| | Married | 38 (40) | 53 (55.8) | 4 (4.2) | | | |
| | Divorced | 6 (85.7) | 1 (14.3) | 0 | | | |

#### 4.1.5.2 Influence of work-related characteristics on NIHL

Duration of work, Figure 4.7 below shows that majority (46.6%) of the respondents had worked for a duration of 6 to 10 years, time that is enough to develop NIHL, while the list (2.1%) worked for 16 to 20 years.

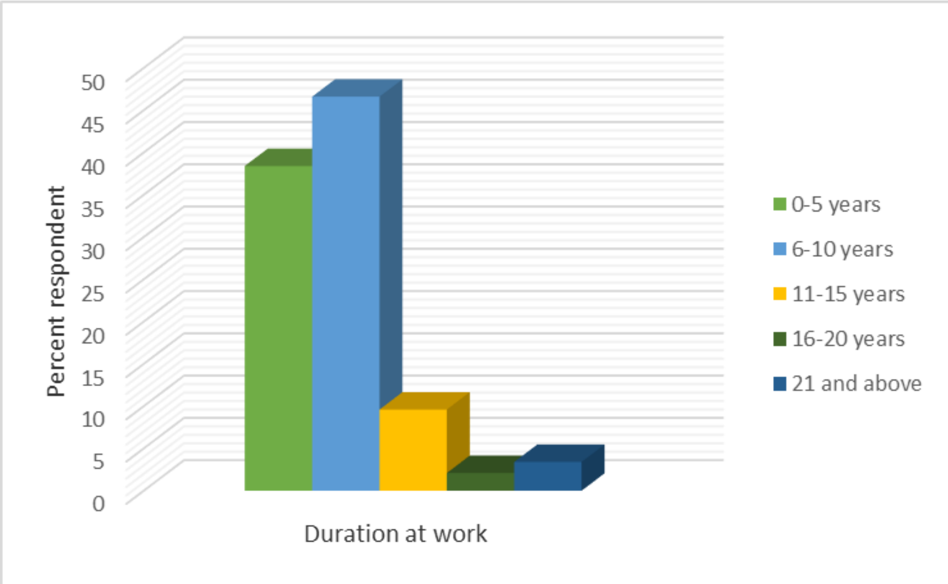


**Figure 4.7: Duration of work among the percentage respondents in metal "*Jua kali*" sheds in Mombasa- Kenya 2018**

For position at work, 71.2% of the respondents had worked as artisans, 19.2% were trainees, while 9.6% worked as supervisors (Figure 4.8).

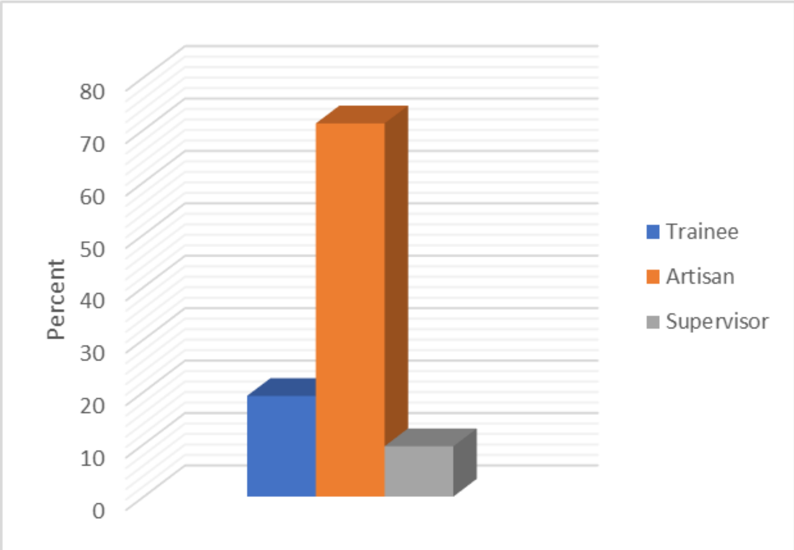


**Figure 4.8: Percentage respondent in different position at work in metal "*Jua kali*" sheds in Mombasa- Kenya, 2018**

For number of working hours**,** Figure 4.9 shows that 68.5% worked for more than 8 working hours, 28.8% worked for 5 to 8 hours while 2.7% had worked for 1 to 5 hours.

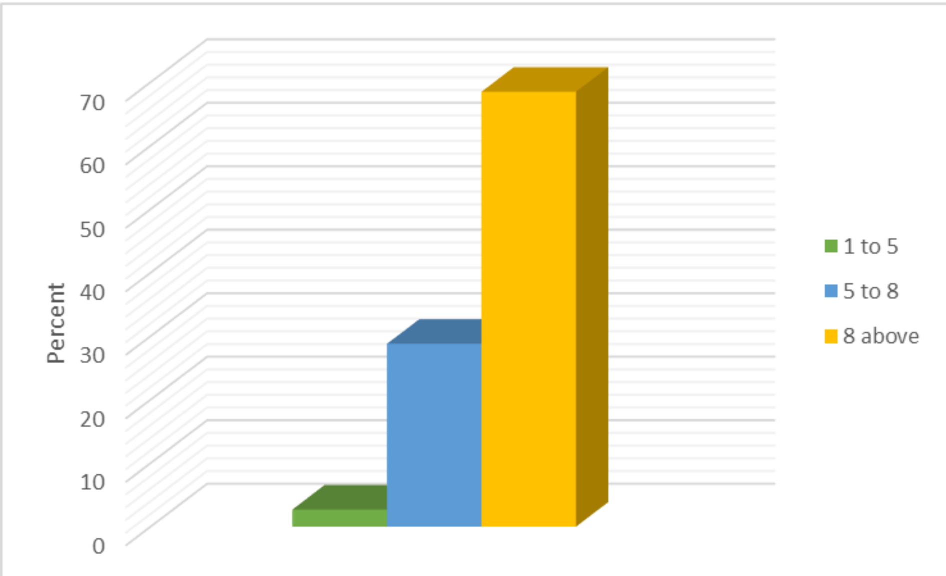


**Figure 4.9: Number of working hours among the respondent in metal "Jua kali" sheds in Mombasa- Kenya, 2018**

A significant association was found between duration on the job (p=0.00), daily position at work (p=0.014) and hours worked per day (p=0.012) with NIHL as shown in Table 4.3.

**Table 4.3: Chi square test of association of work relater factors and NIHL among the respondent in metal "*Jua kali*" sheds in Mombasa- Kenya, 2018**

| **Characteristic** | | **Hearing loss** | | | **$\chi^2$ value** | **df** | **P value** |
|---|---|---|---|---|---|---|---|
| | | **Normal** | **Moderate** | **Severe** | | | |
| Position at work | Trainee | 12 (42.9) | 14 (50) | 2 (7.1) | 12.46 | 4 | 0.014 |
| | Artisan | 53 (51) | 51 (49) | 0 (0) | | | |
| | Supervisor | 7 (50) | 5 (35.7) | 2(14.3) | | | |
| Duration | 0-5 years | 44 (78.6) | 11 (19.6) | 1 (1.8) | 48.578 | 8 | 0.000 |
| | 6-10 years | 23 (33.8) | 44 (64.7) | 1 (1.5) | | | |
| | 11-15 years | 4 (28.6) | 10 (71.4) | 0 | | | |
| | 16-20 years | 0 | 2 (66.7) | 1 (33.3) | | | |
| | 21 and above | 1 (20) | 3 (60) | 1 (20) | | | |
| Number of hours worked in a day | 1-5 | 1 (25) | 3 (75) | 0 | 12.936 | 4 | 0.012 |
| | 5-8 | 23 (54.8) | 15 (35.7) | 4 (9.5) | | | |
| | Above 8 | 48 (48) | 52 (52) | 0 | | | |

### 4.1.6 Knowledge, attitude and practice of workers on NIHL in *Jua kali* metal work sheds within Mombasa County Kenya 2018

Results on knowledge, attitude and practice of workers is presented in Figure 4.10 4to 4.12.

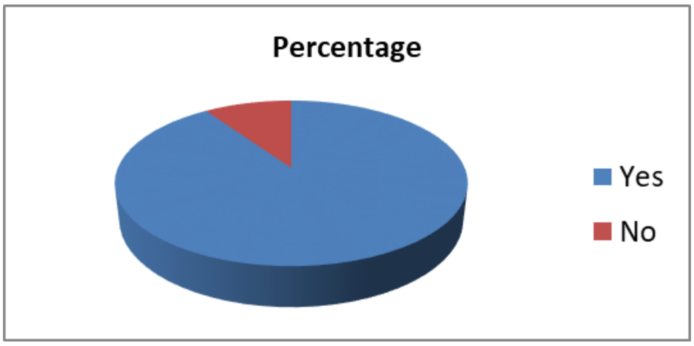


**Figure 4.10: percentage of workers aware that work place produce noise**

Most (90.4%) of the metal workers in the *Jua kali* sheds were aware that their work place produced a lot of noise while 9.6% were not aware.

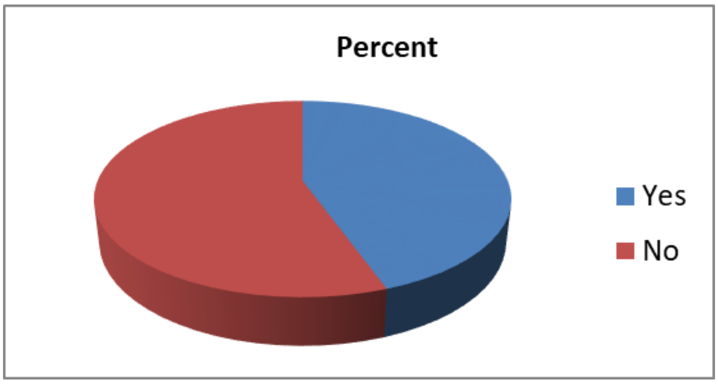


**Figure 4.11: percentage of workers aware that work place produce noise**

Among the respondents 55.5% had no knowledge that noise exposure could lead to NIHL while 44.5% had the knowledge.

Most of the respondents 81.5% had the knowledge that they could be protected against NIHL.

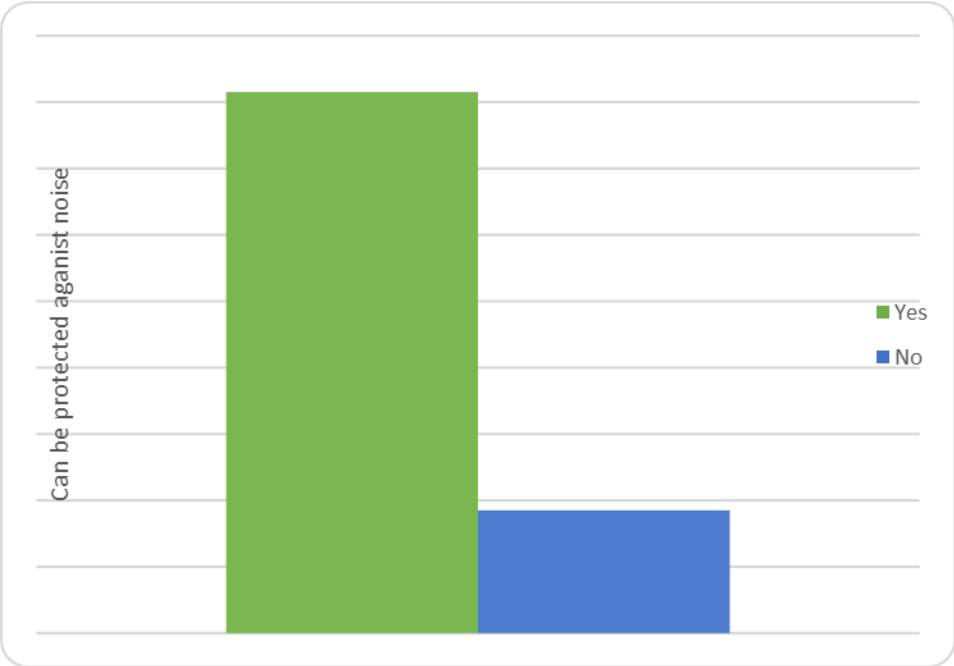


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**Figure 4.12: percentage of workers aware that work place produce noise**

19.9% used hearing protection while 80.1% did not use hearing protection.

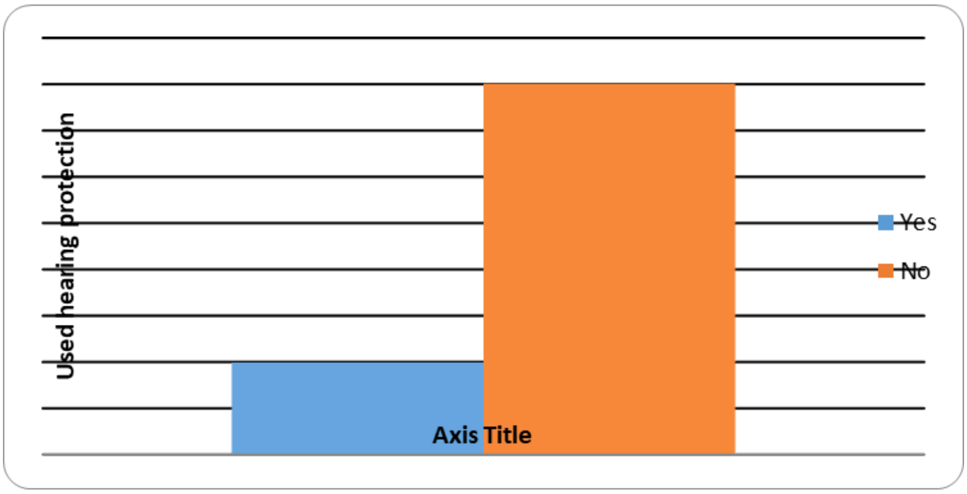


**Figure 4.13: percentage of workers aware that work place produce noise**

From figure 4.10 to 4.13, respondents knew they were being exposed to high noise levels (90.4%) but did not know this noise could lead to NIHL (55.5%). Thou most (81.5%) respondents new that noise could be protected only a few 19,9% used hearing protection.

### 4.1.7 Association of knowledge, attitude and practice of workers on NIHL among the respondents

Results on association between knowledge, attitude and practice of workers with noise induced hearing are presented in Tables 4.4 to 4.9.

#### 4.1.7.1 Association of NHIL with Awareness of noise-inducing factors

Table 4.4 results show that only two variables, gender ($p = 0.014$) and marital status ($p = 0.014$), had significant association with awareness about production of a lot of noise at place of work can result to deafness.

**Table 4.4: Chi-square test of association of awareness of work produce noise among the respondents in metal "Jua kali" sheds in Mombasa County- Kenya, 2018**

| Characteristic | | Awareness of work produce noise | | $\chi^2$ value | df | P value |
|---|---|---|---|---|---|---|
| | | Yes (%) | No (%) | | | |
| Age | 20-35 years | 70 (92.1) | 6 (7.9) | 5.205 | 3 | 0.157 |
| | 36-45 years | 46 (92) | 4 (8) | | | |
| | 46-60 years | 15 (83.3) | 3 (16.7) | | | |
| | 60 and above | 1 (50) | 1 (50) | | | |
| Gender | Male | 111(93.3) | 8 (6.7) | 6.098 | 1 | 0.014 |
| | Female | 21 (77.8) | 6 (22.2) | | | |
| Duration | 0-5 years | 50 (89.3) | 6 (10.7) | 2.704 | 4 | 0.608 |
| | 6-10 years | 62 (91.2) | 6 (8.8) | | | |
| | 11-15 years | 13 (92.9) | 1 (7.1) | | | |
| | 16-20 years | 2 (66.7) | 1 (33.3) | | | |
| | 21 and above | 5 (100) | 0 (0) | | | |
| Location | Kongowea | 17 (81) | 4 (19) | 2.535 | 2 | 0.282 |
| | Buxton | 93 (92.1) | 8 (7.9) | | | |
| | Changamwe | 22 (91.7) | 2 (9.3) | | | |
| Level of education | None | 4 (66.7) | 2 (33.3) | 4.896 | 3 | 0.18 |
| | Primary | 81 (92) | 7 (8) | | | |
| | Secondary | 41 (89.1) | 5 (10.9) | | | |
| | Tertiary | 6 (100) | 0 (0) | | | |
| Marital status | Single | 44 (100) | 0 (0) | 8.59 | 2 | 0.014 |
| | Married | 83 (87.4) | 12 (12.6) | | | |
| | Divorced | 5 (71.4) | 2 (28.6) | | | |
| Position at work place | Trainee | 25 (83.9) | 3 (16.1) | 0.138 | 2 | 0.934 |
| | Artisan | 94 (90.4) | 10 (9.6) | | | |
| | Supervisor | 13 (92.9) | 1 (7.1) | | | |
| Daily assignment | Hammering | 71 (89.9) | 8 (10.1) | 6.676 | 3 | 0.083 |
| | Riveting | 34 (94.4) | 2 (5.6) | | | |
| | Welding | 15 (100) | 0 (0) | | | |
| | Food vendor | 12 (75) | 4 (25) | | | |
| Number of hours worked | 1-5 | 4 (100) | 0 (0) | 0.724 | 2 | 0.696 |
| | 5-8 | 37 (88.1) | 5 (11.9) | | | |
| | Above 8 | 91 (91) | 9 (9) | | | |

**Table 4.5: Chi square test or association of awareness that exposure to noise can cause NIHL among the respondents in metal "*Jua kali*" sheds in Mombasa-Kenya, 2018**

| Characteristics | | Awareness that exposure to noise can cause deafness | | | | |
|---|---|---|---|---|---|---|
| | | **Yes (%)** | **No (%)** | **$\chi^2$ value** | **df** | **P value** |
| Age | 20-35 years | 30 (39.5) | 46 (60.4) | 4.388 | 3 | 0.223 |
| | 36-45 years | 22 (44) | 28 (56) | | | |
| | 46-60 years | 12 (66.7) | 6 (33.3) | | | |
| | 60 and above | 1 (50) | 1 (50) | | | |
| Gender | Male | 58 (48.7) | 61 (51.3) | 4.637 | 1 | 0.034 |
| | Female | 7 (25.9) | 20 (74.1) | | | |
| Duration | 0-5 years | 23 (41.1) | 33 (58.2) | 1.108 | 4 | 0.893 |
| | 6-10 years | 31 (45.6) | 37 (54.4) | | | |
| | 11-15 years | 7 (50) | 7 (50) | | | |
| | 16-20 years | 2 (66.7) | 1 (33.3) | | | |
| | 21 and above | 2 (40) | 3 (60) | | | |
| Location | Kongowea | 14 (66.7) | 7 (33.3 | 5.001 | 2 | 0.082 |
| | Buxton | 42 (41.6) | 59 (58.4) | | | |
| | Changamwe | 9 (37.5) | 15 (62.5) | | | |
| Level of educatic | None | 2 (33.3) | 4 (67.3) | 1.284 | 3 | 0.733 |
| | Primary | 42 (47.7) | 46 (52.3) | | | |
| | Secondary | 18 (39.1) | 28 (60.9) | | | |
| | Tertiary | 3 (50) | 3 (50) | | | |
| Marital status | Single | 17 (38.6) | 27 (61.4) | 1.192 | 2 | 0.551 |
| | Married | 44 (46.3) | 51 (53.7) | | | |
| | Divorced | 4 (57.1) | 4 (42.9) | | | |
| Position | Trainee | 9 (32.1) | 19 (67.9) | 6.506 | 2 | 0.039 |
| | Artisan | 53 (51) | 51 (49) | | | |
| | Supervisor | 3 (21.4) | 11 (78.6) | | | |
| Daily assignment | Hammering | 37 (46.8) | 42 (53.2) | 0.637 | 3 | 0.888 |
| | Riveting | 15 (41.7) | 21 (58.3) | | | |
| | Welding | 7 (46.7) | 8 (53.3) | | | |
| | Food vendor | 6 (37.5) | 10 (62.5) | | | |
| Number of hours | 1-5 | 0 (0) | 4 (100) | 4.724 | 2 | 0.094 |
| worked | 5-8 | 16 (38.1) | 26 (61.9) | | | |
| | Above 8 | 49 (49) | 51 (51) | | | |

Table 4.5 results show that that only two variables, gender (p = 0.034**)** and position at work (p = 0.039), were found to have significant association with awareness that exposure to noise can cause deafness.

#### 4.2.7.2 Association of NHIL with Awareness of noise-inducing factors

For awareness that one can be protected, two variables, showed a significant association with being aware that one can be protected from noise, age (p = 0.015) and location (p = 0.03) (Table 4.6).

**Table 4.6: Chi-square test of association of awareness of one can be protected from noise at work place with factors the respondents in metal "*Jua kali*" sheds in Mombasa- Kenya, 2018**

| Characteristic | | Response | | $\chi^2$ value (exact) | Df | P value |
|---|---|---|---|---|---|---|
| | | Yes (%) | No (%) | | | |
| Age | 20-35 years | 60 (78.9) | 16 (21.1) | 10.466 | 3 | 0.015 |
| | 36-45 years | 43 (86) | 7 (14) | | | |
| | 46-60 years | 16 (88.9) | 2 (11.1) | | | |
| | 60 and above | 0 (0) | 2 (100) | | | |
| Gender | Male | 100 (84) | 16 (16) | 2.726 | 1 | 0.099 |
| | Female | 19 (70.4) | 8 (29.6) | | | |
| Duration | 0-5 years | 43 (76.8) | 13 (23.2) | 2.243 | 4 | 0.691 |
| | 6-10 years | 58 (85.3) | 10 (14.7) | | | |
| | 11-15 years | 11 (78.6) | 3 (21.4) | | | |
| | 16-20 years | 3 (100) | 0 (0) | | | |
| | 21 and above | 4 (80) | 1 (20) | | | |
| Location | Kongowea | 14 (66.9) | 7 (33.1) | 7 | 2 | 0.03 |
| | Buxton | 88 (87.1) | 13 (13.9) | | | |
| | Changamwe | 17 (70.8) | 7 (29.2) | | | |
| Level of education | None | 3 (50) | 3 (50) | 4.911 | 3 | 0.178 |
| | Primary | 71 (80.7) | 17 (19.3) | | | |
| | Secondary | 40 (87) | 6 (13) | | | |
| | Tertiary | 5 (83.3) | 1 (16.7) | | | |
| Marital status | Single | 32 (72.7) | 12 (28.3) | 4.299 | 2 | 0.117 |
| | Married | 80 (84.2) | 15 (15.8) | | | |
| | Divorced | 7 (100) | 0 (0) | | | |
| Position | Trainee | 20 (71.4) | 8 (28.6) | 2.369 | 2 | 0.306 |
| | Artisan | 87 (83.7) | 17 (16.3) | | | |
| | Supervisor | 12 (85.7) | 2 (14.3) | | | |
| Daily assignment | Hammering | 63 (79.7) | 16 (20.3) | 3.456 | 3 | 0.326 |
| | Riveting | 32 (88.9) | 4 (11.1) | | | |
| | Welding | 13 (86.7) | 2 (13.3) | | | |
| | Food vendor | 11 (68.8) | 5 (31.2 | | | |
| Number of hours worked | 1-5 | 2 (50) | 2 (50) | 3.287 | 2 | 0.193 |
| | 5-8 | 33 (78.6) | 9 (21.4) | | | |
| | Above 8 | 84 (84) | 16 (16) | | | |

For use of protective equipment, significant association was only found between the number of hours worked ($p = 0.026$) (Table 4.7).

**Table 4.7: Chi-square test of association of use of protective equipment and characteristics of metal workers in "*Jua kali*" sheds in Mombasa - Kenya, 2018**

| Characteristics | | Use of protective equipment | | | | |
|---|---|---|---|---|---|---|
| | | **Yes (%)** | **No (%)** | **$\chi^2$ value (exact)** | **Df** | **P value** |
| Age | 20-35 years | 14 (18.4) | 16 (21.1) | 2.058 | 3 | 0.560 |
| | 36-45 years | 9 (18) | 41 (82) | | | |
| | 46-60 years | 5 (27.8) | 13 (72.2) | | | |
| | 60 and above | 1 (50) | 1 (50) | | | |
| Gender | Male | 24 (20.2) | 95 (79.8) | 0.036 | 1 | 0.846 |
| | Female | 5 (18.5) | 22 (81.5) | | | |
| Duration | 0-5 years | 11 (19.6) | 45 (80.4) | 4.535 | 4 | 0.338 |
| | 6-10 years | 17 (25) | 51 (75) | | | |
| | 11-15 years | 1 (7.1) | 13 (92.9) | | | |
| | 16-20 years | 0 (0) | 3 (100) | | | |
| | 21 and above | 0 (0) | 5 (100 | | | |
| Location | Kongowea | 5 (23.8) | 16 (76.2) | 0.868 | 2 | 0.648 |
| | Buxton | 18 (17.8) | 83 (82.2) | | | |
| | Changamwe | 6 (25) | 18 (75) | | | |
| Level of education | None | 0 (0) | 6 (100) | 2.289 | 3 | 0.515 |
| | Primary | 17 (19.3) | 71 (80.7) | | | |
| | Secondary | 10 (21.7) | 36 (78.3) | | | |
| | Tertiary | 2 (33.3) | 4 (66.7) | | | |
| Marital status | Single | 8 (18.2) | 36 (81.8) | 2.113 | 2 | 0.348 |
| | Married | 21 (22.1) | 74 (77.9) | | | |
| | Divorced | 0 (0) | 7 (100) | | | |
| Position at work | Trainee | 9 (32.1) | 19 (67.9) | 4.242 | 2 | 0.12 |
| | Artisan | 19 (18.3) | 85 (81.7) | | | |
| | Supervisor | 1 (7.1) | 13 (92.9) | | | |
| Daily assignment | Hammering | 17 (21.5) | 62 (78.5) | 2.439 | 3 | 0.486 |
| | Riveting | 7 (19.4) | 29 (80.6) | | | |
| | Welding | 4 (26.7) | 11 (73.3) | | | |
| | Food vendor | 1 (6.2) | 15 (93.8) | | | |
| Number of hours worked | 1-5 | 0 (0) | 4 (100) | 7.265 | 2 | 0.026 |
| | 5-8 | 14 (33.3) | 28 (67.7) | | | |
| | Above 8 | 15 (15) | 85 (85) | | | |

Figure 4.14 show reasons given by respondents for not using protection, 43.2% of the respondents were not aware of protective equipment, 24.7% said that they were not provided with the equipment, 4.8% did not find the need to use protective

equipment, 4.8% were not comfortable with the equipment, 14.4% had no reason for not using the equipment and 8.2% indicate that the equipment was expensive.

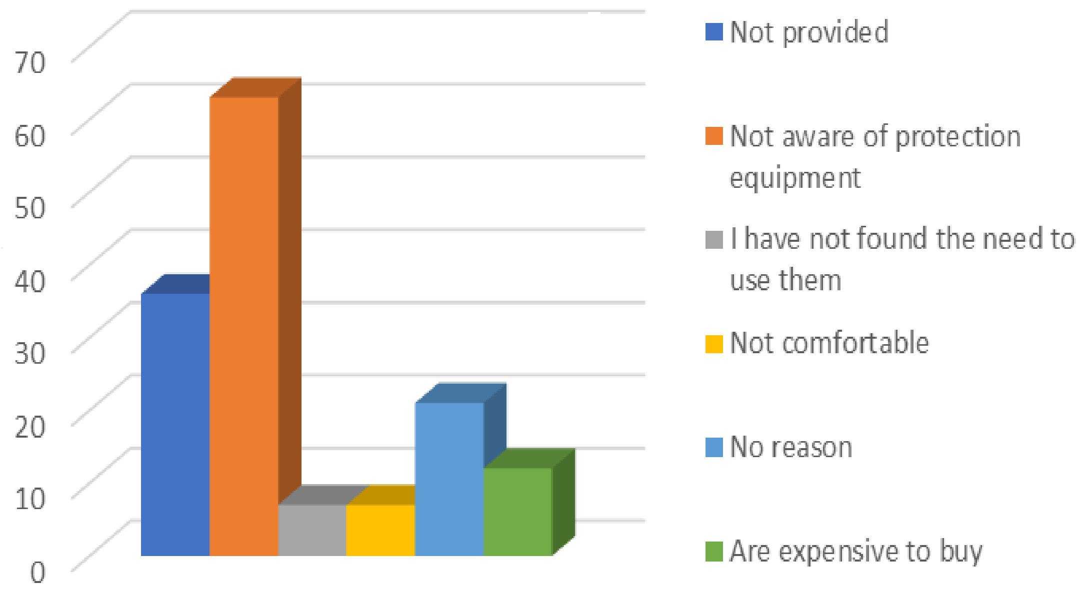


**Figure 4.14: Reason for not using hearing protectors among the metal workers in "*Jua kali*" sheds Mombasa County 2018**

## 4.2 Discussion

### 4.2.1 Intensity of noise within metal workplaces in "*Jua kali*" sheds in Mombasa county- Kenya

The mean noise level 108.87dB(A) in metal workplaces in "*Jua kali*" sheds within Mombasa County was significantly higher ($p = 0.012$) than the recommended level of 85 dB(A) by OSHA 2007 and NEMA 2015. Changamwe metal work "*Jua kali*" shed had the highest level of noise (119.4 dBA), no significant differences in the locations ($p = 0.594$). Noise level was highest (144.166 dB(A) within hammering zone However, there was no significant differences in noise levels among the various working zones ($p = 0.174$), These results show higher noise levels in Mombasa county than what Gongi, (2016) found in Kamukunji – Nairobi County were noise level was 93.8, 90.5 and 92.2 dBA in.

This could be due to confinement of workers in one small area ("*Jua kali"* shed) concentrating the noise in that work place.

### 4.2.2 Level of hearing loss among the workers in *Jua kali* metal work sheds within Mombasa County-Kenya

Among the respondents, 49.3% had normal hearing; 47.9% moderate hearing loss; 2.7% severe hearing loss. These results are lowerer than the findings of Milkau *et al*. (2016) who found 56.6% prevalence NIHL in King'orani Mombasa. Gongi, (2016) 60% noise prevalence with 80.2% of the workers affected by NIHL in Kamukunji-Nairobi. This is evidence that NIHL was developing among jua kali workers in Mombasa County due to continuous exposure to noise leading to destruction of the inner ear hence hearing loss.

### 4.2.3 Influence of socio-demographic and work-related factors on NHIL among the metal workers in Jua Kali sheds within Mombasa County-Kenya.

Most (52.1%) of the metal "*Jua kali"* workers were aged 20-35 years an indicator that most of the workers are youthful as shown by Malikau *et al*., (2016) 38.7% within age 21-31 years and 35.5% within age 31-40years.

Majority of the respondents (81.5%) were male an indicator that this is a male dominated sector due to the African culture of masculine activities belong to men as confirmed by Malikau *et al.*, (2016) who found 86,3% of respondents in King'orani Mombasa were men.

Married respondents were the most (65%) showing that most of the workers are family people, Malikau, (2016) found 92% of respondents in King'orani Mombasa were married.

Most (60.3%) of the respondents had Primary school education 41% had no school education, and 4.1% had Tertiary school education showing that most of the respondents had low or lacked formal education agreeing with Malikau *et al.,* (2016) 45.2% of respondent had Primary school education, 3.2% no education and 19.4% tertiary education, Langat (2020) and Chauchari (2015). A significant association was found between age (p=0.00), gender (p=0.00), marital status (p=0.020) with NIHL

### 4.2.4 Influence of work-related factors on NHIL among the metal workers in *Jua Kali* sheds within Mombasa County-Kenya

Majority (46.6%) of the respondents had worked for a duration of 6 to 10 years, time that is enough to develop NIHL, while the list (2.1%) worked for 16 to 20 years which gives evidence for long term exposure to noise that could cause NIHL.

For position at work, 71.2% of the respondents had worked as artisans, 19.2% were trainees, while 9.6% worked as supervisors' evidence that most respondents worked as artisan

Most of the respondents (68.5%) worked for more than 8 working hours which agrees with Malikau *et al.* (2016) who found out that most of the respondents (83.9%) spent more than 8 hours at the workstation which is above. 8 hours is the recommend number of working hours by OSHA 2009, hence people were working beyond the recommended maximum hours per day. A significant association was found between duration on the job (p=0.00), daily position at work (p = 0.014) and hours worked per day (p = 0.00) with NIHL.

### 4.2.5 Knowledge, attitude and practice of workers on NIHL in *Jua kali* metal work sheds within Mombasa County-Kenya

Most (90.4%) of the metal workers in the "*Jua kali"* sheds were aware that their work place produced a lot of noise however 55.5% of the respondents had no knowledge that noise exposure would cause deafness. 81.5% of the respondents had the knowledge that could be protected against NIHL showing the reason for 81.1% of the respondents who did not use PPE while 19.9% used PPE agreeing with

Malikau *et al.,* (2016) who found 6.5% use of PPE's. Data collected showed Most metal workers (43.2%) in *Jua kali* sheds were not aware of the type of PPE to use.

It is evident from the data collected that respondent knew that their workplace was produced high levels of noise but most did have knowledge of NIHL.

Though most of respondent knew about PPEs only 19.9% used PPE's and they had no knowledge of the correct PPEs to use.

# CHAPTER FIVE

# CONCLUSION AND RECOMMENDATIONS

## 5.1 Conclusion

The metal workplaces in "*Jua kali*" sheds within Mombasa County were found to have high levels, with a mean noise level 108.87dB(A) which is significantly higher (p=0.012) than the recommended level of 85 dB(A) by OSHA 2007 and NEMA 2015.
These results are in agreement with Gongi, (2016) who found noise level of 93.8, 90.5 and 92.2 dBA in Kamukunji – Nairobi County. This could be due to confinement of workers in one small area ("*Jua kali"* shed) concentrating the noise in that work place.

Noise level was highest (144.166 dB(A) within hammering zone. However, there was no significant differences in noise levels among the various working zones (p = 0.174)

This study established that the "*Jua kali"* sectors in Mombasa sub-county had 49.3% of the respondent with normal hearing; 47.9% moderate hearing loss; 2.7% severe hearing loss. Hammering was the main daily assignment, with all workers with sever hearing loss and most with moderate hearing loss

Male gender was the highest (81.5%) among the respondents in metal workplaces in *"Jua kali"* sheds within Mombasa County, age 20-35 with largely primary education and mainly artisan. Most of the workers worked for 6-10 years and for more than 8 hours. A significant association was found between age (p=0.00), gender (p = 0.00), marital status (p = 0.020), duration on the job (p = 0.00) daily position at work (p = 0.014) and hours worked per day (p=0.00) with NIHL. These results are in agreement with studies by Daniel (2007), and Warner-Czyz (2016).

Most (90.4%) of the metal a lot of noise. workers in the "*Jua kali"* sheds were aware that their work place produced, but 55.5% of the respondents had no knowledge that noise exposure would cause deafness.

81.5% of the respondents had the knowledge that one could be protected against NIHL but 81.1% of the respondents did not use PPE while 19.9% used PPE and among those who used PPE (43.2%) of the respondents were not aware of the type of PPE to use.

**5.2 Recommendations**

The County Director of Directorate of Occupational Safety (DOSH) are the main bodies mandated to enforce OSHA 2007 and should design policies to govern "*Jua kali"* sector as a workplace.

DOSH Mombasa County to come up with Programs designed to encourage "*Jua kali"* workers to embark on less noisy business ventures after five years of continuous exposer since NHIL developed after long term exposure.

Job rotation to be encouraged where one does not work in one skill for long and to work for few hours since most of worker had more than 8 working hours.

Educative programs specially designed for the "*Jua kali"* workers to create awareness on personal protective clothing, advantages associated with the use and the appropriate way of using them.

County DOSH to organize for a continuous periodic creation of awareness on OSHA act of 2007, safety training and safety responsibility of every "*Jua kali"* worker which will enable the workers to know that it is their right to safe workplace free from recognized hazard, right to information of safety and health hazards associated with their workplace.

TVET institutions in Kenya to consider tailor made program to fit the "*Jua kali*" workers so as to equip them with latest/timely technical and safety skill and encourage equal opportunity to all genders.

To petition the county government of Mombasa to provide subsidized hearing protection equipment, and install warning signs indicating noisy work place and use of PPE to every worker.

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# APPENDICES

## Appendix 1: Consent to Participate in a Research Study

### Introduction

You are being requested to take part in research study of determining the predisposing factors to hearing losses among Jua kali workers in Mombasa subcounty. This research study is to be conducted by **Adelinah M. Kilonnzo** a student in **Jomo Kenyatta University of Agriculture and Technology** in Partial Fulfillment for the Requirements of the Master of Science Degree in Occupational Safety and Health

Since you have been working in Jua kali sector for more than three years, you were randomly selected from the register presented by the workers representative

I request you to read this form and ask any questions that you may have before agreeing to be in the study.

### Purpose of Study

The purpose of the study is to determine the intensity of noise in Jua-Kali Shades in Mombasa County, the number of people with hearing loss and the level of awareness of noise-induced hearing loss among the workers in Jua Kali sheds in Mombasa County. Ultimately, this research may be published or presented as a paper for education purpose only

### Description of the Study Procedures

If you agree to be in this study, you will be asked to do the following things: a questionnaire will be given to you, please answer it accurately and to the best of your knowledge. You will also be requested to avail yourself for an audiometry test to establish your hearing ability for at least 10 minutes, an audiometer shall be.

**Risks/Discomforts of Being in this Study**

The audiometry test is a medical procedure that is acceptable and will take place in the confines of a hospital under supervision by an ENT doctor. The participants may have a ringing in the ears which is temporal and is expected to stop after some time.

**Benefits of Being in the Study**

The benefits of participation are the participate will be able to their ears examined and know their hearing ability, any complication will be treated and exert advise given. No monitory gain since it is an educational research

**Confidentiality**

This study is anonymous.  We will not be collecting or retaining any information about your identity.

**Right to Ask Questions and Report Concerns**

You have the right to ask questions about this research study and to have those questions answered by me before, during or after the research.  If you have any further questions about the study, at any time feel free to contact me, Adelina Kilonzo *email* addykilonzo@gmail.com or by telephone 0724629267.

If you have any problems or concerns that occur as a result of your participation, you can ask through the contacts given above

**Consent**

Your signature below indicates that you have decided to volunteer as a research participant for this study, and that you have read and understood the information provided above. You will be given a signed and dated copy of this form to keep, along with any other printed materials deemed necessary by the study investigators.

Participant’s Signature: ………………………………. Date: ………………………

Researcher’s Signature:……………………………… Date: ………………………

## Appendix II: Consent/Instruction Letter

Dear Sir/ Madam,

My name is **Adelinah Kilonzo** a Student at Jomo Kenyatta University of Agriculture and Technology, Student number **EET32-C005-0196/2012.** I am conducting an Audiometry survey among Jua Kali workers in Mombasa Sub County in Partial fulfillment of Master's Degree in Occupational Safety and Health. I appreciate your co-operation and assistance in the data collection process. The information you give in this study will be treated confidential and private.

You are allowed to ask any question.

I …………………………………………………………………… being an Adult I do give my consent to Adelinah Kilonzo to include me in her intended research. I have read and understood the content of this questioner, I also understand that I am allowed to withdraw from the study if compelled to do so without prejudice, this has been explained to me in a language I understand well.

Volunteers signature…………………………………………………………………

Researcher's signature……………………………………………………………….

Date …………………………………………………………………………………

Name …………………………………...……...Age…. …. Gender……………

Nature of work………………………………………………………………………

Duration at current job ……………………………Date….……..………………

## Appendix III: Questionnaire

The questionnaire below is on Assessment of Noise Exposure in Mombasa County metal *Jua kali* Sheds

The questions provided below focus on exposure to hazardous sounds.

The questionnaire is divided into three sections.

**SECTION I: Socio demographic Characteristics**

1. What is your gender? Male ☐ Female ☐

2. What is the level of your education?

a) None ☐ b) Primary ☐ c) Secondary ☐

c) Tertiary (College) ☐ e) No response ☐

3. What is your marital status?

a) Single ☐ b) Married ☐ c) Divorced ☐

4. What is your position in the workplace?

a) Trainee ☐ b) Artisan ☐ c) Supervisor

5. What is your daily assignment?

6. How many hours do you work in a day?

a) 1-5 ☐ b) 5-8 ☐ c) Above 8 ☐

7. Did you receive any training in the job you do?

Yes ☐ No ☐

**SECTION II: Causes of Work-related hearing problems**

8. Does your work produce a lot of noise? Yes ☐ No ☐

9. How far do you think the noise can be heard?

10. Are you aware that exposure to noise can cause deafness? Yes ☐ No ☐

11. Are you aware that one can be protected from the noise?

Yes ☐ No ☐

12. Have you ever had any health problem from exposure to workplace noise? Yes ☐ No ☐

13. If yes, State which health problems you experienced?

a) Headache ☐ b) Ringing in the ears ☐

c) Inability to hear well ☐ d) Sleep disturbance ☐

e) Stress and disturbance ☐ f) Fatigue ☐

14. Do you shout at your workplace to be heard by your workmate?

Yes ☐ No ☐

15. Do you have trouble hearing conversation after work shift?

Yes ☐ No ☐

17. Do many people you talk to seems to mumble (or not to speak clearly)?

Yes ☐ No ☐

18 Do people complain that you turn T.V/Radio volume too high?

Yes ☐ No ☐

19. Do you find yourself asking people to repeat themselves?

Yes ☐ No ☐

**SECTION III: Prevention of work-related hearing problems**

20. Do you use hearing protective equipment? Yes ☐ No. ☐

21. If the answer to question 20 is No, then why do you not use hearing Protectors?

a) Not provided ☐

b) Not aware of protection equipment. ☐

c) I have not found the need to use. ☐

d) Not comfortable. ☐

e) No reason. ☐

f). Expensive to buy ☐

22. If the answer to No 21 is yes, then how often do you use?

a) Always ☐

b) Sometimes ☐

23. Have to ever gone to hospital due to problems related to exposure to noise?

Yes ☐ No ☐

24. If No to question no.23, what are the reasons?

a) I have no time to go ☐

b) Financial problem ☐

c) Not necessary ☐

d) No reason ☐

25. Would you like your hearing tested /examined and advised accordingly?

Yes ☐ No ☐

26. What is your comment about noise in *Jua Kali*?

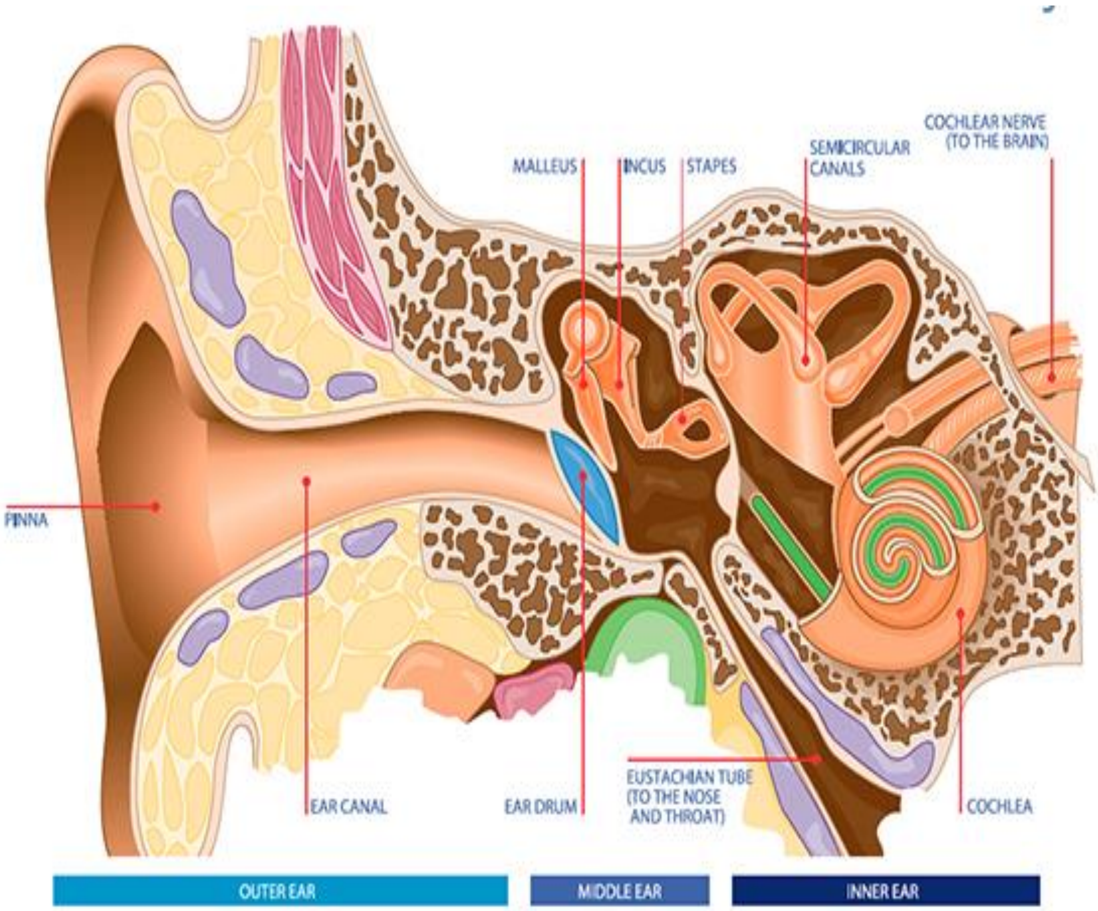
a) Normal ☐ b) Low ☐ c) High ☐

Thank you for your time.

**Appendix VI: Audiometer**

**Appendix V: Sound Level Meter**

**Appendix VI: The Human Ear**




**The parts of the ear** *(Australian hearing institute 2013)*

## Appendix VII: Ethical Committee Certificate

NACOSTI ACCREDITED

ERC/MSc/029/2017R

Pwani UNIVERSITY

**ETHICS REVIEW COMMITTEE**

**ACCREDITTED BY THE NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION (NACOSTI, KENYA)**

# CERTIFICATE OF ETHICAL APPROVAL

THIS IS TO CERTIFY THAT THE PROPOSAL SUBMITTED BY:

**KILONZO A. MUTHIKE**

REFERENCE NO:
**ERC/MSc/029/2017R**

ENTITLED:
**Predisposing factors to hearing losses among jua kali workers in Mombasa Sub County, Mombasa County**

TO BE UNDERTAKEN AT:
**MOMBASA COUNTY, KENYA**

FOR THE **PERIOD OF ONE YEAR**

HAS BEEN **APPROVED** BY THE ETHICS REVIEW COMMITTEE

AT ITS SITTING HELD AT PWANI UNIVERSITY, KENYA

ON THE **5th DAY OF FEBRUARY 2018**

CHAIRMAN SECRETARY LAY MEMBER

PTO

Pwani UNIVERSITY

*Ethics Review Committee,*
*Pwani University, www.pu.ac.ke, email: r.thomas@pwaniunversity.ac.ke, tell: 0719 182218.*
*The ERC, Giving Integrity to Research for Sustainable Development*

## Appendix VIII: Map of Mombasa County