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FOOD SAFETY KNOWLEDGE, ATTITUDES AND PRACTICES OF FISH HANDLERS IN KIRINYAGA COUNTY MARKETS, KENYA

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ABSTRACT

Fish and fish products have high nutritional value and are important in supplementing human diet. Fish products have little or no cholesterol and saturated fat, but instead have omega 3 and low-fat content essential for human health. Despite the high nutritional value of fish products, their consumption is hindered significantly by setbacks such as spoilage and foodborne diseases that spread through contamination in the fish supply chain. The objective of this study was to evaluate fish vendors' attitudes, knowledge, and practices on food safety in selected markets in Kirinyaga County that included Sagana, Tebere, Mwea, Ndia, Kianyaga, and Kerugoya markets. A structured questionnaire was administered to 54 fish vendors to collect information on fish safety, spoilage, risk factors, personal hygiene, food contamination, type of hazards, foodborne diseases and attitudes towards training on food safety. Statistical Package for Social Sciences (SPSS) version 22.0 was used to analyse the data from the respondents. The relationship between fish vendors' demographic characteristics and risk factors was assessed using Spearman's rank correlation coefficient. The majority of the fish vendors had a positive attitude towards education in hygiene practices (56%). There was a positive correlation between education and fish vendors' awareness of fish foodborne diseases at $p<0.05$. The study revealed that fish foodborne diseases awareness was positively influenced by respondents' level of experience and age. Moreover, there was also a significant ($p< 0.05$) positive correlation on the awareness of fish foodborne diseases with hygiene and food safety. Majority of the fish handlers had average level of knowledge, attitude and hygiene practices for food safety. These findings presented a foundation for formulating policies to increase food safety and hygiene practices of fish handlers in the region, thereby preventing foodborne diseases and postharvest losess. The results of this study can also form a basis for an indepth research for students and researchers in verious disciplines scuh as public health, marketing, community development and more.

Key words: Fish products, Food Safety, Knowledge and Attitude, Foodborne diseases

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INTRODUCTION

Fish and fish products have high nutritional value that is essential in the human diet [1,2]. These products are rich sources of minerals such as potassium, calcium, sodium and phosphorus, biomolecules including polyunsaturated fatty acids and protein [3]. Besides, they have relatively low-fat content, cholesterol, omega 3 and saturated fat. These nutritional benefits present better alternatives for consumers facing food insecurity challenges, especially in developing countries. Apart from dietary benefits, fish products are an essential source of revenue, especially for exporting [4]. In Kenya, fish products are a major source of income for fish vendors [5].

Currently, world fish production is estimated at 53.4 million tonnes accounting for 47.7 % of total aquaculture products [6]. Out of these, approximately 46.3 million tonnes are for human consumption [6]. It is also projected that the world's supply of fish for human consumption will decline significantly by the year 2050 due to population growth and the effects of climate change. Kenya has a long fishing history, with approximately 180,000 metric tonnes of annual consumption leading to importation to meet the domestic demand [7]. It is estimated that Kenya *per capita* annual consumption of fish is at 4.5 kg and is expected to increase in future [7]. Despite the high demand and increased handling of fish products, fish and fish products handling and safety guidelines in Kenyan markets are not adhered to, leading to public health threats [8].

According to Grace [9], food safety is vital and should be prioritized since fish and fish products are highly prone to rapid contamination. The safety concerns of fish and fish products include: unhygienic handling of the fish and fish products, insufficient refrigeration, substandard processing and poor packaging [10]. According to Torell *et al.* [11], the inability to adhere to fish safety measures negatively impacts fish and fish products because of spoilage losses. The losses that result from poor handling of the fish and fish include physical losses, nutritional value loss and economic losses [11]. Moreover, the poor safety measures when handling fish and fish products result in reprocessing large quantities of fish into different types of feeds used by different animals instead of availing them for human consumption [12]. Besides, poor safety measures result in fish-borne illnesses and fish and fish product export restrictions [13]. Fish-borne illness may lead to a financial burden on the healthcare systems and families due to increased hospital admission rates [14]. According to Wanga *et al.* [15], consumption of poorly handled fish and fish products accounts for approximately 30% of the global reported foodborne illnesses.

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Under normal circumstances, the potential risk factors predispose fresh and lightly preserved fish and fish products to microbial activity, enhancing the degradation of fish and fish products' freshness and quality [16]. After harvesting, fish contamination mostly occurs along the fish marketing and supply chain. This is due to increased exposure to poor hygienic conditions [17]. The contamination of fish and fish products by microorganisms is a threat to human health and public health [18]. The microbial contamination in fish can be minimized using diverse strategies. One of the strategies is cooling and freezing the fish immediately after harvesting [19]. Also, fish and fish product preservation methods such as chilling, salting, canning, drying and smoking reduce contamination of the harvested fish by microbial pathogens [20,21]. Similarly, fish and fish product contamination can be reduced by maintaining high personal hygiene when handling these products in fish retail stores and during processing [22]. On the other hand, locally available spices such as garlic can be used to increase the shelf life and enhance the aroma and flavour of the fish and fish products [23]. Furthermore, techniques that increase the shelf-life of the fish and fish products should be considered in the preservation of fish and fish products [24].

The safety of fish and fish products in Kenyan markets plays a significant role in shaping the harvesting and use of fish. Consequently, fish safety significantly impacts food security and food safety [25]. Understanding the vendors' knowledge, attitudes and practices provides vital insights necessary in formulating new policies that are aimed at ensuring fish safety is adhered to in the fish supply chain. This can be achieved through the generation of adequate information which can be used to model interventions that can guarantee safety of fish and fishery products. Therefore, this paper aimed to evaluate the knowledge, practices and attitudes toward fish and fish products' safety among fish vendors in Kenyan markets.

MATERIALS AND METHODS

Study site

The study was carried out in Kirinyaga County (0°34'23.43"S; 37°19'31.7"E), Central Kenya (Figure 1). Kirinyaga County covers an area of 1,478.1 square kilometers with a population of 610,444 persons and an annual growth rate of 1.5% (Kenya National Bureau of Statistics, 2019). The respondents included in this study were from Kerugoya, Ndia, Kianyaga, Mwea, Sagana and Tebere fish markets. Apart from fish farming, the main economic activity in the study area is livestock and crop farming.

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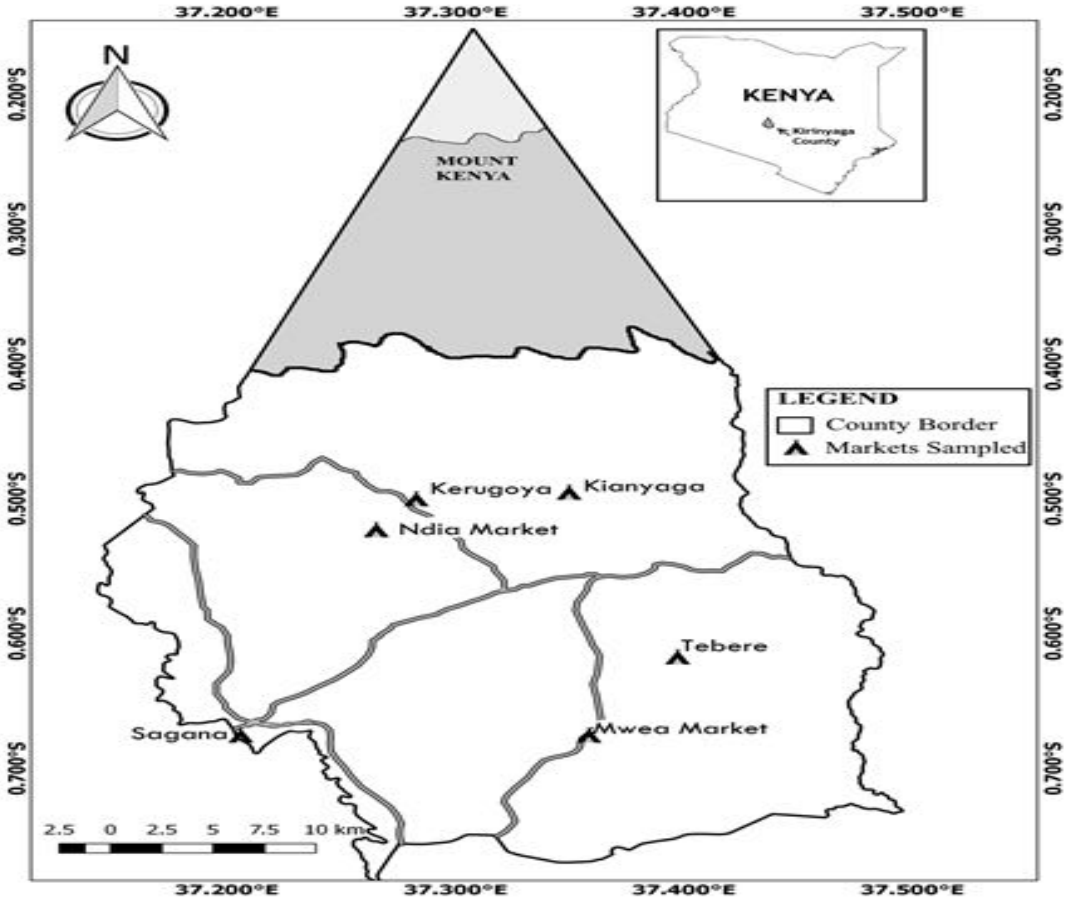

Figure 1: A map of Kirinyaga County where samples were obtained (Source: Google maps)

Study validation and sampling design

A team of six experts from fisheries and health authority validated the study questionnaire where they proposed to group questions. A pilot study followed to evaluate acceptability, comprehension and answer time of the questions by a group of 21 fish vendors from Nyeri town market. The selected markets were only considered if: they sold fish and a minimum of three associated fish products, sold products directly to consumers, had an established location for vending the products and were consistent with the county operation regulation. The selected markets comprised of Tebere, Mwea, Ndia, Kerugoya, Sagana and Kianyaga. The relationship between microbial contamination of fish products and identified risk factors was established using a descriptive research design. The livelihood and the nature of fish handling in the selected markets within Kirinyaga County were determined using a stratified sampling design. To ensure equal representation, each market was divided into two strata (fish vendors with established premises vs fish vendors with temporary setup) and participants were selected equally from

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each stratum. Within each stratum, transects were randomly selected and used in the sampling of fish handlers. The acceptability of the questionnaire, determined by the response rate, content validity and reliability was good and answer time ranged between 12 and 20 minutes. Some terms and grammatical modifications were made to improve clarity based on difficulties and suggestions made.

Sample size determination

The sample size determination was based on the Snedecor and Cochrane [26] formula as follows:

$$N = 4pq/(L)^2$$

Where, N is sample size; p, proportion of the target population; L, accepted error (5 %); and q=1-p.

According to Kenya Marine and Fisheries Research Institute (KMFRI), Sagana, the number of fish vendors in Kirinyaga County was 5246. There were 173 fish vendors in the selected markets within Kirinyaga County. Therefore, the sample size of this study was 54 respondents.

Data collection

Face-to-face interviews were used to administer semi-structured questionnaires to collect the data from the randomly selected fish vendors. The questionnaires were administered within seven days. The interviews focused on fish safety, knowledge of fish foodborne diseases, fish species handled, microbial contamination, types of fish products, food health standards, target consumers and other risk factors associated with fish products.

Statistical data analysis

The data gathered from market surveys was coded in excel sheets and analysed using Statistical Package for Social Sciences (SPSS) version 22.0. The normality of the collected data was determined using Shapiro-Wilk's test while Levene test was used to confirm the homogeneity of the variance. The categorical data from the study was presented in proportions (%) along with frequencies (N) while continuous variables were described using means with their standard deviation. The Likert scale was used for knowledge scoring criterion where the scores ranged from 1-5 (5 = Highest score, 4 = satisfactory, 3 = average, 2 = unsatisfactory, 1 = least score). However, a minimum score of 3 or more (>50%) was used to determine the acceptable practical knowledge among the fish vendors and higher scores represented better knowledge. Acceptable practical knowledge was scored

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as one (1) while lack of practical knowledge was scored as zero (0) for the incorrect answers. The mean knowledge scores of the respondents across various social demographic factors were determined using t-tests and analysis of variance. Spearman's rank correlation coefficient assessed the association of identified risk factors and demographic factors of fish vendors.

RESULTS AND DISCUSSION

Demographic conditions of respondents

Among the respondents, 66% were male while 34% were female (Table 1). The respondents' level of education varied with 44% having secondary school education training as their highest academic qualification while 22% had attained college and university education. Besides, 72% of the respondents operated self-employed businesses while 16% were in formal employment and had self-employed businesses other than farming while 8% were farmers. The majority of the fish handlers had a monthly income of between Kenyan Shillings 16000 – 30000 and experience of working in the fish industry of 5 years and below.

Types of fish and their sources

In this study, eight different fish species were identified from the fish markets. The distribution of the fish species significantly varied from one market to another (Figure 2). The most dominant and abundant fish species was Tilapia (*Oreochromis niloticus*) and was cited by 86% of the sampled respondents, followed by African catfish (*Clarias gariepinus*) cited by 68% of the respondents. Nile perch (*Lates niloticus*) and Common carp (*Cyprinuscarpio*) were equally cited by 48% of the respondents. The least cited fish species were Labeo/Ningu (*Labeo victorianus* cited by 12% of the respondents, while Eel fish (*Anguilliformes*), ornamental fish and Black bass (*Micropterus salmoides*) were also least reported (2%).

Majority of the Nile perch and tilapia fish species were reported to come from Lake Victoria to Kirinyaga County fish markets. However, a small percentage of the Tilapia fish species were sourced from local rivers and dams and from local fish farmers in the rural areas (Figure 3). Similarly, African catfish, common carp and other fish species were also supplied from Lake Victoria. Riverine from Kirinyaga County was reported to be the source of Labeo fish and some species of African catfish. (Figure 3). Fish fillets were also very abundant (26%) in Kirinyaga fish markets compared with other fish products. However, fish fingers and fish balls were also preferred by the vendors and were reported by 19 % and 15 % of the sampled respondents, respectively. Smoked fish was the least preferred fish

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product where only 7 % of the respondents confirmed they sold this product to their clients.

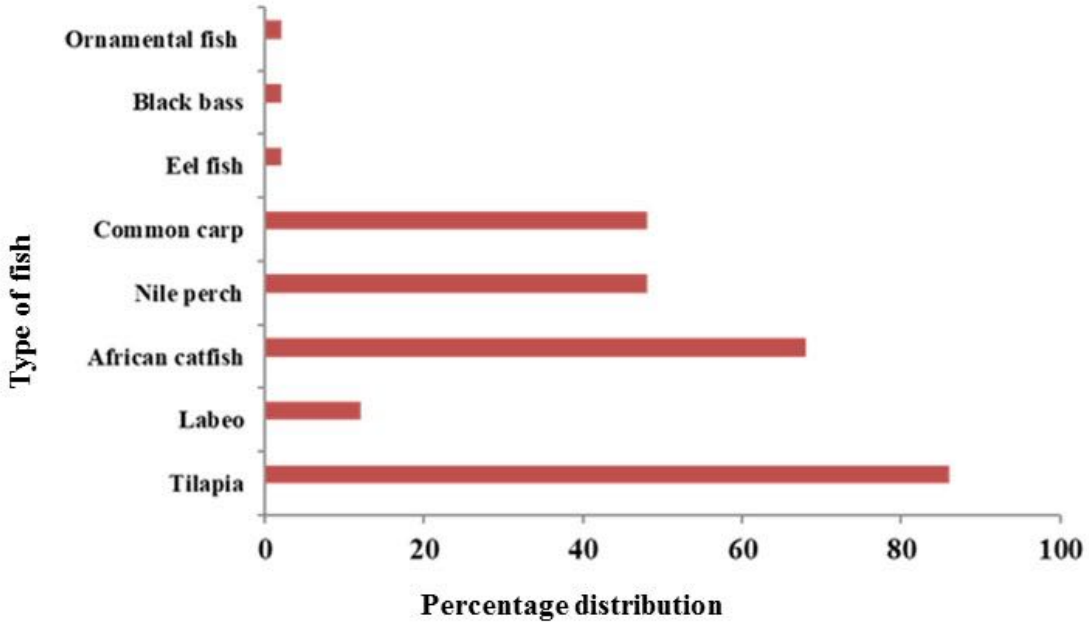

Figure 2: Types of fish in selected markets in Kirinyaga County

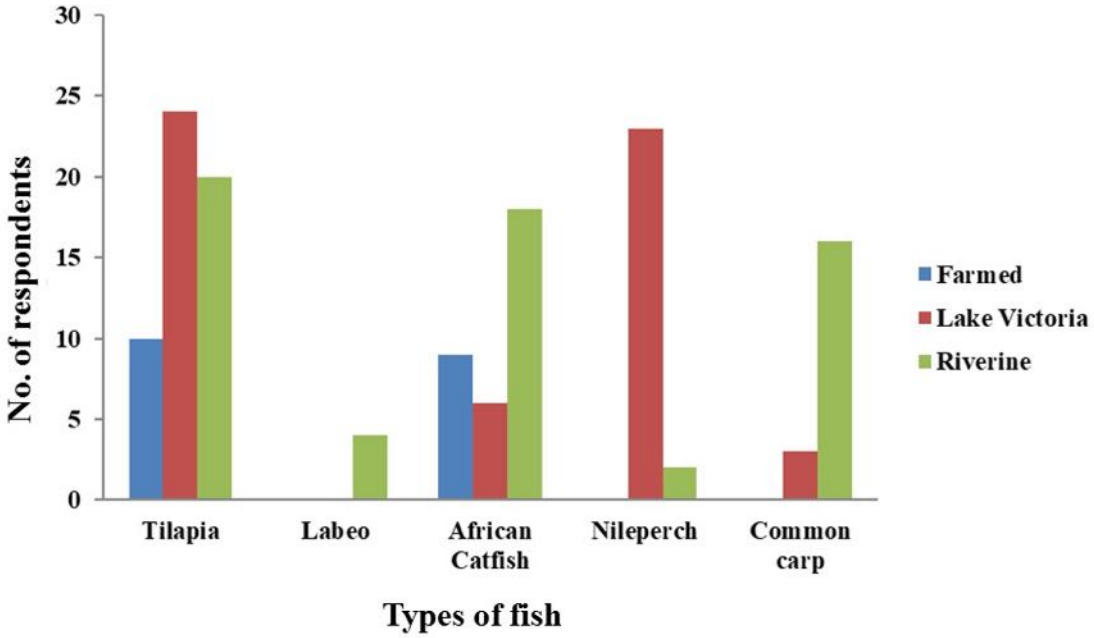

Figure 3: Sources of fish present in the markets in Kirinyaga County

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Assessment of fish quality by fish vendors

The study revealed that the quality of fish products was assessed using different methods. Fish vendors used various methods to assess the quality of the fish and fish products. In this study, 30 % of the fish vendors established fish safety and quality by pressing the fish and then making a decision on their safety. Besides, 76% of the sampled respondents indicated that the fish color was the most reliable method to establish the fish quality while 68% of the respondents focused on the gills' appearance. Out of the total sampled respondents, 8% indicated that white eyes in the fish suggested that the fish were affected by foodborne disease-causing pathogens. Similarly, smelling of fish products was prominent among some fish vendors (14%) as a method of assessing fish quality. A change in odour indicated contaminations by foodborne disease-causing pathogens (Table 2). Also, 68% of the sampled respondents refrigerated their fish and fish products. In contrast, the use of open shelves and display units without ice were the least popular methods of fish preservation with 4 % and 6 % of the respondents indicating they use the method.

Fish vendors' hygiene practices

This study revealed that 32% of the fish vendors were cautious and sensitive on use of hand gloves while handling fish (Table 3). However, 42% of the respondents never used gloves while handling fish food products and were unaware why they should use clean gloves and of any associated risk of cross-contamination between already cooked fish products and raw fish.

In addition, high percentage of the respondents (82%) observed the hygienic importance of handwashing after and before dealing with fish products.

From the study, it was also noted that 76% of the participants considered it unhealthy to handle fish whenever they were sick and were cautious whenever they experienced foodborne disease -related symptoms. However, 8% of the respondents stated they handled fish and fish products even they were unwell. This is because they prioritized their daily income. Similarly, 98% of the respondents indicated that they used disinfectants and detergents to clean their hands, fish containers, utensils, processing equipment and work surfaces (Table 3).

Common foodborne diseases

In this study, 89% of the respondents indicated that cholera was the most commonly known foodborne disease, followed by diarrhoea and typhoid related illnesses (74% and 48%, respectively). In addition, 22% of the sampled respondents indicated that they were unaware of complications that could emanate from the consumption of contaminated fish products (Figure 4).

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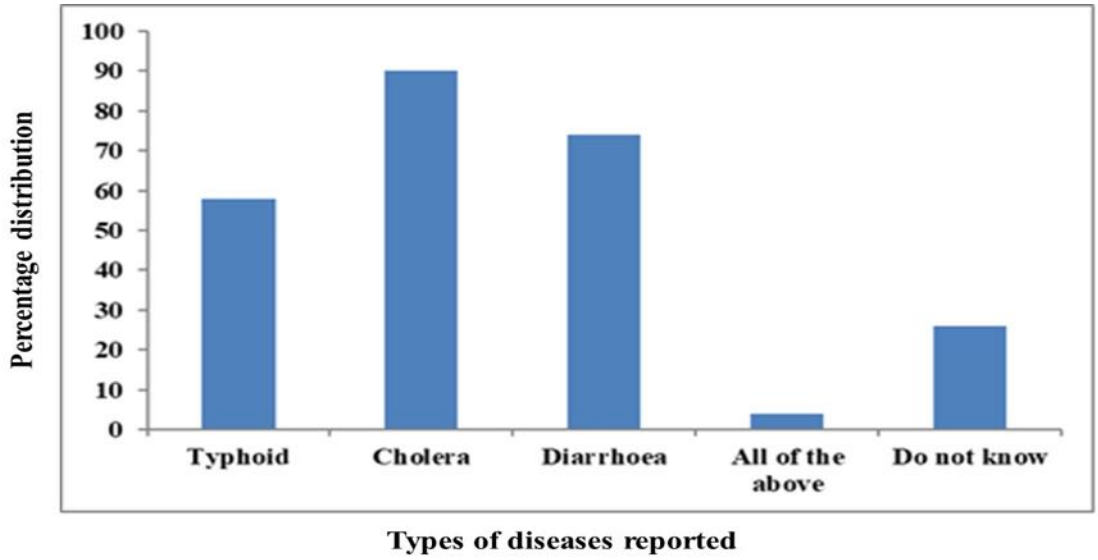

Figure 4: Knowledge of common foodborne diseases

Fish handlers' knowledge on safety

The descriptive statistics concerning fish safety knowledge revealed that personal hygiene was the most prominent practice to ensure fish safety with the highest score of 3.84 ± 0.35 out of 5 (Table 4). However, the respondents demonstrated excellent mean knowledge scores (90 % and above) on the risk of contamination due to mixing of cooked and uncooked fish. Majority of fish handlers also reported that it was inappropriate to store dangerous food for consumers and it was their responsibility to maintain good personal hygiene. Some respondents had a satisfactory score on knowledge of fish safety in areas such as wearing protective clothing (85.19%), consistent knowledge of fish safety (86.19%), cooking fish to reduce contamination (81.48%), and cleaning of chopping boards and kitchen towels (85.19 %) (Table 4). In contrast, not wearing of rings, watches and necklaces to minimize contamination had the least mean knowledge score of 2.11 ± 0.97 out of 5 together with evaluation of the health status of fish and fish product handlers. In addition, knowledge of ideal fish storage conditions was the least scored with only 53.70%.

The study revealed that the respondents were aware that high temperatures promoted bacterial growth, creating the need to refrigerate their fish products. However, some of the fish vendors could not freeze their fish and fish products due to inadequate resources to purchase refrigerators. This is in agreement with Lokuruka [28], who reported that financial constraints limited majority of fish vendors to preserve the fish products in cold boxes and even during the transportation to prevent spoilage and growth of pathogenic bacteria. Previously, it was demonstrated that in Bangladesh, authorities tried to reduce fish foodborne

disease and post-harvest losses through the provision of cold storage facilities to fish handlers [29]. Moreover, from this study it was evident that some fish handlers preferred not to use open shelves and displays without ice to cut on cost. This explains why there were many cases of foodborne associated problems from the selected markets in the region. The high levels of fish contamination call for proper food storage to prevent contamination [21].

Symptoms of common foodborne disease were well known to majority of the participants. The most known symptom by the respondents in the study area was diarrhoea. The respondents indicated they took precautionary measures whenever they experienced the signs and symptoms of foodborne disease. However, the fish vendors may prepare and sell the fish and fish products without necessarily consuming them and hence, they cannot be relied on in determining foodborne infection outbreaks [30]. This calls for awareness targeting the fish vendors and consumers on the required standards and measures that improve fish and fish safety. Besides, information on the signs and symptoms of foodborne diseases is important to the fish vendors because the information helps them take action to prevent the spread of foodborne diseases through the consumption of contaminated fish and fish products [31]. Similarly, the majority of the sampled respondents reported that they were familiar with cholera, its cause and symptoms and that they could take precautionary measures to prevent the spread of this disease. This finding is in agreement with a study by Akabanda *et al.* [8], where knowledge of the current fish and fish products preservation practices among the fish vendors was reported to reduce possible risks of spreading foodborne diseases.

The respondents in this study reported a high knowledge score on fish safety. This demonstrated that the fish handlers in Kirinyaga County have adequate information that consumption of contaminated fish and fish products poses a risk of foodborne diseases. As a result, they have put measures in place such as maintaining hygiene while handling fish and fish products. This finding is in agreement with a previous study by Ncube *et al.* [32] where the fish handlers had high knowledge scores on food safety because they understood the risks associated with food contamination, consumption of contaminated food and the impact of unhealthy food handling on food safety.

In addition, a high percentage of the fish handlers in Kirinyaga County reported that proper hand hygiene, wearing of protective gloves, caps, appropriate outfits and masks help in reducing fish contamination. This agrees with Faour-Klingbeil *et al.* [33] where 96.2% of the respondents indicated that hand hygiene and personal

protective equipment reduce food contamination and increase food safety. In addition, the fish handlers in this study had high knowledge scores on separating cooked fish from uncooked fish, adequate cooking of fish and handlers' cleaning of chopping boards before using them. This shows that the fish vendors in Kirinyaga County are aware that cooking fish and fish products exposes the foodborne pathogens to high temperatures hence reducing the chances of these pathogens surviving, and hence it is one of the strategies for reducing foodborne pathogens in food. According to Al-Kandari *et al.* [34], temperatures significantly contribute to reducing foodborne disease -transmission hence adequate cooking kills the pathogens making it safe for human consumption. On the other hand, the fish handlers indicated high scores (52%) on the fact that it is crucial to know the ideal fish storage conditions to prevent spoilage of the fish and fish products and prevent microbial contamination of the fish and fish products. This finding corroborates with Sheng and Wang [35], who indicated that knowing the ideal temperatures of fish and fish product storage help in reducing microbial contamination and enhances fish product safety.

In this study, the fish handlers indicated that handling fish and fish products while having physical injuries or abrasions should not be allowed. Also, healthy fish handlers, chopping boards and knives are potential carriers of foodborne diseases. This is in agreement with Augustin *et al.* [36] who indicated that food handling practices and materials such as knives, and chopping boards significantly contribute to foodborne infectious diseases. The fish handler's health status should be evaluated before they are allowed into the fish and fish product business. This is because they could be agents of foodborne pathogens because they have little knowledge and experience in handling these products.

Poor personal hygiene practices among the food handlers have been reported to be the source of contamination of fish and fish products [37]. One of the precautions used to prevent the high contamination in fish and fish products is by maintaining high personal hygiene through the use of clean gloves. However, some fish handlers do not consider using gloves when handling fish and fish products. This could be attributed to inadequate information on the cross contaminations in the handling of food products such as fish [38]. This is a risk hazard especially when the fish handlers are the carriers of the potential human pathogenic microbes[39]. Besides, this finding collaborates with a comparative study in Ghana on the use of bare hands versus gloves which showed that the use of bare hands in handling ready to eat food increases contamination levels [40]. Studies have shown that some bacteria such as Salmonella typhi and other entero-pathogens can survive on bare hands for hours [39,40]. A similar observation was

reported in Saudi Arabia where the majority of vendors were ignorant of proper hygiene in the handling of fish [16]. Besides, it agrees with a previous study by Lues *et al.* [20] where the source of fish and fish product contamination was as a result of uncleaned and uncovered hands, especially during processing and fish handling in vending areas.

Additionally, a high percentage of the respondents washed their hands before handling fish and fish products. This is very crucial since hand washing reduces the bacterial load in the hands, thus minimizing cross-contamination of the fish and fish products [38]. According to Hashanuzzaman *et al.* [38], many street fish vendors are aware of standards of hygienic practices, nevertheless, many of them do not practice them and are negligent in complying with the required hygiene and health standards sometimes due to inadequate infrastructural support [39].

Fish handlers' food safety attitudes

In this study, the respondents' attitude toward food safety was positive (3-5 scores out of 5) with percentages on yes/no questions ranging from 59%-96% (Table 5). Besides, 96.29% of the respondents were willing to learn basic hygiene to increase their knowledge of food safety. In addition, 95.44% of the respondents suggested that their superiors ought to organize trainings to improve the fish handler's knowledge on hazards that contaminate fish and fish products. Similarly, 90.74% of the respondents indicated that spoiled or contaminated fish and fish products should not be consumed. In contrast, the respondents reported least scores in the following statements: I will always use hand gloves when handling no packed fish products 18.52% and I need some incentives to prevent fish contamination 14.81% (Table 5).

The attitude of the fish handlers in Kirinyaga County was positive towards fish and fish product safety, willingness to learn about fish safety, fish handling, improving personal hygiene and cooking fish within the recommended duration. The positive attitude demonstrates that the fish handlers in this study had information on the importance of fish safety procedures when handling fish and fish products. This finding corroborates with previous findings where fish handlers reported a positive attitude toward fish safety and they would request their supervisors to be exempted from work should they have diarrhoea, wounds and cuts [38]. Also, the attitude of the fish handlers enables them to be curious and willing to learn diverse ways of enhancing fish safety [22]. Besides, the attitude of the food handlers in this study could be due to the fish handlers understanding that they have the responsibility to prevent food spoilage and contamination. Previously, *Pham-Duc et al.* [26]

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indicated that the positive attitude of fish handlers towards fish safety is inculcated by them taking responsibility for protecting the public from foodborne diseases.

Fish handlers' challenges in the selected markets

The respondents from Kirinyaga County indicated diverse challenges associated with fish businesses. The absence of ideal fish product storage facility was reported by majority (76 %) of the respondent as a major challenge due to the nature of the food on perishability (Figure 5). However, 16 % of the respondents indicated that changes in consumer preferences for different fish species, changes in seasons and changes in fish consumers' attitudes and behaviours were the main challenges they experienced in fish and fish product businesses in Kirinyaga County. Moreover, 32 % of the respondents reported that poor sales and unstable prices occurred, simultaneously affecting the growth of their fish businesses. In contrast, 12% of the respondents reported that the main challenge they faced was the entry of many fish handlers who increase competition which negatively affects the growth of the fish businesses (Figure 4).

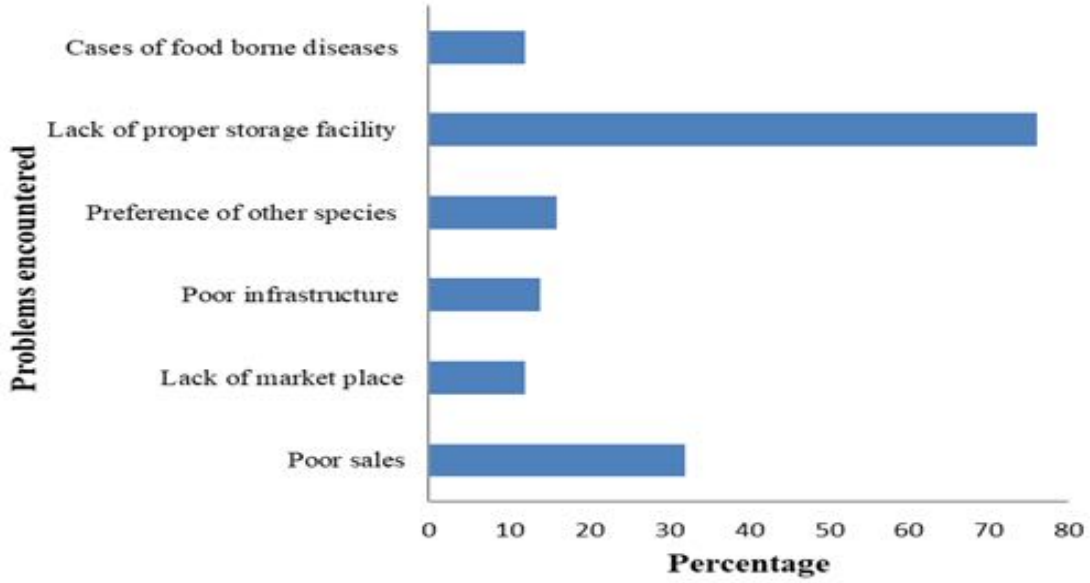

Figure 5: Challenges encountered by fish handlers in selected markets

Despite the efforts that they have put in place, the fish vendors in Kirinyaga face a few challenges. In most instances, the fish vendors were aware and had the willingness to adhere to food health standards. However, these fish vendors were limited by inadequate materials and resources required to comply with the set hygiene standards. These include handwashing points with clean water, waste management and disposal systems, good drainage and portable water [27]. In this study, the respondents indicated that even if they experienced symptoms of

foodborne diseases known to them, they would continue with their business as usual. This could be attributed to the fear of losing daily income and a bridge of trust from the consumers due to inconsistency in the supply of the fish products. The study finding is in agreement with Eltholth *et al.* [17] who established that food vendors fear the risk of losing current customers and also incurring losses if they are not operating while still avoiding additional costs of hiring more personnel if they fail to be in the market for different reasons including being sick. Ethically, it is not right to handle food in the market when sick because the disease- causing pathogens can be spread to the healthy population [38]. Despite handling the fish without gloves, the selected respondents indicated they used detergents which are important in reducing microbial contamination. To clean fish containers, processing equipment, work surfaces and utensils, detergents are commonly used [29].

The sampled respondents reported transporting fish products using open crates and buckets to the market. The severity of contamination during transportation can also be exacerbated by the nature of packaging for both processed and raw fish. The majority of fish vendors were from rural areas and were unable to possess the required equipment for fish and fish product storage and hence subjecting the product to post-harvest losses and foodborne diseases.

Nexus of fish vendors' sociodemographics, awareness of risk causing factors and biophysical factors

The fish vendors' biophysical factors and risk factors awareness had significant correlation based on Spearman's correlation coefficient (Table 6). There was a positive correlation between education and fish vendors' awareness of fish foodborne diseases at $p<0.05$. There was positive correlation ($r = 0.152$, $p < 0.05$) of fish foodborne awareness by age of fish vendors (Table 6). Training on hygiene and food safety on the other hand significantly affected the level of awareness of foodborne associated diseases with a positive correlation coefficient of $r = 0.314$ ($p < 0.05$). However, the gender of fish vendors had no significant effect on the level of awareness of risk factors such as foodborne diseases.

There was a positive relationship between the level of education and fish vendors' awareness of foodborne diseases in this study. The educated fish vendors knew about the possible contamination of fish and fish products. Also, they were aware that fish contamination increases the risk outbreak of foodborne diseases hence there is a need for improved personal hygiene when handling the fish and fish products in the market. Similarly, there was a significant relationship between foodborne awareness and age. With the increase in age, the fish vendors gain insights into foodborne contamination and foodborne related diseases. This finding

corroborates with Alejandra *et al.* [22], who reported that education level and age were significant factors in determining knowledge and foodborne disease awareness levels among fish vendors. Correlation analysis of professional training on hygiene revealed a significant effect on the level of awareness. Training increases knowledge of fish safety and foodborne disease prevention [13].

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

The study showed that the respondents from Kirinyaga County had an average level of knowledge, attitudes and practices towards fish safety and hygiene. The main reason for this is that most of the fish vendors in Kirinyaga County had no formal training on fish safety. Besides, there was no robust system for assessing the quality and the safety of fish and fish products in Kirinyaga County. In the study area, there were different types of fish species. However, the availability and consumer preference varied from one fish species to another. Moreover, there were no standards on the hygiene level of the fish vendors hence, there was a possibility of high fish and fish product contamination. Therefore, there is a need for training and safety regulation of fish and fish product business in the county to prevent a future outbreak of foodborne diseases spread through consumption of contaminated fish and fish products.

The results of this work have been used in improving training materials for fish handlers in Kirinyaga and other parts of the country. Future studies and projects can use this work as basis for formulation and execution of surveys and trainings in food safety especially in the fisheries sector.

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Competing interest

The authors declare no conflict of interest.

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Table 1: Fish vendors' demographic information

	parameter	Frequency (n=54)	Proportion (%)
Gender	male	36	66
	female	18	34
Age	<18	1	2
	18-25	9	16
	26-45	34	64
	>45	10	18
Education	Primary	18	34
	Secondary	24	44
	Certificate	1	2
	Diploma	9	16
	University degree	2	4
Occupation	Self-business	39	72
	Employed	4	8
	Framing	2	4
	Employed and Self-business	9	16
Monthly Income	Below 15000	17	32
	16000-30000	27	50
	Above 30000	10	18
Work experience in fish industry	≤ 5 years	31	56
	6 - 15 years	18	34
	16-25 years	4	8
	Above 25 years	1	2

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Table 2: Quality assessment of quality of fish and fish products in the selected markets

Method	N (%)
Color	41(76)
Looking at gills	37(68)
By pressing	16(30)
Odour	8(14)
White eyes	5(8)

N: Number of individuals

Table 3: Fish vendors hygiene practices (N = 54)

	Never N (%)	Rarely N (%)	Sometimes N (%)	Often N (%)	Always N (%)
Handling fish while having symptoms of foodborne diseases	41(76)	4(6)	5(8)	1(2)	4(8)
Use of clean gloves when handling fish products	23(42)	12(22)	2(4)	0	16(32
Cleaning of tools, work surfaces and equipment with detergent/ disinfectant/sanitizer.	0	0	1(2)	0	53(98)
Washing of hands after touching contaminated objects (dirty objects) before handling fish	0	0	1(2)	9(16)	44(82)

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Table 4: Knowledge of fish handlers on food safety in Kenyan markets

	Agree n (%)	Score Mean ± SD
Wearing of protective gloves, caps, appropriate outfits, and masks can minimized risk if fish adulteration	46 (85.19)	3.45±1.52
The safe operating temperature for a refrigerator is 1–5°C	36 (66.67)	2.94±1.23
Fish management is related to food safety	41 (75.92)	3.05±0.85
It is inappropriate to store dangerous food for consumers	45 (83.33)	3.49±1.21
Practices such as not wearing necklaces, watches and ornamentals can reduce fish contamination	28 (53.84)	2.11±0.97
It is crucial to know ideal fish storage conditions	29 (53.70)	2.57±0.87
Cooked and raw fish should be kept separate to reduce risk of contamination.	50 (92.59)	3.67±0.98
Fish handlers' knowledge of food safety should be consistent	46 (85.19)	3.45±1.52
It is my personal work duty for harmless food management	49 (90.74)	3.67±0.98
Fish handlers with physical injuries or abrasions should not contact fish without packaging.	40 (74.07)	2.95±1.14
Proper hand hygiene can reduce risk of fish contamination.	51 (94.44)	3.84±0.35
Well cooked fish and fish products are free from microbial contamination.	44 (81.48)	3.25±1.13
Fish handlers' health status should be evaluated before employment.	28 (51.85)	2.11±0.68
Chopping boards and knives should be properly cleaned to prevent contamination.	45 (83.33)	3.24±1.23
Dish towels can be a potential source of contamination	41 (75.93)	3.05±0.85
A healthy food handler can be a carrier of infectious foodborne diseases	36 (66.67)	2.75± 1.66

Key: SD, standard deviation. Scores (1-5), 5 = Highest score, 4 = satisfactory, 3 = average, 2 = unsatisfactory, 1 = least score

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Table 5: Attitude of fish handlers on food safety in Kenyan markets

Statement	Disagree n (%)	Neutral n (%)	Agree n (%)
I am ready to learn fish safety and hygiene basics	2 (3.70)	0 (0.00)	52 (96.29)
My superior should organize trainings such as hazard analysis for fish handlers	0 (0.00)	3 (5.56)	51 (94.44)
I should take sick leave if I have cuts, wounds, or diarrhea.	8 (14.81)	2 (3.70)	44 (81.48)
It is my key responsibility to prevent fish spoilage and contamination.	8 (14.81)	4 (7.41)	32 (59.26)
Spoiled or expired fish products should never be consumed.	0 (0.00)	5 (9.26)	49 (90.74)
I will always use hand gloves when handling no packed fish products.	42 (77.77)	12(22.22)	10 (18.52)
I need some incentives to prevent fish contamination.	38 (70.37)	8 (14.81)	8 (14.81)
Assessing fish handlers' personal hygiene is crucial to minimizing fish products contamination.	9 (16.67)	5 (9.26)	40 (74.07)
Fish should be cooked for the recommended duration.	4 (7.41)	4 (7.41)	46 (85.16)
To assess the importance and the effectiveness of handwashing, one can swab nails and palms of fish vendors	12 (22.22)	6 (11.11)	36 (66.67)

Key: Scores (1-5), 5 = Highest score, 4 = satisfactory, 3 = average, 2 = unsatisfactory, 1 = least score

Table 6: The association of demographic factors on fish vendors risk factors based on Spearman's correlation coefficient (r)

	Education level	Age of fish vendors	Gender of fish vendors	Training on food safety and hygiene	Awareness of any foodborne disease
Education	1				
Age	0.030	1			
Gender	-0.111		1		
Training on food safety and hygiene	-0.256	-0.027**	0.041	1	
Awareness of any food-borne disease-causing microbes	0.585**	0.152**	0.069	0.314**	1

* Correlation is significant at the 0.05 level (two-tailed)
** Correlation is significant at the 0.01 level (two-tailed)

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