

**HEALTH EFFECTS OF NOISE EXPOSURE AMONG THE
'JUAKALI' ARTISANS: A CASE STUDY OF KING'ORANI
"JUA KALI" ARTISANS IN MVITA SUB-COUNTY
MOMBASA KENYA**

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**Health Effects of Noise Exposure among the 'Juakali' Artisans: A Case
Study of King'orani "Jua Kali" Artisans in Mvita Sub-County
Mombasa Kenya**

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DECLARATION

This Thesis is my original work and has not been presented for a degree in any other university

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

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DEDICATION

This thesis is dedicated to my mother Roselidah, my wife Catherine, My daughters Elsey, Tracey, and Lindsey for the support they accorded me in all endeavors undertaken in developing this thesis.

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ACRONYMS AND ABBREVIATIONS

DALY	Disability adjusted life years
WHO	World health organization
NIHL	Noise induced hearing loss
NIOSH	National institute of occupational safety and health
CCOSH	Canadian centre for occupational safety and health
RBA	Retirement Benefits Authority
OED	Operation ear drop
dB	Decibel
KHz	kilohertz
EMCA	Environmental Management and Co-ordination Act
OSHA	Occupational Safety and Health Act
NEMA	National Environmental Management and Co-ordination Act
DOSHS	Directorate of occupational safety and health services
SPSS	Statistical package for social sciences

PPE Personal protective Equipment

CBD Central business district

MSDS Material safety data sheet

DEFINITION OF TERMS

Anatomy: The study or illustration of bodily structure for example the ear

Artisan: Skilled worker who makes things by hand (Merriam Webster)

Cerebellum: It is part of the brain responsible for human movement, coordination, motor control, and sensory perception.

Cochlea: A hollow tube in the inner part of the human ear, which is coiled like a snail shell and contains the sensory organ of hearing

Dosimetry: Scientific determination of amount, rate, and distribution of noise

Endolymph: It's the fluid contained in the membranous labyrinth of the inner ear

Frequency: The rate at which sound waves reaches the ear

Hair Cells: They are the sensory receptors of hearing and balance systems of the ear.

Hazard: Any source of potential damage, harm, or adverse health effect on something or someone under certain conditions at work (NIOSH, 2008)

Incus: Part of the middle ear, which receives vibrations from the malleus, unto which it is connected laterally, and transmits these to the stapes medially.

Juakali: Direct translation is fierce sun but used in Kenya to denote the informal sector of the economy (Wiens, 2011)

Malleus:The word is Latin for hammer or mallet. It transmits the sound vibrations from the eardrum to the incus. Malleus is the advanced version of ossicle.

Noise:Sound of any kind that may affect the hearing and general functioning of the ear

Organ of Corti: It's the receptor organ for hearing and is located in the human cochlea

Physiology:The study of bodily functioning for example the ear

Pneumatic: Systems used extensively in industry and are commonly powered by compressed air or compressed inert gases.

Pollution: Introduction of contaminants into natural environment that cause adverse change (NEMA, 2009)

Risk:The chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard (CCOHS, 2014)

Sensorineural hearing loss:It's a type of hearing loss in which the root cause lies in the vestibulo-cochlear nerve (cranial nerve VIII), the inner ear, or central processing centers of the brain.

Stapes: A bone in the middle ear of humans and other mammals, which is involved in the conduction of sound vibrations to the inner ear

Stereocilia: These are the mechano-sensing organelles of hair cells, which respond to fluid, motion in the inner ear the fluid-filled cochlea.

Threshold: A level or point at which something starts or ceases to happen or come to effect likes loss of hearing

Tinnitus: This is the hearing of sound where in reality there is no external sound present. While often described as a ringing, it may also sound like a clicking, hiss or roaring

Tympanic Membrane: Also called the eardrum is a thin, cone-shaped membrane that separates the external ear from the middle ear in humans. Its function is to transmit sound from the air to the ossicles inside the middle ear, and then to the oval window in

ABSTRACT

The informal (*Juakali*) sector in Kenya lacks occupational health and safety services and hence workers are unsuspectingly exposed to health hazards. Worldwide, occupational noise is a significant cause of adult onset-hearing loss and 16% of disabling hearing loss in adults(Theuri, 2012) More than 500 million individuals are at risk of developing noise induced hearing loss (NIOSH, 2014). The aim of the study was to identify the health effects of noise to the *Juakali* artisans in King'orani area Mombasa County by identifying key sources of noise, assessing hearing threshold levels, examining auditory health effects of noise and the prevalence of noise induced hearing loss. This was done by administration of structured questionnaires, observation checklist, noise level mapping, and pure tone audiometry to stratified randomly selected subjects. Data was coded, cleaned, and analyzed using SPSS version 21.0. Pearsons correlation coefficient and chi square test for independence were used to analyze data at 0.05 significance level. Prevalence of NIHL was 59.7% while 4% had profound impairments. The level of impairment increased with the duration and level of exposure to noise above 90 dB ($X^2=6.51$ $P<0.05$). Exposure level and duration was greatly associated with auditory effects such as Tinnitus, headache, poor concentration, and sleep disorders. In conclusion, NIHL, headaches, tinnitus, poor concentration, and sleep disturbances are related to prolonged exposure to high level of noise above 90dB with a positive correlation coefficient of 0.248. OSHA 2007 should be enforced to effectively regulate the informal sector, create awareness on effects of noise exposure, establishment of hearing monitoring centers, special subsidies and provision of PPEs will be able to arrest the otherwise forgotten irreversible disability causing Hazard the *Juakali* artisans are exposed to.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Globalization has been associated with wide and far-reaching changes in the structure of labor markets all over the world. The decline of jobs with secure and lasting contracts and work-related social benefits as well as the corresponding rise in informal and unprotected work are phenomena affecting both industrialized and developing countries. For many, employment not only fails to secure them a successful pathway out of poverty but also further contributes to vulnerability (Lund & Marriot, 2011).

Many informal jobs are hazardous and take place in settings, which are both unhealthy and unsafe. Such work environments can include, informal market areas, roadsides and poorly serviced buildings, all of which can expose the workers who work in them to environmental disease, traffic accidents, fire hazards, crime, assault, weather related discomfort, and muscular-skeletal injuries (Laura, 2012). There is an essential need for the control of exposure to hazards in the small-scale sector and informal economy. However majority of this workers' access to occupational safety and health services is absent or at best grossly inadequate (Edith, 2012)

In Kenya, the informal sector encompasses a range of economic units in urban areas with low levels of organization. They include but not limited to *Juakali* artisans shades that are located along roadsides, for instance service motor vehicles that breakdown on

the roads, sell products, and services to passersby and also in interiors of informal settlements (Okungu *et al*, 2013). The majority of *Juakali* shades operators are low-income earners, with little or no basic education and limited knowledge of modern technology in hazard management. Developing countries, Kenya included, rarely monitors the activities of informal sector and the working conditions of the artisans. Therefore, provision of a healthy and safe environment to workers in this sector is a big challenge that requires an integrated approach to safety and health promotion (Theuri, 2012).

Physical hazards including noise are associated with inadequate safety and health standards and are evident in the informal sector whose workers do not have necessary awareness, technical means, and resources to implement safety and health measures. Due to lack of formal employment in Kenya up to 8 million (75%) of workforce are in the small-scale enterprises and the informal sector while only 2.8 million are in the formal sector (Theuri, 2012). The distinction between the work and the non-work environment in some small-scale informal operations is becoming increasingly blurred. This is due to, among others, massive expansion of the informal economy, outsourcing of production to home-based work and the direct proximity of homes to the place of work (Rabat, 2008).

Toxic substances are used in home-based production processes. The hazardous exposures these substances pose in the domestic setting are less likely to be adequately identified or controlled, and may result in human health risks that are not found in

typical workplace setting (Edith, 2012). Physical hazards are factors in the environment that can harm the body without necessarily touching it. They are the hazards that affect physical safety and include Noise, vibrations, extreme temperatures, and many others. Work related noise is one of the most common occupational hazards that are associated with irreversible hearing impairment. Noise is undesired sound or unwarranted disturbance within a useful frequency band; however, it is present in every human activity either occupational (workplace) or environment that include residential, community (Concha- Barientos *et al.*, 2014). Noise equivalent power (NEP) is the measure of the sensitivity of a photo detector system. It is a signal power that gives a signal to noise ratio of one in one hertz output bandwidth (Richards, 1994). Johnson noise is a random variation of voltage due to thermal agitation of charge carrier in a resistor (Yale lab, 2016). Shot noise is form of noise that arises because of the discrete nature of the charges carried by charge carriers, electron holes. It is noticeable in semi conductors (Pool, 2016).

Flicker noise is also known as 1/frequency noise in view of the fact that its power density decreases with increasing frequency or increasing offset from a signal. It follows a 1/frequency characteristic, having what is termed a pink noise spectrum. Flicker noise or 1/frequency noise occurs in almost all electronic devices, and it has a variety of different causes, although these are usually related to the flow of direct current. It is important in many areas of electronics and it is particularly important within oscillators

used as radio frequency (RF) sources. For RF oscillators overall noise performance is important, and 1/f noise forms one element of this (Jekins, 2014).

Noise pollution or disturbance is excessive noise that may harm the activity or balance of human life (Laura, 2012). A high level of occupational noise remains a problem in all regions of the world. Occupational hearing loss is the most common work related illness. In USA, 30 million workers are exposed to hazardous noise annually (NIOSH, 2014). In Germany 4-5 million (12-15% of the workforce) are exposed to noise levels defined as hazardous (Barientose *et al.*, 2004). Smaller enterprises are likely not to have effective noise control measure due to lack of adequate/ insufficient knowledge of the effects of hazardous noise on hearing and hearing loss and quality of life, believing that control cost too much, it will not happen to me and other cultures that resist change (perri-Timmins & Oliver Granger, 2010).

Traumatic noise exposure may cause an immediate hearing loss in some cases but most occupational hearing losses occur too gradually that workers are unaware they are losing their hearing. The rate of hearing loss growth is greatest during the first 10 years of exposure (NIOSH, 2008). The *Jua Kali* sector in Kenya is facing enormous health challenges that are threatening its very existence .The *Juakali* artisans work in very noisy and dusty conditions that have affected their health negatively. The noise that the artisans are exposed to each day is far much beyond the recommended levels and some have already loosed sense of hearing totally. Levels of occupational safety and health in Africa are low compared with the rest of the world. This is because in sub-Sahara Africa

public health problems are so massive that occupational healths are sub-ordinate (spee, 2006). More than 90% of *Juakali* related activities generate noise above the recommended 85dB, they include panel beating more than 100dB, Compressor used in Panel beating 90-100dB, Pneumatic tools use produce sound greater than 90dB (Gerges *et al.*, 2006)

1.2 Statement of the problem

Globally, 12.5% of children and adolescents aged 6-19 years (5.2 million) and 17 % (26 million) adult have permanent hearing loss due to excessive exposure to noise (Centre for Disease control, 2016). In Kenya, 8 million (75%) of workforce, are in the small-scale enterprises/the informal sector while 2.8 million are in the formal sector (Theuri, 2012). 75% of informal sector workers are exposed to noise level above 85Db daily out of which 22% have disabling hearing impairment(RBA-OED, 2011) Noise is one of the most common physical hazards associated with some detrimental health effects. Noise induces hearing loss occurs through excessive wear and tear to the delicate inner ear structures causing damage to the ear by progressive consequences (Lund & Marriot, 2011). High levels of occupational noise remain a problem in all regions of the world. In the US, 30 million workers are exposed to hazardous noise while 242 million dollars spent annually on workers compensation for hearing loss disability (NIOSH, 2014).

In Kenya, the "*Jua Kali*" sector is facing enormous health challenges that are a threat to its very existence (OED, 2011). The level of noise the artisans are exposed to each day is far beyond the recommended levels 80Db. This results to noise induced hearing loss.

however mechanisms influencing attitudes towards noise hazards and prevention of hearing loss as a result are poor (Foluwasayo *et al.*, 2005).

. In the developing countries, noise induced hearing loss is the most common of occupational injuries. it is associated with social isolation, impaired communication with co-workers and family, decreased ability to monitor the work environment (warning signal, equipment sound), increased injuries (from impaired communication and isolation), expenses for workers' compensation and hearing aids, loss of productivity and decreased self esteem (Concha-Barientos *et al.*, 2008). Efforts to address occupational health problems in these countries receive very little attention by health service planners due to inadequacy of data and long latency periods (Cauntley *et al.*, 2015).

1.3 Justification

King'orani area of Mvita sub County hosts the largest number of *Juakali* artisans in Mombasa County. The artisans including mechanics, spray painters, metal fabricators, scrape dealers, motor vehicles body builders, and many others. Survey done randomly by RBA and OED in 2011 shows *Jua Kali* artisans in Mombasa had the highest exposure level to noise hazard and had the highest level of disabling hearing loss of 57 % of those surveyed. From the distribution of the artisan in the area, it is clear that no regulations are in force to ensure workers' safety making them more vulnerable to hazards exposure. The *Juakali* workers are exposed to many hazards unknowingly. Majority of them are ill trained or semi trained and not aware of the consequences of exposure to these hazards in the work places.

The aim of this study was to identify noise hazards, its health effects to the *Juakali* artisans, to investigate measures that will be in need for healthy and safe working environment which is a pre requisite for sustainable development and protect vulnerable groups and the poor that forms the majority in the informal sector. Secondly, the research also endeavored to identify those with auditory health effects through audiometric tests. The findings were used to recommend interventions in controlling excessive noise exposure and associated health effects.

1.4 Research Questions

1. What are the sources and levels of noise hazard among the *Jua Kali* artisans in King'orani area?
2. What are the hearing thresholds of *Jua Kali* artisans?
3. What are the auditory effects of noise hazard among the *Jua Kali* artisans?
4. What is the prevalence of occupational hearing loss among the *Jua Kali* artisans?

1.5 Hypothesis

H₀ "*Jua Kali* "Artisans' activities in King'orani do not generate noise above allowable limits of 85d (B)

H₀ Occupational Noise hazards do not affect hearing ability of "jua kali" artisans in King'orani.

1.6 Objective

1.6.1 General objective

To determine health effects caused by exposure to noise among the "*Juakali*" Artisans in King'orani area of Mombasa County.

1.6.2 Specific objectives

1. To identify, sources and levels of noise hazards among the "*Jua Kali*" artisans in King'orani area.
2. To evaluate the hearing thresholds levels of the "*Juakali*" artisans in King'orani area.
3. To assess auditory health effects of noise hazards among the *Jua Kali* artisans
4. To determine the prevalence of noise induced hearing loss among the "*jua kali*" artisans in King'orani area.

1.7 Scope

The research focused on the *Juakali* artisan based at kingorani area of Mvita sub-County. They included metal fabricators; mechanics, body works, and small-scale scrap metal recycling that are based in the area. Both men and women working within the shades were involved in the research. The other categories that were involved are those people within Mvita sub-County but were within safe zones of noise exposure that formed the control group. All were adults of 18 years and over.

1.8 Limitation o the study

Some study subjects may have developed ear problems due to illness or inborn deficiency only to discover while working in *Juakali* sector. Some workers may have been exposed to noise away from workplace for example repeated exposure to loud music. However, this was addressed by capturing in the questionnaires their medical history and thorough evaluation of their lifestyles that could have expose them to noise. Secondly, some would be study participants declined to take part in the study after sampling had been performed citing fears of the outcome of audiometric test and recorded as non-respondents. Other limitations were cost of conducting study and ethical clearance and permit from the county government

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Cultural risk theory

A health and safety culture is a 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, even though it is of major importance to integrate core values based on a policy into the whole process of and maintaining good health and safety behavior. Daily pro-active supervisory is important as a visible commitment to the high priority safety has within the organization. Mary Douglas and Aaron Wildavsky developed cultural Theory (sometimes known as 'the cultural theory of risk' in 1978). It 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 (Tansley & Rayner, 2009). Cultural theory have evolved for over twenty years into an important framework for understanding how groups in society interpret danger and build trust or distrust in the institution creating and regulating risks. It provides paradigm in social analysis of risk, criticizes the apparent de-politicization of risk issues which is a subtle process of taking for granted the link between hazard identification and the normative choice that follow. Cultural theoretical approach to risk preparation do explain why some issues become politicized and hence embroiled in disputes over the allocation of blame and the distribution of power while others appear to be tolerated within norms of social values and trust.(Tansley & Rayner, 2009).

Risk concerns both the probability for and the consequences of happening of an event. People are expected to vary in whether they focus upon probability or consequence. a

persons' own estimate of risk may be very different from the objective estimate which is the risk that exists independent of an individual's knowledge and worries of the source of risk. However to some extent perceived risk is clearly a reflection of real risk especially when risks are well known.

Globally there is continuous debate involving the identification, assessment, and management of risks, to environment and to public health and safety. There is ever emergence of new risks/dangers in food, water, air we consume; chemical, energy, and substances we use; the products, processes, artifacts in our daily life; are exacerbating public fears regarding environmental and health hazards. perceptions and communications of risks focuses mainly on possible harms largely ignoring the cultural contexts in which hazards are framed, debased, Risk taking and risk perception occurs.

While individuals perceive risks and have concerns it is culture that provides socially constructed myths about nature; systems of beliefs that are reshaped and internalized by persons, becoming part of the worldview and influencing their interpretation of natural phenomenon. Cultural theory has analogous role in making sophisticated expert lay dichotomy as it relates to risk issues in focusing on group and their role in politicization of issues , can furnish more complex interpretations from more neutral position. In interpreting politicized risk issues, it is useful to address who is being blamed and why that might be the case; because this process reinforces the social structures allocating responsibilities (Tansley & Rayner, 2009).

2.1.2 The risk theory

James Reason developed the defense in depth, accident trajectory model, which is widely adopted in the area of occupational health. It allows any organization to build in

layers the defense to safeguard against failures (in this aspect include noticeable injuries, loss in productivity due to ill health, or post employment claims). In occupational health setting defense in depth, theory looks at four critical health defense layers that can improve the ability to control health risk. They include pre-employment health screening, health management, injury management and exit medical each of which can catch, retard, or retire risk (Castidy, 2012).

2.1.3 Attribution theory

Most workers assume that their organizations will take all necessary measures to ensure that they return home safely at the end of the workday, yet work-related injuries and deaths continue to occur at an alarming rate. Heider states that there is a strong need in individuals to understand transient events by attributing them to the actor's disposition or to stable characteristics of the environment. Causal attributions represent an important link between workplace safety problems and the actions taken to manage them. In fact, actions to manage safety derive more from attributions than from actual causes. Attribution theory suggests that people generally make causal attributions for their own and other peoples' behavior to facilitate understanding and to shape future behavior (Gyekye, 2010).

2.2 Empirical review

Informal sector is defined by International Labor conference of 1995 as small scale units producing and distributing goods and services and consisting largely of independent self

employed producers (Rongo *et al.*, 2004). The rapid rate of urbanization in Sub-Saharan Africa has not been accompanied by a corresponding formal sector. This has resulted to growth of urban unemployment on one hand and thriving informal sector on the other (Bulenkosi *et al.*, 2013). Physical hazards are related to inadequate safety and health standards and this is evident in the informal sector whose workers do not have necessary awareness, technical means, and resources to implement safety and health measures. Many informal jobs are hazardous and take place in settings that are both unhealthy and unsafe. Such work environments include, informal market areas, roadsides and poorly serviced buildings, all of which can expose the workers to numerous hazards (Laura, 2012).

There is an essential need for the control of exposure to hazards in the small-scale sector and informal economy. However, majority of workers accessibility to occupational safety and health services is absent (Edith, 2012). In Kenya, the informal sector encompasses a range of economic units in urban areas with low levels of organization. They include *Juakali* artisans' shades that are situated along roadsides to service motor vehicles that breakdown on the roads and in interiors of informal settlements. The majority of *Juakali* shades operators are low-income earners, with little or no basic education and limited knowledge of modern technology in hazard management (Karanja, 2003).

Developing countries Kenya included rarely monitors the activities of informal sector and the working conditions of those employed. Protection of the health and safety of workers in this sector is big challenge that requires an integrated approach to safety and health promotion (Theuri, 2012). In Kenya, the "*Jua Kali*" sector is facing enormous health challenges that is threatening its very existence. Majority of *Juakali* workers are constantly exposed to numerous hazards ranging from physical, chemical, biological, and ergonomic. Physical hazards like Noise, vibration, extreme temperature, flying objects are the commonest hazards. Noise is undesired sound or unwanted disturbance within a useful frequency band.

Noise is present in every human activity either occupational (in workplace) or environmental wise or other settings like residential, community or domestic (Concha-Barientos, 2014). Noise is a pervasive and influential source of stress, whether through the acute effects of impulse wise or the chronic influence of prolonged exposure. The challenge of noise confronts many who must accomplish vital performance duties in its presence (Szalma *et al.*, 2011). In developing countries noise, induced hearing lose is the most common of all occupational injuries. However, efforts to address occupational health problems in these countries receive very little attention by health services planners due to inadequacy of data and long latency period (Cauntley *et al.*, 2015)

2.2.1 Anatomy, physiology of the Ear and the hearing process

The ear as an organ is divided into 4 parts; the outer ear, the middle ear, the inner ear, and the central auditory nervous system. The outer ear consists of one: the auricle or the pinna that gathers sound waves helps in localizing and amplification (approximately 5-6 db). Two is the External auditory canal, which is S shaped and approximately 1 inch long. It allows air to warm before reaching tympanic membrane as well as isolating tympanic membrane from physical damage (Irwin, 2006). The Mastoid bone protects inner ear and supports the outer ear.

The middle ear consists of one, the Tympanic membrane which is a thin membrane forming the boundary between the outer and middle ear. It vibrates in response to sound waves changing acoustical energy into mechanical energy. Two, the Ossicles (three small bones) joined to form ossicular chain. They are Malleas, incus, and stapes. They focus /amplify Vibrations of tympanic membrane to smaller area. The stapes following tympanic membrane vibration knocks the oval window on the cochlea (Major component of the inner ear) triggering movement of the endolymph (fluid inside the cochlea) in the cochlea creating a hydraulic energy. This fluid movement causes the membrane in the organ of corti(found in the cochlea) to shear against the hair cells inside the cochlea creating an electric signal which is sent up the auditory nerve to the brain which interpret it as sound (Butt, 2012).

In the middle ear there is a stapedius muscle attached to the stapes, it usually contracts in response to loud noise (Acoustic reflex) changing stapes mode of vibration rendering it less efficient and reducing loudness perceived. Absent Acoustic reflex could signal conductive loss or marked sensorineural loss (Irwin, 2006). Inside the Cochlea there are 3 semicircular canals containing endolymph and hair cells that are connected to the nerves that go to the cerebellum (balance and coordination centre) in the brain. The canals are responsible in maintaining balance and equilibrium. They determine movements in three planes (Butt, 2012).

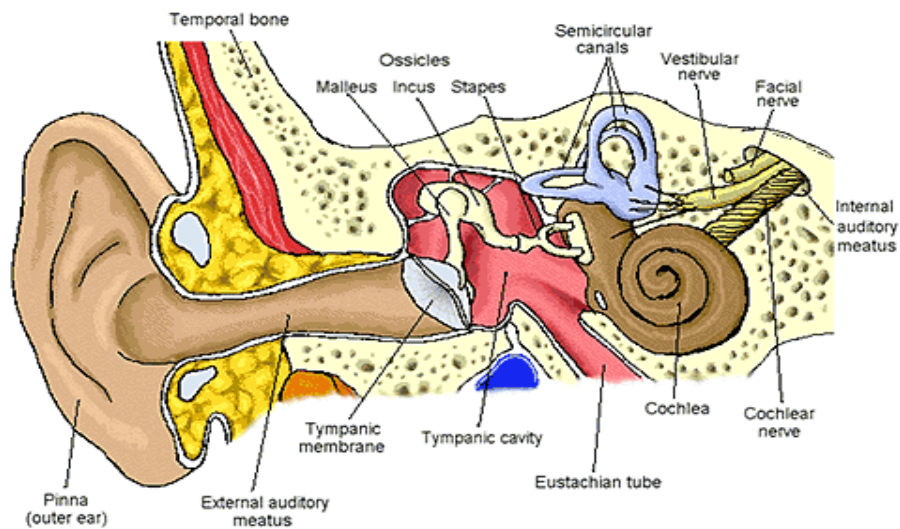


Figure2.1: Anatomy of the Ear. Source: Enriquem12bio.wikispace.com

THE INNER EAR – BALANCE

The balance portions of the inner ear can detect acceleration of the head in any direction, whether in a straight line or twisting and turning.

Semicircular canals

The three semicircular canals lie at right angles to each other. The canals are fluid filled and each contains a sensory organ called a crista, which is capped by the cupula

When the head moves, the fluid in the canals displaces the cupula, stimulating the nerves in the crista



Location

Vestibule

There are two fluid-filled chambers each containing a sensory organ called a macula. When the head moves, the gelatinous membrane of the macula is displaced, stimulating the nerve

Vestibular nerve

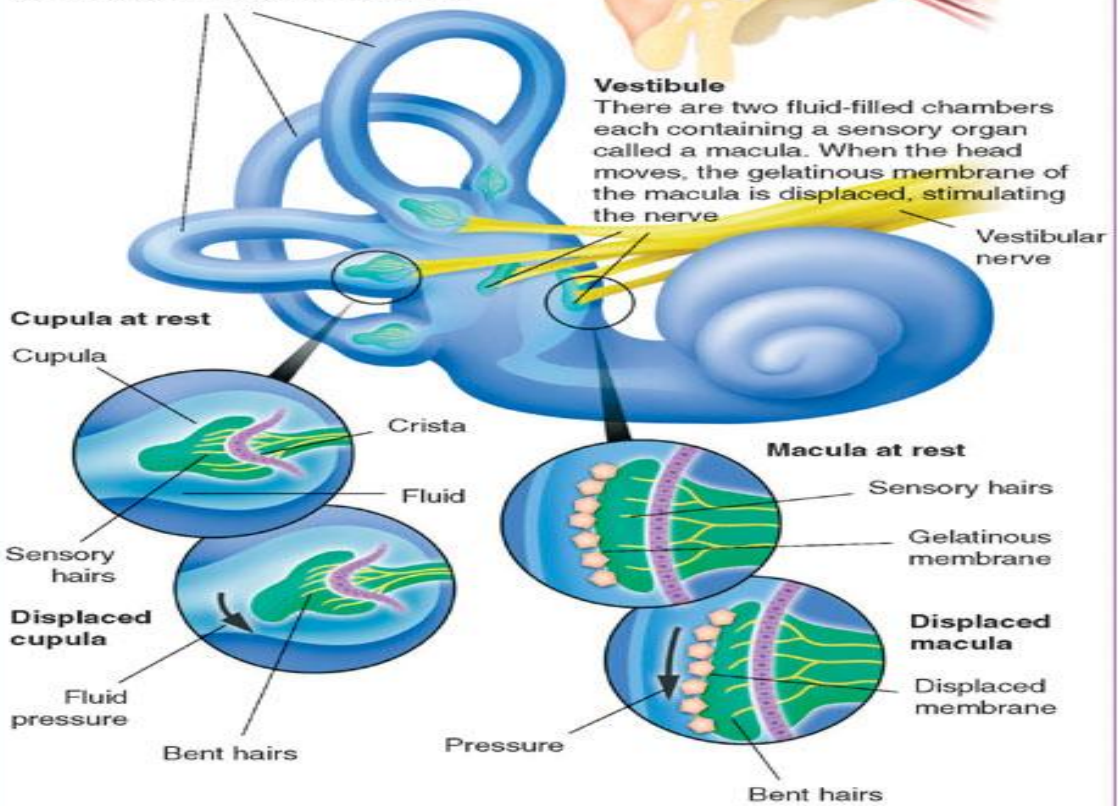


Figure 2.2: Structure of the inner ear and function. Source family doctor publications 2015

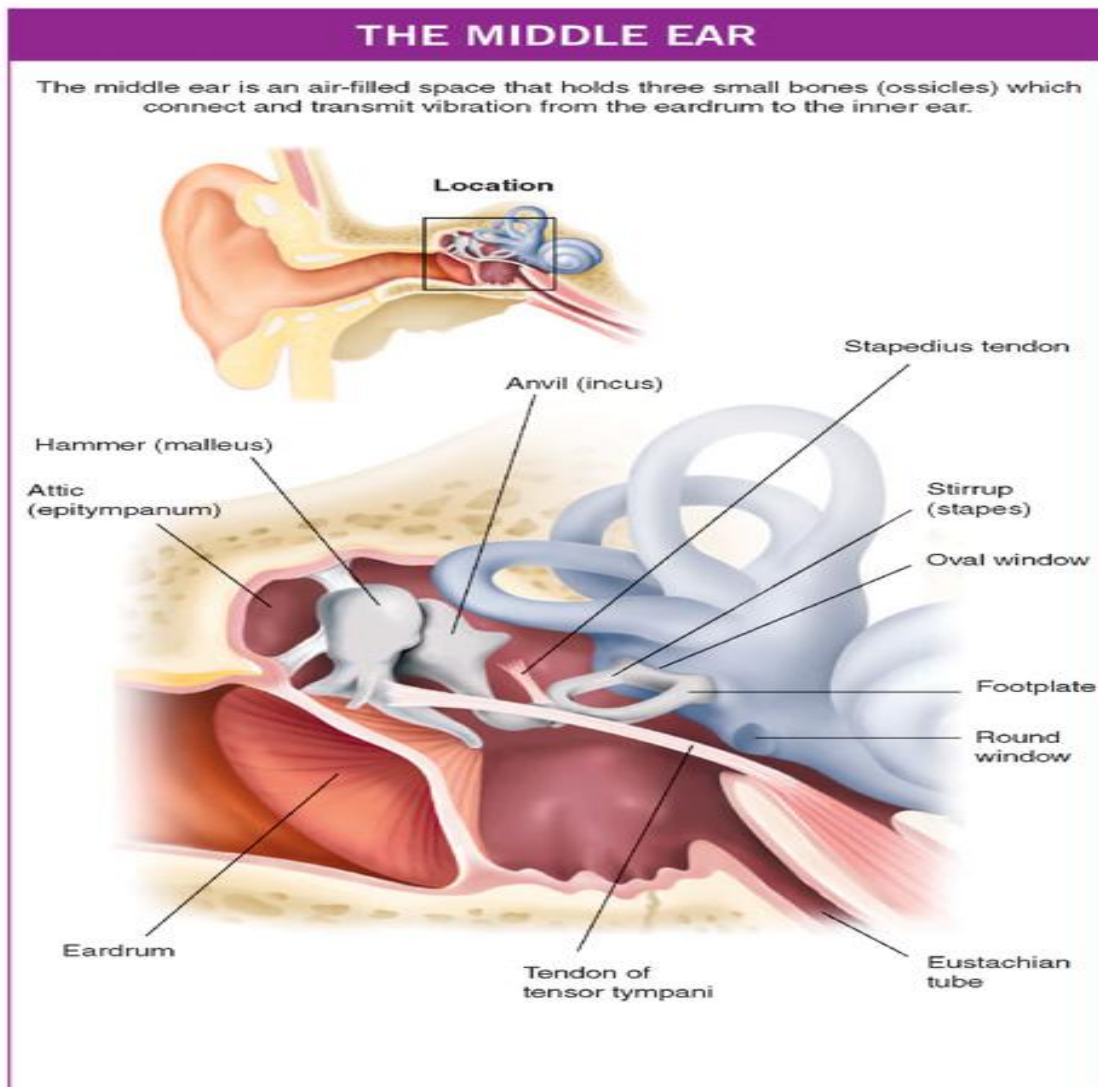


Figure 2.3: Structure and function of the outer ear. Source: Family doctor publications 2015

2.2.2. Noise

According to Collins Hansen (2009), Noise can be defined as disagreeable or undesired sound. Sound and noise constitute the same phenomenon of atmospheric pressure

fluctuations about the mean atmospheric pressure. Sound waves are because of vibrations in matter .They include air, liquid or solid. These vibrations move the air particles around the vibration, moving particle then collide with nearby particles resulting in an area of high-pressure compression. These areas of compressions then result to areas of low pressure called rare factions. The number of high-pressure areas reaching the ear in a given second known as the frequency determines the pitch of the sound. A low frequency wave (with fewer areas of high pressure in a given time period) will be perceived as low pitch while high frequency wave give a high pitch (Poiuliakas & Theodossiou, 2010).

2.2.3. Sources of occupational noise hazard in "Juakali" Sector.

There are various noise sources in work places. However generation(of noise) depends on the particularly noisy operation and equipment including crushing, drilling, pneumatic equipment, cutting torches, electrical furnace and many others (Gerges *et al.*, 2006). Mechanics, welders, and body works repair technicians are among the most exposed groups to high levels noise. Key sources of noise in the "*Juakali* sector" include Removal and repair of body panels during preparations for spray painting. This is done by use of pneumatic tools like air saws, chisels, producing noise levels as high 107 dB . Grinders and orbital sanders produce sound levels as high as 97dB. Noise levels from flame cutting, spray painting produces sound high as 93 dB (HSE, 2015).

Circular saw metal produces sound between 95- 105 dB. it is used for cutting metal bars. Metal fabrication produces sounds of 85-95dB, pressing - blanking produces sound of 95-110 dB, Punch- pressing used in fixing bushes produces sounds high as 110-120 dB, Hammering steel to make farm equipment, home appliances and multi spindle automatic turning produces sound as high as 105 dB. All these sources are producing sounds way above the limit of 85 dB that makes a major hazard among the " *Juakali*" workers. Compressors used in vehicle body spray painting, sand blasting, engine wash is one of the noisiest machines with high-pressure pulses of 105dB (Gerges, 2006).

2.2.4 Types of noise

Before properly evaluating noise exposure, the type and level must be clearly determined. The following are the major types of noise. Steady noise is one with negligibly smaller fluctuations of sound pressure levels within the periods of observations. Non-Steady noise is a type whose sound pressure levels shift significantly during the period of observation. It can be further classified into intermittent noise and fluctuating noise where the latter is a type, which the level shifts significantly during the period of observation. Tonal noise may be continuous or fluctuating and is characterized by one or two single frequencies. This type of noise is much more annoying than broadband noise characterized by energy at many different frequencies and of the same sound pressure levels as tonal noise (Alberti *et al.*, 2009). Intermittent Noise is one where the levels drop to that of the background noise several times during the period of observation. Impulsive noise consists of one or more bursts of sound energy, each with a

duration of less than 1 second. It is classified into type A (Like the gun short) and Type B like those found in industries (Hansen, 2009)

2.2.5 Noise measurement

Measuring noise levels and workers noise exposure is important part of a workplace hearing conservation and noise control program. It helps identify source of noise, employees affected and when additional need to be made. In occupational hygiene, the sound pressure level is measured to determine noise exposure (NIOSH, 2006). Sound levels measurement is however influenced by factors such as instrumentation calibration, background noise, measurement location, machine operation and measurement environment(NIOSH, 2006).The process of workplace noise measurement and monitoring include identifying noise problem, then consideration of the noise measurement including the purposes of measurement and determination of perennial noise exposure levels (CCOHS, 2013). Common instrument measuring noise includes the following:

2.2.5.1 Sound level meter (SLM)

It consists of a microphone, electronic circuits, and a readout display. The microphone detects the small air pressure variations associated with sound and changes them to electrical signals. The electrical signals are processed by electric circuitry of instrument. The readout display sound level in decibel. SLM takes the sound pressure level at one instant in a particular location (CCOHS, 2013).

2.2.5.2 Dosimeter

A small light device clips to a person's belt with small microphone that fastens to the person's collar near the ear. It stores the noise level information and carries out an averaging process. It is useful in industry where noise usually varies in duration, intensity and where person changes location. It has 3 components, the criterion level exposure limit for eight hours per day five days per week, an exchange rate as specified in noise regulation and finally threshold which is a noise level limit below which the dosimeter does not accumulate noise dose data (NIOSH, 2006).

2.2.5.3 Integrating sound level meter (ISLM)

It is similar to dosimeter. It determines equivalent sound levels over measurement period. The major difference is that ISLM does not provide personal exposures limit and because it is hand held like SLM and not worn. It determines equivalent sound levels of a particular location. It yields a single reading of a given noise even if the actual sound level of the noise changes continually. It uses a preprogrammed exchange rate with time constant that is equivalent to the slow setting on SLM (CCOHS, 2013).

2.2.6 Health effects of noise to the exposed

The needs for healthy and safe working environment is a fundamental pre-requisite for sustainable development and protect vulnerable groups and poor who are the majority in the informal sector (Buhlebenkosi *et al.*, 2013). However, throughout the world many

adults and some children spend most working hours at work where they are pre-disposed to many health hazards. Smaller enterprises like the *Juakali* sector are more likely not have effective noise control which is attributed to lack of adequate or insufficient knowledge of the effects of loud noise on hearing, hearing loss and quality of life (Timmins, 2010). A developing country rarely monitors the activities of informal sector and the working conditions of those employed. The rapid rate of urbanization in Sub-Saharan Africa has not been accompanied by a corresponding expansion of the formal sector. This has resulted to growth of urban unemployment on one hand and thriving informal sector on the other (Rongo *et al.*, 2013)

2.2.6.1 Hearing loss during hazardous noise exposure

For sound to be perceived, it must exert a shearing force on the stereocilia of the hair cells lining the basilar membrane of the cochlea. When excessive (sound force) can lead to cellular metabolic overload, cell damage and cell death. However, three attributes must be ascertained to describe individual hearing loss and they are; the location of the damage in auditory pathway, degree of hearing loss, and configuration of the hearing loss (frequencies affected). The variation of degree, type, and configuration of persons hearing loss has an impact on the resultant communication impairment (Fausti *et al.*, 2005).

Noise induce hearing loss therefore represents excessive wear and tear on the delicate inner ear structures hence noise induced damage to the ear has a progressive

consequences that are considerably more spread than are revealed by conventional threshold testing (Fernandez, 2008). Hearing impairment is the most frequent sensory deficit in human population. Globally, over 275 million people are affected and 80% of them are in low and middle income countries. In developing countries occupational noise accounts for about 3.8 million Noise induce hearing loss which represents a much heavier burden in developing countries than in developed regions of the world (Chandambuka *et al.*,2013).WHO, 2014 defines disabling hearing impairment in adults as permanent hearing threshold level of 41 decibels or greater. This is based on unaided hearing threshold in the better ear and as averaged over the 0.5, 1, 2, and 4 frequencies (Health Australia, 2008).

Table 2.1: Grades of hearing impairment. Source: Health Australia

Grade	Hearing Level	Impairment
0	< 25 DB	None can hear whispers
1	26-40 DB	Slight can hear words at 1 meter in raised voice
2	41-60 DB	Moderate can hear words in a raised voice
3	60-80 DB	Severe- can hear words if shouted into the ear
4	> 80DB	Profound cannot hear shouted words

The first indication of noise induced hearing loss is usually a shift in the pure tone threshold in the 3-6 KHz frequencies. Noise induced hearing loss is a well and long recognized occupational hazards but methods influencing attitudes towards Noise hazards and prevention of hearing loss as a result are poor (Foluwasayo *et al.*, 2005). Traumatic noise exposure may cause an immediate hearing loss in some cases, but most occupational hearing losses occur too gradually that workers are unaware they are losing their hearing with greatest growth during the first 10 years of exposure (NIOSH, 2008).

Worldwide, occupational noise is a significant cause of adult onset hearing loss. 16% of disabling hearing loss in adults (over 4 million Daly) is attributed to occupational noise. More than 500 million individuals are at risk of developing noise induced hearing loss (Nelson *et al.*, 2005). Hearing impairment is the most frequent sensory deficit in human population. Globally over 275 million people are affected and 80% of them are in low and middle income countries. Occupational noise accounts for about 3.8 million noise induced hearing loss which represents a much heavier burden in developing countries than in developed regions of the world and it is attributed to lack of noise prevention programs and awareness of the consequences of excessive noise exposure(Chandambuka *et al.*, 2013). In a survey conducted among the *Juakali* artisans of Kibuye market in Kisumu County and Kamukunji *Juakali* shades it was established that 22% of 1200 artisans assessed had disabling hearing loss (RBA & OED, 2010). In a similar survey done in Mombasa at county referral hospital, 779, artisans were assessed and 31.1% had

disabling hearing loss in which 95% of metal artisans are exposed to hazardous noise. Which is higher than the Kibuye and Kamukunji (RBA & OED, 2011).

2.2.6.2 Extra auditory health effects of noise hazards

In humans, noise is an important and recognized cause of health problems. Apart from auditory problems, noise is associated with other effects, which are mainly due to perturbations, which can appear after exposure noise levels as low as 50dB. These effects include physiological (cardiovascular, endocrine), psychological (mood, attention, memory), and sleep disturbance that can lead to psychiatry problem (Rabat, 2008). These may result to outcomes like stress, depression, burnout, ringing ears, elevated speech levels and decreased coordination and concentration by those affected (CCOHS, 2014).

In laboratory studies there is strong evidence indicating that noise exposure impairs performance. It shows that tasks performed during noise are unimpaired while those performed after noise are impaired and overall reduced when subjects are given noise control. Noise exposures do slow down rehearsal memory, influence process of selectivity in memory and choices of strategies for carrying out tasks (Stansfeld & Matheson, 2003). Annoyance is the most prevalent response to those exposed to noise .This is as result of noise interfering with daily activities, feelings, thoughts, rests and accompanied by negative responses like anger, displeasure, exhaustion, and stress related symptoms (Basner *et al.*, 2013).

2.2.7 Noise regulation at workplace and environment

In Kenya National Environmental Management Authority (NEMA) and Directorate of Occupational Health and Safety Services (DOHSS) enforce laws regulating noise at workplaces and the environment at large. These are provided under the Environmental management and co-ordination act of 2015 (EMCA, 2015) and Occupational safety and health act 2007 respectively.

2.2.7.1 The Environmental management and co-ordination act of 2015 (EMCA 2015) Noise and vibration pollution control

These Regulations aim at ensuring the maintenance of a healthy environment for all people in Kenya, the tranquility of their surroundings and their psychological wellbeing by regulating noise levels and excessive vibration. The Regulations elevate the standards of living of the people by prescribing acceptable noise levels for different facilities and activities. The Regulations prescribe the maximum permissible noise levels from a facility or activity to which a person is exposed; provide for the control of noise; and provide for mitigating measures for the reduction of noise. The maximum permissible noise levels are based on the various zones as outlined in the Regulations. These regulations apply even to work places and do not negate the Factories and Other Places of Work (Noise Prevention and Control Rules, 2005). However, the enforcement of this in the informal sector and *Juakali* in particular is non-existence exposing the *Juakali* artisans and those in the surrounding to noise hazards (NEMA, 2015)

2.2.7.2 Occupational safety and health act 2007

Main roles of this Act is to provide a framework for implementing safe and healthy work practices in the Kenya in all sectors of economy. The Act, among others ensures Promotion of safe and healthy work environment, monitoring work practices of all workers in order to minimize work-related injuries and occupational diseases. The act also ensures Promotion of a culture of safe and healthy attitudes and practices; Ensures that health and safety management in the workplace constitutes a core management function of all sectors and promotes a culture of co-operation between the major stakeholders. Promote the incorporation of OSH educational programs aimed at reducing workplace hazards and risks into the work plans, Facilitate compliance to OSH policy and legislation by clients, contractors, and visitors at any work place, Provide guidance for minimum OSH requirements for various tiers of organization, and Provide OSH risk assessments guidance and tools for use in all sectors (OSHA, 2007)

The objectives of the OSHA (2007) On Noise control and hearing conservation were to set limits for noise exposure and requirements for noise control and hearing conservation programs to prevent noise induced hearing loss in workplaces. Permissible noise levels set were that no worker should be exposed to noise levels above 90dB for more than eight hours in a duration of twenty-four hours. worker should not be exposed to noise level of 140 dB at any given time and where noise is intermittent, noise exposure should not exceed the sum of the partial noise equivalent to continuous sound level of 90 dB in eight hours duration within any twenty four hours duration. Where noise in workplace

exceeds 85dB , an effective noise control and hearing conservation has to be put in place (Kimani, 2012).

However the informal sector in Kenya receives no attention from the enforcers of the EMCA 2015, OSHA 2007 since their activities are not monitored which puts them in more danger of exposure to noise and other debilitating hazards (Theuri, 2012)

2.3 Conceptual framework

A conceptual framework is a model where a researcher illustrates the relationship between the variables under study (Robson, 2011). It explores the relationship between independent variables and dependent variables. An independent variable is the presumed cause of changes in the dependent variable. Dependent variable is the variable the researcher wishes to explain; also referred to as the criterion or predictor variable (Kothari, 2004). The conceptual framework of this study is based on the following independent variables: sources and levels of noise, level of training, education, awareness of the hazards, and how they contribute towards negative health effects on exposed *Juakali* artisans.

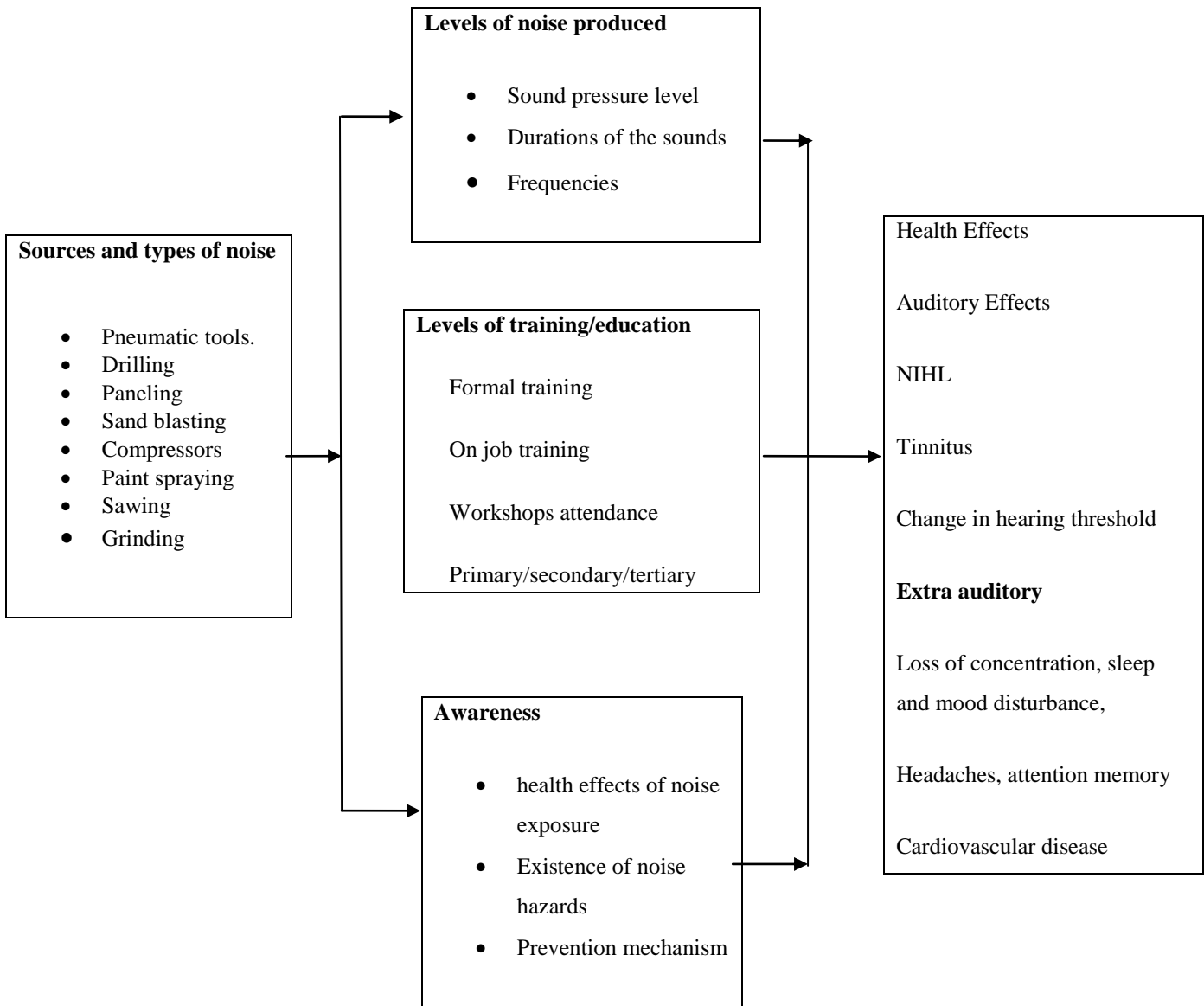


Figure 2.4: Conceptual framework with independent variables effect on dependent variable

2.4 Critique of the existing literature

From the relevant literature reviews on this study, Buhlembenkosi 2013; Chandambuka, 2013 carried studies on a Noise related hearing loss but fell short on circumstances under which they occur. Theuri, 2012 study of Hazards in informal sector brought out key issues ranging from organization and knowledge gaps but didn't draw relationship of this and development of hearing loss. Agencies Such as OED, RBA 2011 report showed how noised hearing loss was consuming the *juakali* artisan but recommendation and intervention are very limited.. Developing countries face problems of rapid changes in industrialization, population growth, rural urban migration, and international trade competition. The changes influence heavily on the quality of work environment, focus of the workers health and safety by employers and the state, on the performance of the agencies in charge of workers welfare in achieving the intended objectives and goals. The informal sectors workers (*Jaukali* artisans) have been continuously exposed to disabling noise levels, where a very good number have developed irreversible hearing loss with minimal or little research being undertaken.

2.5 Research Gaps

Exposure to hazards by *Juakali* artisans is inevitable as well as elimination of the same not possible. Occupational health and safety in Kenya is enforced by Directorate of occupational health and safety services (DOSHS) through OSHA 2007, which provides a legal framework for regulating health and safety in workplaces. However there are over 100,000 workplaces in kenya with only 58 Doshs officers countrywide (DOSHS

report, 2016) this makes it difficult to effectively enforce the OSHA 2007. The legal framework covers both informal and formal sectors and encompasses all hazards and responsibilities of all stakeholders. Therefore lack of human resource has led to poor regulation of *Juakali* sector has leading to expanding *Juakali* sector with associated increased exposure to hazards including noise among the most common. Therefore, this study aim was to bridge the gaps and documenting challenges of hazards control in the *Juakali* sector, impacts of noise related health effects to the *Juakali* artisans, families, society, and country as whole. Noise as a major hazard, its awareness, sources, effects to the hearing ability, associated extra auditory health effects in the *Juakali* sector is an area where the researcher investigated in King'orani area of Mvita sub-county.

CHAPTER THREE

METHODOLOGY

3.1 Research design

The purpose of this study was to ascertain noise production and its effects on hearing capabilities and auditory health effects of *Juakali* artisans in king'orani area. The research employed a cross-sectional study design. A research design according to (Kothari, 2014) is a conceptual structure within which research would be conducted aimed at providing for the collection of relevant evidence with minimal expenditure of effort, time, and money. Creswell (2013) defines research designs as plans and procedures for research that span the decisions from broad assumptions to detailed methods of data collection and analysis. According to Levin Kate (2006), cross-sectional study design is used when the researcher is interested in investigating exposure to risk factors and outcomes as well as estimating the prevalence of the outcome within relatively a short time in a population or a subgroup within a population in respect to an outcome and set of risk factors.

3.2 Study population

Mugenda and Mugenda (2003) define a target population as a complete set of numbers with some common observable characteristics. Sekaran and Bougie (2011) defines a target population in terms of numbers, geographical boundaries, and time. In this study, the target population was the "*Juakali* artisans working in the garages, shades, and open

spaces within the king'orani area of Mvita Sub County. The artisan involved in the research were those who had been in the locality for at least one year.

3.3 Sampling frame

Study sample was obtained from *Jua Kali* artisans working in areas producing or associated with noise production. They were categorized into two groups. The experimental groups (Panel beaters, drillers, spray painters, mechanics, grinder operators, and welders) and the none exposed (water vendors, food vendors, clients) within king'orani area who were the control group. Those who were present at work during the period of study were the only ones sampled.

3.4 Sample and Sampling technique

Representative sample was calculated using Atchleys formula (Saunders & Thornhill, 2009).

$$n = \frac{z^2 p(1-p)}{d^2}$$

n= deserved sample size

p- Proportion in target group or prevalence estimated to have the measured character

Z-reliability co-efficient or standard normal deviation at the required confidence level

d - Is the level of statistical significance or degree of freedom

z= reliability co-efficient (1.96)

p= prevalence (50%)

d= degree of freedom (0.05)

$$n = \frac{1.96^2 \times 0.5(1-0.5)}{0.05^2}$$

The required sample was

$$n = 384$$

However, since target population was way below 10,000 the final sample estimate (nf) was calculated using

$$n_f = \frac{n}{1 + n/N}$$

Where N, is the estimated population (212) and n, actual sample size.

$$\frac{384}{\dots\dots\dots 1 + 384/212}$$

(nf) final sample was = 136

Sampling was through stratified random sampling where each stratum consisted of different disciplines among the *Juakali* artisans and the control group. The 136 who constituted the main sample size were those exposed and active *Juakali* workers who were also selected for questionnaire administration. The other participants that were only involved in audiometric tests as the control group; were randomly sampled from food vendors, hawkers, and clients to the *Juakali* artisans. This is because they had minimal

exposure to noise hazards. They were 78 in number and those sampled were 26. Among the respondents Twelve (12) participants changed their mind and withdrew from the study during questionnaire interview, otoscopic and audiometric examinations: these participants were categorized as non-respondents.

Table3.1: Sample population of the exposed group

Occupation	Population	Sample
Mechanics	55	32
spray painters	58	34
Panel beaters/welders	99	58
Total	212	124

Table 1.2: Sample population of the control group (non exposed)

Occupation	population	Sample
Food Vendors	34	11
Hawkers	32	10
Clients	12	5
Total	78	26

3.5 Instruments.

The researcher used structured questionnaire, audiometers observational chart and dosimeter to collect data. The structured questionnaire was important, as it gave respondent freedom to express their views objectively and collection of social demographic information, health history, and views of respondents. Observation by the researcher captured other key information left out by the respondent but key to the

objectives of research. The researcher used sound level meter IEC61672-1 class to measure noise level generated by different machines and equipments operated. Audiogram MON 650A was used to determine hearing threshold of the participants.



Figure 3.1: Audiogram for conducting pure tone audiometric tests



Figure 3.2: Meter used to measure noise levels

3.6 Data collection methods

Collection of data was through three processes. One was through the questionnaire. Trained research assistants assisted the respondents to complete the questionnaire during face-to-face interview and observations. The structured questionnaire captured social demographics, health history and current complains in relation to exposure to noise hazard. Audiometric test (pure tone eudiometry), were carried out on the exposed group (experimental group) and the control group to determine the hearing threshold at difference frequency bands and the findings recorded. The workplaces noise levels was measured using sound level meter and their sources to establish the levels of noise and those within the range of being exposed and forming the experimental group. Those

operating outside the maximum exposure limit including food vendors, hawkers painters, had less exposure with limited duration formed the control group.

3.6.1 Hearing evaluation

Hearing evaluations were done in four stages. Stage 1 involved briefing the participants on procedures they were to be taken through and likely duration of each. Stage two involved physical examination of the ear for any physical and anatomical defects that could affect hearing ability using otoscope. Stage three involved pure tone audiometry where the participants were ushered into a soundproof room for hearing thresholds (audiograms) evaluation. The audiograms were done beginning with the best ear at different frequencies of 1000 Hz, 2000 Hz, 400 Hz. Hearing threshold was determined by getting satisfactory response by reducing levels of the tone in 10 dB then increasing with 5 dB until the subject gives response at the same level while twice in descending or ascending sound level adjustments.

3.7 Pilot study

Prior to actual collection of data, the researcher conducted pilot study to obtain assessment of the questions and sound level meters for validity and reliability of the data that were to be collected. This was carried at Likoni area that is located outside the sampling area. It is during the pretest of the instrument that the researcher is able to assess the clarity of the instrument and the ease of use of the instrument (Mugenda and Mugenda 2003)

3.8 Ethical Consideration

The research involved human subjects as the main source of Data. Therefore all the details, intentions , objectives and procedures were subjected to ethical committee review for approval (Appendix 5)after which the research participants were fully informed of all the details of research and there after allowed to make informed decision on whether to take part or not. The details of research participant remained secured and findings kept confidential.

3.9 Data processing and Analysis

Collected data were coded, cleaned, tabulated, and analyzed using SPSS version 21 to determine frequencies, means, standard deviations, Chi square and Pearson's correlations among the variables of interests. Presentation is through percentages, tables, frequencies, bar charts and graphs.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the key findings of the study. The study was, conducted among the *Juakali* workers in King'orani area Mvita Sub-county. This chapter captures the questionnaire findings, workstation noise analysis, and audiometric tests of the *Juakali* workers. Presentation is through frequency tables, Bar graphs, pie charts, and percentages from which the conclusions were drawn.

4.2 Results

The targeted sample size was 136 participants, however 124 out of the 136 took part in the study to conclusion while the 12 withdrew midway during questionnaire administration and a number declined to take part in otoscopic and audiometric examination. Therefore the 12(8.82%) constituted non respondents while response rate stood at 124(91.18%) which is statistically reliable in giving significant findings

4.2.1 Social demographics

Social demographics gives wide outlook and analysis of the key indicators of human population development that any changes have a far and wide reaching implications . They determine the health, social, economic well-beings, and status. These indicators are vital in how certain occurrences in the society takes place and also give a basis on how

to approach solution to given challenges. For the purpose of this study, social demographics provided the basis of the measurement of the key variables. Table 4.1 gives a summary of the key demographics parameters of importance to this study.

Table 2.1: Social demographics of the participants

Variable	Characteristic	Frequency	Percentage
Gender	Female	17	13.7
	Male	107	86.3
Age in years	18-20	4	3.2
	21-30	48	38.7
	31-40	44	35.5
	41-50	24	19.4
	More than 50	4	3.2
Marital status	Single	16	12.9
	Married	92	74.2
	Separated	8	6.5
	Divorced	8	6.5
Level of Education	No education	4	3.2
	Primary Education	56	45.2
	Secondary education	40	32.3
	Tertiary education	24	19.4
Residence	Likoni	48	38.7
	Magongo	16	12.9
	Migadini	24	19.4
	Kisauni	8	6.5
	Kongowea	12	9.7
	Changamwe	4	3.2
	Mishomoroni	12	9.7

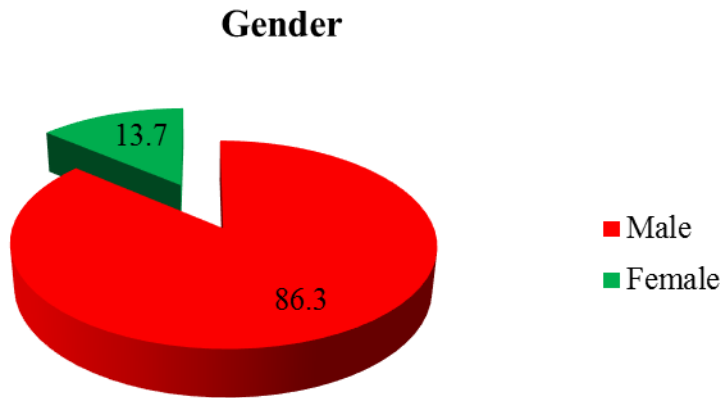


Figure 4.1: Gender distribution among *Juakali* workers of king'orani area

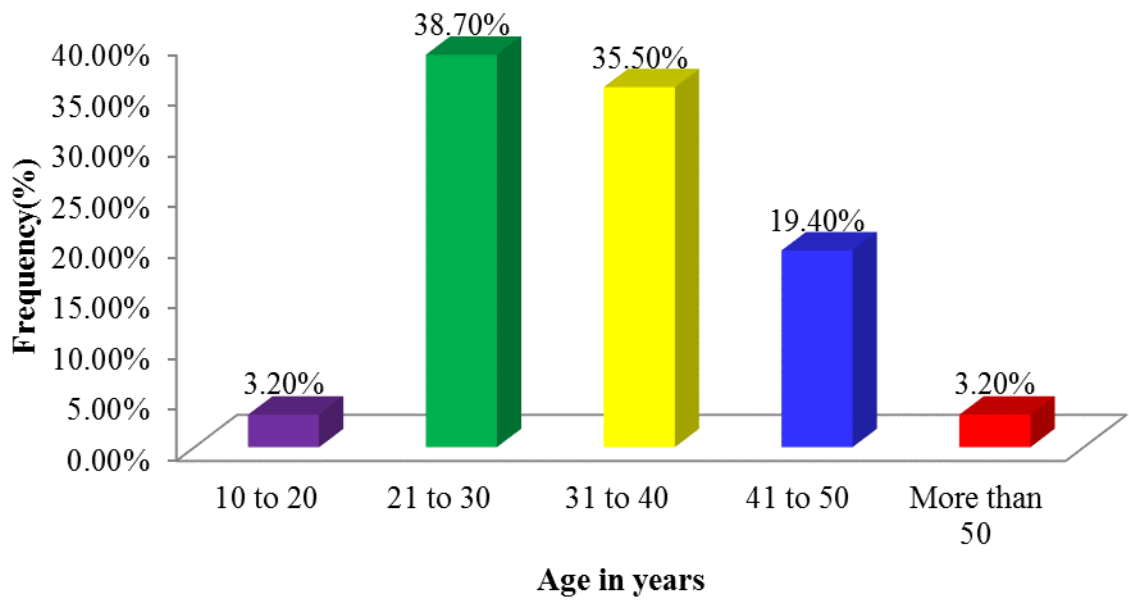


Figure 4.2: Age distribution among the *Juakali* artisans of King'orani area

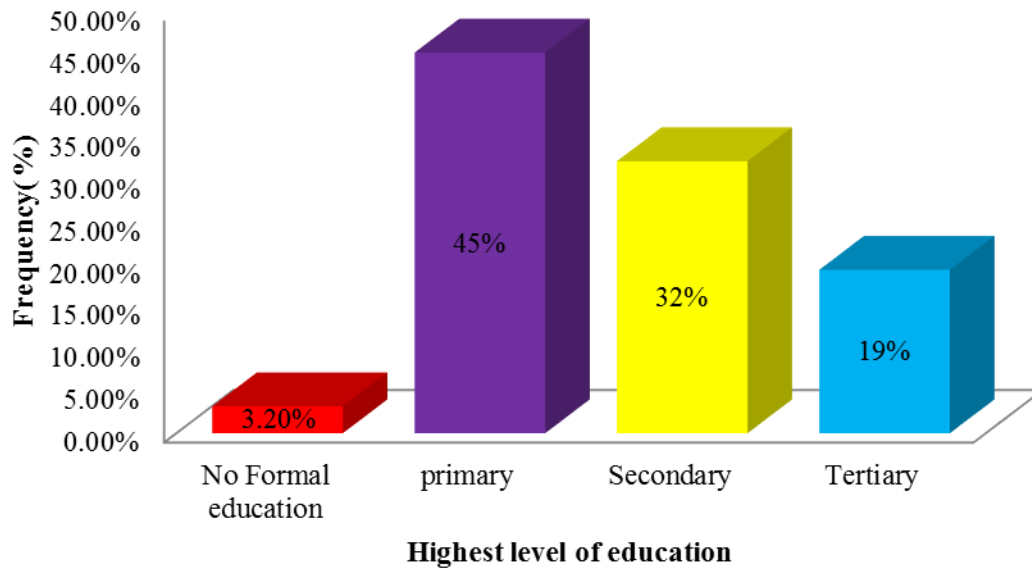


Figure 4.3: Level of education of the participants

Majority of the participants were Male at 86.3 percent and female at 13.7 percent. This indicates that this is a male dominated field as shown in table 4 and figure 9. Age is a significant observation as it has a major contribution on duration at workplace and exposure period as well as experience. Most of the participants age was between 20 to 50 years; where those aged 21 to 30 years were 48(38.7%), 31-40 were 44(35.5%) ,and few were between the age of 10 to 20 years 4(3.2%) and above 50 years (3.2%) as shown in table 4.2 and figure 4.1 Mean age was 36 ± 2.8 indicating majority of the respondents had worked for longer period and exposure.

Education level is vital in any discipline as it provides basis of creating understanding and awareness among those involved. Majority of the participants 45.2%(56) had

attained primary education level, 32.3(40) had secondary education while only 19.4%(24) had formal training and those who had no formal education were 3.2%(4). This indicates that majority of the king'orani *Juakali* workers have no background knowledge of health and safety provided during formal professional trainings as shown in table 4.2 figure 4.3.

4.2.3 Nature of work and noise production

4.2.3.1 Working area

Table 4.2: Nature of workstations used by Juakali artisans in King'orani area

	Frequency	Percent	Valid %	Cumulative %
Open air	84	67.7	67.7	67.7
Over head shades	12	9.7	9.7	77.4
Workshop	8	6.5	6.5	83.9
Open air and shades	12	9.7	9.7	93.5
Open air, shades and Workshop	8	6.5	6.5	100.0
Total	124	100.0	100.0	

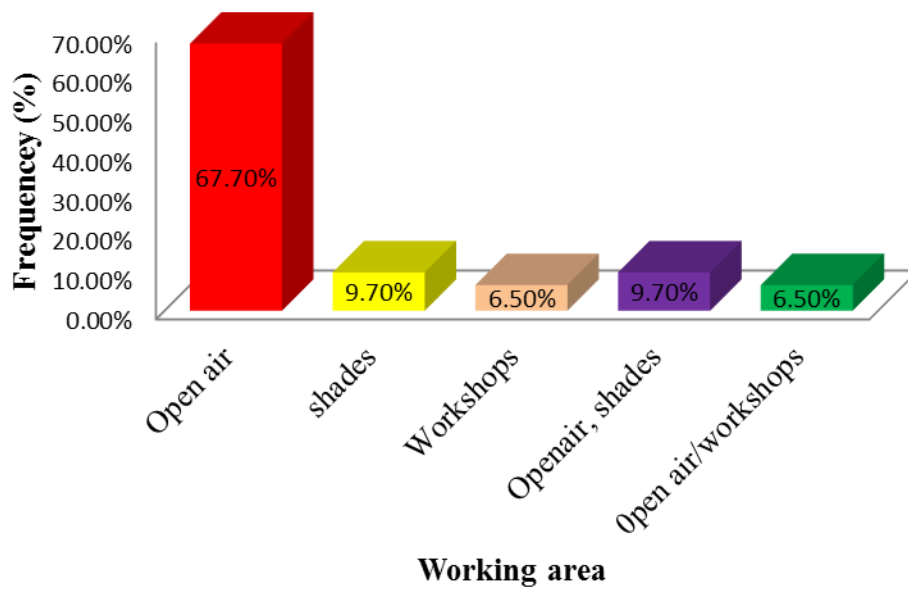


Figure 4.4: Frequencies of utilization different working areas

67.7% of the activities and work was carried out in open air while 9.7% under overhead sheds, 6.5% done in workshops while 16.2% was in both overhead, open air and workshop as shown in table 4.3 and figure 4.5. This is a clear indicator of occupationally poor work environment, lack of mechanism of controlling noise generated within the workstations and other potential hazards. Similar results were observed in the study done in South Africa by Laura, 2012 where most informal work environment were along the streets without structures attendant poor organization.

4.2.3.2 Sources of Noise

Table 4.3: Activities associated with noise generation

Activity	Frequency	Percent	Valid %
Paneling, drilling, welding	48	38.7	38.7
Grinding, spray painting	24	19.4	19.4
Paneling, spray painting	20	16.1	16.1
Auto services, Sandblasting	32	25.8	25.8
Total	124	100.0	100.0

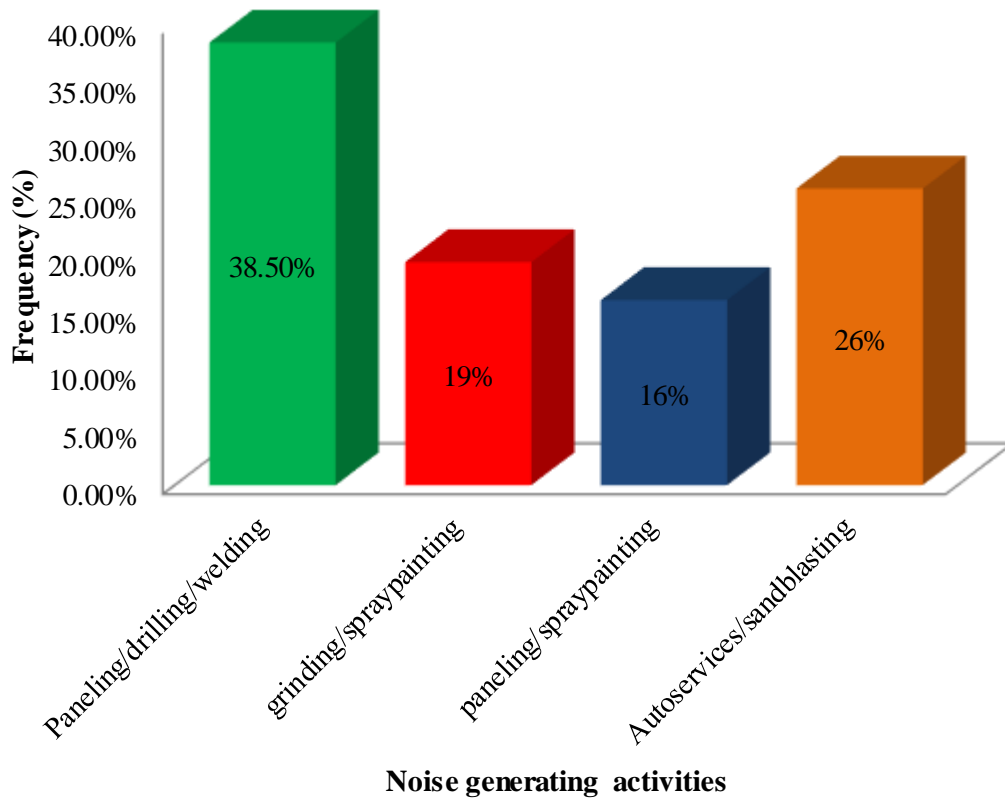


Figure 4.5: Different work activities associated with noise generation

Most of the noises generating activities within the kingorani *Juakali* sector are mechanical. Majority of the workers undertook more than one activity and hence activities are in clusters. . They included Panel beating/drilling/welding 38.5 %(48), Grinding/ spray painting 19 %(24), panel beating /spray painting 16 %(20), Motor vehicle repairs/ sandblasting 26 %(32) indicated in table 4.4 and figure 4.6. However, these activities took place in the same environment and majority of the artisans in the workstations exposed to the noise generated by most of these activities at ago.

4.2.3.3 Noise level measurement

Table 4.4: Levels of noise in dB generated by artisans' activities

Activity	Noise level in dB(A)
Grinding	94.6
Drilling	98.5
Welding	89.9
Spray painting	103.8
Motor/mechanical service	106.8
Sandblasting	89.8
Panel beating/ Fabrication	104.6

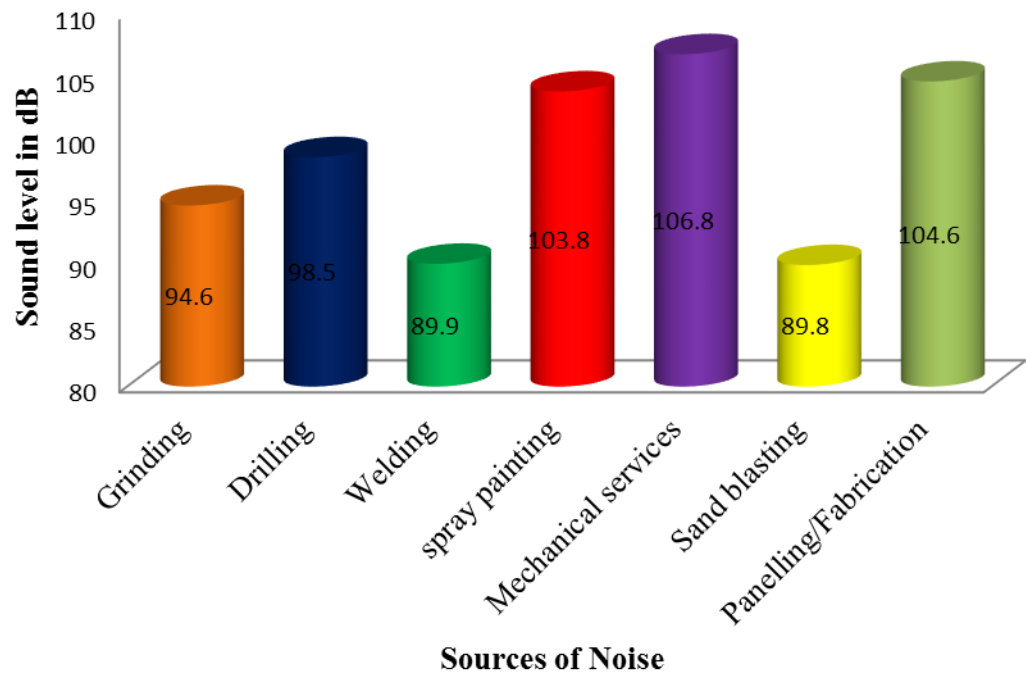


Figure 4.6: Levels of noise generated by artisans' activities

Activities carried out by *Juakali* artisans generated noise at significant levels of; grinding 94.6 dB, drilling 98.5 dB, welding 89.9 dB, spray painting 103.8 dB, mechanical and automotive services 106.8 dB, Sandblasting 89.8 and Panel beating 104.6 dB. The noise generated by these activities above the recommended 85 dB, mean of 99.6 ± 0.794 which is above the maximum allowable limits hence exposing the artisans to Hazardous effects (Table 4.5 and figure 4.7).

4.2.3.4 Noise exposure level

Table 4.5: Exposure levels and frequency among the study participants

Level of exposure	Frequency	Percent	Valid %	Cumulative %
less than 70 dB	1	0.8	0.8	0.8
70-80 dB	1	0.8	0.8	1.6
81-90 dB	15	12.1	12.1	13.7
91-100 dB	38	30.6	30.6	44.4
101-110 dB	69	55.6	55.6	100.0
Total	124	100.0	100.0	

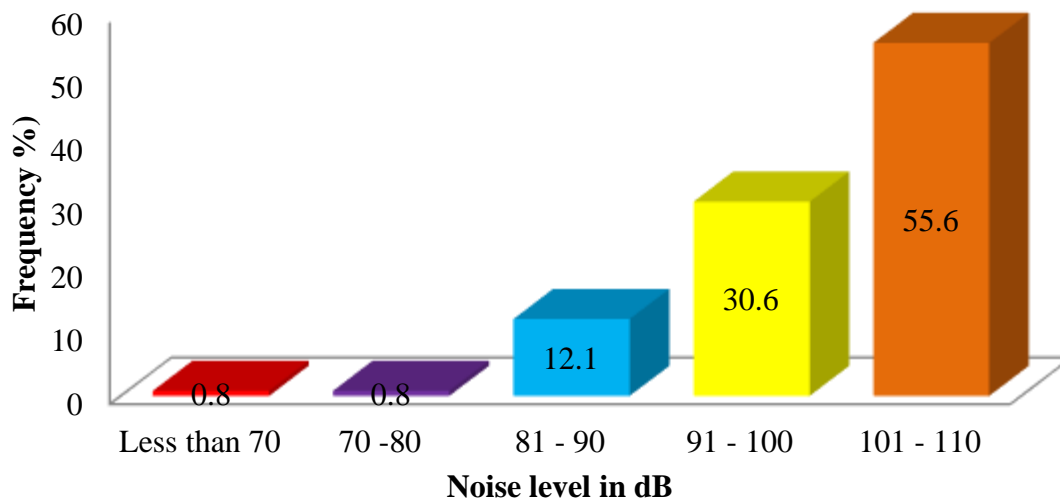


Figure 4.7: Noise levels and frequency of exposure by the artisans in kingorani area

Exposure levels were high as most of the Artisans 55.6 % (69) had noise exposure of 101 to 110 dB and 30.6% (38) with noise exposure level of 91 to 100 dB While at 81 to 90 dB 12.1% (15). Those with exposure level below 80 dB were 0.8 % (1) with exposure level 70 to 80 dB and 0.8% (1) with exposure level below 70 dB respectively shown in table 4.6 and figure 4.7. The measurement categorizations were done based on activity one was undertaking during noise measurement and usual daily work performed by the study subject.

4.2.4 Duration of exposure

Table 4.6: Duration of exposure frequency in years by the artisans

Period in years	Frequency	Percent	Valid %	Cumulative %
Less than 1 year	8	6.5	6.5	6.5
1 - 10 years	46	37.1	37.1	43.5
11- 20 years	44	35.5	35.5	79.0
21- 30 years	20	16.1	16.1	95.2
More than 30 years	6	4.8	4.8	100.0
Total	124	100.0	100.0	

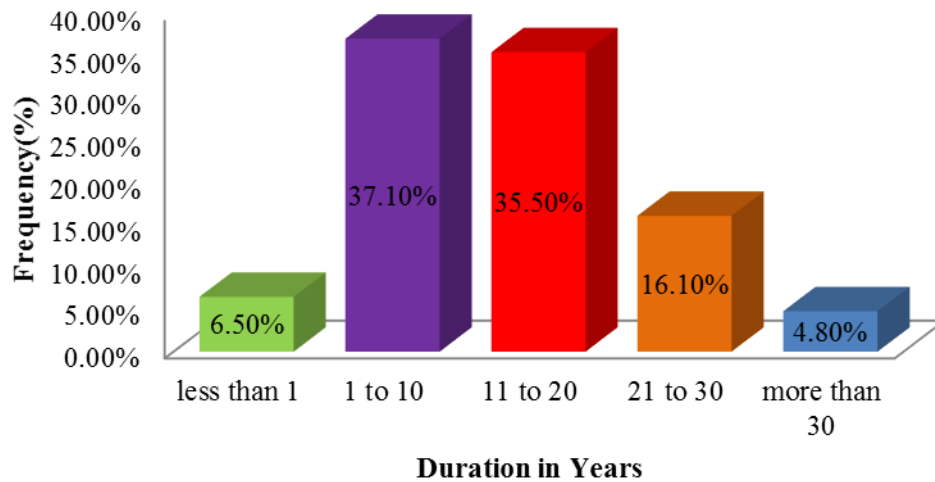


Figure 4.7: Frequency of exposure duration in years by the artisans

The duration of exposure to noise was based on the number of years the artisan have been working in the same environment while carrying out similar activities and they were, less than 1 year 6.5%(8), 1-10 years 37.1% (46), 11-20 years 35.5 %(44), 21-30 years 16.1% (20) and more than 30 years 4.8% (6) with standard deviation of 0.99. as shown in figure 4.8 and table 4.7.

4.2.5 Daily exposure duration

Table 4.7: Number of hours' artisans spends at work (daily exposure duration)

Exposure duration	Frequency	Percent	Valid %	Cumulative %
less than 1	8	6.5	6.5	6.5
5-8	12	9.7	9.7	16.1
more than 8	104	83.9	83.9	100.0
Total	124	100.0	100.0	

Daily sustained exposure to noise measurement was important, because it plays a key role in determining the overall exposure and outcome (effects of exposure). Most of the respondents spent more than 8 hours at the workstation 83.9 % (104), while 9.7 % (12) spend between 5-8 hours and 6.5 % (8) spend less than 1 hour with Standard deviation of 0.77((Table 4.8). 55.6% of the respondents had exposure to noise above 101 dB generated by their daily activities, which is 10 dB above the allowable limit. There was significant association between exposure level and auditory health effects with chi square significance of 0.951

4.2.6 Nature of noise generated

Table 4.8: Nature of noise generated by the work activities of artisans

Noise description	Frequency	Percent	Valid%	Cumulative %
Normal	4	3.2	3.2	3.2
Loud	16	12.9	12.9	16.1
Very Loud	24	19.4	19.4	35.5
Very loud/ ,irritating/Deafening	44	35.5	35.5	71.0
Irritating and Deafening	24	19.4	19.4	90.3
Painful and deafening	12	9.7	9.7	100.0
Total	124	100.0	100.0	

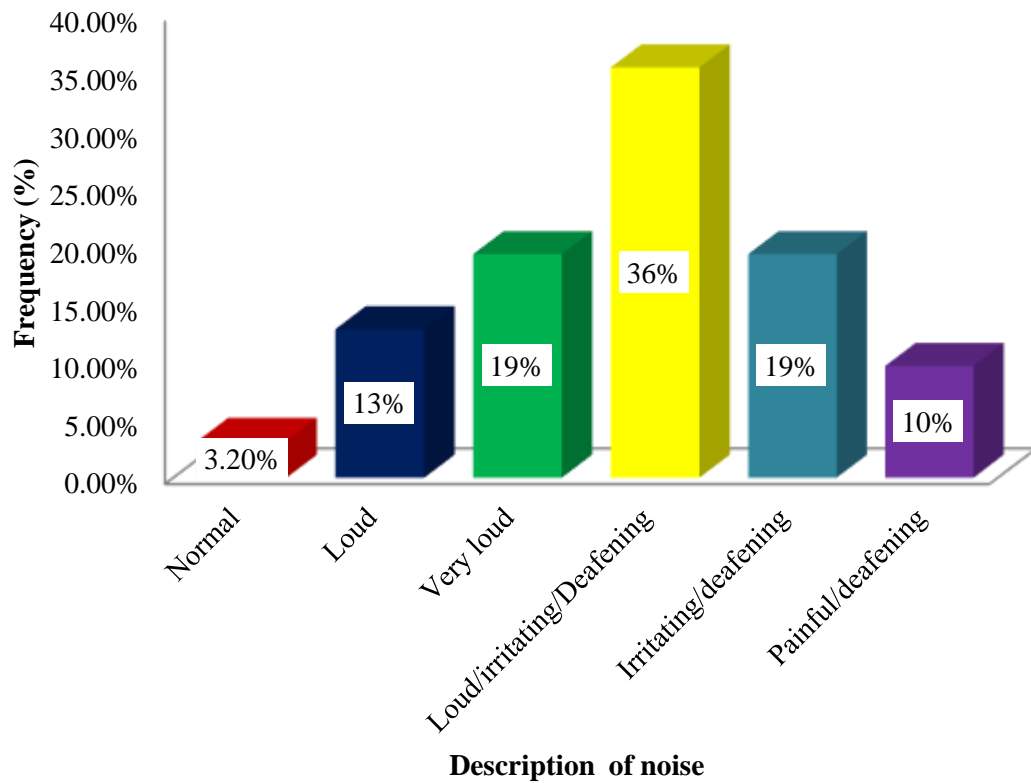


Figure 4.8: Nature and description of noise generated by artisan's activities

Noise description by the respondents was that those who felt it is normal 4(3.2%), Loud 16(12.9%), very loud 24(19.4%), irritating and deafening 24(19.4%), Painful and deafening 12(9.7%), Very loud, irritating and deafening 44(35.5%) was important as illustrated how they discern noise produced by the activities they carry out. This also indicated if they view it as health hazard as shown in figure 4.9 and table 4.9.

4.2.7 Medical history

Table 4.9: Past medical history related to the ear of the artisans

Variable	Characteristic	frequency	Percentage
Prior exposure to noise	exposed	16	12.9
	Not exposed	108	87.1
Exposure period	less than 1 year	15	12.1
	1-5 years	1	.8
	No prior exposure	108	87.1
PPE use	Rarely	8	6.5
	Never	116	93.5
Prior ear infection	Suffered ear infection	17	13.7
	No infection	107	86.3
Trauma to the ear	Suffered ear injury	16	12.9
	No injury to the ear	108	87.1
Outcome	No ear Trauma	108	87.1
	Recovered fully	16	12.9
Hearing assessment	Assessed	15	12.1
	Not assessed	109	87.9
Outcome of assessment	No prior assessment	109	87.9
	No hearing impairment	15	12.1

Among the respondents, 87.1%(108) had no prior excessive noise exposure, while 12.1%(15) have previous exposure for period less than 1 year, while only 1 respondent had exposure for a duration of 1- 5 years. 13.7% (17) of the respondents had prior

history of ear infection as shown in table 4.10 out of which all fully recovered without complication following treatment. Those with history of trauma to the ear were 16 (12.9%) out of which they recovered fully as shown in table 4.10 .Use of ear protectors was almost absent as 93.5% (116) having never used while only 6.5% (8) having rarely used as show in table 4.10 . Due to poor infrastructure, PPE use is the more realistic way of controlling exposure to noise by the artisans

4.2.8 Health effects

Table 4.10: showing noise effects experienced by the artisans

Effect experienced	Frequency	Percent	Valid%	Cumulative%
Hearing impairment	24	19.4	19.4	19.4
Tinnitus, Headache	36	29.0	29.0	48.4
Hearing, Tinnitus	24	19.4	19.4	67.7
Hearing, concentration	8	6.5	6.5	74.2
Tinnitus, loss of sleep	12	9.7	9.7	83.9
Tinnitus, concentration, Hearing	20	16.1	16.1	100.0
Total	124	100.0	100.0	

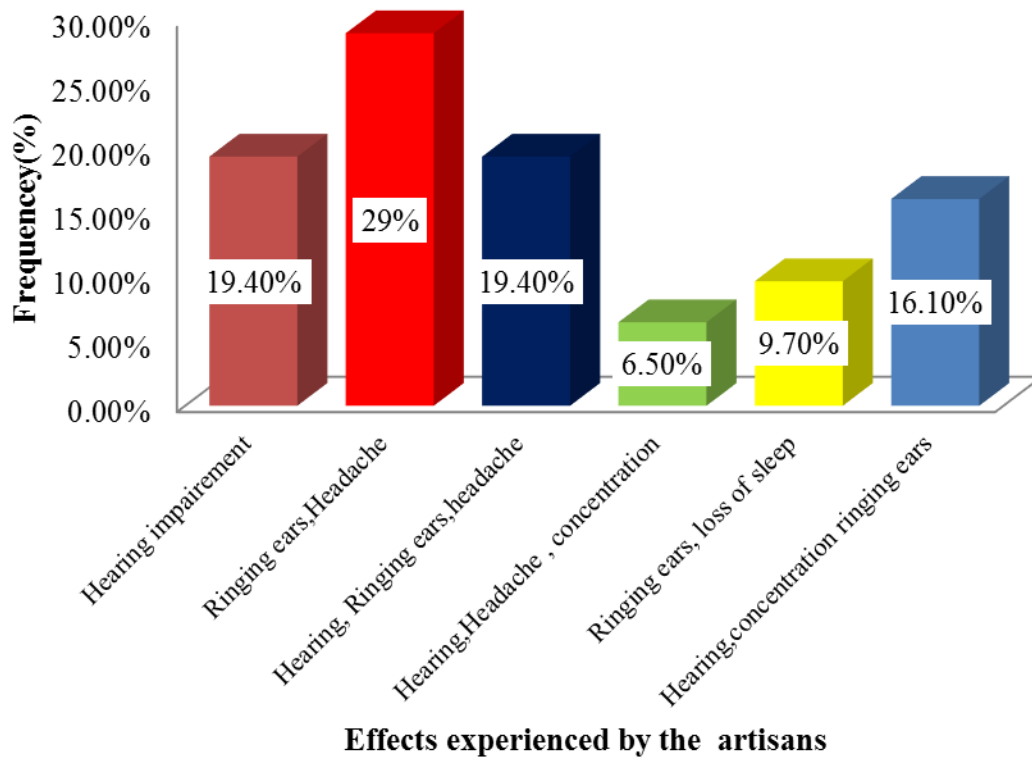


Figure 4.9: Noise effects experienced by the artisans

As shown in table 4.11 and figure 4.10, Study subjects experienced varied symptoms and health related problems after spending considerable time at the working area with high (above 80Db) levels of noise. This included Hearing impairment 19.4%(24) Headache with ringing ears 29%(36) Ringing ears, Hearing impairment and headaches (19.4%)(24) Concentration deficiency 6.5%(8), Loss of sleep and ringing ears 9.7%(12) and a combination of Hearing, concentration, ringing ears 16.1%(20)

4.2.9 Hearing ability

Table 4.11: Communication and hearing abilities of the artisans

Hearing ability	Frequency	Percent	Valid %	Cumulative %
Spoken communication in low tones	24	19.4	19.4	19.4
spoken communication one on one	64	51.6	51.6	71.0
only hears when one shouts	28	22.6	22.6	93.5
Affected with background noise	8	6.5	6.5	100.0
Total	124	100.0	100.0	

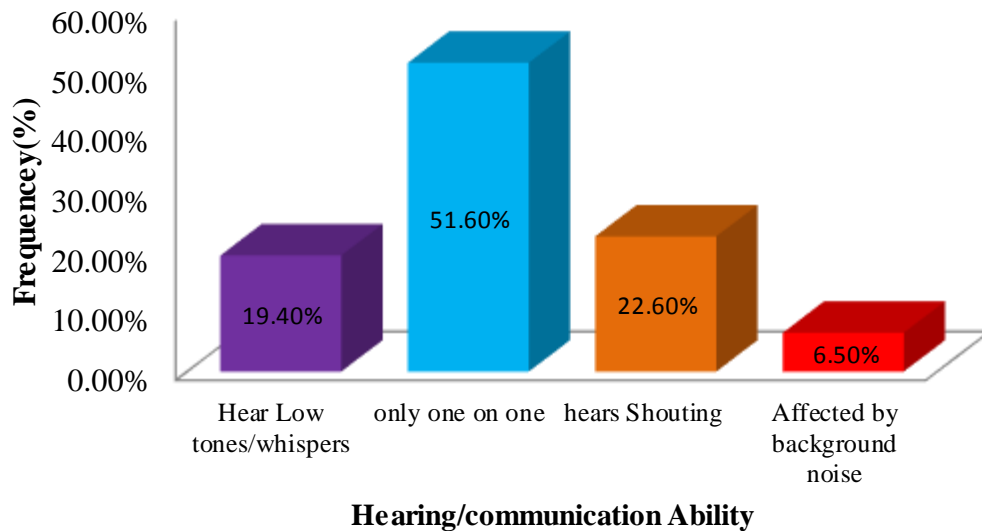


Figure 4.10: Hearing and communication abilities of the artisans

As illustrated in figure 4.11 and table 4.12, Majority of the respondents' communication and hearing ability deficiencies, was due to exposure to high levels of noise. 19.4%(24) of the respondents were able to here communications in low tone and whispers, 51.6%(64) were able to hear communication one on one, 22.6%(28) were able to here when one shouted or raised voice, and 6.5%(8) were unable to here whenever there background noise . This shows that the level of noise at the workplace greatly affected communication between the artisans and hearing ability

4.2.10 Hearing Evaluation

4.2.10.1 Otoscopy

Table 4.12: Otoscopic examination

Observation	Frequency	Percent	Valid %	Cumulative %
Normal	88	71.0	71.0	71.0
Foreign body	12	9.7	9.7	80.6
Wax impaction	16	12.9	12.9	93.5
Narrowed auditory canal	8	6.5	6.5	100.0
Total	124	100.0	100.0	

Before pure tone audiometric tests, all respondents underwent otoscopic examination for any anatomical and physical defects that affect hearing process. as indicated in table 4.13 those with physically Normal ears were 71 %(88), foreign bodies 9.7 %(12), wax impaction 12.9 %(16), Narrowing of auditory canal 6.5 %(8).

4.2.10.2. Audiometric examination

Table 4.13: Categorized hearing thresholds of respondents

Level of impairment	Frequency	Percent
Normal sound below (25 dB)	50	40.3
Slight (26-40 dB)	39	31.5
Moderate (41-60 dB)	23	18.5
Severe (61-80 dB)	7	5.7
Profound (Over 81 dB) loss	5	4
Total	124	100.0

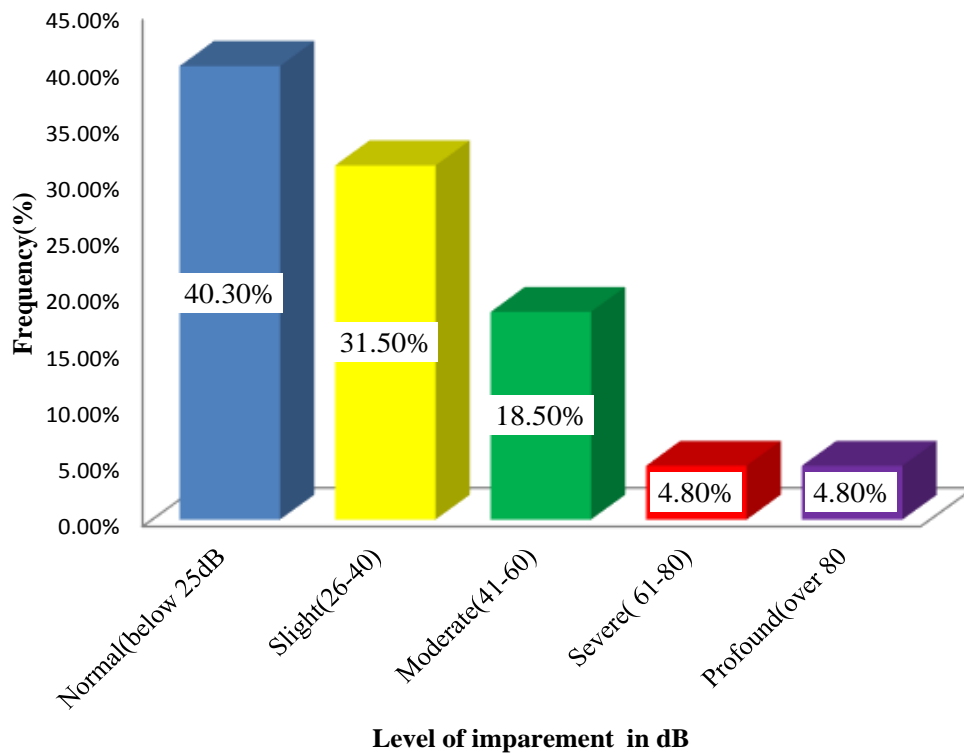


Figure 4. 11: Categorized levels of hearing impairments of the artisans

As shown in table 4.14 and figure 4.11, A total of 124 audiograms were studied out of which, 40.3%(50) were able to pick sounds below 25 dB, 31.5 % (39) of the respondents had slight impairment where the threshold was 26-40 dB. Moderate impairment of 41-60 dB 18.5 % (23), severe impairment (61-80 dB) was 4.8 % (6) and profound impairment (over 81 dB) 4.8%. When compared with noise exposure level and overall duration of exposure, there was chi square significance level of 0.641 and 0.131 respectively at p values less than 0.05.

Table 4.14: Relationship between activities and hearing loss

	Normal >25dB	Slight 26-40 dB	Moderate 41-60 dB	Severe 61-80dB	Profound over 81dB loss	
Paneling, grinding, drilling, welding	17 35.4%	17 35.4%	11 22.9%	2 4.2%	1 2.1%	48 100.0 %
Paneling, Grinding, spray painting,	8 33.3%	9 37.5%	2 8.3%	2 8.3%	3 12.5%	24 100.0 %
Paneling, Grinding, spray painting, Sandblasting	8 40.0%	4 20.0%	6 30.0%	0 0.0%	2 10.0%	20 100.0 %
Auto services, Sandblasting	17 53.1%	9 28.1%	4 12.5%	2 6.3%	0 0.0%	32 100.0 %
Total	50 40.3%	39 31.5%	23 18.5%	6 4.8%	6 4.8%	124 100.0 %

Among Artisan undertaking paneling, grinding, drilling (48) 35 % (17) normal hearing, 35% (17) had slight impairment, 11(22.9%) moderate, 2(4.2%) severe and 1(2.1%) had profound hearing loss Table 17. Those involved in spray painting paneling and grinding (20), 8(40%) had normal hearing, 4(20%) had mild, 6(30%) moderate, none had severe while 2(10%) had profound loss. Those involved in automobile service (mechanics) and sandblasting (32), 17(53.1%) had normal hearing, 9(28.1%) had slight impairment, 4(12.5%) had moderate impaireemnt, 2(6.3%) and non had profound impairment. This

shows that most of the activities generated noise that was hazardous and hearing loss was distributed across different strata of the artisans (table 4.15).

4.2.11 Observation findings

Table 4.15: Observations on occupational safety and health practices

Observation	N	Yes (%)	No (%)
Donning earmuffs/earplugs	124	2.4	97.6
Working in an open-air/ Makeshift station	124	84.7	15.3
Engaged in noise generating activities	124	83.8	16.2
Isolation of noise producing activities	53	0	100
Good housekeeping of the workstation	53	0	100
Evidence of OSH inspection documentation	53	0	100
Display of safety signs	53	0	100
Display of safety policy	53	0	100
MSDS on machines and equipments	85	16.4	83.6
Records of machines and equipment maintenance	85	0	100

During the administration of questionnaires; observations was made based on basic occupational health and safety practices. The findings (Table 4.15) were as follows: 97.6% of *Juakali* workers exposed to high levels of noise had no ear personal protective equipments. Only 15.3% of the workers operated from permanent structures with well-defined shades. 83.8% were actively engaged in noise generating activities whereas none

of these activities was carried out in isolation. In all the sampled workstations, there was poor housekeeping and no evidence of OSH policy, safety signs, nor evidence of machines and equipment maintenance records displayed. There was no OSH inspection documentation displayed while only 16.4% of the machines and equipments had MSDS (Material Safety Data Sheet) displayed on them.

4.3 Discussion

Despite noise being a major occupational hazard among those working in *Juakali* sector, practices show there is low level of awareness. Mean age was 36 ± 2.81 with standard deviation of 0.889. Considering that majority of the workers in *Juakali* sector start at an early age, the average age of the artisans has a direct link to exposure duration average of 16 ± 2.76 years with STD of 0.996. This average duration of exposure is a long period that greatly contributes to NIHL. This is similarly found by the study done by Musiba, z. (2015) among Tanzanian miners at Msasani peninsula where 47% had noise induced hearing loss and majority had more than 10 years of exposure. as well as Faluwasayo *et al.*,(2005) among steel rolling mills workers in Nigeria where exposure period of more than 10 years to noise above 90 dB increases one's risk to NIHL. Most of the *Juakali* artisans had not undergone tertiary level of training and relied heavily on job training. This contributed to low level of awareness and lacked information on the risks associated with certain activities they are involved. This makes them vulnerable to exposure to hazards like noise, as observed by Theuri (2012) who indicated that most of

the informal sector workers (78 %) lack basic education and therefore equally are deficient in knowledge of hazard management.

During the assessment of, key sources and level of noise, as indicated in table 4.8,4.9, and figure 4.8, 4.9. Activities carried out by the artisans generated noise levels way above the NEMA 2015 and OSHA 2007 allowable limit of 90 dB maximum of 8 hours daily. This is in agreement with Gerges *et al.*, (2006), where they found out that informal sector activities such as welding, drilling, operation of pneumatic equipments, generate noise above 85 dB. Artisans had exposure to noises above 90 dB for more than 8 hours daily. 55.6% of the respondents had exposure to noise above 101 dB generated by their daily activities, which is 10 dB above the allowable limit. There was statistically significant association between exposure level and auditory effects with ($X^2= 9.51$ $P<0.05$), Hearing impairment chi square value ($X^2 =6.41$ $P< 0.05$) . Majority of whom had worked for more than ten years at exposure level above 90 dB (56.4%); and had developed hearing impairment (Ranging from mild to severe). 59.6% had hearing threshold shift, (ranging from mild to severe as shown in table 16). This was also found in the study by NIOSH (2008) where NIHL is gradual and more common among those who were exposed to noise for over 10 years. Similarly, Chandambuka *et al.*, (2013) also found that exposure to noise levels above 90dB for duration more than 10 years contributed greatly to high prevalence of NIHL among the mineworkers of Zambia.

During the study there was significant association between noise exposure level and duration with hearing impairment, ($X^2=6.41$, $P< 0.05$) level and positive correlation

coefficient of 0.248 on hearing ability and 0.279 on hearing impairment, at 0.05 significance level. This shows that the artisan had a prolonged exposure to noise levels above 90dB, and this contributed to them developing NIHL with other auditory health problems. Therefore, the null hypothesis rejected. This was also in the study done by Fernandez (2008) which showed that prolonged exposure to noise causes progressive wear and tear of the delicate inner ear attendant NHIL

80.7% of the respondents reported to suffer from other auditory effects (ringing ears, headache, concentration, loss of sleep) which depend on prolonged exposure and the level of noise generated There was strong association between level of exposure, duration of exposure and auditory ($X^2=6.63$ $P<0.05$). The daily hours spent at workplace had strong association with these effects especially headache ringing ears concentration, ($X^2=8.25$ $P< 0.05$). Similarly, in Msasani peninsula Daresalam, Musiba (2012) found that there was high prevalence of NIHL among those with exposure period of more than 10 years compared to those less than ten years.

Occupational health and safety practices were absent and the awareness of some of control measures available. Use of ear protectors was not in practice except 6.5% who used them on rare occasions.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The main objective of this study was to identify the health effects of noise exposure among the *Juakali* artisans of king'orani area Mombasa County. It sought specifically to identify sources and level of Noise, hearing thresholds of the *Juakali* artisans, assess auditory effects, and prevalence of noise induced hearing loss. The research therefore established that: Most of the artisans' activities including Panel beating, drilling, grinding, sandblasting, and spray painting generated noise above 90dB, which is overtly hazardous. Noise exposure led to headaches, ringing ears, poor concentration, and sleep disturbances auditory health effects among *Juakali* artisans. The prevalence of Noise induced hearing loss was 59.6% with majority having mild to moderate impairment at 62% among those affected.

5.2 Recommendation

1. The informal sector workers (*Juakali*) are exposed to numerous hazards. Noise is among the commonest hazards with debilitating irreversible effects. Therefore, serious prompt interventions need to be established and they include regular training and awareness programs on the effects of exposure to noise and prevention mechanisms. Introduction of Government sponsored personal protective equipments provision at an affordable cost. Enforcement of OSHA

2007 act to exhaustively regulate and protect those working in the informal sector considering that over 75% of workers are in the informal sector. Provision of regular, hearing screening services to the informal sector workers to ensure early detection and prevention of serious auditory health effects caused by noise exposure. Development of an infrastructural master plan that includes sound absorbers for example wall netted with egg-tray like structures to ensure steady development of healthy, safe working environment for all workers. Finally, further research to be done to establish number of hours that one is able to work in noisy environment with reduced chances of developing hearing impairment.

REFERENCES

- Alberti, P.W., Sharon, M.A., Kunov, H., Pichora, F.** (2009). Signal Detection in Industrial Noise Exposure History, Hearing Loss, and the Use of Ear Protection. *Scandinavian Audiology Journal*
Doi:10.3190/01050398509045937 Page 161-173
- Alfers, L.** (2010). Occupational Health and Safety for Informal Workers in Ghana. *A case study of market and street traders in Accra. School of developmental studies*, University of Kwazulu Natal. Durban.
- Anatomy and Physiology of the ear.** Accessed online media.johnwiley.com.au/product data/excerpt/70/.../1861565070.pdf Accessed 7/7/2015
- Ashraph, J.J., Kinyua, R., Mugambi, F., & Kalebi, A.**(2012)Health Effects of Lead Exposures Among *Juakali* (informal sector) Workers in Mombasa Kenya. A Case of the Express jua Kali Workers. *International journal of Medicine and Medical science*. 5(1).
- Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., & Stansfeld, S.** (2014). Auditory and non-auditory effects of noise on health. *Lancet*, 383(9925), 1325–1332. [http://doi.org/10.1016/S0140-6736\(13\)61613-X](http://doi.org/10.1016/S0140-6736(13)61613-X)
- Buhlebenkosi, F., Sibanda, N., Chaurura, P., & Chiwira, O.**(2013). Occupational Safety in the Urban Informal Sector of Gaborone, Botswana:A Scientific Situational Analysis. *international Journal of Scientific and Technology Research* 2(12), 2277-8616
- Butt, M.I.** (2012) Anatomy and Physiology of The ear. Retrieved from: www.slideshare.net/ahsanshafi90/anatomy-and-physiology-of-the-ear.

- Cantley, L.F, Galusha, D., Cullen, M.R., Dixon-Ernst, C., Robinwitz, P.M. & Neitzel, R.L.** (2015). Association between Ambient Noise Exposure, Hearing Acuity and Risk of Occupational Injury. *Scand J Work Environ Health*, 4(1), 75-83.
- Chandambuka, A., Mususa. F., Muteti, S.** (2013) Prevalence of Noise Induced Hearing loss Among the Employees at Mining Industry in Zimbabwe. *African Health Sciences Journal*. 13(4), PMC 4056470.
- Concha-Barrientos, M., Campbell-Lendruin, D., Steenland. K.** (2004) Occupational Noise: Assessing the Burden of Disease from Work Related Hearing Impairment at National and Local levels. *WHO Environmental Burden of Disease series 9*. Geneva: World Health Organization.
- Extra-auditory effects of Noise Hazards** (2014). Canadian Centre for Occupational Health and Safety. Retrieved from: www.ccohs.ca/osh/answers/
- Fausti, S.A., Wilmington, D.J., Helt, V.P., & Konrad-Martin, D.**(2005). Hearing health and care:The need for improved hearing loss prevention and hearing conservation practices. *Journal of rehabilitation research and development*. 42(4), 45-62.
- Foluwasayo, E.O., Tanimola, M.A., & Olajida, T.G.** (2005). Noise Exposure, Awareness, Attitudes and Use of Hearing Protection In Steel Rolling Mill In Nigeria. *Journal of Occupational Medicine*, 55, 485-487.
- Gerges, N.Y.S., Sehrndt, G.A., & Parthey, W.** (2006). Noise Sources. *W.H.O Occupational Health Publications*. Retrieved from [www.who.int/occupational health/publications/noise5_pdf](http://www.who.int/occupational_health/publications/noise5_pdf)

- Goelzer, B., Hansen, C.H., & Sehrdt, G.A.** (2015). Occupational Exposure to Noise , Evaluation, Prevention and Control. Retrieved from: www.who.int/occupational.../occupnoise/en/
- Gyekye, S.** (2010) Occupational Safety Management: The role of Causal attribution. *International journal centre for biotechnology information*, 1(4566), 405-16.
- Ian, p.** (2016). The basic of short noise. Retrieved from Electronics .com
- Irwin, J.** (2006). *Basic Anatomy and Physiology of the Ear*. England: John Wiley and Sons ltd.
- Jenkins, R. (2014). *All the noise in resistors*. Hartman: Technica.
- Karanja, I.W., Muchiri, F.K., & Muruka, N.** (2003). Health and Safety in the Informal Economy. *African Newsletter on Occupational Health and Safety*. 13(1).
- Laura, A.** (2012).Empowering Informal Workers, Securing Livelihood. Women in Informal Employment: *Globalizing and Organizing*, 3.
- Lund, F., & Marriot, A.** (2011). Occupational Health and Safety and the poorest. Women in informal employment Globalizing and organizing Working Paper(Social protection) number 2.
- Mariola, S. K., Dudarewicz, A., Topilla, E., Malgorzata, P.L.**(2012). The Influence of Selected Risk Factors on the Hearing Threshold Levels of Noise Exposed Employees. *Archives Acoustics*, 35(3), 371-382.doi:10.2478/v10168010-0031-03.

- Marriot, A.** (2010). *Extending Health and safety protection to informal worker. An analysis of small scale mining in Kwazulu Natal.* Kwazulu Natal: Macmillan.
- Mugenda, O. & Mugenda, A.** (2003). *Research Methods: Quantitative and qualitative Approaches.* Nairobi: Acts Press.
- Mugenda, A.** (2008). *“Social science Research: Theory and Principles”*, Applied Research and Training services, Nairobi: Acts Press.
- Musiba, Z.** (2015). The prevalence of Noise induced Hearing loss among the Tanzanian miners. *Journal of occupational medicine* 65, 365-390
Doi:10.1093/occmed/kqv046.
- Nelson, D., Nelson, R., Concha-Bariento, M. & Fingerhnt, M.** (2005). The Global Burden of Occupational Noise Induced Hearing Loss. *American Journal of Industrial Medicine.* Washington DC: Wiley.
- Occupational Noise exposure** (2013). Occupational Safety and Health administration
Retrieved from :[www.Osha.gov/SLTC/noise hearing conservation](http://www.Osha.gov/SLTC/noise%20hearing%20conservation)
- Okungu, O., Mayoga, W.R., & Bayeyo, D.W.** (2013). Awareness of Occupational Hazards and use of Safety Measures among the Small Scale Industrial Welders in Jinja Municipality Uganda. *African Newsletter on Occupational Health and Safety.* 22(2).
- Pettinger, C.B.** (2011). Improving Occupational Safety and Health Interventions-A comparison of Safety Self- Efficacy and Safety Stages of Change. *Centre for Applied Behavior System.* Virginia: Virginia Polytechnic Institute and State University.

- Richards, P.L.** (1994). Bolometer for infrared and milimeter waves. *Journal for applied physics*, 76, doi:10.1063/1357
- Pouliakas, k., & Loannis, T.** (2010). An Inquiry into the Theory, Causes and Consequences of Monitoring Indicators of Health and Safety at Work. *Discussion Paper Series No. 4734. Institute For the Study of Labor.* University of Aberdeen Business School.
- Rabat, A.** (2008). Extra-auditory Effects of Noise in Laboratory Animals Focusing on the Relationship between Noise and Sleep. *Research Department Institute of Naval Medicine for the French Health Services of Armed Forces, Saint Anne, France: Army Teaching Hospital.*
- Rongo, L. M., Barten, F., Msamanga, G.I., Heederik, D., & Dolmans, W.M.** (2004). Occupational Exposure and Health Problems in Small Scale Industry Workers in Dareesalam Tanzania: A Situation Analysis. *Journal of Occupational Medicine*, 54, 2-46 N Do1:10:1093/Occmed/kq hoo1
- Sliwinska-Kowaiska, M., & Adrian, D.** (2012). Noise Induced Hearing Loss. *Department of audiology and phoniatics.* Poland: Nofer Institute of Occupational Medicine.
- Spee, T.** (2006).Occupational Hygiene in Africa. *British Occupation hygiene Society*, 5 431-435. Englant: Oxford University Press.
- Stanfeld, S.A., & Matheson, M.P.** (2003). Noise Pollution: Non-Auditory Effects on Health. *British Medical Bulletin*, 68, 243-257 Doi:10.1093/bmb/ldg033.
- Szalma, J.L, & Hancock, PA.(2011).** Noise effects on human performance: a meta-analytic synthesis. *Psychol Bull.* 137(4), 682–707. <http://dx.doi.org/10.1037/a0023987>.

Tansley, J. & Ryner, S. (2009). Cultural Theory and Risks. *Handbook of Risk and Crisis Communication*. United Kingdom: Tylor Francis Publishers.

Theuri, C.K. (2012). Small Scale Enterprises and the Informal Sector in Kenya. *African Newsletter on occupational health and safety*. 22(2).

Timmins, p. & Granger, O. (2010) Occupational Noise Induced Hearing Loss In Australia: Overcoming Barrier To Effective Noise Control And Hearing Loss Prevention. *Safe Work Australia*, 539.

www.oedkenya.org/the-rba-oed-kenya-Juakali-hearing-conservation.html/

APPENDICES

Appendix 1: Questionnaire

Questionnaire for determination of the health effects of exposure to noise among the " Juakali" Artisans in King'orani area of Mombasa County.

Section A: Social Demographics

Please indicate your answer with a tick (√).

1. Gender.....

a. Male []

b. Female []

2. What is your highest education level?

a. No formal education []

b. Primary []

c. Secondary []

d. Tertiary, specify

3. What is your age?

a. 10-20 Years []

b. 21-30 Years []

c. 31-40 Years []

d. 41-50 Years []

e. Above 50 Years []

4. Marital status

- a. Married []
- b. Separated []
- c. Divorced []
- d. Single []

5. Residence.....

Section B: Nature of work and sources of noise

6. Indicate your working area

- a. Open air work stations []
- b. Overhead shades []
- c. Workshops []
- d. Food shades []
- e. Auto-spare shops []

7. What are your daily areas of operations/activities?

- a. Panel beating []
- b. Grinding []
- c. Drilling []
- d. Welding []
- e. Spray Painting []
- f. Sandblasting []

g. Engine and auto-services []

h. Any other (specify.....)

8. How long have you been involved in the activities/operations mentioned in question 7 above?

a. <1 Year []

b. 1-5 Years []

c. 5-10 Years []

d. 10-15 Years []

e. 15-20 Years []

f. 20-25 Years []

g. 25-30 Years []

h. »30 Years []

9. How many hours do you work on a daily basis?

a. < 1 Hour []

b. 1-4 Hours []

c. 5-8 Hours []

d. >8 Hours []

10. Does the operations/activities mentioned in question 7 above produce any sound?

a. Yes []

b. No []

11. If yes, describe the nature of sound

- a. Normal []
- b. Loud []
- c. Very loud []
- d. Irritating []
- e. Deafening []
- f. Painful []

g. Other,

Specify.....
.....

12. Have you ever worked in areas associated with loud noise before?

- a. Yes []
- b. No []

13. If yes, in Q12 above Specify and for how

long.....

14. Do you wear ear protection equipment when operating the equipments or working?

- a. Always []
- b. sometimes []
- c. Rarely []
- d. never []

Section C: Health effects (NIHL and extra auditor effects) in relation to noise

14. Has noise affected you or your performance in anyway?

a. Yes []

b. No []

15. If yes which way?

a. Hearing []

b. Ringing ears []

c. Headache []

d. Concentration []

e. loss of sleep []

f. Irritation []

16. If you suffer from hearing problems, are you able to hear:

a. Spoken communication in low tones []

b. Spoken communication one on one []

c. only hear when one shouts []

d. Cannot hear whenever there is background noise []

e. Can only hear when one shouts to the ear or very loud sound []

17. Have you ever been treated of, or suffered from any ear infection?

a. Yes []

b. No []

18. If yes did you

a. Recover fully

b. Develop complications

(specify).....

.....

.....

19. Have you ever been involved in accident or trauma to the head that affected the ear or hearing process?

a. Yes.

(Specify).....

.....

b. No

20. Did you recover fully or develop complications?

a. Yes

b. No.

(Specify).....

.....

21. Have you ever been assessed on you hearing ability?

Yes.

No

22. If yes, state the frequency and reason(s).....

23. Briefly describe the assessments carried out in Qn21 above and the outcomes:

.....

Appendix 2: Consent form

Study Title:

Health effects of hazardous noise exposure among the '*Juakali*' workers : a case study of King'orani "jua kali" artisans in Mvita sub-county

Principal Investigator:

Sawanga Jared Milikau

P.O. Box 41197 G.P.O 80100 Mombasa, Kenya.

Telephone: +254 722622578

E-mail addresses jsawanga@gmail.com

Aim and Objectives of the Study

The purpose of this research is to;

1. To identify, sources and levels of noise hazards among the "*Jua Kali*" artisans in King'orani area.
2. To evaluate the hearing thresholds levels of the "*Juakali*" artisans in King'orani area.
3. To assess auditory health effects of noise hazards among the *Jua Kali* artisans
4. To determine the prevalence of noise induced hearing loss among the "*Jua Kali*" artisans in King'orani area.

Procedure

1. About 132 participants will take part in this research.
2. You will be required to respond to questions contained in a structured questionnaire. The questions may take about 5 minutes. Please provide correct information to assist us in drawing meaningful conclusions.
3. You will undergo a hearing test to determine your hearing ability.
4. The finding will be recorded
5. To determine your hearing ability, the findings will be analyzed using your number/code and not your name.
6. The research findings will be shared with the relevant authorities to assist in policy making about health risks of exposure to noise and necessary control measures.

Risk/Benefit

1. There would be no risk directly attributed to this research.
2. It is anticipated that you will not endure any or no substantial physical and psychological discomfort.
3. Your hearing ability will be evaluated
4. If your hearing ability is affected, then you will be referred to a health institution for management.
5. After the research process, there will be health education on health effects of noise exposure and prevention.

Assurance of confidentiality

Strict confidentiality relating to your information will be observed. The information

Right to Refuse or Withdraw

Participation in this study is voluntary because you have been informed of the intentions of the research and your hearing ability measured to determine if noise exposure has affected you in any way.

Statement of Consent

I have read the information in this consent form including risks and possible benefits. All my questions about the research have been answered to my satisfaction. I understand that I am free to withdraw at any time without penalty or loss of benefits to which I am otherwise entitled.

I consent to participate in the study.

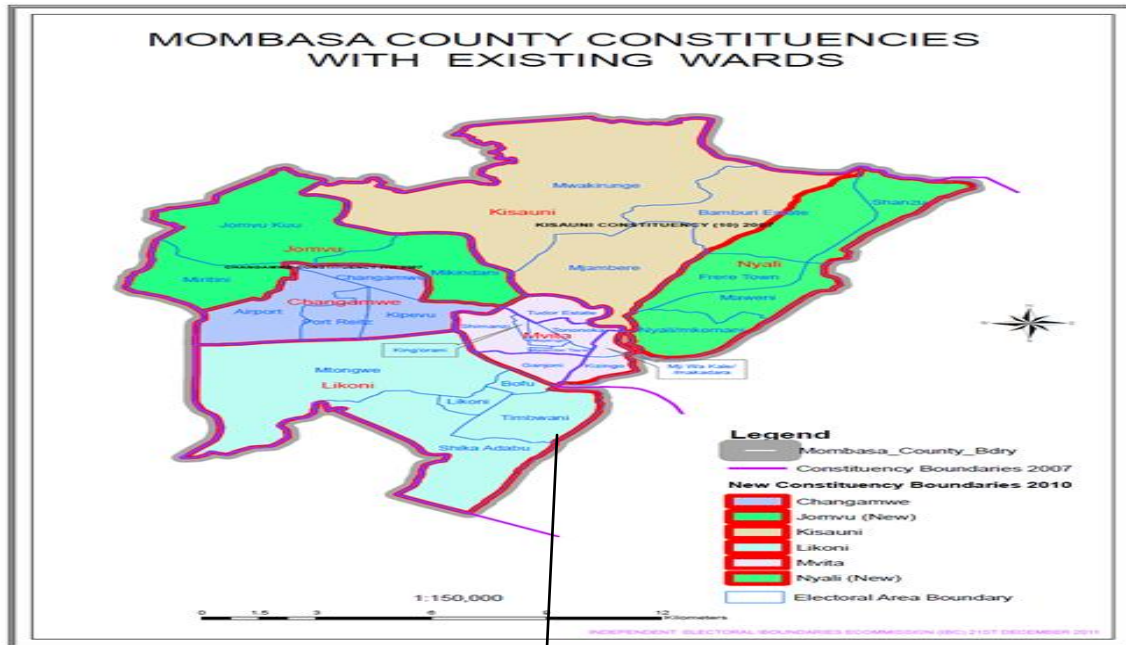
SIGNATURE

Your signature below indicates your permission to take part in this research

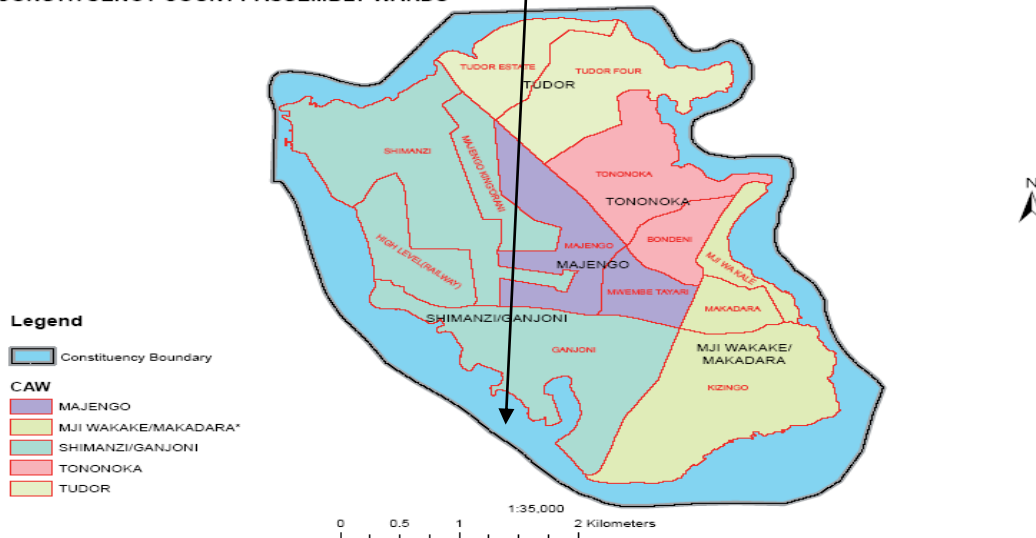
Code of participant

Name of person obtaining consent

Appendix 3: location of study



IEBC REVISED MVITA CONSTITUENCY COUNTY ASSEMBLY WARDS



showing map of Mombasa county showing king'orani area of study. Source: Google maps

Appendix 4 ethical review certificate

