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

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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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Introduction

Fisheries can be either inland or marine. Marine fisheries involve seas and oceans while inland involves freshwater such as lakes and rivers. In addition, fisheries may involve aquaculture or wild fish capture from marine or freshwater. Ten percent of the world's fisheries come from inland waters as opposed to oceans and seas.¹

Small-scale inland fisheries play an important role in the achievement of the post-2015 United Nations Sustainable Development Goals (SDGs) 1, 2, and 3: poverty alleviation, end hunger, and ensuring healthy lives, respectively.² In Kenya, fisheries employ approximately 2 million people.³ With employment creation, more people earn a living, thus helping to reduce poverty and end hunger as the fisherfolk will be able to buy food, which is a basic need. Fish is an important source of proteins, vitamins, and minerals fundamental for human health, which thus helps in the achievement of SDG 3 on ensuring healthy lives.^{4,5}

Fish is of high nutritional value as it contains proteins, omega-3 fatty acids, vitamin D, calcium, B vitamins, vitamin A, iron, zinc, and lysine, which boost consumers health.^{4,6} Fish consumption has many health benefits: improve oxygen transport in the body, increase energy, reduce risk of blood pressure

and arthritis, and enhance development of child brain. The demand for fish is therefore on the increase due to its high nutritional value, which is important for human health.⁵⁻⁷

Despite the many benefits derived from fisheries, numerous health and safety issues ranging from physical, chemical, ergonomic to bacteriological are involved.⁸ Globally, approximately 2.78 million deaths occurring yearly are attributed to work-related hazards.⁹ Worldwide, 20% to 50% of the workers, especially in developing countries, suffer from occupational risks and experience great losses.¹⁰ Although fishing is the oldest, it is considered to be one of the riskiest occupations in the world.^{11,12}

Different injuries have been reported in fishing industries, including, cuts, eye irritability, skin burns, falls, sunburns.¹³⁻¹⁵ Moreover, smoke inhaled during fish smoking process increases the risk of developing asthma and eye problems.¹⁶ In Ghana, 1126 of 1340 fisherfolk reported that they were suffering from eye problems: ocular irritability, pain, and blurry vision.¹⁷ In addition, smoked fish has also been reported to contain carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs) residues that pose potential threats to fisherfolk as well as other consumers.¹⁸⁻²⁰ Fisherfolk in marine and inland fisheries experience injuries that affect negatively on their health.²¹



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Handling of fish with bare hands results in injuries such as bites and pricks by spines and fins. Catfish species such *Clarias gariepinus* have strong pectoral fins with spines and sharp small teeth capable of pricking and biting fisherfolk, respectively.²² Fisherfolk reported having experienced fish bites from sharks and pricks from catfishes and stingrays in Nigeria.¹² Lungfish species such as *Protopterus aethiopicus* have tooth plates in the form of cutting very sharp ridges, which can cause bite injuries to fisherfolk.^{12,23} In an Andalusia community in Spain, 247 fisherfolk (87%) reported to have experienced health problems, namely, respiratory problems, eye problems, skin problems, and musculoskeletal injuries as a result of lifting, pulling, and transporting heavy fish loads.²⁴ In Bangladesh, 45% of the fisherfolk reported to have suffered from sunburns due to long exposure in the open sun.²⁵

Fatalities in fishing industries have been reported in Australia, the United States, Canada, Spain, Korea, Estonia, Italy, Poland, and the entire world at large.^{26,27} In America, fisheries is among the industries that contributed to the rise of injuries by 284 in 2015 along with farming and forestry which have been the highest recorded rise in 7 years.²⁸ Between 1996 and 2015, the injury rate in fisherfolk has been recorded in Finland with 40% occurring aboard, 11% occurring in the lake, and 37% occurred ashore.²⁹

Personal protective equipments (PPEs) are important in reducing occupational injuries in fisherfolk.³⁰ Protective gloves are important in preventing fisherfolk from cuts by sharp knives, razor blades, pricks from fish spines, and bites. Eye goggles help prevent direct sunlight from the eyes of fisherfolk. Nose masks are important in reducing smoke inhalation during fish smoking process.^{30,31} Gloves and overalls protect fisherfolk from fish spines.^{32,33} A study conducted in India reported that the use of latex gloves by fisherfolk reduced hand freezing when handling frozen fish while processing. Moreover, 84% of the female processors in India never showed any cold-induced symptoms on hands as a result of using protective gloves.³⁴ Due to the many occupational hazards and risks involved in the fishing industry, PPEs are important as they reduce the exposure to these health risks and hazards. Lack of use of PPEs increases contact with these hazards, which thus put their health at risk of cuts, eye problems, and burns.^{13,32,34}

A healthy and safe environment promotes productivity as it reduces time lost in work in case of injury.³⁵ Despite the numerous documentation on occupational health risks in fishing industries, there is limited awareness on the occupational hazards in the fishing sector, especially in the developing nations, and more specifically for inland fisheries. There exist the Occupational Health and Safety Act in Kenya addressing the health and welfare of workers.³⁶ However, the shortcomings in the enforcement of the Act have not led to significant reductions in the number of health risks encountered in this sector. This article presents the findings of a study that assessed the fisherfolk exposure to health risks through fishing at Kampi Samaki, Lake Baringo, Kenya.

Materials and Methods

Study setting

The study was conducted at Kampi Samaki, a village located on the shores of Lake Baringo, Baringo County, Kenya (Figure 1). It is 1054 m 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. Lake Baringo is a freshwater lake, located about 150 km North of Nakuru town at 0°38'N 36°05'E. It has a surface area of about 130 km², which may rise to 168 km² during the rainy seasons, and an altitude of about 1100 m and is surrounded by mountains rising to almost 3000 m.a.s.l. The lake is fed by 2 permanent rivers, Molo and Perkerra, and seasonal rivers Ol Arabel, Dau, Mugurn, Chemeron, Makutan, Tangelbei, and Endao.³⁷ According to the population and housing census conducted in 2009, the population size of Baringo County was 555 566, consisting of 279 081 males and 276 480 females. The county growth rate is 3.3% per annum, which is above the national average of 3%.³⁸

Target population, sampling, sample size

The sampling unit for this study was the fisherfolk living in Kampi Samaki, Baringo County, Kenya. The sample population was fisherfolk aged at least 18 years and above.

Systematic random sampling was used in the selection of respondents in Kampi Samaki. According to Kenya population and housing census of 2009, there are 300 households at Kampi Samaki.³⁸ The 2009 Kenya population statistics was used because it is the latest census done in Kenya. The Nassiuma 2000 formula, $n = NC^2 / (C^2 + (N - 1)e^2)$, was used to estimate the sample size, where n is the estimated sample size, N is the total number of households in the study area (300 households), C is coefficient of variance (30%) and e is the margin of error (0.03).³⁹ Using the Nassiuma formula, a sample size of 100 households was obtained.

Research design and instruments

The research design adopted was a cross-sectional social survey. Based on prior studies on occupational health risks and hazards, a semi-structured questionnaire and observation checklist were adopted.^{13,15-20,25} The questionnaires were then administered to the respondents to collect socioeconomic data and occupational health hazards and risks the fisherfolk at Kampi Samaki are exposed to. More information on occupational risks were explored through interviews with local community and from secondary literature sources.

Two research assistants were trained on data collection, including questionnaire administration. The researcher supervised the administration of the questionnaires and key informant interviews.

Before the actual study, a pilot study was conducted at Salabani, a fishing landing site in Lake Baringo, which had similar ecological conditions to pretest the tools. The respondents

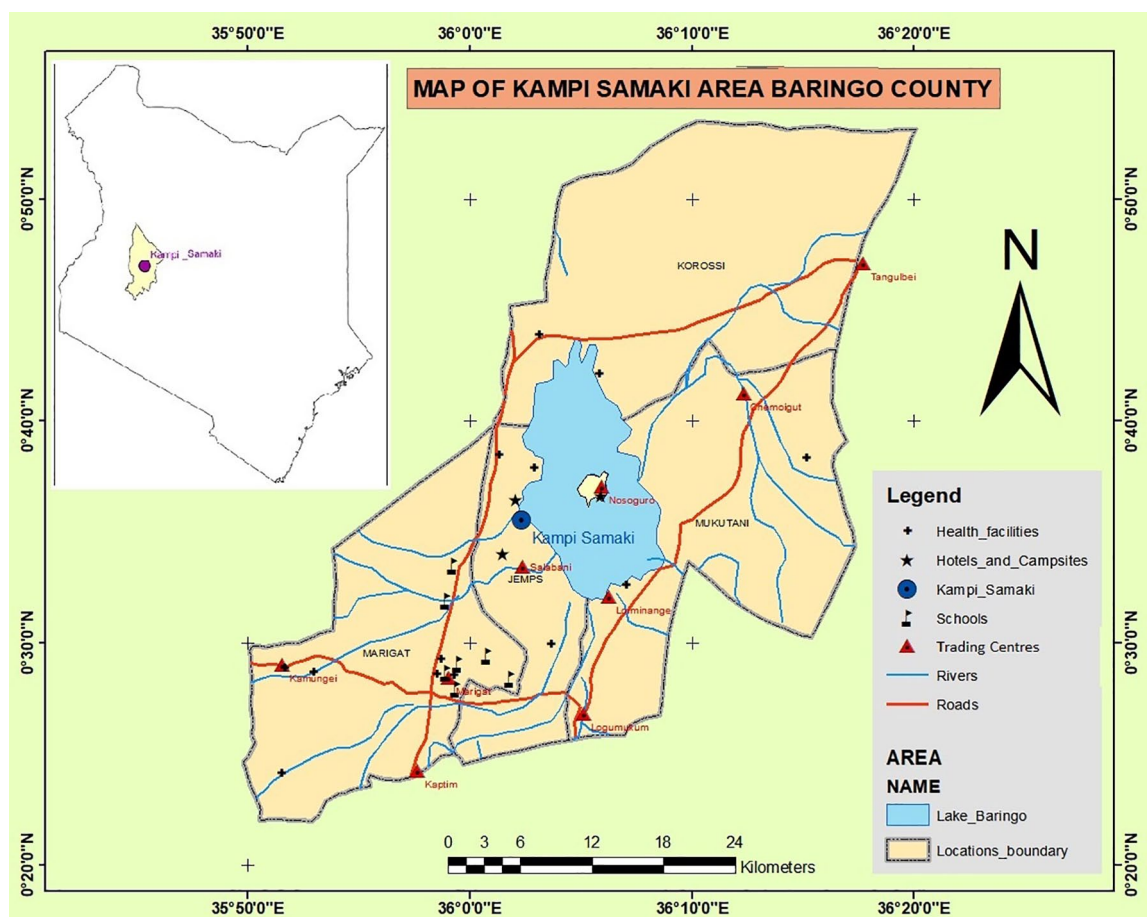


Figure 1. Map of the study area.

Source: Topographic map of Kenya; Scale 1:100 000, Field survey.

were given semi-structured questionnaire and were exposed to the same questions. The same coding system was used to record their responses throughout the study. In-person interview procedure was used to assist the respondents without formal education. This ensured that all the questionnaires were filled.

Data management and analysis

Data collected were organized, coded, and entered in SPSS software 20.0. Both descriptive and inferential statistics were used in analyzing socioeconomic data and occupational health hazards and risks involved in fish handling and processing at Kampi Samaki. Pearson χ^2 test was used to show associations between various variables: the gender of the respondent and the role he or she played as fisherfolk; gender and occupational hazard; gender and occupational health risks; PPEs and occupational health risks; marital status and occupational health risks. The level of significance was tested at $\alpha = 0.05$. Pie charts, graphs, and tables were used to represent the data.

Measurement of dependent variable

The dependent variable, occupational health risks, measured in the study included eye irritability, nose irritability, cuts, sun-burns, cold, pricks from spines, and musculoskeletal injuries.

The occupational health risks variable was measured based on the number of fisherfolk who recorded to have suffered from the health risk(s) included in the study. Frequencies and valid percentages were used to analyze the descriptive data.

Ethical issues

Before data collection, approval to conduct this research was sought from the National Council for Science and Technology (NACOSTI). Approval was granted and a permit was issued (Permit No. NACOSTI/P/18/52733/25734). Further ethical clearance was given by the Bioethics Research Committee under the Division of Research and Extension of Egerton University. Finally, the researchers sought informed consent from the respondents who participated in the study.

Results

Characteristics of study participants

There was a 100% response rate. Of the total 100 respondents, 52% were male fisherfolk, whereas 48% were female fisherfolk (Figure 2). A total of 60 respondents were married (Figure 3). As shown in Figure 4, 48% of the respondents had attained primary level of education and only 5% had tertiary level of education (Figure 4). A total of 51% of the respondents were in

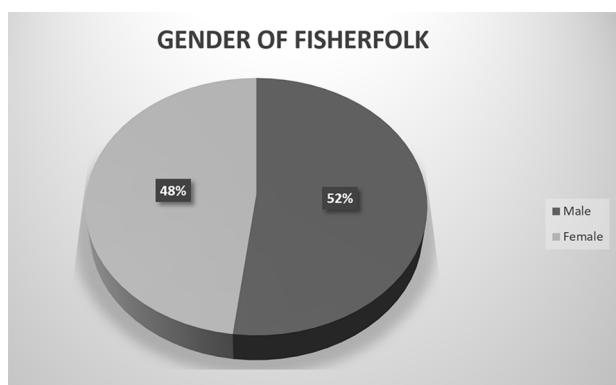


Figure 2. Demographic information of the respondent (n = 100 fisherfolk).

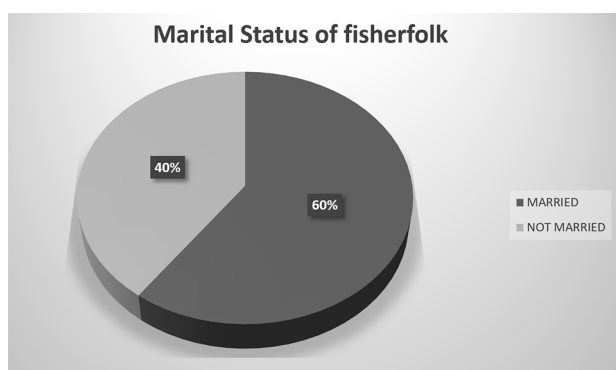


Figure 3. Marital status of the respondent.

the 22 to 34 years age bracket, 29% in 35 to 45 years, and 12% in the 45+ years (Figure 5).

Respondents in the study area encountered numerous occupational hazards. According to the study results, the occupational hazards encountered include sharp knives/razor blades (24%), spine (18%), and sunrays (9%) (Table 1).

As shown in Table 2, 20% of the respondents suffered from cuts and pricks from fish spines. A total of 61% respondents indicated to have missed work as a result of occupational health risk encountered. Of the total respondents, 88% did not wear any personal protective clothing (Table 2).

Pearson χ^2 tests were run to evaluate whether there was a significant association between gender of respondent and the role played at Kampi Samaki: various variables and occupational health risks and hazards at Kampi Samaki. There was a significant association between gender of respondent and the role played ($\chi^2=39.517, P<.05$) (Table 3). The male respondents were likely to be involved in fish harvesting as compared with female respondents who were involved in fish processing.

There was a significant association between gender of respondents and occupational hazards encountered at Kampi Samaki ($\chi^2=21.352, P<.05$). The female respondents were more likely to encounter smoke, sharp knives/razor blades, hot oil, and slippery floors as compared with male fisherfolk (Table 4).

Table 5 shows that there was an association between gender of respondent and occupational health risk experienced at

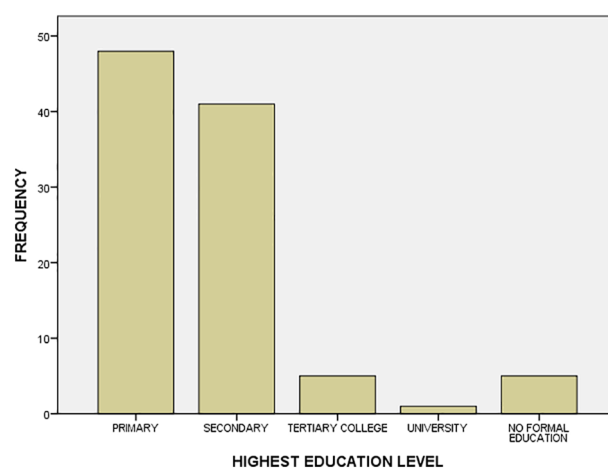


Figure 4. Highest level of education of the fisherfolk.

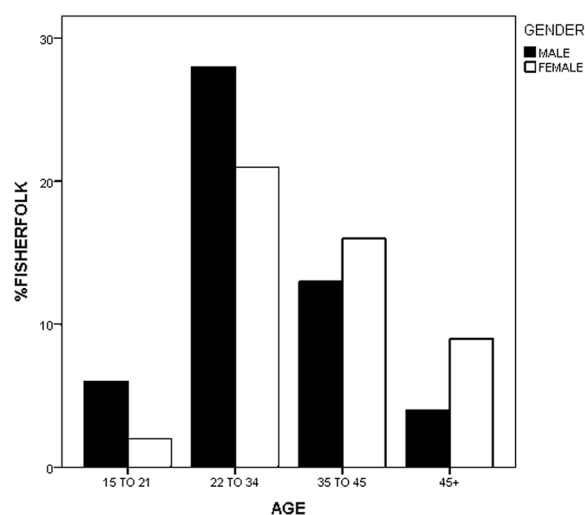


Figure 5. Age of the fisherfolk as stratified by gender.

Table 1. Occupational hazards encountered at Kampi Samaki.

CHARACTERISTICS	FREQUENCY	VALID %	N = 100
Experienced hazards			
Yes	100	100	
Occupational hazard encountered			
Smoke	6	6	
Sharp knives/razor blades	24	24	
Sunrays	9	9	
Heavy fish loads	19	19	
Hot cooking oil	3	3	
Cold condition	15	15	
Spine	18	18	
Slippery ground	6	6	

Table 2. Occupational health risks encountered by fisherfolk at Kampi Samaki.

CHARACTERISTICS	FREQUENCY	VALID %
Occupational risks experienced in fishing industry		
Cuts	7	7
Sunburns	3	3
Falls	1	1
Cold	13	13
Musculoskeletal injuries	17	17
Pricks from spines	10	10
Cuts, pricks from spines	20	20
Cold, musculoskeletal injuries	17	17
Eye irritability, nose irritability	7	7
Skin burns, cuts	5	5
Have any of the hazards caused you to miss work		
Yes	61	61
No	39	39
Do you wear any protective clothing		
Yes	12	12
No	88	88
Protective clothes used		
Heavy clothes	6	6
Gumboots	1	1
Cap	1	1
Eye glasses	4	4
No protective clothing	88	88

Kampi Samaki ($\chi^2 = 16.283$, $P < .05$). Female respondents are likely to suffer from the occupational health risks indicated as compared with the male respondents (Table 5).

There was no association between occupational health risks and use of PPEs ($\chi^2 = 1.089$, $P > .05$) (Table 6). There was no association between marital status of the respondents and occupational health risks experienced ($\chi^2 = 1.305$, $P > .05$) (Table 7). However, married respondents suffered more from the occupational health risks as compared with those who are not married. Respondents experience different occupational health risks that arise from the activities they are involved in fishing at Kampi Samaki (Table 8).

Discussion

Characteristics of fisherfolk at Kampi Samaki

The study findings showed that the majority of the male fisherfolk were involved in fish harvesting, and females in fish

processing. Male fisherfolk dominate fish harvesting as it is believed to be a more risky task, which is thus reserved for men.⁴⁰ Furthermore, the majority of the world's small-scale fishing communities prescribe male to be the primary producers.⁴¹ A study on lifestyle and socioeconomic characteristics of fishers in South Africa indicated that men have a greater propensity to be fish harvesters.⁴² Roles played by fisherfolk expose them to different occupational hazards and risks.^{17,24,25,34} 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.^{13,34} Tripathi et al⁴³ reported a significant statistical association between gender of fisherfolk and health problem due to work, where more female than male fisherfolk 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 with those in a study on perceptions of occupational risk, which reported low levels of education among fisherfolk in the United States.⁴⁴ Kyei et al¹⁷ 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.⁴⁵ 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 the chances of an encounter with occupational risks and hazards.⁴⁶ A study by Budhathoki et al⁴⁷ reported that education increased knowledge and awareness of occupational hazards among welders in Eastern Nepal. According to Percin et al,⁴⁸ high levels of education were also associated with less occupational risks as compared with low levels of education.

This study revealed that the majority of the fisherfolk were in the age bracket of 22 to 45 years. In a study on effects of occupational health hazards in Nigeria, only 10.83% of the fisherfolk were reported to be 50 years and above, revealing that the majority were in their active ages than the relatively old age.⁴⁹ Oyediran et al⁵⁰ also found that the majority of the fisherfolk were below 35 years, who are thus in their economically active age groups. The younger the fisherfolk, the higher the chance of experiencing occupational hazards and risks. Tadesse et al⁵¹ also reported greater odds of hazards awareness to be 6 times higher among employees who had longer job experience as compared with those who had less experience. In a study on the 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.⁴⁴ In addition, Breslin et al⁵² reported that younger workers had 1.2 to 2 times higher rate

Table 3. Gender roles at Kampi Samaki.

ROLE PLAYED	GENDER OF THE RESPONDENTS, %		PEARSON χ^2 VALUE
	MALE	FEMALE	
Fish harvest	79.41	20.59	$\chi^2=39.517, P < .05$
Fish processing	11.11	88.89	
Fish harvest and selling	100	0	
Fish processing and selling	11.11	88.89	

Table 4. 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	$\chi^2=21.352, P < .05$
Sharp knives/razor blade	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	

Table 5. Occupational health risks as stratified by gender of fisherfolk at Kampi Samaki.

OCCUPATIONAL HEALTH RISK	GENDER, %		PEARSON χ^2 VALUE
	MALE	FEMALE	
Cuts	14	86	$\chi^2=16.283, P < .05$
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	

of occupational risk as compared with older ones. The less experience of younger workers in their job causes them to overestimate their physical capabilities or underestimate the safety and health associated with their role.⁵³

This study also pointed out that 60% of the 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 al⁵⁴ 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 well-being by risking their own lives in fishing even when weather conditions are unfavorable compared with the unmarried.¹⁴ However, in a study by Whitlock et al,⁵⁵ drivers who were

Table 6. Occupational health risks as stratified by PPEs used by fisherfolk.

OCCUPATIONAL HEALTH RISKS	PPES, %		PEARSON χ^2 VALUE
	YES	NO	
Cuts	19	81	$\chi^2 = 1.089, P > .05$
Sunburn	50	50	
Falls	0	100	
Cold	9	91	
Musculoskeletal injuries	11	89	
Pricks from spine	7	93	
Cuts, pricks from spine	0	100	
Cold, musculoskeletal injuries	0	100	
Eye irritability, nose irritability	22	78	
Skin burn, cut	0	100	

PPES, personal protective equipments.

Table 7. Occupational health risks as stratified by marital status of the fisherfolk.

OCCUPATIONAL HEALTH RISKS	MARITAL STATUS, %		PEARSON χ^2 VALUE
	MARRIED	NOT MARRIED	
Cuts	76	24	$\chi^2 = 1.305, P > .05$
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	

unmarried were at a higher risk of driver injury as compared with the married people.

Occupational hazards and risks at Kampi Samaki

The fishing sector like any other industries is faced with different occupational hazards and risks.¹⁰ This study also assessed the potential occupational hazards and risks to fisherfolk associated with fish handling and processing. Fisherfolk reported to have encountered hazards in their daily fish handling and processing activities. Different studies have revealed that fisherfolk experience occupational hazards and risks.^{6,12-14} In a study on occupational hazards and injuries, fisherfolk in Nigeria reported to have suffered from cuts, burns, eye redness, cuts from sharp

knives, and pricks from fish spines.¹³ Moreover, a study by Kyei et al¹⁷ reported ocular disorders among fisherfolk in Ghana as a result of smoke and sun rays. Due to a number of hazards involved, the fishing industry is reported in different studies as one of the most dangerous occupations in the world.^{56,57}

Fisherfolk from Kampi Samaki reported to have experienced cuts. Most female fisherfolk (86%) experienced cuts as compared with 14% of the males. From the study, male fisherfolk who dominate fish harvesting experience cuts from hooks attached on the longline gears used in fish harvesting. This occurs when the fisherfolk unhook the harvested fish and when attaching baits onto the hooks. In addition, female fisherfolk who dominate fish processing experience cuts from sharp razor blades and knives used in gutting and descaling.¹⁰ These cuts

Table 8. Occupational health risks encountered and activities involved.

HEALTH RISKS	ACTIVITY (MALE)	ACTIVITY (FEMALE)
Cuts	Cuts from hooks while using longline during fish harvesting.	Fish handling; experience cuts from sharp razor blades and knives they use during gutting and scale removal
Sunburns and skin burns	During fish harvesting as they work under the open sun.	Fish processing as they work in the open environment, thus exposed to direct sun and skin burns during deep frying.
Musculoskeletal injuries	From pulling nets with harvested fish into the fishing vessels, as well as offloading.	Transport the harvested fish from shores of Lake Baringo to the processing site by shoulders, head, and back.
Pricks and bites	Fish harvesting male fisherfolk experience pricks from fish spines and bites from fish as they handle the fish with bare hands	Experience pricks from fish spines and from fins as they use their bare hands during the gutting, scale removal, and processing.
Eye irritability	Eye irritability due to extreme exposure to the sun	Eye irritability as their eyes are exposed directly to smoke during fish smoking.
Nose irritability	Not applicable	Suffer from nose irritability as they inhale smoke during fish smoking and deep frying as they use wood fuel.
Cold and falls	Exposed to cold environment as they operate early in the morning and fall due to slippery vessel surfaces	Exposed to cold during rainy seasons and the floors become slippery

are minor and nonfatal but, if left unattended, may result into infections.^{58,59} The majority of the respondents never reported missing work due to cuts as they were considered minor incidents.¹² A study on occupational health in the Andalusian fisheries sector reported that a number of fisherfolk had experienced cuts during work.²⁴ Different studies done on occupational hazards and risks in fisheries have also reported that fisherfolk had suffered from cuts.^{13,58,60,61} These findings are similar to other findings in a study done on health and hazards complaints among fish processors in India.³⁴ Cuts expose workers to virus infections, biological agents, and tetanus.^{62,63}

Extreme cold condition was also reported to have been experienced by fisherfolk in the study area. Fish harvesting is done early in the morning. They experience extreme cold conditions resulting into respiratory irritability (sneezing and coughing). During cold and rainy seasons, fisherfolk are exposed to extreme weather conditions as they operate in the open. In Nigeria, reports also reveal that fisherfolk encounter cold from their working environment, which results in respiratory irritability.¹³ Bhavya et al⁶⁴ also found out that female fisherfolk experience cold from their working environments.

Fifty-six percent of the male and 44% female fisherfolk reported that they were suffering from musculoskeletal injuries. These are caused by lifting and pulling of harvested heavy fish loads into the fishing vessels and offloading them.¹¹ Musculoskeletal injuries have been reported to arise from repetitive lifting of heavy nets and objects by the fisherfolk.⁶ Male fisherfolk suffer from musculoskeletal injuries by pulling in the fishing gears with harvested fish into the canoes and offloading them. Moreover, female fisherfolk transport the harvested fish to Kampi Samaki resulting into musculoskeletal injuries. In another study done in Alexandria, 91% of the fisherfolk reported to have suffered from musculoskeletal injuries.⁵⁶ These findings are consistent with those from a study on

some hazardous practices associated with artisanal fish processing in Ogun waterside local government area of Ogun State, Nigeria. The study revealed that fisherfolk were suffering from musculoskeletal injuries.⁴⁹ Another study on occupational hazards and injuries associated with fish processing in Nigeria revealed fisherfolk suffered from musculoskeletal problems.¹³ Moreover, a study done in Bangladesh reported that 75% of the fisherfolk were also suffering from musculoskeletal injuries.²⁵ Nag and Nag³⁴ also reported musculoskeletal complaints among 67% of the female fisherfolk in India.

Eye and nose irritability were also experienced by fisherfolk in the study area. From this study, all female fisherfolk are exposed to smoke hazard, unlike male fisherfolk. These findings are similar to those of a study done in Ghana that reported more than 50% fish processors, majorly female, have been more exposed to smoke hazard, unlike their male counterparts.¹⁷ During smoking and deep frying of fish, the smoke from burnt wood in Kampi Samaki comes into contact with their eyes and noses directly, causing pain and itching. Similar findings have reported eye problems among female fish smokers in a study conducted in Abuesi, a Ghanaian fishing community.¹⁶ Oyediran et al⁴⁹ also reported 28.33% of the fisherfolk to be more exposed to smoke during the fish smoking process in Ogun State, Nigeria. Exposure to smoke hazard increases risks of asthma attacks, blurred vision, itching, eye redness, and coughs.^{11,13} In addition, wood fuel used during smoking process exposes fish to PAHs, which are carcinogenic. This poses a serious health hazard to both fisherfolk and consumers.⁶⁵ However, 56% of the male fisherfolk at Kampi Samaki reported that they were exposed to excessive reflection of sunrays, which majorly results into eye irritation. Kyei et al¹⁷ also reported that more than 50% male fisherfolk who dominated fish harvesting in Ghana indicated exposure to sun rays hazard as the main reason for eye problems experienced in the region.

Furthermore, fisherfolk experience skin burns in the study area. All the female fisherfolk reported to have been exposed to hot cooking oil that causes skin burns. These burns ranged from mild to severe. Skin burns result in loss of working hours depending on its severity.¹³ Skin burns also result in open wounds that act as pathways to pathogens that cause infections.^{66,67} Jeebhay et al⁶⁸ also reported that allergens from fish juices may find their way to fisherfolk body through open wounds.

Fisherfolk at Kampi Samaki also reported to have encountered pricks and bites. Fisherfolk suffer from bites and pricks from spines and fins from the fish harvested in Lake Baringo. *C gariepinus* has spines, which are hard and do puncture the skin of the fisherfolk causing injury. Both *C gariepinus* and *P aethiopicus* have very strong sharp teeth, which may bite through the skin of the fisherfolk, especially when handled alive. *Barbus intermedius*, *Oreochromis Niloticus Baringoensis*, and *Labeo cylindricus* have fins, which prick fisherfolk too.^{13,22,23} If the wounds are not treated, they create a gateway for infections.¹³ This is in line with a study done on occupational health hazards on artisanal fish production in Ogun State, Nigeria, that reported 78.3% of the fisherfolk to experience pricks and bites in their fishing activities.⁴⁹ Moreover, a study done in Nigerian fisheries on occupational hazards revealed pricks and bites from fish as health risks among fisherfolk.¹² Another study that was undertaken in Okavango Delta fisheries in Botswana also revealed that fisherfolk experienced pricks and fish bites.¹⁴ Olaoye et al¹³ reported infections due to pricks and bites that caused amputation of fingers of fisherfolk.

Sunburns and falls were also encountered by fisherfolk in the study area. Fisherfolk activities such as fishing, handling, and processing are all performed outside, exposing them to sun radiations that cause sunburns. In a study done on occupational health in the Andalusian fisheries, it is reported that 54% of the fisherfolk suffered from skin injuries as a result of exposure to the sun.²⁴ Mandal et al²⁵ also reported that more than 45% of the fisherfolk were exposed to sunburns, which ranged from moderate to mild in Bangladesh. Saadawy et al⁵⁷ also reported 57.3% of the fisherfolk in Alexandria to suffer from sunburns. Exposure to sun rays increases the risks of skin cancer.^{69,70}

Falls also occur mostly on rainy days due to slippery floors. Another study on risk factors for fishermen's health and safety in Greece reported fisherfolk to have experienced falls.¹¹ The findings are similar to those from a study done in Okavango Delta, Botswana, that reported falls among 20.5% of the fisherfolk resulting into injuries.¹⁴ In addition, Bhavya et al⁶⁴ reported that female fisherfolk were more likely to fall while undertaking their work due to wet slippery floors.

Globally, exposure to occupational hazards is the leading cause of substantial disabilities.⁷¹ Health risks and injuries experienced in fishing industries result in absenteeism in work. This negatively affects productivity.³⁰ The use of PPEs such as protective gloves, nose masks, gumboots, caps, sunglasses, sunscreen

creams, and overalls has been reported to reduce injuries in fisheries.³⁰⁻³² According to a study by Jeebhay et al,⁶⁸ on fish processing workers, the use of appropriate gloves and plastic sleeves is fundamental in the prevention of infection and allergens from fish to the fisherfolk's skin. Another study on hazards and health complaints associated with fish processing activities in India indicated reduced cut injuries and hand temperature through the use of appropriate gloves.³⁴ Bull et al⁷² also reported increased protection against occupational risks by the use of PPEs. Different studies have reported the importance of PPEs in the prevention of occupational health risks at work.⁷³⁻⁷⁵

Conclusion and Recommendations

Results from this study show that fisherfolk experience numerous occupational health hazards and risks. The occupational hazards range from physical, chemical, and ergonomics. Occupational health risks lead to absence from work, thus affecting their productivity. Despite fisheries being a risky occupation, the fisherfolk at Kampi Samaki depend on it for livelihood, exposing them to potentially serious injuries, long-term health conditions, and death. The study findings also show that fisherfolk experience minor injuries, which, if left unattended, may result in serious long-term health risks. Therefore, fisherfolk should consider minor injuries, because, in the long run, it may result in serious health conditions. Although PPEs have proven to contribute to reduced occupational risks in other studies, only a small percentage of fisherfolk wear appropriate PPEs in this study. In addition, the gender of fisherfolk determined their roles in Kampi Samaki. The study findings further demonstrate that gender of the fisherfolk influenced the occupational health hazards and risks fisherfolk experience. Occupational health risks and hazards were the result of fish harvesting performed mostly by male and fish processing done by the female fisherfolk. Therefore, a consideration of fisherfolk's gender roles is fundamental to achieve occupational health and safety in fisheries.

There is a need for public health campaigns to sensitize fisherfolk on the associated health risks in fishing. Furthermore, there is a need to educate the fisherfolk on the Kenya Occupational Safety and Health Act and its importance in the protection of their health. There is also a need for health campaigns for the fisherfolk to appreciate the need for First Aid Kits during the fishing operations.

Limitations of the Study

First, the study did not research on stress levels among fisherfolk at Kampi Samaki. Second, the study did not research on the hazards involved when selling fish to customers.

Author Contributions

FWN, GMO, and MAM conceived and designed the study, agreed with the results, conclusions and came up with arguments for this manuscript. FWN analysed the data and wrote the first draft of the paper. All the authors made critical revision

and agreed on the final version of the manuscript. FWN, GMO, and MAM reviewed the final manuscript and approved it for submission.

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