FISHERFOLK EXPOSURE TO HUMAN HEALTH RISKS THROUGH FISH HANDLING AND PROCESSING AT KAMPI SAMAKI, LAKE BARINGO, KENYA

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A Thesis Submitted to the Graduate School in Partial Fulfillment of the Requirements for the Master of Science Degree in Environmental and Occupational Health of Egerton University

EGERTON UNIVERSITY

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DECLARATION AND RECOMMENDATION

Declaration

This is my original work and has not been presented in this or any other university for the award of a degree.

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Recommendation

This thesis has been submitted with our approval as University supervisors.

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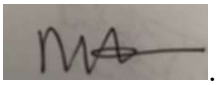
Signature……  ……Date…12/01/2021……

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DEDICATION

To my beloved parents (Mr. Simon Ngaruiya and Mrs. Esther Ngaruiya) and siblings (Kevin, Titus, Francis, and Jane).

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ABSTRACT

Globally, almost 2.78 million deaths that occur are attributed to work related hazards. Fishing is an ancient occupation and like many others it is characterized by numerous hazards and risks. The study aimed at assessing the exposure of fisherfolk to human health risks, through fish handling and processing in Lake Baringo, Kenya. A cross-sectional social survey design was used in the study. Systematic random sampling was employed in selection of 100 fisherfolk at Kampi Samaki. A semi-structured questionnaire was used to collect data on fish handling and processing methods, human health risks and hazards associated with fish handling and processing and water sanitation and hygiene (WASH). Interviews and observation checklist were also used to collect more information on fish handling and processing and WASH attributes. Data was managed by SPSS 20 software. Both descriptive and inferential statistics were used. Inferential statistics included Pearson Chi square (χ^2) Test and multinomial logistic regression (MLR). The level of significance was tested at alpha= 0.05. The study was done due to the prevalent Water related diseases (WRDs) and other potential health risks among fisherfolk in Kampi Samaki. The MLR was conducted to assess the relationship between WASH attributes (water sources, drinking water treatment, presence of sanitation facilities) and the dependent variable, waterborne diseases. The study findings reveal that the fisherfolk encountered risks such as cuts, eye irritability, sunburns, skin burn, and musculoskeletal injuries. The results showed that only 12% of the fisherfolk use personal protective equipment (PPE) at work. Pearson χ^2 Test analysis showed there was an association between gender and gender roles (χ^2=39.517, $p<0.05$). Additionally, an association was revealed between occupational health risks and gender (χ^2 =16.283, $p<0.05$). However, there was no association revealed between occupational health risk and marital status (χ^2 =1.305, $p>0.05$). Further, results indicate that 61% of the fisherfolk who suffered from occupational health risks, missed work. It can be concluded that all the fisherfolk at Kampi Samaki are exposed to various health risks while working, thus likely to negatively affect their health. From the study results, it can be recommended that there should be public health campaigns to sensitize fisherfolk on the associated risks in fish handling and processing. Fisherfolk should also adequately treat drinking water, store, maintain proper hygiene practices aimed at making water safer and thus improving human health not only among the fisherfolk but all the residents of Kampi Samaki.

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LIST OF ABBREVIATIONS AND ACRONYMS

ARI	Acute Respiratory Infections
ASALs	Arid and Semi-arid Lands
CDC	Center for Disease Control
CIDP	County Integrated Development Plan
FGDs	Focused Group Discussions
GBD	Global Burden of Disease
GOK	Government of Kenya
JMP	Joint Monitoring Programme
KAP	Knowledge Attitude and Practice
KMFRI	Kenya Marine and Fisheries Research Institute
MLR	Multinomial Logistic Regression
NACOSTI	National Commission for Science Technology and Innovation
OAA	Occupational Asthma and Allergy
OSH	Occupational Safety and Health
PAHs	Polycyclic Aromatic Hydrocarbons
PPE	Personal Protective Equipment
SDGs	Sustainable Development Goal(s)
SID	Society for International Development
SPSS	Statistical Packages for Social Sciences
UNICEF	United Nations Children's Fund
WASH	Water Sanitation and Hygiene
WBDs	Waterborne Diseases
WHO	World Health Organization
WMSDs	Work-Related Musculoskeletal Disorders
WRDs	Water Related Diseases

CHAPTER ONE
INTRODUCTION

1.1. Background Information

Globally, approximately 2.78 million deaths are attributed to work related hazards (Global Burden of Disease [GBD], 2015). Twenty (20%) to 50 % of workers worldwide, especially in developing countries suffer from occupational hazards and experience great losses (World Health Organization [WHO], 2016a). Fishing is an old and considered to be one of the most dangerous occupations in the world (Frantzeskou et al., 2012; Rodrigues & Kiran 2013; Udolisa et al., 2013).

Fisheries can either be inland or marine. Marine fisheries involve seas and oceans while inland involves freshwater such as lakes and rivers. Additionally, fisheries may involve aquaculture or wild fish capture from marine or freshwater. Ten (10%) percent of the world's fisheries come from inland waters as opposed to oceans and seas (Omotayo et al., 2006).

Fish is delicate food therefore, requires careful handling and processing (Nguka, et al., 2017). They are harvested using various methods which include harpooning, dredge, gillnetting, and bottom trawl, mid water trawl, purse seining, open net cages, hand lines, long lining, trolling and traps. They are then placed in the fishing vessels where they are gutted and may be chilled in ice before landing. Different fish processing methods; smoking, frying, chilling, freezing fermenting and drying then follow after landing (Adeyeye, 2016; Arvanitoyannis & Kotsanopoulos, 2012; Nzioka 1986; Omotayo et al., 2006).

Small scale inland fisheries have helped in achievement of the post 2015 United Nations Sustainable Development Goals 1, 2 and 3; poverty alleviation, end hunger and ensuring healthy lives respectively. The demand for fish is on the increase due to its high protein, vitamins and minerals content which are important for human health (Mozaffarian & Rimm, 2006; Tacon & Metian, 2013). Fish consumption has many health benefits including; improve oxygen transport in the body, increase energy, reduce risk of blood pressure, arthritis and enhance development of child brain (Food Agricultural Organization [FAO], 2012). According to Food Agriculture Organization, fisheries provide employment to approximately 2 million people in Kenya. With employment creation, more people earn a living thus helping to reduce poverty and also end hunger as the fisherfolk will be able to buy food which is a basic need (FAO, 2016b).

Despite the many benefits derived from inland fisheries, numerous health and safety issues ranging from physical, chemical, ergonomic to biological depending on the fish handling and processing methods used by the fisherfolk exist (Yagoub, 2009; Zakia et al., 2012). Between 1996- 2015 the injury rate in fisherfolk has been recorded in Finland with 40% occurring abroad, 11% occurring in the lake and 37% occurred ashore (Kaustell et al., 2016). In America fisheries is among the industries that contributed to the rise of injuries by 284 in 2015 along with farming and forestry which has been the highest recorded rise in 7 years (Bureau of Labor Statistics [BLS], 2015).

Fisherfolk experience physical hazards in the course of their work as cuts, pricks from fish, noise, sprains, burns (Olaoye et al., 2015). In Nigerian artisanal fisherfolk have indicated to suffer from pricks of fish spines by cat fish and sting rays (Udolisa et al., 2013). Chemical hazards include smoke during the smoking process. Smoke results into respiratory problems such as asthma and eye problems. In Ghana, 1126 out of 1340 fisherfolk reported to suffer from eye problems; ocular irritability, pain and blurry vision (Kyei et al., 2016). In a Andalusia community in Spain 247 fisherfolk (87%), reported to experience health problems namely; respiratory problems, eye problems, skin problems and musculoskeletal injuries as a result of lifting, pulling and transporting heavy fish loads (Novalbos et al., 2008). Musculoskeletal injuries have been reported by fisherfolk in France (Chauvin & Le, 2007).

Additionally, adequate water, sanitation and hygiene go hand in hand in ensuring healthy workers especially in fish handling and processing. However there is inadequate potable water and sanitation in Sub-Saharan Africa especially in the Arid and Semi-Arid Lands (ASALS). These pose a challenge in the achievement of SDG 3 and 6 (WHO, 2016b). Fisherfolk are exposed to waterborne diseases example cholera, diarrhea, typhoid due to frequent contact with contaminated water (Zakia et al., 2012). Fish from poor quality water are contaminated resulting to waterborne diseases (WHO, 2006). In France and New York fish have been reported to be contaminated with *Vibrio cholerae* as a result of poor quality water (Farmer et al., 2005; Hervio-Heath et al., 2002). Moreover, in Chennai, India fish were reported to harbor fecal pathogens; *Escherichia coli*, *Salmonella typhi* and *Vibrio cholera* due to contaminated water. Therefore, fish can be a potential source of pathogens for human beings (Novotny et al., 2004).

A healthy and safe environment promotes productivity as it reduces time lost in work in case of injury (International Labor Organization [ILO], 2010). Despite the numerous documentation on occupational health risks in fisheries industries there is limited awareness on the occupational hazards in the fishing sector especially in the developing nations and more specifically for inland fisheries. It is against this background that a study to assess the fisherfolk exposure to human related health hazards through fish handling and processing in Kampi Samaki, Lake Baringo, Kenya was conceived.

1.2. Statement of the Problem

The high nutritional value of fish has increased their demand for health promotion in Kenya. Fish is a high source of protein, rich in vitamins and minerals which are essential for human health. However, the fisherfolk may be exposed to potential health risks during harvesting, processing and selling of the product. There is limited information on risks to the fisherfolk in the Kenya's fishing sector, which may impact negatively on their health. Further, there have been concerns over inadequate water sanitation and hygiene (WASH) that exposes the fisherfolk and consumers to pathogens resulting to waterborne diseases (WBDs). There have been reports of diarrhea at Kampi Samaki and thus the need to assess the relationship between the WASH attributes in the study area and WBDs in this area. In this study I assessed the fisherfolk' exposure to human health risks through fish handling and processing at Kampi Samaki, Lake Baringo, Kenya. Adequate water, sanitation and hygiene (WASH) attributes are essential in any workplace.

1.3. Objectives

1.3.1. Broad Objective

Assessment of fisherfolk exposure to human health risks through fish handling and processing at Kampi Samaki, Lake Baringo, Kenya.

1.3.2. Specific Objectives

i. To characterize the fish handling and processing methods at Kampi Samaki.
ii. To identify the human health risks and hazards associated with fish handling and processing methods used at Kampi Samaki.
iii. To assess the water, sanitation and hygiene attributes at Kampi Samaki.
iv. To analyze the relationship between the waterborne diseases and the water, sanitation and hygiene attributes at Kampi Samaki.

1.4. Research Questions

i. Which are the fish handling and processing methods used in Kampi Samaki?

ii. Are there human health risks and hazards associated with fish handling and processing methods used at Kampi Samaki?

iii. Which are the WASH attributes at Kampi Samaki?

iv. Are there any relationships between the WASH attributes at Kampi Samaki and waterborne diseases?

1.5. Justification of Study

Promotion of human health is essential for the survival of human beings. However presence of hazards in workplaces poses a threat to human health and thus is of great concern. The study was in line with achievement of sustainable development goal (SDG) 3: on ensuring good health and wellbeing and SDG 6: on ensuring availability and sustainable management of water and sanitation for all. It would also make a contribution in achievement of the social pillar of the Kenya's vision 2030 on health, water and sanitation that is, to develop a population that is healthy and productive and ensure that improved water and sanitation are available and accessible to all. It was also in line with Baringo County Integrated Development Plan (CIDP) of 2018- 2022 health sector that aims at achieving good health, wellbeing and Sanitation in Baringo County. It was also in line with the Occupational Safety and Health Act of 2007 (OSH), on ensuring health and welfare of workers or fisherfolk in Kenya. Safe handling and processing will help reduce potential health risks among fisherfolk which boost the national economy of Kenya. The beneficiaries of this study include fisherfolk in Kenya and in other countries, Ministry of Health, Ministry of Water and sanitation, who are to use the data to address the potential negative health hazards to fisherfolk and WASH situation at Kampi Samaki.

1.6. Scope, Assumptions and Limitations of the Study

1.6.1. Scope of the Study

The study was carried out in Kampi Samaki which is a settlement in Baringo County where harvested fish from Lake Baringo are landed. The study was carried out in July to September 2017, since the fishing season was still open therefore, fisherfolk were available for the study. A 100 fisherfolk were selected for the study. The study focused on the WASH attributes, fish handling and processing and the effects on human health associated with fish handling and processing methods in Kampi Samaki.

1.6.2. Assumptions of the Study

The study assumed that:-

- The political and security situation would be stable allowing administration of questionnaires and smooth interactions with the community.
- The prevalence of waterborne diseases in Kampi Samaki are linked by inadequate water and sanitation.

1.6.3. Limitations of the Study

Language barrier due to high illiteracy level. This was mitigated by help from local research assistants who translated and interpreted the questions to the respondent.

1.7. Definition of Terms

Access to clean water- refers to a distance of not more than 200metres from home to a public stand post, 20 liters of clean water per person per day.

Characterize- to describe how fish handling and processing methods is undertaken in the study area.

Clean water- refers to water that is safe to drink and use for food preparation.

Fish capture- refers to all kind fish harvesting methods.

Fish Handling and Processing-it involves the entire activities involved from when fish is harvested to when it is sold including landing, inclusive of the vessels and equipment used to hold and store the fish and also handling by use of bare hands.

Fisherfolk- refers to a person who depends on fishing, fish handling and processing activities for their living.

Hazards- refer to biological, physical, chemical and ergonomic risks to human health which may cause death, injuries or disability among fisherfolk in Kampi Samaki arising from their daily fish handling and processing methods

Human health- it refers to the waterborne diseases, injuries and risks among fisherfolk in Kampi Samaki that arise from fish handling and processing methods.

Improved sanitation- include flush toilets, connection to a piped sewer system and to a septic system, flush or pour-flush to a pit latrine, pit latrine with a slab, ventilated improved pit latrine and composting toilets.

Injury- refers to the negative effects to fisherfolk' health as a result of encounter with any hazards and risks in fish handling and processing methods in Kampi Samaki

Inland fisheries- involve handling and processing of fish from fresh water bodies such as Lake Baringo.

Musculoskeletal injuries- refer to damage of muscular/skeletal systems, due to strenuous activity.

Open defecation- refers to defecating in the open fields and bushes.

Risk- it refers to possibility of loss or injuries among fisherfolk as a result of exposure to any hazard due to fish handling and processing methods undertaken in Kampi Samaki.

Shelf-life- refers to the length of time for which fish remain fit for consumption after a processing method.

Unimproved sanitation- include facilities that do not separate fecal matter from coming in contact with humans.

WASH attribute- it refer to the water, sanitation and hygiene characteristics.

Water Related Diseases refer to diseases which are transmitted by insects that breed in water that is stagnant and of poor quality such as; skin disease, malaria

Waterborne Diseases refer to the diseases caused by ingesting water contaminated by animal or human feces containing pathogenic microorganisms such diseases include: cholera, dysentery and typhoid.

Water-washed Diseases refer to diseases as a result of lack of enough water for proper personal hygiene and sanitation. For example scabies.

CHAPTER TWO
LITERATURE REVIEW

2.1. Fish Capture and Handling

Fish capture is done using different gears which include, gill nets, cast nets, hooks and line, traditional traps, hand lines, trolling, ring nets, small (mosquito) seines, beach seining, trawl netting, scuba diving, monofilament gill netting, spear gunning and vertical integration of gears. Long line is a gear that uses bait placed on hooks attached on a long line that attract fish (Fulanda et al., 2011).

Boats and small crafts made of planks and propelled by sail, with modern boats having engines and larger dhows with lateens are used (Munga et al., 2014). Gill nets are gears with strings of single, doubles or triple netting walls, vertical, near the surface, in mid water on the bottom in which fish are trapped by their gills (FAO, 2016c). Hook and lines are used to catch fish at the shore of a water body (Heileman et al., 2015). They have been attached with floats, usually made up of plastic that are either cylindrical, egg-shaped or spherical on the upper lines to allow gillnet to be suspended vertically in the water. Hook and line is the simplest of them all; it consists of a rod attached with a string that has a small hook (with bait) on its end (FAO, 2016c).

2.2. Methods of Fish Processing

2.2.1. Fish Drying

Fish like any other protein is delicate and thus should be handled with care to avoid spoilage due to microbial contaminations. This is a traditional method that uses thermal energy from sun. It increases the shelf-life of fish (up to 5-6 months) as it reduces water content to 10% and less. It is the most used method of fish processing in developing countries due to its important role in fish drying and inexpensive nature since, it only requires sun energy and a surface to place the fish during drying (Welcomme et al., 2010). Drying preserves fish by inactivating fish stomach enzymes and removing the moisture necessary for bacterial and mold growth (Bellagha et al., 2002).

In sun drying, fish are placed on raised racks with a wire mesh on the upper surface and left to the open space. The items used in making the rack are usually non-corrodible to avoid exposure of fish to rust. Drying is effected by the action of the sun and wind causing water to evaporate

from within the tissues of the fish (Ward & Beyen, 2015). Different structures are used for drying fish which include cabinet drier, kiln drier, tunnel drier, spray drier and solar tent drier. This processing method has several limitations which are exposure to rodents, insects, birds and dust since it is done in open spaces. Unfavorable weather conditions (rainy and cloudy days) also are a limitation to this fish processing method as it prevents proper drying hence increasing chances of spoilage (Ndiaye et al., 2015).

2.2.2. Deep Frying and Smoking

Deep frying method involves introducing fish into heated oil reducing its water content. The heat destroys microorganisms and the enzymes and it leaves the fish dried out (Olaoye et al., 2015). This is another widely used method especially in developing countries as it is least expensive and uses little space. Oil is heated in food grade metallic pans to high temperature (180˚C to 200˚C) and fish fried until cooked. The oil is replaced with fresh oil once it turns dark (Ward & Beyens, 2015). Fisherfolk are exposed to burns during deep frying process thus affecting their health (Olaoye et al., 2015).

Smoking is fundamental in killing any microbes that may be present on the fish thus help in fish preservation (Byamukama et al., 2005). For smoking to be effective it should be done after salting the fish thus receive combined treatment for their preservation. It is of two forms that is, cold smoking and hot smoking. In cold smoking, fish are hung in order to develop a pellicle, then after they are smoked between temperatures 20˚C to 30˚C, they develop a smoked flavor, but remain relatively moist. In hot smoking fish are hung to develop a pellicle then after they are smoked to a temperature range of between 52˚C to 80˚C, the fish become fully cooked, moist and flavored (Ward & Beyens, 2015). Hot smoking reduces the yield of fish as both moisture and fat are cooked away (Gomen-Gullen et al., 2009; Horner, 1997). Smoking is done using ovens, made up of a combustion chamber and smoking chamber, with a wire mesh surface on the upper side where fish are placed and a lid to cover the fish during the process (Odoli et al., 2018). It should be done in a clean and an area protected from rain and animals. Wood used during smoking process exposes fish to Polycyclic Aromatic Hydrocarbons (PAHs) which are carcinogenic thus a potential health hazard to both fisherfolk and consumers (Ward & Beyens, 2015).

2.2.3. Freezing and Chilling

The simple way to preserve fish is by keeping it cool. This can be achieved through freezing and chilling which increases fish shelf life (Tawari & Abowei, 2011). Freezing prepares fish for storage thus is usually done after salting, drying for effective preservation results. Harvested fish are transferred to the fishing vessels where they are mechanically refrigerated by circulating cold air or by packing the fish boxes by ice before landing. Fish are frozen at temperature below -18˚C though it varies from area to area (Gokoglu & Yerlikaya, 2015; Li & Sun 2002).

In chilling the temperature of harvested fish are lowered to a point near the freezing point which varies from -0.6 to 2.2˚C depending on different fish species while in super chilling fish are kept at temperature slightly below the freezing point which varies from -2.2 to -5.0˚C. Different chilling methods exist which include, chilling with ice, cold air blown over fish and fish immersed in chilled water (Garthwaite, 1997). The cold environment is maintained by circulating refrigerated brine thus reducing the spoilage of fish. The cool environment help reduce growth rate of bacteria on fish. Furthermore, the melting ice washes away the bacteria present on fish thus, the melt water should be drained away from the fish (Nwaigwe, 2017). These processing methods expose fisherfolk to cold environments affecting their health (Olaoye et al., 2015).

2.3. Water, Sanitation, Hygiene and Water Related Diseases

Access to improved water and sanitation still remains a concern in world, with East Asia 65%, Southern Asia 33% and Sub-Saharan Africa 31% being the most affected (Sommer et al., 2015; WHO/UNICEF, 2015). In Baringo County, 76% of the people rely on unimproved water sources, some 61% rely on unimproved sanitation while some households lack any sanitation facilities (Kenya National Bureau of statistics [KNBS] & Society for International Development [SID], 2013). Water related diseases are classified into; water borne, water washed (water hygiene), water washed (water contact) and insect vector (Cairncross & Feachem, 1993). Unimproved WASH has been associated with high prevalence of WRDs in the world. In Nigeria, the unimproved WASH attributes has been reported to contribute to high diarrheal illnesses among children under the age of five years (He et al., 2018). Poor sanitation and hygiene practices has been reported to cause fecal contamination of stored water (Oloruntuba et al., 2014). There are reports on reliance on unimproved water sources in some counties in Kenya. Residents in Baringo County, Kenya depend on unimproved water sources

such as lake, natural rivers, dams, traditional rivers for drinking and other domestic uses (KNBS & SID, 2013). Additionally, Baringo County Integrated Development Plan (2018) report, shows that use of poor water quality is still prevalent in Baringo County.

Clean water is essential for all human beings, flora and fauna on earth. Globally 2.1million people lack access to clean water (WHO/UNICEF, 2017). Access to clean water is essential for health, a basic human right and a component of effective policy for health protection (Government of Kenya [GoK], 2010). Lack of access to clean water is detrimental to our health as it results to water related diseases, which affect mostly the poor people (Montgomery & Elimelech, 2007; WHO, 2011).

From the year 1990 to 2016, 1.8 billion people had achieved access to improved sanitation. However, 2.5 billion people lack access to improved sanitation, 1.1billion (15%) still practice open defecation (WHO/UNICEF, 2015). Approximately 4.5billion people lack access to improved sanitation (WHO/UNICEF, 2017). Inadequate sanitation increases water contamination with fecal pathogens and thus considered unsafe for consumption. One of the major triggers to unimproved sanitation is poverty (Gordon, 2005). The poor lack the income to set up improved sanitation facilities as they have more priorities on food, shelter and clothing thus are most hit by waterborne diseases (Gordon, 2005). A study done in Isiolo, Kenya revealed high fecal contamination of water sources which was associated with the high practice of open defecation in the area (Okullo et al., 2017). Additionally, in Lodwar, Kenya 81% of the respondents indicated not having any sanitation facility resulting to high prevalence of open defecation (Busienei et al., 2019).

Hygiene, sanitation and water are all linked together (Prüss-Ustün et al., 2014). Personal hygiene is fundamental in prevention of waterborne diseases for example, washing of hands before food handling and washing of foodstuffs and utensils before cooking or handling food. Lack of awareness of the danger of poor hygiene practices has exacerbated the burden of waterborne diseases (Prüss-Ustün et al., 2014). In some Tanzanian communities despite using improved water sources, poor hand hygiene practices among children and mothers was positively correlated to fecal contamination stored drinking water (Pickering et al., 2010). WASH is important in fish handling and processing as it determines if fish will be contaminated with fecal matter which would translate to waterborne diseases. Open defecation results to contamination of water sources where fish are harvested. When it rains fecal matter finds its

way in rivers and lakes as runoff. The fisherfolk who handle and process the fish are at a risk of contracting waterborne diseases such diarrhoea as well as the consumers. Inadequate hygiene among fish handlers have been reported to cause waterborne diseases through food contamination with fecal pathogens that, impact negatively on human health (Lambrechts et al., 2014). These pose a risk to both the fish handlers and the consumers at large as it increases the risks for diarrheal diseases hence affecting negatively on their health (Garedew, 2014).

Fish like any other protein food is susceptible to deterioration and thus require careful handling and processing to prevent economic loses (Okonta & Ekelemu, 2005). Developing countries lack adequate fish handling and processing methods unlike in developed countries (Ayuba & Omeji, 2006). Poor handling of fish result into spoilage of fish and contamination with microbes (Hoffmann et al., 2015; Sant'ana, 2012). In Brazil and Europe burden of waterborne diseases have been reported to arise from ingestion of fish contaminated with *Salmonella spp.* as a result of poor handling (European Food Safety Authority [EFSA], 2017). *Vibrio cholera* and *Escherichia coli* have also been reported to contaminate fish as a result of poor handling by fisherfolk (Hassan et al., 2016; Pallabi et al., 2017). Clean water is used for washing hands, fishing vessels and gears to prevent fish contamination.

Table 2.1: Classification System for Water related Diseases

Transmission	Examples	Causes
Waterborne	Diarrhea, cholera, typhoid Hepatitis A	Ingestion of fecal contaminated food and water
Water-washed (water hygiene)	Trachoma, Scabies Eye and skin disease	Lack of water for proper hygiene
Water-washed (water contact)	Guinea worm Schistosomiasis	Pathogen requires aquatic environment for part of life cycle Eating insufficiently cooked aquatic species
Insect vector	Malaria, river blindness, Gambian, sleeping sickness	Insects that bite or breed near water

Source: Cairncross & Feachem (1993)

2.4. Hazards in Fish Handling and Processing

Occupational hazards in workplaces result to injuries among workers such as fisherfolk, which results to disabilities (Leary et al., 2012). The different fish handling and processing methods expose fisherfolk to health risks. It is one of the most dangerous occupations recorded in different countries example Greece, Finland, America, France, Nigeria (Frantzeskou et al., 2012; Kaustell et al., 2016; Olaoye et al., 2015). In France, between the year 1980 and 2007, fish handling and processing has been linked to many accidents which affect the health of fisherfolk (Chauvin & Le, 2007).

In handling fish, pricks, bites and cuts have been reported among fisherfolk (Oyediran et al., 2017). Fisherfolk also suffer from musculoskeletal problems through loading and offloading harvested fish from the vessels (Novalbos et al., 2008). Exposure to sunrays and heat due to working in open environments has been reported to cause ocular disorders among fisherfolk (Kyei et al., 2016). In Bangladesh 45% of the fisherfolk reported to suffer from sun burns due to long exposure in the open sun (Mandal et al., 2017). Smoke produced during deep frying and smoking processes have been reported to cause eye irritation, cataract and asthma development. Smoked fish has also been reported to contain carcinogenic polycyclic hydrocarbons (PAHs) residues that pose potential threats to fisherfolk as well as other consumers (Adeyeye et al., 2016; Orony et al., 2015; Remy et al., 2016). Among the reported fisheries' health hazards in America range from redness or swelling of eyes, stress to musculoskeletal injuries, all of which do have a negative impact on the human health especially for the fisherfolk involved (Ben-Yami, 2000; Huss et al., 2000; Jeebhay et al., 2001).

Fishing has been recorded as an occupation with the highest fatalities in Australia, United states, Canada, Spain, Korea, Estonia, Italy, Poland and the entire world at large (ILO, 2000; Saha, 2014). Despite the many concerns on fisherfolk' health, there is lack of documentation hazards related to small scale fisheries especially in developing countries which may be impacting negatively on fisherfolk in different areas including those in Kampi Samaki, Kenya. Small scale fisheries are fundamental in employment creation and provision of highly nutritious meat. Fish is of high nutritional value as it contains proteins, Omega-3- Fatty acids, vitamin D, Calcium, B vitamins, Vitamin A, Iron, Zinc, Lysine which boost consumers' health (Youn et al., 2014). In Tanzania for instance, the fisheries sector provides employment to more than 4 Million people directly and indirectly (Tanzanian fisheries sector, 2016). Despite the many health benefits to consumers, those fisherfolk involved may encounter hazards that may

impact negatively to their health (Olaoye et al., 2015). A study done in Nigeria revealed the numerous occupational hazards experienced by the fisherfolk (Zakia et al., 2012). A research on mortality among fisherfolk in Lake Victoria emphasized more on HIV/AIDS related diseases however, there is no mention of the physical hazards that are experienced (Opemo et al., 2014). In spite of the many records of fatalities and injuries in fisheries there is a gap in documentation of the health hazards in Kenya therefore, this study set to assess fisherfolk exposure to human health risk through fish handling and processing in Kampi Samaki, Lake Baringo, Kenya. Additionally, no study has been undertaken on fisherfolk' exposure to occupational hazards and risks, arising from fish handling and processing methods in Kampi Samaki.

2.5. Theoretical Framework

Hazards are conditions with potential to cause harm to human, damage to environment and property or a combination of them. Occupational hazards arise as a result of work one does for a living (Alli, 2008).

This study is based on the domino model/theory developed by Herbert W. Heinrich in 1941. Heinrich explained five dominos that show sequence for accident occurrence. The first domino based on Social environment and/or ancestry states that, undesirable personalities of an individual are usually acquired through inheritance or from social environment, resulting to faults of person. The second is the fault of a person, refer to unpleasant traits of an individual such as ignorance, recklessness which result to unsafe acts/ conditions. The third domino is the unsafe acts/ unsafe conditions, which is labelled at the center of sequences in the domino, contributing to accident. The unsafe acts/ conditions are most significant in accident causation. The fourth is accident, which are undesirable events that happen and cause injury, for example falling from height or striking person from collapse of objects. The fifth one is injury, which is suffering or damage to someone's body due to encounter with an accident. Additionally, Heinrich Domino theory stated that among the direct and proximate causes of industrial accidents: 88% are unsafe acts of persons; 10% are unsafe mechanical or physical conditions and 2% are unpreventable referred to as "act of God".

According to Peterson (1971) incident/accident causation theory, prevalent occupational hazards, affect their job performance. Job performance is how well a worker is able to carry out his work to achieve a set goal. Exposure to occupational hazards negatively affects job

performance negatively as it results to loss of working hours due to injuries and spending more on treatment by the workers.

The social environment and/or ancestry: undesirable traits such as lack of use of PPEs, drinking untreated water, children accessing drinking water themselves are acquired from the environment the fisherfolk come from. The fisherfolk acquire the traits by observing what the other older fisherfolk have been doing.

Fault of person: after fisherfolk have acquired the undesirable traits they become ignorant and reckless in their activities. Fisherfolk become ignorant for example, on using personal protective equipment such as gloves when handling fish, nose masks when smoking fish, heavy clothing when harvesting, drinking water treatment, covering of drinking water. This results to unsafe acts/condition.

Unsafe acts/ unsafe conditions: Fisherfolk for example, undertaking fish handling and processing without personal protective equipment, drinking untreated water, not covering drinking water which result to accidents. Accident: Fisherfolk encounter occupational hazards such as cuts, exposure to smoke, biological pathogens such as bacteria (*Salmonella typhi*, *Vibrio cholera*, *Escherichia coli*) which results to injuries.

Injury: Fisherfolk encounter with accidents results into injuries and potential health risks such as eye irritability, nose irritability, skin burns, diarrhea, and infection of wounds. Moreover, exposure to risks and injuries results in loss of working days among the fisherfolk that, negatively affect their job performance (Peterson, 1971).

2.6. Conceptual Framework

There is a direct relationship between fish handling and processing methods and human health. Fish handling and processing methods; gutting, harvesting, smoking, sun drying, deep frying, chilling and freezing increases fisherfolk' exposure to occupational hazards. Encounter with occupational hazards by the fisherfolk increases negative effects on their health for example, continuous exposure to smoke during processing of fish increases risk of development of asthma or eye problems. Moreover, pulling gill nets with harvested fish into the fishing vessels and offloading increases musculoskeletal injuries among the fisherfolk.

There is also a direct relationship between WASH attributes; (covering drinking water, livestock drinking source, children access to drinking water, water treatment, and used water disposal) and human health. Inadequate water, sanitation and hygiene increase exposure to biological hazards which result to waterborne diseases among fisherfolk. Poor hygiene practices among fisherfolk such as inadequate hand washing before handling fish, increases contamination of fish with fecal pathogens that result to waterborne diseases among fisherfolk and other consumers.

Legal frameworks have an indirect impact to human health. The Occupational Safety and Health Act 2007 ensure that occupational hazards are reduced and mitigated in order to promote workers' health. Article 42 of the Kenya constitution states that all human beings are entitled to clean and healthy environment. Failure of adherence to the legal frameworks indirectly increases negative effects to human health (Figure 2.1).

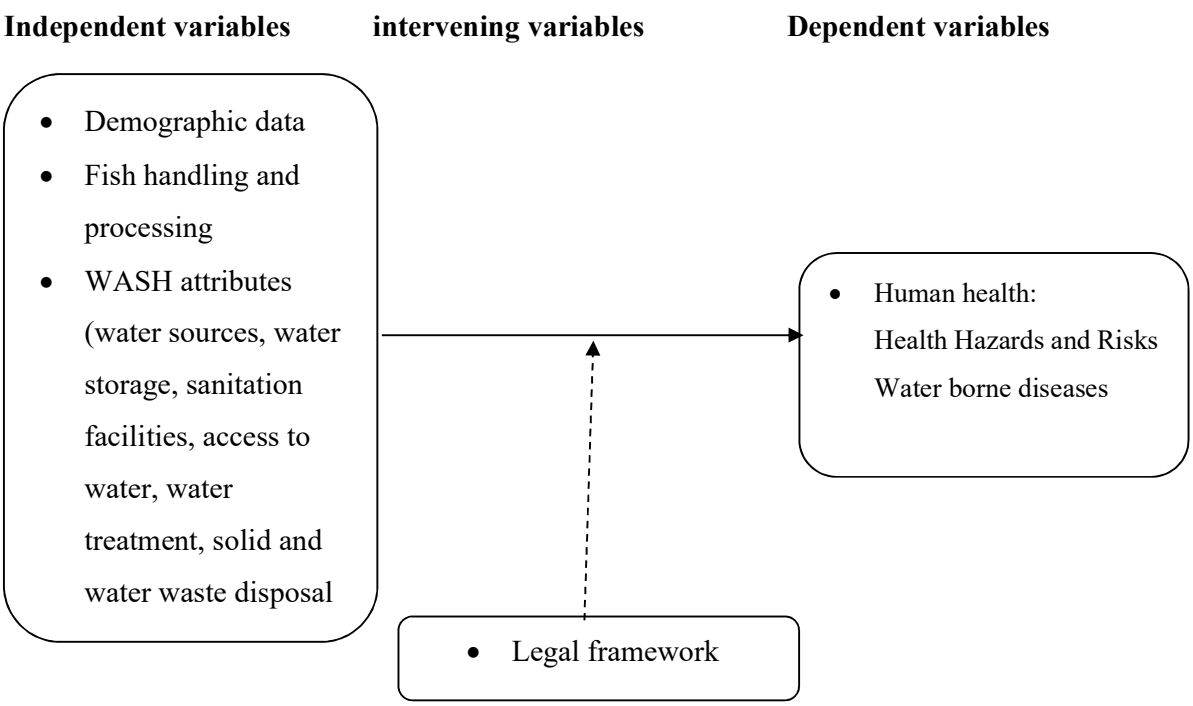

Figure 2.1: Conceptual Framework

CHAPTER THREE
METHODOLOGY

3.1. The Study Area

The study was conducted at Kampi Samaki; a village located on the shores of Lake Baringo, Baringo County, Kenya (Figure3.1). It is 1054 meters above sea level (m.a.s.l) and forms a major landing site for fish harvested from the Lake Baringo. It lies between Latitudes 0°36`42.40″ -0°37`37.63″North and Longitudes 36°1`3.63″-36°1`55.11″East. Approximately, 70% of the residents of Kampi Samaki depend on Lake Baringo for domestic purposes. Kampi Samaki is classified as a rural area. Lake Baringo is a fresh water lake, located about 150Km North of Nakuru town at $0^0$38`N 36°05`E. The lake is fed by two permanent rivers, Molo and Perkerra, and seasonal rivers Ol Arabel, Dau, Mugurn, Chemeron, Makutan, Tangulbei, and Endao (GoK, 2009). The county growth rate is 3.3% per annum, which is above the national average of 3%. The population of Kampi Samaki is basically from the Arror sub-tribe of the Tugen (KNBS, 2009).

3.1.1. Climate and Geology

Kampi Samaki, Baringo County is classified as arid and semi-arid (ASAL). The rainfall varies from 1,000mm to 1,500mm in the highlands to 600mm per annum in the lowlands. The rainfall pattern is tri-modal, with the long rains received during March- May and two short rains seasons that are experienced between June- August and October- December. A larger area is characterized by stony soils with rock outcrops and lava borders. Air temperature varies between 16^0C in the highland areas and 42^0C in the Lake ecosystem (Odada et al., 2006).

3.1.2. Socioeconomic Characteristics of the Study Area

According to Baringo County Government Annual Development Plan 2015/2016 there are different social institutions present in the County and a lot of economic activities are undertaken. Most members of the community at Kampi Samaki depend on Lake Baringo for fishing as their major source of income. Different fish species namely *Oreochromis niloticus (*endemic*), Protopterus aethiopicus, Clarias gariepinus, Barbus intermedius and Labeo cylindricus* are found in Lake Baringo. Fishing nets, hooks, traps, motorboats and canoes used for fishing and different methods of processing including chilling, freezing, drying, salting, smoking are practiced. Livestock keeping, bee keeping, tourism, boating, trade, pastoralism, agro-pastoralism are among the other economic activities practiced in the study area.

The water sources in Kampi Samaki, Baringo County include dams, lakes, water pans, streams, wells, springs and boreholes. However, the main water source is Lake Baringo water. The livestock in Kampi Samaki drink from the same lake water too. There is prevalence of water shortage in the county with majority relying on unimproved sources. Seventy six percent (76%) of the residents use unimproved water sources including, dams, lakes and water pans (KNBS & SID, 2013). According to Baringo county Government Annual Development plan 2015/2016, water scarcity is a problem thus increases cost of production as the residents, spend more time and money in search for clean water. Approximately 61% of the residents use unimproved sanitation facilities (KNBS & SID, 2013). Moreover, Baringo County Government Annual Development Plan 2015/2016, reported that only 5% have access to proper sanitation, 49% practiced open defecation and 46% used pit latrines.

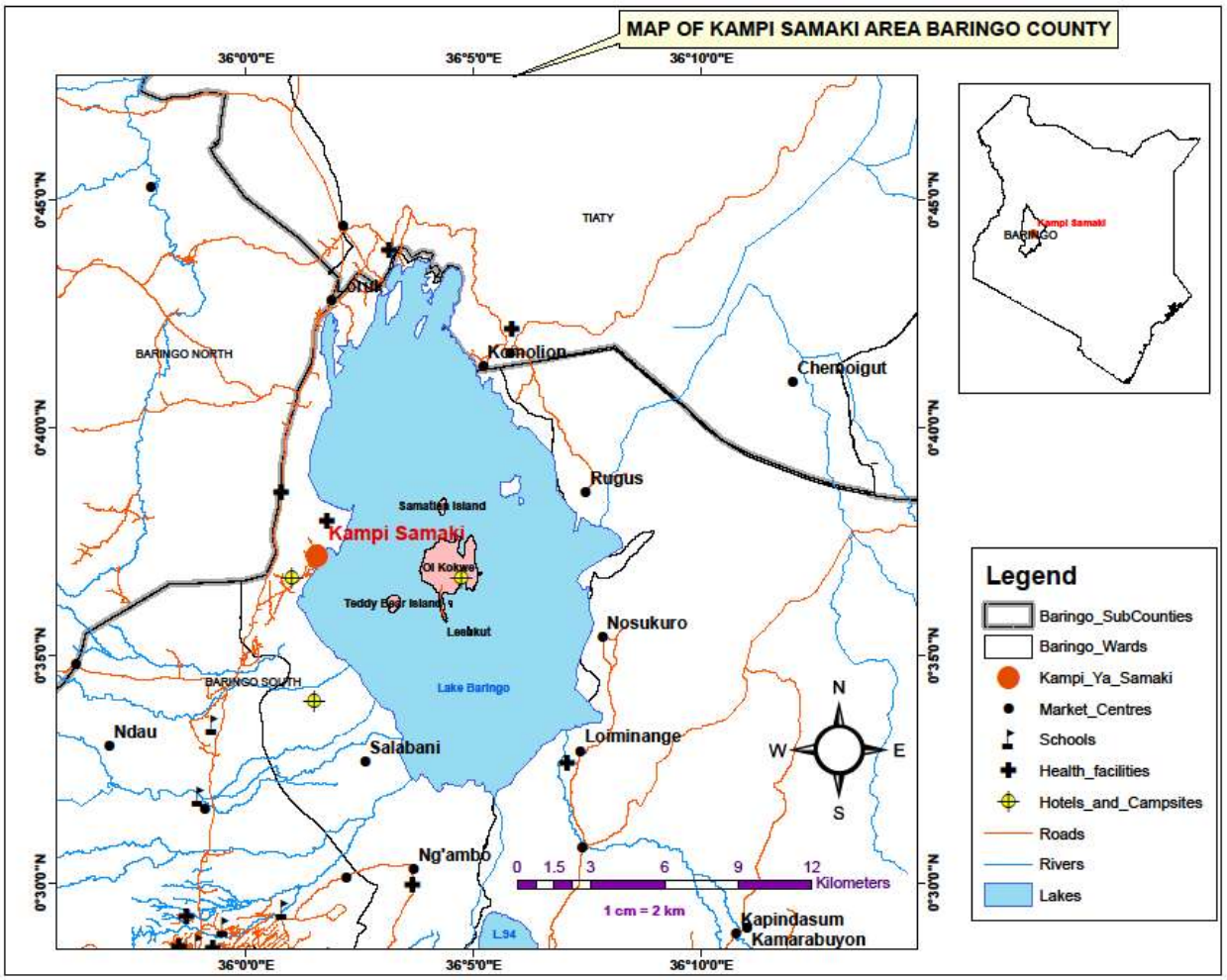

Figure 3.1: Map of Study Area

Source: Topographical map from Survey of Kenya Map series Y731 (D.O.S. 423), Sheet 91/3, Edition 3-D.O.S. Scale 1:50,000.

3.2. Research Design

The research design adopted was a cross-sectional social survey where data is collected from a population at one specific point in time. The information on fish handling and processing among fisherfolk in Kampi Samaki was examined. Additionally, the effect of fish handling and processing methods among the fisherfolk in the study area was examined. Further, gender roles was also examined among the fisherfolk The relationship between dependent variable (waterborne diseases) and independent variable WASH attributes (water sources, drinking water treatment, drinking water storage, access of drinking water from the storage containers, presence of sanitation facilities) in Kampi Samaki was also examined.

3.3. Sampling Design

3.3.1. Sample Population

The sampling population for this study was the fisherfolk in Kampi Samaki, Baringo County, Kenya.

3.3.2 Sampling Procedure

Systematic random sampling was employed in selection of fisherfolk in Kampi Samaki. The first fisherfolk household was selected randomly then a specific interval was then used (3 households) to select the remaining 99 household samples. The interval of 3 households was derived by dividing the population size (N) by sample size n (300/100). According to Kenya population and housing census of 2009 there are 300 households at Kampi Samaki. The Nassiuma (2000) formula was used to calculate sample size.

$$n = NC^2/C^2 + (N-1)\, e^2$$

Where;

n= sample size

N= population size in the study area

C= coefficient of variance of 30%

e= margin of error which is between 0.03

n= $300*(30/100)^2/ (30/100)^2 + (300-1)0.03^2$

= 100 households

A sample of 100 households was used for the study. Coefficient of variance used was 30% (Nassiuma, 2000). Moreover, local community was interviewed to provide more information about the study objectives.

3.4. Pilot Study

Prior to the actual study, a pilot study was conducted in Salabani village, where fish are landed in Baringo County, with similar ecological conditions to pre-test the tools. Pilot studies enable validity and reliability of the data that would be collected. Reliability is the consistency with which research instrument measures what it purports to measure; validity is the accuracy and meaningfulness of inferences, which are based on research results (Mugenda & Mugenda, 2003). To ensure validity and reliability 10% (10) of the sample size (100) was used (Mugenda & Mugenda, 2003). Same set of questionnaires were administered to the 10 participants in Salabani who were randomly selected for the pilot study. The data collected in the pilot study, was then used to generate dummy data for 100 participants in order to run a trial test on the selected methods of data analysis and subjected to a reliability test. Cronbach's alpha calculation was used in scoring out an average response, and a value of 0.860 was achieved. The pretest revealed that the questionnaire was adequate for administering to the fisherfolk since the Cronbach's reliability coefficient was 0.860 (Fraenkel & Wallen, 2000).

3.5. Ethical Consideration

Prior to data collection, an approval letter to carry out the research was sought from the research and extension division of Egerton University for ethical purposes. Furthermore, a research permit was obtained from National Commission for Science, Technology and Innovation (NACOSTI/P/18/52733/25734). Before participation in filling questionnaire, the researcher explained to the respondent what the research was about. Respect for Respondents privacy and confidentiality was maintained for those who volunteered to participate.

3.6. Data Collection

Data collection was done from July to September, 2017. Two well-trained research assistants helped in the research. During the training the research assistants were taken through every question in detail and provided with proper explanation of what was required in each question and observation checklists. Furthermore, they were trained on how to approach the fisherfolk to ensure their willingness to participate. Structured questionnaires and observation checklists were used to collect data on fish handling and processing methods, WASH attributes at Kampi Samaki, hazards involved in fishing handling and processing methods. The researcher supervised the administration of the questionnaires and interviews to ensure that they were well conducted. The questionnaires included the demographic information of the respondents that is; age, gender, number of children, household head, education status, Water, sanitation and

hygiene information, fish handling and processing methods and occupational hazards in fish handling and processing methods. Additionally, information on WASH attributes and fish handling and processing methods were explored through secondary sources; Fish species, fish handling and processing methods, water sanitation and hygiene and prevalent WASH Diseases.

3.7. Data Analysis

Data collected was organized, coded and entered in SPSS software 20.0 from which statistical analyses were done. Descriptive statistics involving frequencies and valid percentages were used in analyzing demographic, socio-economic and WASH attributes. Pearson Chi-Square Test was used to show associations between various variables, the gender of the respondent and the role he/she played as fisherfolk; gender and occupational hazard; gender and occupational health risks; PPE and occupational health risks; Marital status and occupational health risks. Additionally, multinomial logistic regression analysis was used to identify the relationships between dependent variable (Waterborne diseases) and independent variables (water treatment, water storage, water covering, livestock access to water source, children access to drinking water, used water disposal) (Table 3.1).

It was found to be suitable for this study because the dependent variable has different categories/levels that is waterborne diseases (diarrhea, typhoid, amoebic dysentery etc.) while the independent variable is WASH attributes have different categories/levels that are nominal. MLR explains relationship between nominal dependent variable with more than two levels (diarrhea, typhoid, amoebic dysentery) and one or more independent variable (water storage, water source, water treatment etc.). The logistic regression model is shown as the following form:

$$\ln (p/1-p) = \beta o+\beta iXi$$

Where p = the probability of waterborne disease;

(p/1-p) = odds of waterborne disease;

βo = constant; Xi = vector of independent variables;

βi = parameter estimate for the i^{th} independent variable.

The logistic regression is powerful in its ability to estimate the individual effects of continuous or categorical independent variables on categorical dependent variables (Wright 1995). The multinomial logistic regression model used is generally effective where the dependent variable

is composed of a category having multiple choices. The results were presented in the form of tables and graphs. The level of significance was tested at alpha= 0.05.

Table 3.1: Summary of Methods of Data Analysis

Research questions	Variables	Statistical tables
Which are the fish handling and processing methods used in Kampi Samaki?	Methods of processing fish Handling, harvesting, cleaning, disposal of fish waste, fish processing methods. Gender roles	Descriptive statistics Chi-square Test
Which are the WASH attributes at Kampi Samaki?	Water sanitation and hygiene information included; water sources, water storage containers, water treatment, covering of water storage containers, cleaning of the storage containers, agents used in cleaning, livestock access water source, hand washing routine and sanitation facility present	Descriptive statistics
Are there negative human health associated with fish handling and processing methods used at Kampi Samaki?	Occupational hazards and risks e.g. sharp knives, Cuts, smoke, musculoskeletal injuries, skin burns, sun burns, eye irritability. Marital status, PPE, Gender.	Descriptive statistics Chi-square Test
Is there relationship between the WASH situation in Kampi Samaki and water related diseases?	Prevalence of waterborne diseases Water hygiene and sanitation	Descriptive statistics Multinomial logistic regression

CHAPTER FOUR
RESULTS

4.1. Results

4.1.1. Demographic data and Characterization of Fish Handling and Processing

Fifty two percent (52%) of the respondents were males. Fifty percent (50%) of the fisherfolk were found to be in the age bracket of 22-34, while 8% in the 15-21. Forty eight percent (48%) indicated primary as their highest education level, 1% university level and 5% had not received any level of education (Table 4.1).

Table 4.1: Demographic Information of the Respondents

Characteristics	Valid percent	Characteristics	Valid percent	Characteristics	Valid percent
Gender		**Age**		**Education level**	
Male	52	15-21	8	Primary	48
Female	48	22-34	50	Secondary	41
Marital Status		35-45	29	Tertiary college	5
Married	60	45+	13	University	1
Not married	40			No level of Education	5

Twenty eight percent (28%) of the fish harvested are *Clarias gariepinus* while 6% are *Labeo cylindricus* (Plate 4.2). Sixty five percent (65%) of the fisherfolk indicated use of gill nets for fishing, 30% long line and 5% hook and line. Sixty three percent (63%) indicated to dispose waste from gutting in the lake and 17% in pits. Fifty five percent (55%) indicated to transport fish using their shoulder and on their back and 1% used motor vehicle. Thirty seven percent (37%) indicated to smoke the fish and 4% freezing (Table 4.2, Plate 4.5). Fifty seven percent washed their fishing gears on a daily basis and 18% indicated washing on a monthly basis. Seventy nine percent harvested fish are placed in plastic surfaces and 21% in sack. Of the respondents, 92% indicated to use *Prosopis juliflora* in smoking (Appendix 3). For more information on fish handling and processing activities, see Appendix 6.

Table 4.2: Fish Handling and Processing at Kampi Samaki

Characteristics	Valid percent	Characteristics	Valid percent	Characteristics	Valid percent
Types of fish harvested		**how are the waste after gutting disposed**		**Fish processing methods**	
Protopterus aethiopicus	20	In lake	63	Smoking	37
Clarias gariepinus	28	Ground	20	Freezing	4
Barbus intermedius	24	Pit	17	Sun drying	26
Oreochromis Niloticus Baringoensis	22	**Transport of the fish to processing site**		Chilling	12
Labeo cylindricus.	6	motor vehicle	1	Deep frying	21
Method of fish harvest		Head	44	**Source of water used to wash the fish**	
Gill nets	65	Shoulder and back	55	Lake water	89
Long line	30			Tap water	4
Hook and line	5				
				Water vendors	7

The findings indicated that the role played by the fisherfolk was dependent on their gender (X^2=39.517; p<0.05). Approximately 90% of the females were involved in fish processing and selling while about 80% of the male respondents were involved in fish harvesting (Table 4.3; Plate 4.1, Plate 4.3).

Table 4.3: Gender Roles at Kampi Samaki

Role played	Gender of the respondents		Pearson chi square value
	Male	Female	X^2=39.517
Fish harvest	79.41%	20.59%	p <0.05
Fish processing	11.11%	88.89%	
Fish harvest and selling	100%	0%	
Fish processing and selling	11.11%	88.89%	

4.1.2. Effects of Fish Handling and Processing on Human Health

All of the respondents indicated having experienced hazards related to fish handling and processing. About 20% experienced cuts, pricks from spines and 1% falls. About 61% indicated to have missed work due to the hazards experienced. Approximately 52% indicated to have missed work for a week, 9% missed for a month. Eighty eight percent of them did not use any protective clothing during their operations. About 6% indicated to wear heavy clothes and gumboots and caps each 1%. (Table 4.4).

Table 4.4: Health Risks/ Hazards encountered by Fisherfolk at Kampi Samaki

Characteristics	Valid percent	Characteristics	Valid percent	Characteristics	Valid percent
Experienced hazards		Pricks from spines	10	Heavy fish loads	19
Yes	100	Cuts, pricks from spines	20	Hot cooking oil	3
Hazards experienced in fishing industry		Cold, musculoskeletal injuries	17	Cold condition	15
Cuts	7	Eye irritability, nose irritability	7	Spine	18
Sunburns	3	Skin burns, cuts	5	Slippery ground	6
Falls	1	**Occupational Hazard encountered**		Smoke	6
Cold	13	Sharp knives/Razorblades	24	**Protective clothes used**	
Musculoskeletal injuries	17	Sunrays	9	Heavy clothes	6
Hazards caused you to miss work		**Protective clothing**		Gumboots	1
Yes	61	Yes	12	Cap	1
No	39	No	88	Eye glasses	4
Time work missed				N/A	88
A week	52				
A month	9				
N/A	39				

There was a strong association between Occupational hazards and the gender of the fisherfolk (χ^2 =21.352, p<0.05). The female respondents were more likely to encounter smoke, sharp knives/ razor blades, hot oil, spines and slippery floors as compared to male fisherfolk (Table 4.5).

Table 4.5: Occupational Hazards as stratified by gender of fisherfolk at Kampi Samaki

Occupational hazards	Gender of the respondent (%)		Pearson χ^2 value
	Male (%)	Female (%)	
Smoke	0	100	χ^2 =21.352, p<0.05
Sharp knives/ Razorblade	8	92	
Sun rays	56	44	
Heavy loads	53	47	
Hot Oil	0	100	
Cold condition	60	40	
Spine	33	67	
Slippery floor	45	55	

There was an association between occupational health Risks and gender of the fisherfolk (χ^2= 16.283, P<0.05). Female respondents are likely to suffer from the occupational health risks indicated as compared to the male respondent (Table 4.6).

Table 4.6: Occupational Health Risks as stratified by gender of fisherfolk at Kampi Samaki

Occupational health risk	Gender Male (%)	Gender Female (%)	Pearson χ^2 value
Cuts	14	86	χ^2= 16.283, P<0.05
Sunburn	56	44	
Falls	47	53	
Cold	55	45	
Musculoskeletal injuries	56	44	
Pricks from spine	43	57	
Cuts, pricks from spine	14	86	
Cold, Musculoskeletal injuries	75	25	
Eye irritability, Nose irritability	44	56	
Skin burn, Cuts	0	100	

There was no association between occupational health risk and marital status (χ^2= 1.305, p>0.05). However, married respondents suffered more from occupational health risks as compared to those who are not married (Table 4.7).

Table 4.7: Occupational Health Risks as stratified by marital status of the fisherfolk

Occupational Health Risks	Marital status Married (%)	Marital status Not married (%)	Pearson χ^2 value
Cuts	76	24	χ^2= 1.305, p>0.05
Sunburn	75	25	
Falls	50	50	
Cold	36	64	
Musculoskeletal Injuries	78	22	
Pricks From Spine	64	36	
Cuts, Pricks From Spine	57	43	
Cold, Musculoskeletal Injuries	25	75	
Eye Irritability, Nose Irritability	44	56	
Skin Burn, Cut	50	50	

4.1.3. WASH Attributes at Kampi Samaki

Seventy percent (70%) of the respondents used lake water for drinking while 5% used water from water pans. Eighty percent indicated that the livestock were watered from the same water source that is the lake. Fifty one percent spend 5 to 10 minutes to the water source while 3% spend above 20 minutes. Forty five percent of the respondents indicated to store their drinking water in jerry cans and 4% in clay pots. (Table 4.8).

Table 4.8: Water information at Kampi Samaki

Characteristics	Valid percent	Characteristics	Valid percent	Characteristics	Valid percent
Water source		**Walking distance to the water source and back**		**Water storage containers**	
Lake water	70.0	5 to 10 minutes	51.0	Plastic container	33.0
Tap water	11.0	10 to 15 minutes	37.0	Jerry can	45.0
Water pans	5.0	15 to 20 minutes	9.0	Clay pot	4.0
Boreholes	6.0	Above 20 minutes	3.0	Jerrycan, plastic container	18.0
Water vendors	8.0				
Do livestock drink from same water source					
Yes	80.0				
No	20.0				

All the respondents indicated that they wash their water storage containers. Forty percent (40%) washed their containers daily while 6% indicated on monthly basis. Fifty six percent of the respondents indicated not treating drinking water. Twenty percent indicated to practice boiling, 5% filtration and 56% not applicable. Ninety two percent covered their drinking water containers. Eighty one percent covered the water storage containers using the lid of the container while 3% used clean clothes (Table 4.9). Sixty nine percent used soap and water while 2% ash and water for washing the storage containers. Fifty five percent indicated to use water only while, 1% used soil and water to wash their hand before handling food. Fifty one percent indicated that an adult fetches drinking water for the children (Table 4.9).

Table 4.9: Hygiene Information at Kampi Samaki

Characteristics	Valid percent	Characteristics	Valid percent	Characteristics	Valid percent
Water storage container washing		**Water treatment**		**Water storage container cover**	
Yes	100.0	Yes	44.0	Yes	92.0
No	0	No	56.0	No	8.0
Daily	40.0	Boiling	20.0	Lid of the container	81.0
	39.0	Chlorine	19.0	Clean cloth	3.0
After two days					
Weekly	15.0	Filtration	5.0	N/A	7.0
Monthly	6.0	N/A	56.0	Plastic lid	9.0
Agent used for washing		**Children access to drinking** water		**Hand washing material**	
Water only	23.0	Children fetch themselves	49.0	Water only	55%
Soap and water	69.0	Adult fetches for them	51.0	Soap and water	41%
Ash and water	2.0			Ash and water	3%
soil and water	6.0			soil and water	1%

Seventy two percent (72%) of the respondents indicated to having a pit latrine, 26% had no latrine facility in their homes. About 32% indicated that their sanitation facilities was located 15-20metres while, 8% are located 10-15metres from the water source. (Appendix 4).

Health record from Kampi Samaki Health Center showed that there were prevalence of waterborne diseases in Kampi Samaki. The most prevalent of the waterborne diseases being typhoid and least prevalent was amoebic dysentery (Table 4.10).

Table 4.10: Prevalence of Waterborne Diseases in Kampi Samaki

Waterborne Disease	Prevalence rate
Typhoid	19.3%
Skin infection	15.5%
Amoebic dysentery	8%
Diarrhea	9.8%

4.1.4. Relationship between WASH attributes and waterborne diseases in Kampi Samaki

The results of the study indicated that fisherfolk who treated drinking water were 0.035 less likely to have suffered from typhoid as compared to those who did not. The respondents who cover drinking water were 0.963 less likely to have had typhoid compared to those who cover. There was 1.087 higher likelihood of having had typhoid where children access drinking water themselves as compared to where adult fetch drinking water for the children (Table 4.11a).

There was 0.088 lower likelihood of having suffered from diarrhea for fisherfolk who treated drinking water as compared to those who did not treat. Fisherfolk who covered drinking water had 0.454 lower likelihood of having suffered from diarrhea compared to those who did not cover. The odds of fisherfolk selecting having diarrhea to not having diarrhea was 1.684 higher in households where children access drinking water themselves than where an adult fetches for them (Table 4.11b).

The odds of fisherfolk selecting having amoeba to not having amoeba was 0.257 lower in households where they drink treated water compared to where they drink untreated water. The odds of fisherfolk selecting having amoeba to not having amoeba was 2.435 higher in households where children access drinking water themselves than where an adult fetches for them. Fisherfolk who treated drinking water had 0.414 lower likelihood of having suffered from skin disease as compared to those who did not treat (Appendix 5).

Table 4.11a: Relationship between WASH attributes and Prevalent WBDs at Kampi Samaki

Waterborne Diseases	WASH Attributes	B	Std. Error	df.	EXP(B)
Typhoid	Intercept	1.057	1.654	1	
	Drinking water treated	-3.365	.749	1	.035
	Drinking water not treated	0[b]	.	0	.
	Water storage container covered	-.038	1.244	1	.963
	Water storage container not covered	0[b]	.	0	.
	Livestock drink from the same water source	.485	.791	1	1.624
	Livestock don't drink from the same source	0[b]	.	0	.
	Children access drinking water themselves	.083	.650	1	1.087
	An adult fetches drinking water for children	0[b]	.	0	.
	Used water disposed in the garden	.192	1.082	1	1.212
	Used water disposed on the ground	.699	.775	1	2.012
	Used water disposed in the pit	0[b]	.	0	.
Diarrhea	Intercept	.692	1.559	1	
	Drinking water treated	-2.429	.708	1	.088
	Drinking water not treated	0[b]	.	0	.
	Water storage container covered	-.790	1.076	1	.454
	Water storage container not covered	0[b]	.	0	.

Table 4.11b: Relationship between WASH attributes and Prevalent WBDs at Kampi Samaki

Waterborne Diseases	WASH Attributes	B	Std. Error	df.	EXP(B)
Diarrhea	Livestock drink from the same water source	1.061	.817	1	2.889
	Livestock don't drink from the same source	0[b]	.	0	.
	Children access drinking water themselves	.521	.627	1	1.684
	An adult fetches water for children	0[b]	.	0	.
	Used water disposed in the garden	.177	1.085	1	1.194
	Used water disposed on the ground	.694	.751	1	2.003
	Used water disposed in the pit	0[b]	.	0	.

N=100 (Number of Fisherfolk) Model fitting chi square= 50.834, $p<0.05$; Reference category; N/A= No Waterborne Disease; B= variable Coefficient; Exp (B) = Odds Ratio.

CHAPTER FIVE
DISCUSSION

5.1. Characteristics of Fisherfolk at Kampi Samaki

The study findings showed that the majority of the male fisherfolk were involved in fish harvesting and female in fish processing. Male fisherfolk dominate fish harvesting since it is believed to be a more risky task thus reserved for men (WorldFish, 2008). Furthermore, the majority of the world's small scale fishing communities prescribe male to be the primary producers (McGoodwin, 2001). Branch et al. (2002) indicated that in South Africa, men have a greater propensity to be fish harvesters. Roles played by fisherfolk, expose them to different occupational hazards and risks (Kyei et al., 2016; Mandal et al., 2017; Nag & Nag, 2007; Novalbos et al., 2008). The strong association between occupational risks/hazards and gender in this study can be explained by the different roles played by the fisherfolk. Female fisherfolk who are mainly the processors are exposed to several occupational hazards and risks than male fisherfolk (Nag & Nag, 2007; Olaoye et al., 2015). Tripathi et al. (2017) reported a significant statistical association between gender of fisherfolk and health problem due to work, where more female than male indicated to suffer from occupational risks.

Low level of education was reported among fisherfolk at Kampi Samaki. Here, only 5% fisherfolk had attained tertiary levels of education. These results are consistent to those in a study on perceptions of occupational risk, which reported low levels of education among fisherfolk in USA (Davis, 2012). Kyei et al. (2016) also reported low levels of education, where most of the fisherfolk had attained primary and secondary education, while only 2% had attained tertiary level of education in Ghana. These findings are also consistent with those from a study done in Okavango Delta, Botswana, where more than 50% fisherfolk had not attained any level of education (Ngwenya & Mosepele, 2008). This can be explained by the low level of technology and skills involved in small scale fisheries that do not require high levels of education. Education increases awareness among individuals, therefore, the lower the education level among fisherfolk the higher chances of an encounter with occupational risks and hazards (Faremi et al., 2014). A study by Budhathoki et al. (2014) reported that education increased knowledge and awareness of occupational hazards among welders in Eastern Nepal. According to Percin et al. (2011) high levels of education was also associated with less occupational risks as compared to low levels of education.

This study revealed that the majority of the fisherfolk were in the age bracket of 22-45 years. In a study on effects of occupational health hazards in Nigeria, only 10.83% of fisherfolk were reported to be 50 and above years revealing that majority were in their active ages than the relatively old age (Oyediran et al., 2017). Oyediran et al. (2013) also found that majority of the fisherfolk were below 35 years thus in their economically active age groups. The younger the fisherfolk the higher the chance of experiencing occupational hazards and risks. Tadesse et al. (2016) also reported greater odds of hazards awareness to be six times higher among employees who had longer job experience as compared to those who had less experience. In a study on perception of occupational risk by US commercial fishermen, they reported that the older fisherfolk rated risk as higher than younger fisherfolk, therefore, fewer chances of an encounter with the risks (Davis, 2012). Additionally, Breslin et al. (2007) reported that younger workers had 1.2 to 2 times higher rate of occupational risk as compared to older ones. According to Graveling (2011) the less experience of younger workers in their job, causes them to overestimate their physical capabilities or underestimating the safety and health associated with their role.

This study also pointed out that 60% of fisherfolk were married. However, there was a lack of association between occupational risks and the marital status of fisherfolk at Kampi Samaki. A study by Cui et al. (2015) also reported a lack of association between marital status of coal workers in Shanxi province and the occupational risk they experienced. Married fisherfolk are likely to safeguard their family's wellbeing by risking their own lives in fishing even when weather conditions are unfavorable compared to the unmarried (Kolawole & Bolobilwe, 2019). However, in a study by Whitlock et al. (2004) revealed that, drivers who were unmarried were at a higher risk of driver injury as compared to the married people.

5.2. Characterization of Fish Handling and Processing Methods

5.2.1. Fish handling at Kampi Samaki

This study characterized the fish handling and processing methods at Kampi Samaki. There are five species of fish harvested in Lake Baringo and processed in Kampi Samaki; *Protopterus aethiopicus, Clarias gariepinus, Barbus intermedius, Oreochromis Niloticus Baringoensis* and *Labeo cylindricus*.

There are simple fishing gears involved in Kampi Samaki, which include nets, long lining, hooks and lines. The findings are similar to a report by FAO (2012) done in Norway that

indicated, use of simple technology such as gill nets in harvesting as a result of the small-scale inland nature of fisheries involved. Additionally, Lymer et al. (2008) reported use of gill nets in harvesting of fish in Thailand due to the small-scale nature of fisheries. Moreover, FAO (2016a) reported use of gillnets and hook and lines in Ghana in small scale fisheries during harvesting.

Male fisherfolk experience cuts from hooks attached on the longline gears. This occurs when the fisherfolk unhook the harvested fish and when attaching baits onto the hooks. Male fisherfolk also experience cuts and pricks from spines and fins when handling the harvested fish.

After harvest the different fish species are placed in canoes or boats and a tag bearing names of female fisherfolk attached on the different fish harvested. On arrival to Kampi Samaki landing site, each fisherfolk collects the fish with their names tag on. The Harvested fish are then placed on plastic surfaces and some in sack which are cleaned on a daily basis. Sixty five percent (65%) of the fisherfolk wash the surfaces using soap and water which are then disposed into the lake water (Appendix 3). Martin and Griswold (2009) reported that some soap contain heavy metals such as arsenic. Fish accumulate heavy metals from the water they live in and what they eat. According to Ayandiran et al. (2009), contamination of water sources with soap, increases accumulation of heavy metals in body and gut of fish. Furthermore, Shrivastava (2011) reported that, consumption of fish contaminated with heavy metal causes serious health hazards. Female fisherfolk gut using sharp razor blades at the shores of the lake, while others gut away from the shore (Plate 4.3).

Majority of the fisherfolk (89%) use lake water, an unimproved source in cleaning the gutted fish. Of the respondents, 26% indicated having no latrine facility in their household therefore, practiced open defecation. Fecal matter finds its way to the lake water source as runoff when it rains resulting to microbial contamination. According to Okullo et al. (2017), inadequate sanitation attributes; open defecation in Isiolo resulted into fecal contamination of water sources. Tambekar and Neware (2012) also reported 48% fecal contamination of water sources in open defecation areas. Adequate sanitation is importance as it offers a chance to save lives of children from diarrhea and enhance human dignity (WHO/UNICEF, 2014). Moreover, Coffey et al. (2013) reported that in India, 188000 children under age five suffered from diarrhea as a result of open defecation practices. WHO/UNICEF (2010) reported 2.5 billion

people worldwide, lacked improved sanitation which was linked to millions of deaths due to waterborne diseases. Fish from microbial contaminated water, stores pathogens such as *Escherichia coli, Salmonella typhi* which when consumed result into waterborne diseases such as diarrhea, typhoid, cholera (Novotny et al., 2004). Majority of the fisherfolk indicated to dispose waste from the fish viscera and water used in washing fish into Lake Baringo. Gumisiriza et al. (2009) reported that poor disposal and management of the fish waste results in deterioration of water quality.

5.2.2. Fish Processing at Kampi Samaki

After gutting, fish are then placed on raised racks with an upper surface attached with wire mesh for sun drying (Plate 4.4). They are arranged in such a way that they do not overlap each other to ensure efficient drying by the sun. Sun-drying of fish is done on a raised structure with a wire mesh on the upper surface to allow for proper drying (Ward & Beyens, 2015). Some fish are then smoked using smoking kiln; a stone made structure which has two openings on the side where firewood is placed and the top surface separated in two sections which have wire mesh on to place the harvested fish (Plate 4.5). *Prosopis juliflora* locally known as Mathenge tree is majorly used in fish smoking (Appendix 3). Olaoye et al. (2015) reported on smoking kiln usage in fish smoking process in Nigeria. Fish smoking is done in a well-ventilated place that is clean away from animals and rain (Ward & Beyens, 2015). Sixteen percent of the fish are frozen and chilled. Some of the fish are transported fresh to other areas in special cooler boxes for selling via road transport.

5.3. Effects of Fish Handling and Processing on Human Health

Fish handling and processing has been associated with health hazards, which may be very severe (Chauvin & Le, 2007). All of the fisherfolk in this study indicated to have encountered risks in their daily fish handling and processing activities. Olaoye et al. (2015) reported fisherfolk in Nigeria to experience occupational hazards; eye irritability, skin burns, cuts, pricks, musculoskeletal injuries in the fishing industry.

Extreme cold condition is experienced by fisherfolk. Fish harvesting is done early in the morning mainly by men. The fishermen use canoes and harvest fish mainly by use of fishing gill nets and some (5%) use hook and line. While fishing and landing, fishermen experience extreme cold conditions resulting to respiratory irritability (sneezing and coughing). However, the female fisherfolk are partly affected only during the cold rainy seasons as they are involved

in processing and selling of fish. Additionally fisherfolk are exposed to cold through handling frozen fish. Olaoye et al. (2015) also reported that fisherfolk encountered cold from their working environment that resulted to respiratory irritability. This finding concurs with that of Zakia et al. (2012) who reported that fisherfolk experience extreme cold conditions during fish handling and processing.

Fisherfolk also experience cuts during fish handling and processing. These cuts are caused by sharp knives and blades used in gutting. Male fisherfolk suffer from cuts by hooks during fish harvesting while females suffer from cuts by sharp blades and knives in fish processing (Table 4.3). They are minor and non-fatal but, if left unattended may result into increased opening to infections (Erondu & Anyanwu, 2005; Martin, 2016). Majority of the fisherfolk never reported to miss work due to cuts as they were minor (Udolisa et al., 2013).

The fisherfolk also suffer from musculoskeletal injuries. They are caused by lifting heavy fish loads. Male fisherfolk suffer from musculoskeletal injuries by pulling the gill nets and long line with harvested fish into the canoes and offloading them. Female fisherfolk on the other hand suffer from the injuries by transporting the harvested fish to Kampi Samaki, using their shoulders, head and back, thus straining the muscles. Majority of the fisherfolk do not go for medical treatment instead they just apply creams and take some painkillers (Olaoye et al., 2015). Zakia et al. (2012) further reported, repetitive lifting of heavy nets by the fisherfolk which resulted to musculoskeletal injuries.

Eye and nose irritability are also experienced by fisherfolk. Female fisherfolk suffer from eye and nose irritability. During smoking and deep frying of fish the smoke from burned *Prosopis juliflora* and *Acacia tortilis* contact their eyes directly and nose causing pain and itching. However, male fisherfolk who are involved in fishing suffer from excessive reflection of sun rays which results to eye irritation. Findings from Kyei et al. (2016) showed that exposure to sunrays and smoke was associated with eye problems among both male and female fisherfolk. Gifty (2018) reported increased risks of asthma attacks, eye problems and coughs due to fish smoking. Eye irritability results from direct exposure to smoke by fisherfolk during processing by a smoking kiln that uses wood. It results into itching, pain, blurred vision and redness of the eye (Olaoye et al., 2015).

Furthermore, fisherfolk experience skin burns. Most of the female fisherfolk are involved in deep frying fish suffer skin burns from when the hot oil gets into contact with the skin. The burns range from mild to severe. Depending on the nature of the burns, they result to loss of working hours. Severe skin burns result to a week to months of loss of working hours due to the injury and pain (Olaoye et al., 2015).

Fisherfolk experience pricks and bites: Both male and female fisherfolk suffer from bites and pricks from spines and fins from the harvested fish they handle. *Clarias gariepinus* have sharp small teeth that bite and spines which are hard (Plate 4.7). These puncture the skin of the fisherfolk causing injury (Doroosh, 2012). *Protopterus aethiopicus* have very strong tooth-plates in form of cutting ridges which cut through skin of the fisherfolk especially when handled alive. *Barbus intermedius, Oreochromis Niloticus Baringoensis* and *Labeo cylindricus* have fins which prick fisherfolk too (Van Oijen, 1995). If the wounds are not treated they create gateway for infections (Olaoye et al., 2015). Similar finding have been put forward by Oyediran et al. (2017) who reported fisherfolk to experience pricks and bites during handling and processing fish.

Sunburns and falls are also encountered by fisherfolk. Both male and female fisherfolk do suffer from sunburns. All fisherfolk' activities like harvesting, handling or processing of fish are all performed outside, exposing them to sun radiations that cause sunburns. Falls occur mostly in rainy days as the workplaces slippery. Harvested fish are placed on raised structures made of wire mesh outside where they are dried using the suns' energy in process known as sun drying (Plate 4.4). Fisherfolk in Alexandrea have been reported to suffer from sunburns which ranges from mild to moderate due to working in the open sun for long hours (Saadawy et al., 2014).

Encounter with hazards impacts negatively on the health of fisherfolk family as 61% of the respondents reported to have missed work due to pain experienced due to encounter with hazards as a result of fish handling and processing (Table 4.4). Christiansen and Hovmand (2017) reported that some fisherfolk who encountered hazards became absent from their work for more than 72 hours because of injuries that result to pain. Fisheries sector provide employment to over 2million Kenyans thus help in reduction of poverty (FAO, 2016b). Furthermore, waterborne diseases among the fisherfolk, may result into spread of the disease to fisherfolk and other consumers after ingestion. According to the Kenya Fisheries Act, before

handling of fish fisherfolk should was their hands thoroughly with soap, detergent and water and should have PPE (GoK, 2012). However, 88% of the fisherfolk indicated not using any PPE and increasing their chances of encountering with hazards which results to injuries. The use of PPE such as protective gloves, nose masks, gumboots, caps, sunglasses, sunscreen creams and overalls have been reported to reduce injuries in fisheries (Christiansen & Hovmand, 2017; Hayman et al., 2010; Myers & Durborow, 2012).

5.4. WASH attributes at Kampi Samaki and relationship with WBDs at Kampi Samaki

This study assessed WASH attributes and relationship with Waterborne Diseases at Kampi Samaki too. Majority of the fisherfolk indicated that they use unimproved water sources from Lake Baringo water (Table 4.5). According to KNBS and SID (2013) report, only 24% of residents in Baringo County have access to improved water sources. Approximately 663m people globally, use unimproved water sources and nearly half of these population live in Sub-Saharan Africa (WHO/UNICEF, 2015).

Drinking the water without proper treatment or with no treatment at all pose potential risk of contracting waterborne diseases to the fisherfolk and the entire community at large at Kampi Samaki. Cohen and Colford (2017) also reported that adequate household water treatment improved water quality thus reducing waterborne diseases. Eighty percent (80%) of the respondents indicated that the livestock drink from the same water source which is Lake Baringo. Lake Baringo is an open surface water thus the residents in Kampi Samaki take their livestock to quench their thirst there. Pandey et al. (2014) reported that, poor disposal of human waste and direct deposits of fecal matter from livestock, are responsible for microbial contamination to water sources. This increases the risk of waterborne diseases to those drinking the water (Daniel's et al., 2015; Schriewer et al., 2015). Fifty one percent indicated that they take 5 to 10 minutes to the water source showing that water is accessible easily by residents of Kampi Samaki (Table 4.5). Prüss-Ustün et al. (2014) reported that improving water, sanitation and hygiene can help in reducing world's disease burden especially in developing countries where unimproved water sources, sanitation and inadequate hygiene is the greatest problem.

More than half of the fisherfolk do not treat drinking water increasing the risk of waterborne diseases among the fisherfolk of Kampi Samaki (Table 4.6). Fernandes and Chakkarwar (2018) also reported 47.4% of respondents from Sakhwar, Mumbai not treating drinking water.

Additionally, National Family Health Survey (NFHS, 2017) reported that 72.7% of residents in rural India did not treat drinking water. The lack of treatment of drinking water may be due to the rural populations in these areas that are poor, hence don't prioritize on treatment therefore, drink water as it is. In another study done in New Zealand, reported a significant risk of waterborne diseases as a result of lack of drinking water treatment (Ball, 2006). Furthermore, Maharjan (2013) reported outbreak of WBDs in Nepal due to drinking untreated water. Nineteen percent of the respondents indicated to use chlorine in treating water (Table 4.6). Lack of knowledge on the use of chlorine may pose great potential risks; either underuse of chlorine resulting into inadequate treatment or excess use of chlorine which may result to negative health effects as it increases cancer risks to the consumers (Mishra et al., 2014). Further, Gikunju (1990), reported high fluoride levels in Lake Baringo water (5.4mg/l), which is beyond the WHO standards of 1.5mg/l (WHO, 2004). Excess fluoride intake is detrimental to human health as it may result to osteoporosis, cancer, infertility, thyroid disorder, arthritis (Harrison, 2005; Mahramanlioglu et al., 2002; WHO, 1994)

Forty nine percent (49%) of the respondents indicated that the children access drinking water from the storage containers themselves, which is a potential risk to waterborne diseases as they may contaminate drinking water with their dirty hands (Table 4.6). Pickering et al. (2010) reported contamination of household stored drinking water in Tanzanian communities by children. Inadequate water sanitation and hygiene practices accounted to about 685,000 diarrheal illnesses globally (Crump & Mintz, 2010; Prüss-Ustün et al., 2014). World Health Organisation (2002) reported that unhygienic handling of stored household drinking water, serve as a source of pathogen causing waterborne diseases. According to Günther and Shipper (2013) and Rufener et al. (2010), inadequate handling of stored drinking water is associated with increased diarrheal diseases. Dada et al. (2013), further reported microbial contamination of *Escherichia coli* of stored drinking water due to poor handling in Laos and Thailand. Furthermore, in Ibadan, Nigeria, *Escherichia coli* was reported to be present in samples in stored drinking water in households and absent in water sample from source, indicating microbial contamination, associated with inadequate hygiene during handling (Oloruntoba et al., 2014).

Seventy-two (72%) of the respondents indicated having a pit latrine, while 26% indicated not having any sanitation facility (Table 4.6). The Baringo County Annual Development Plan 2015/2016, report indicated that 46% of the residents had pit latrines and 49% practiced open

defecation. Open defecation poses a risk of water borne diseases since it increases contact with fecal matter on ground and also during rainy seasons the fecal matter end up in water sources as runoff. Globally, open defecation has been a major cause of diarrheal illnesses (WHO/UNICEF, 2014). Prüss-Ustün et al. (2014) reported that inadequate sanitation facilities such as bucket latrines also pose potential risks to waterborne diseases. Additionally, Rajgire (2013) reported the burden of waterborne diseases to be more in low income areas where adequate sanitation facilities cannot be afforded. With burden of waterborne diseases, there is an increased risk of resistance to other infections thus more health deterioration (Guerrant et al., 2013).

According to the Kenya food, drug and chemical substance act, food handlers should wear clean outer garments, gloves and other appropriate PPE such as a head dress, which prevents contamination of food been handled (GoK, 2013). Inadequate water sanitation and hygiene in fish and any other food handling are fundamental in deterioration of human health (Crump & Mintz, 2010; Prüss-Ustün et al., 2014; Wolf et al., 2018). This study assessed the relationship between WASH attributes at Kampi Samaki and waterborne diseases. The study indicated that there is positive association between inadequate WASH attributes and the WBDs (Table 4.11a). Adequate treatment of drinking water and proper hygiene practices has been reported to reduce diarrhea a waterborne disease (Clasen, 2015). Moreover, Prüss-Ustün et al. (2014) reported that drinking unsafe water, along with inadequate sanitation and hygiene practices, resulted into many diarrheal diseases especially in low and middle-income setting. Equivalent studies have indicated that with improvement of WASH attributes, such hand washing with soap and adequate water treatment before drinking helps to reduce the waterborne diseases burden among the people (Clasen, 2015; Cohen & Colford, 2017; Wolf et al., 2018).

This study has shown that the fisherfolk suffer from waterborne diseases. Adequate water, sanitation and hygiene are very essential among fisherfolk like any other food handlers. Lambrechts et al. (2014) reported that, inadequate hygiene among handlers such as fish handlers resulted to contamination of food, which increased risk of waterborne diseases. Inadequate WASH exposes some of the fisherfolk to biological hazards. Inadequate hygiene practices among fisherfolk, such as lack of washing hands before fish handling, results to contamination of fish with pathogens present on their hands, increasing the chances of waterborne diseases among fisherfolk as well as other consumers. Proper hygiene practices are essential among all food handlers including fisherfolk. Lambrechts et al. (2014) further

reported, presence of pathogens in hands of the food handlers due to poor hygiene practices. Otieno and Olielo (2014) reported microbial contamination of fish handled in Lake Victoria due to inadequate hygiene. Moreover, Otieno and Olielo (2014) reported that total plate counts on the fish and hygiene of fisherfolk was significant negatively ($p<0.001$). These pose a risk to both the fisherfolk and the consumers as it increases the chances for diarrheal and other waterborne diseases hence affecting negatively on their health (Garedew, 2014).

CHAPTER SIX
CONCLUSIONS & RECOMMENDATIONS

6.1. Conclusions

The study characterized fish handling and processing methods at Kampi Samaki. The activities involved include; Fish harvesting, fish gutting/ washing, fish sun drying, smoking and deep frying. There was clear disaggregation of roles based on gender where, majority of the male fisherfolk were involved in fish harvesting while female fisherfolk in fish processing. It is evident that the fisherfolk are exposed to various health hazards in their everyday fish handling and processing methods that results injuries such as cuts, eye irritability, sun burns, cold, falls musculoskeletal injuries which reduce their job productivity.

Water, sanitation and hygiene is essential in any food handling and processing. Fisherfolk in Kampi Samaki rely on unimproved water sources such as use of Lake Baringo for drinking, unimproved sanitation such as open defecation, sharing same drinking source with livestock and inadequate hygiene practices. The inadequate WASH attributes were linked to the prevalent water related diseases in the area (Diarrhea, typhoid and amoebic dysentery).

6.2. Recommendations

Based on the experience and information gathered during data collection and analysis for this study, the following recommendations are made:

i. More public awareness programs should be done to educate fisherfolk in Kampi Samaki on the negative effects of inadequate water, sanitation and hygiene. Should be taught on the waterborne diseases that arise from drinking untreated water, using unimproved sanitation facilities and poor hygiene practices. Moreover, they should be educated on water treatment methods.
ii. Fisherfolk should be sensitized on the associated risks and hazards in fish handling and processing, and the need to have first aid kits.
iii. The County Government of Baringo and the Fisheries Department should also provide clean and safe working environment facilities for fish handling and processing at Kampi Samaki.

Recommendation for further Research; Further research on stress levels among fisherfolk during fish handling and processing needs to be done. Research on challenges to fish value addition, and hazards they encounter during fish marketing also need to be studied and

documented. Additionally, research on the female discrimination in the fisheries sector needs to be undertaken.

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APPENDICES

Appendix 1: Fisherfolk Questionnaire on Fish Handling and Processing.

My name is Ngaruiya Faith. I am a student of Egerton University taking a Master's Degree in Environmental and Occupational Health. This questionnaire is for the purpose of collecting data and information for this study. The information given will be treated with utmost confidentiality. Your assistance and cooperation will be highly appreciated.

Instructions; Do not write your name, tick inside the brackets provided. In the spaces provide explain your opinion. To be filled by the fisherfolk.

SECTION A: DEMOGRAPHIC DATA

1. Respondent's Gender
   - **a)** Male ( )
   - **b)** Female ( )

2. Respondent's Age
   - **a)** 15 to 21( )
   - **b)** 22 to 34( )
   - **c)** 35 to 45( )
   - **d)** Over 45( )
3. Are you married
   a) Yes ( )
   b) No ( )
4. Who is the head of the household? (……)
5. The size of the family? Male……Female……
6. What is the occupation of the household head?.....
7. What is the main source of income for the family?.....
8. Education level
   - **a)** Primary( )
   - **b)** Secondary( )
   - **c)** Tertiary college( )
   - **d)** University( )
   - **e)** Other specify( )

SECTION B: FISH HANDLING AND PROCESSING

9. How much fish is landed and processed every day? _____

10. What types of fishing gears are used in Kamp Samaki?

a) Gill nets ( )

b) Trawl ( )

c) Long lining ( )

d) Hook and line ( )

e) Harpoon ( )

f) Pots and traps ( )

g) Other

specify……

……

……

11. How are the harvested fish transported to the processing site in Kampi Samaki?

    a. Motorcycle( )
    b. Head( )
    c. Shoulder and Back ( )
    d. Bicycle ( )
    e. Other

    specify……

    ……

    ……

12. Where are the harvested fish placed after been removed from the fishing vessels?

    a. Plastic surface
    b. Wood surface
    c. Mud made surface
    d. Other specify

13. Are fish washed after they are harvested?

    a. Yes ( )
    b. No ( )

14. If yes from which water source is the water drawn from?

    a. Rivers
    b. Tap water

c. Water pans
d. Boreholes
e. Water vendors
f. Others explain

15. How is the used water disposed?
    a. Re-used
    b. In river
    c. In lake
    d. Ground
    e. Pit
    f. Other explain
16. Do you clean the surface where the fish are placed after they have been landed?
    a. Yes ( )
    b. No ( )
17. If yes what cleaning detergent is used to clean the surface?
    a. Water only
    b. Soap and water
    c. Ash and water
    d. Mud and water
    e. Soil and water
    f. Other specify
18. How often is the surface cleaned?
    a. Daily
    b. Weekly
    c. Monthly
    d. Yearly
    e. Other specify
19. Do you wash your hands before handling and processing fish?
    a. Yes ( )
    b. No ( )
20. What fish processing methods do you use?
    a. Smoking ( )
    b. Freezing( )
    c. Salting

d. Drying( )
e. Chilling( )
f. Deep frying ( )
g. Other

specify……

……

21. What tree species do you used in smoking fish?
    a. Acacia spp. ( )
    b. Prosopis spp.( )
    c. Other

    specify……

    ……

22. How are fish stored after processing

    a) Baskets( )

    b) Basins( )

    c) Buckets( )

    d) Paper( )

    Other

    explain……

    ……

    ……

    ……

23. Which role do you play in the fishing sector?
    a) Fish harvesting ( )
    b) Fish processing ( )
    c) Fish selling ( )
    d) Fish harvest, fish selling ( )
    e) Fish processing, fish selling ( )
24. Do you encounter any hazards?
    a. Yes ( )
    b. No ( )
25. If yes which do you encounter?
    a) Smoke
    b) Sharp knives

c) Sun rays
d) Heavy fish loads
e) Hot cooking oil
f) Cold condition
g) Spine
h) Slippery floor

26. Which health risk do you encounter?
    a. Cuts
    b. Eye irritability
    c. Nose irritability
    d. Skin burns
    e. Sun burns
    f. Falls
    g. Cold
    h. Musculoskeletal injuries
    i. Other

    explain……

    ……

27. Did you receive any form of treatment?
    a. Yes ( )
    b. No ( )
28. If yes at what level did you receive the treatment
    a. At home
    b. Hospital
    c. Other

    specify……

    ……

29. Have you suffered from any of the following health conditions if yes tick where necessary
    a. Acute Respiratory infection
    b. Eye redness
    c. Skin disease
    d. Other specify
30. Do you have any protective clothing/equipment to prevent some of the hazards?

a. Yes ( )
b. No ( )

31. If yes which one do you use?
    a. Gloves( )
    b. Heavy clothes( )
    c. Gum boots( )
    d. Musk( )
    e. Cap( )
    f. Eye Glasses( )
    g. Other specify( )
32. Are there any local/government policies safety rules to prevent encounter with these hazards?
    a. Yes ( )
    b. No ( )

SECTION C: INFORMATION ON WATER

33. What is the main source of water for drinking and cooking in your household?
    a. Rivers ( )
    b. Tap water( )
    c. Water pans( )
    d. Borehole( )
    e. Water vendors( )
    f. Others explain( )
34. What are uses of water in your household?
    a) Washing( )
    b) Drinking( )
    c) Livestock( )
    d) Cooking( )
    e) Others
    explain……
    ……
    ……
    ……
    ……

35. How long does it take walking from home to the water source and back?
    a. 5- 10minutes( )
    b. 10- 30minutes( )
    c. 15-20 minutes( )
    d. Above 20 minutes ( )
    e. Other specify…….
36. Do livestock drink water from the same point that you fetch drinking and cooking water?
    a. Yes ( )
    b. No ( )
37. What container do you use to store drinking and cooking water?
    a. Plastic container ( )
    b. Jerry cans( )
    c. Clay pot( )
    d. Other specify……
    …….
38. Do you cover drinking and cooking water?
    a. Yes ( )
    b. No ( )
39. If yes, what do you use to cover the drinking water storage container?
    a. Lid of the container( )
    b. Clean cloth( )
    c. Plastic lid( )
    d. Other specify……
    ……
40. Do you clean the storage containers?
    a. Yes ( )
    b. No ( )
41. If yes how often are the storage containers cleaned?
    a. Daily( )
    b. After two days( )
    c. Weekly( )

d. Monthly( )
e. Yearly( )
f. Other specify

42. What agent do you use in cleaning the storage container?

a. Water only( )
b. Soap and water( )
c. Ash and water( )
d. Soil and water( )
e. Other
specify……
……

43. How do children in your household access the drinking water from the containers?

a. They fetch by themselves( )
b. An adult fetches for them( )
c. Others
specify……
……

44. Do you treat your drinking water?

a. Yes ( )
b. No ( )

45. If yes how do you treat water in your household?

a. Boiling( )
b. Chlorine( )
c. Solar( )
d. Filtration ( )
e. Other specify…….

SECTION D: HYGIENE AND SANITATION

46. Do you wash your hands before handling food?
    a. Yes( )
    b. No( )
47. If yes which material do you use?
    a. Water only( )
    b. Soap and water( )
    c. Ash and water( )
    d. soil and water( )
    e. Others

    explain……

    ……
48. How often do you wash your hands?
    a. Before meal time( )
    b. After meal time( )
    c. Before cooking( )
    d. After using the toilet( )
    e. Other

    specify……

    ……
49. Is hand washing done in specific place?
    a. Yes( )
    b. No( )
50. If no where do you usually wash your hands?
    a. At the water source( )
    b. In the latrine( )
    c. Near the latrine( )
    d. In the kitchen area( )
    e. Other

    specify……

    ……
51. Do you have any of these facilities in your household?
    a. Pit latrine( )

b. VIP latrine( )
c. Bucket latrine( )
d. Other

specify……

……

52. Do you produce any solid waste in your household?

a) Yes ( )
b) No ( )

53. If yes which one (s) do you generate?

a) Plastic
b) Paper bags
c) Sawdust
d) Other

specify……

……

……

54. How do you dispose your solid waste materials in your household?

a. Burn( )
b. Reuse( )
c. Recycle( )
d. Throw away( )
e. Other

specify……

……

55. How do you dispose used water from household?

a. Reuse( )
b. Garden( )
c. Ground( )
d. Pit( )
e. Other

specify……

……

SECTION D: WATERBORNE DISEASES INFORMATION

56. Has anyone suffered from any of these diseases in your household in the past one year?

a) Malaria( )

b) Typhoid( )

c) Diarrhea ( )

d) Cholera( )

e) Amoeba( )

f) Skin infection ( )

g) Eye infection( )

h) Other

explain……

……

……

……

SECTION E: OBSERVATION CHECKLIST

57. How many meters are the latrines located from the household?
58. What is the condition of the storage containers in terms of whether covered or not and cleanliness?
59. How are solid wastes managed within the household

Appendix 2: Occurrence of Water Related Diseases in Hospitals

My name is Ngaruiya Faith. I am a student of Egerton University taking a Master's Degree in Environmental and Occupational Health. This questionnaire is for the purpose of collecting data on water related diseases and information to aid in research that I'm conducting. The information given will be treated with utmost confidentiality. Your assistance will be highly appreciated.

Name of the Hospital: …… Date of visit: ……

Name of clinician: …….

1. Are there any reported cases of water related diseases for the past one year in this hospital?
    a. Yes ( )
    b. No( )
2. If yes, what are the diseases?
    ……
    ……
    ……

Name of Disease	Children		Elderly (55- 70 yrs)	Adults (18 – 54yrs)		Month of disease incidence
	Male(0-5 yrs)	Female 0 - 5yrs)		Males	Females	
Typhoid						
Skin Infections						
Amoeba						
Cholera						
Diarrhea						
Eye infections						
Diarrhea						

Appendix 3: Fish Handling and Processing at Kampi Samaki

Characteristics	Valid percent	Characteristics	Valid percent	Characteristics	Valid percent
Where are the harvested fish placed		Frequency of washing Fishing gears		Agent used in washing the surfaces	
Plastic surface	79			Water only	30
		Daily	57	Soap and water	65
Sack surface	21	Monthly	18	Ash and water	2
Tree species used in smoking/drying		Frequency of washing the surfaces where fish are placed		Soil and water	3
Prosopis juliflora	92	Daily	100		
Acacia tortilis	8				

Appendix 4: Sanitation Information at Kampi Samaki

Characteristics	Valid percent	Characteristics	Valid percent	Characteristics	Valid percent
Sanitation facility presence		Sanitation facilities available		Distance of sanitation facility to water source	
Yes	74.0	Pit latrine	72%	5-10metres	8.0
No	26.0	VIP latrine	1%	10-15metres	5.0
		Bucket latrine	1%	15-20metres	32.0
		No latrine	26%	Above 20metres	29.0
				N/A	26.0

Appendix 5: Relationship between Water Sanitation and Hygiene Attributes and Water borne diseases in Kampi Samaki

Waterborne Diseases	WASH Attributes	B	Std. Error	df.	EXP(B)
Amoeba	Intercept	-34.507	2902.673	1	
	Drinking water treated	-1.358	1.035	1	.257
	Drinking water not treated	0[b]	.	0	.
	Livestock drink from the same water source	.442	1.269	1	1.555
	Livestock don't drink from the same source	0[b]	.	0	.
	Children access drinking water themselves	.890	1.014	1	2.435
	An adult fetches drinking water for children	0[b]	.	0	.
Skin disease	Intercept	-19.326	4426.320	1	
	Drinking water treated	-.882	1.146	1	.414
	Drinking water not treated	0[b]	.	0	.
	Livestock drink from the same water source	.634	1.321	1	1.885
	Livestock don't drink from the same source	0[b]	.	0	.
	Children access drinking water themselves	1.771	1.210	1	5.878
	An adult fetches water for children	0[b]	.	0	.
	Used water disposed in the garden	1.167	1.655	1	3.211
	Used water disposed on the ground	.702	1.317	1	2.018
	Used water disposed in the pit	0[b]	.	0	.

Appendix 6: Plates Showing Related Fish Handling and Processing Activities

Male fisherfolk offloading the harvested fish and giving it to the female fisherfolk for processing (Plate 4.1)

Plate 4. 1: Male fisherfolk off loading at Kampi Samaki

The different species harvested from Lake Baringo ready for gutting and processing (Plate 4.2)

Plate 4. 2: Different fish species landed in Kampi Samaki

Female fisherfolk gutting the harvested fish using sharp knives using bare hands (Plate 4.3)

Plate 4. 3: Female fisherfolk gutting landed fish

The raised racks used by female fisherfolk for fish Sun-drying on the open sun at Kampi Samaki (Plate 4.4)

Plate 4. 4: Fish Sun-Drying at Kampi Samaki

One of the smoking kilns used in fish smoking at Kampi Samaki. It has black soot that has formed due to smoke production during the process (Plate 4.5).

Plate 4. 5: Smoking Kiln used in Kampi Samaki

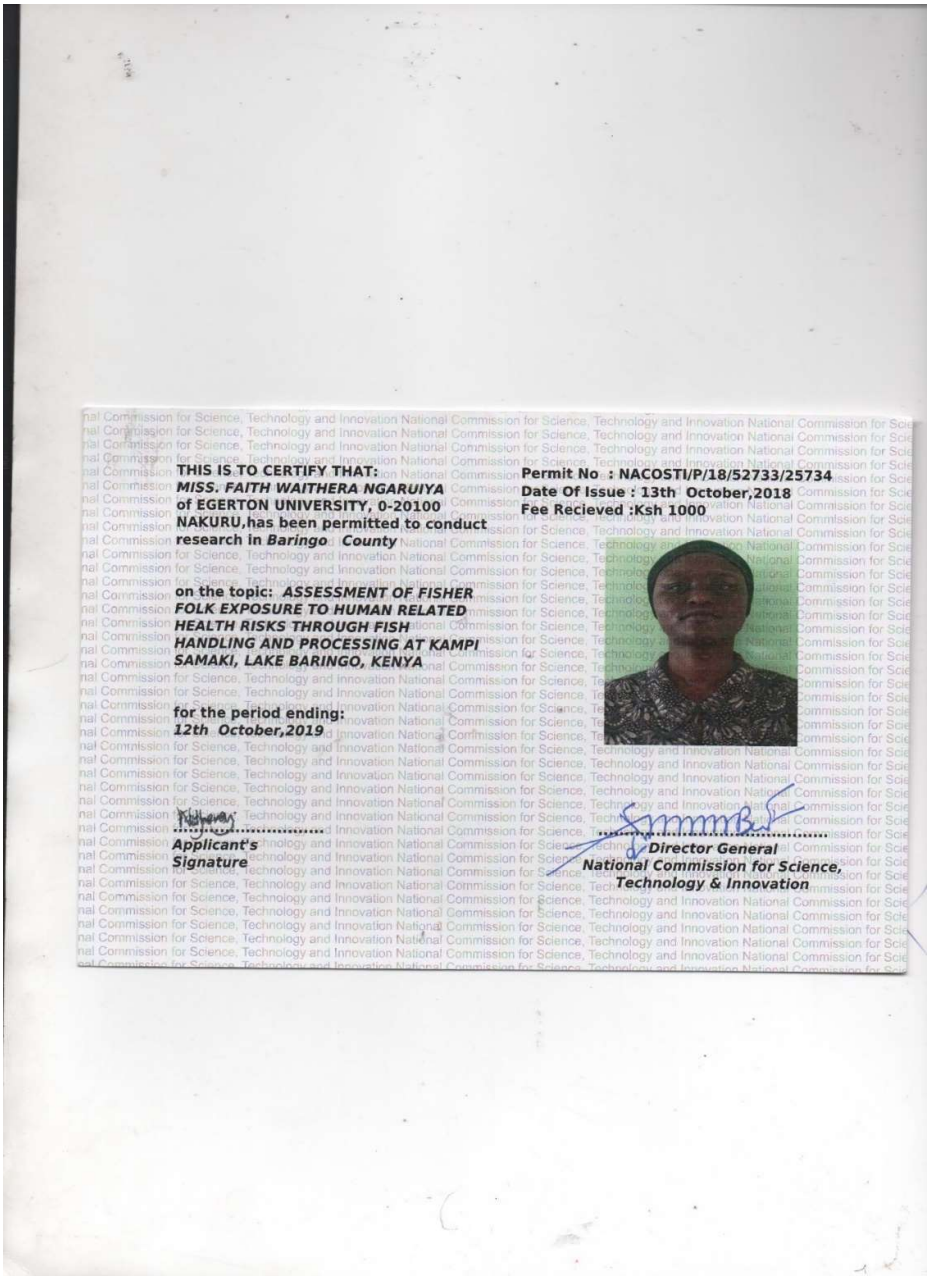
Fish deep frying by use of wood fuel that release smoke in the process (Plate 4.6)

Plate 4. 6: Fish Deep Frying at Kampi Samaki

Spine of Clarias gariepinus responsible for pricking fisherfolk when handling with bare hands (Plate 4.7)

Plate 4. 7: Spine of *Clarias gariepinus* at Kampi Samaki

Appendix 7: NACOSTI Research Permit



THIS IS TO CERTIFY THAT:
MISS. FAITH WAITHERA NGARUIYA
of EGERTON UNIVERSITY, 0-20100
NAKURU,has been permitted to conduct
research in *Baringo County*

on the topic: *ASSESSMENT OF FISHER FOLK EXPOSURE TO HUMAN RELATED HEALTH RISKS THROUGH FISH HANDLING AND PROCESSING AT KAMPI SAMAKI, LAKE BARINGO, KENYA*

for the period ending:
12th October,2019

Permit No : NACOSTI/P/18/52733/25734
Date Of Issue : 13th October,2018
Fee Recieved :Ksh 1000

.....
Applicant's Signature

.....
Director General
National Commission for Science, Technology & Innovation

Appendix 8: Occupational Health Risk and Hazards among the Fisherfolk in Kampi Samaki, Lake Baringo, Kenya

Occupational Health Risks and Hazards Among the Fisherfolk in Kampi Samaki, Lake Baringo, Kenya

Faith Waithera Ngaruiya[1], George Morara Ogendi[1,2] and Millicent A Mokua[1]

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ABSTRACT: Globally, almost 2.78 million deaths that occur annually are attributed to work-related health risks. Worldwide and, especially, in developing countries, about 20% to 50% of the workers are exposed to health risks. Fishing is an ancient occupation, and like many others, it is characterized by numerous health risks and hazards. This study sought to understand the exposure of fisherfolk to human health risks, through fish handling and processing in Lake Baringo, Kenya. The study adopted a cross-sectional social survey design. A systematic random sampling technique was used to select respondents for this study. A semi-structured questionnaire was administered to the respondents to collect data on risks involved during the handling and processing of fish. Key informant interviews and observation checklists were also used to collect more information. Both descriptive and inferential statistics were used to analyze data. Inferential statistics included Pearson χ^2 test, which was used to test the association of various factors on the encounter with occupational health risks. The level of significance was tested at $\alpha = 0.05$. The study findings reveal the fisherfolk-encountered risks such as cuts, eye irritability, sunburns, skin burn, cold, falls, and musculoskeletal injuries during their work. The results showed that only 12% of the fisherfolk use personal protective equipments (PPEs) at work. Pearson χ^2 test analysis showed there was an association between gender and gender roles ($\chi^2 = 39.517$, $P < .05$). In addition, an association was revealed between occupational health risks and gender ($\chi^2 = 16.283$, $P < .05$). There was also an association between occupational hazards and gender ($\chi^2 = 21.352$, $P < .05$). However, there was no association revealed between occupational health risk and marital status ($\chi^2 = 1.305$, $P > .05$) and PPEs ($\chi^2 = 1.089$, $P > .05$). Furthermore, results indicate that 61% of the fisherfolk who suffered from occupational health risks missed work. The study concludes that all the fisherfolk at Kampi Samaki are exposed to various health risks while working, which is thus likely to affect their health. We recommend public health campaigns to sensitize fisherfolk on the associated risks in fish handling and processing. There is also a need for health campaigns for the fisherfolk to appreciate the need for First Aid Kits during the fishing operations.

KEYWORDS: Fisherfolk, occupational health risks, injuries, Lake Baringo

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