Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.14, No.3, 2024

Role of Socio-Economic and Institutional Factors in Influencing Diversity of Fish Consumption Among Households in Kibera Informal Settlement, Kenya

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Abstract
Sustainable food and nutrition security in the world has been greatly encouraged through the Sustainable Development goal 2 which ensures zero hunger in the world by 2030. However, it faces major challenges in achieving this goal since of the 167.2 million tons of fish produced globally, 146.3 million tons are consumed while the remainder is considered waste. Therefore, the growing demand for fish has increased significantly especially due to its nutritional value. Consumption of aquatic foods is important in mitigating micronutrient deficiencies that cause about one million premature deaths yearly. Large fish species including Nile tilapia are key in reducing stunting among children due to their nutritional importance. However, they have been declining due to fishing pressure and market demand. Therefore, more attention has been put on lower-priced small species including Lake Victoria Sardine, which provides more than 60% of the recommended intake of all nutrients. These small-sized species are of high nutritional value, especially protein, and essential micronutrients, including calcium, iron and zinc because they are consumed wholly as food and feed hence nothing is wasted. This study aimed at understanding the diversity of fish species consumed in Kibera informal settlement. Data was collected from 385 households and analyzed using an orders probit model. Findings revealed that the majority of households (98%), consumed different fish species. Further, total household income, Neighborhood effect, cultural influence on food choices, information from neighbors and the number of meals consumed in a day positively impacted species of fish consumed. The most consumed fish species were Silver cyprinid (*Rastrinaebola Orgentae*) (51%), Nile tilapia (*Oreocromis Niloticus*) (34%), Nile perch (*Lates Niloticus*) (12%) and Common carp (*Cyprinus carpio*) (0.3%). To improve the diversity of fish consumption in the informal settlements, there is a call to increase the availability of affordable fish in the market for consumers to access diverse species hence improving nutritional security.

Keywords: Fish consumption, Species diversity, informal settlement, Kibera-Kenya.

DOI: 10.7176/JBAH/14-3-03

Publication date: September 30th 2024

1. Introduction

Food and nutrition security is a major global challenge today as highlighted in the Second Sustainable Development Goal 2030, which intends to eradicate hunger by 2030 (Muringai *et al*., 2021). Among the 167.2 million tons of fish produced globally, 146.3 million tons are consumed while the remainder is considered waste. Therefore, the growing demand for fish has increased significantly especially due to its nutritional value. The outbreak of COVID-19 in 2020 negatively influenced the global economy that largely relied on fish where fish markets were among the most affected through restricted movement leading to the closure of markets (Paredes *et al*., 2021). However, there is an expected increase in the global production of fish due to increased production in Asian countries (85%) which is attributed to the expansion of aquaculture. The growth is expected to reach 206 MT by 2033 compared to 184 MT between 2021-2023. This growth in aquaculture is equivalent to 55% of total fish production in the world with capture fisheries providing about 92 MT every year (EOCD- FAO, 2023; EOCD-FAO, 2024).

Per capita fish consumption is estimated to reach 21.4 kg by 2033 compared to 20.8 kg between 2021 and 2023. Further, the increase in the demand for fish is estimated at 7 kg *per capita* by early 2030. However, this increase will not be significant in Europe and Africa especially due to continuous growth in the human population as it is increasing faster than the fish supply hence causing a deficit in fish supply (EOCD-FAO, 2024; FAO 2022; Kyule *et al*., 2022).

About 12% of the global population is supported by the fisheries sector. This includes the consumption of finfish and shellfish where about 75% of the fish consumed is finfish and about 25% shellfish. This equates to about 17% of the total animal protein and 7% of all proteins consumed. Additionally, freshwater and diadromous fish species provided about 40% of all the fish consumed with marine finfish comprising about 33% of the consumed fish globally (FAO, 2018; FAO, 2022). Consumption of aquatic foods is important in reducing micronutrient deficiencies that cause about one million premature deaths yearly. Small-sized tilapia among other small fish species through value addition can provide flour and spring rolls which enhance the provision of proteins, calcium, Zinc, and Vitamin A which provide recommended dietary knowledge allowance for children under 5 years. They also have a low environmental footprint compared to other animal-source foods (Gephart *et al*., 2021; Peñarubia *et al*., 2023; Rizaldo *et al*., 2023).

Fish provides all the essential amino acids, protein (15%- 24%), and omega -3 fatty acids necessary for proper health and growth of children due to its high digestibility rate of about 95%, mitigating obesity, high blood pressure, coronary heart disease and stroke (Awuor *et al*., 2019; Nuryanto *et al*., 2022). The micronutrient composition of fish varies across species. Iron content ranges from 0.34 to 19 mg/100 g in raw edible parts; zinc from 0.6mg/100g to 4.7mg/100g; calcium from 8.6 to 1900mg/100g; vitamin A, from 0 to 2503 mg retinal activity equivalent/100g; and vitamin B_{12} from 0.50µg/ 100g to 14µg/ 100g. Capture fish contribute between 6% and 35% of daily prescribed supplement consumption for iron, zinc, calcium, vitamin A and B_{12}, more than farmed fish, despite being consumed in smaller portions (Bogard *et al*., 2017).

Capture fisheries has dominated the Kenyan fisheries sector which contribute about 80% of all the fish consumed in the country. The most consumed species include; African catfish (*Clarias gariepinus*), Nile tilapia (*Oreochromis niloticus*), Nile perch (*Lates niloticus*), silver cyprinid (*Rastrineobola argentea*), among others with production of Nile Tilapia and Catfish being restricted to specific regions in the country (Cheserek *et al*., 2022). The annual *per capita* fish consumption has been lower with the current consumption rate being 4.7 kg/person (MoALFC, 2020). Lake Victoria produces a larger percentage of the fish consumed in Kenya 82% which is about 82.5% of the annual national production.

The ever-increasing population, income and adoption of diverse diets have increased the demand for fish across the country (Awuor *et al*., (2019). To reduce the lower *per capita* consumption in the country, farmed fish production is expected to reach 150,000 tons by 2030 (Munguti *et al*., 2021). Additionally, several factors influence the number of fish consumed in the households. Cheserek *et al*. (2022); Ngui *et al*. (2023) identified high prices, limited preparation and cooking skills, taste, smell, consumer attitude, accessibility, and availability as factors hindering fish consumption.

Studies on fish species diversity reveal that different species have varying benefits to human growth. Large fish species including Nile tilapia are key in reducing stunting among children due to their nutritional importance. However, they have been declining due to fishing pressure and market demand. Therefore, more attention has been put on lower-priced small species including Lake Victoria Sardine, which provides over 60% of the recommended intake of all nutrients except for vitamins 19%. These small-sized species are of high nutritional value, especially protein, and essential micronutrients, including calcium, iron and zinc because they are consumed wholly as food and feed hence nothing is wasted. However, large fish species like Nile perch and Tilapia are declining because of the increased fishing pressure and high market demand (Aura *et al*., 2021; Nuryanto *et al*., 2022; Omukoto *et al*., 2024). Further, some cultural and religious aspects limit the consumption of fish the Maasai community considers consuming fish a taboo while laws of the Seventh Day Adventist church do not allow its members to consume fish that do not have scales and fins. This limits the acquisition of the nutritional diversity associated with fish (Chege *et al.,* 2015; Musyoka *et al*., 2023).

2. Material and methods

2.1 Study area

This study was carried out in the Kibera informal settlement, Nairobi-Kenya. Kibera is located about 6.6 kilometres southwest of Nairobi, Kenya's capital city, as shown in Figure 1. Kibera was chosen for this study because it is the largest informal settlement in Kenya and has also been said to be the largest in Africa. Its population is estimated to be between 200,000 and 1 million people, and it has the highest population in the country compared to any other slum. Kibera, among other informal settlements, provides cheap housing and the majority of habitats migrated from rural areas while searching for jobs and better lives (Soma *et al*.,2021). However, facilities such as Water, Sanitation and Hygiene (WASH) are shared, making them highly vulnerable to numerous health risks. Residents depend on informal sources of income generation activities, with the

majority relying on handouts from several charities and well-wishers. Access to food is another challenge that increases the issue of nutritional deficiency, especially protein intake.

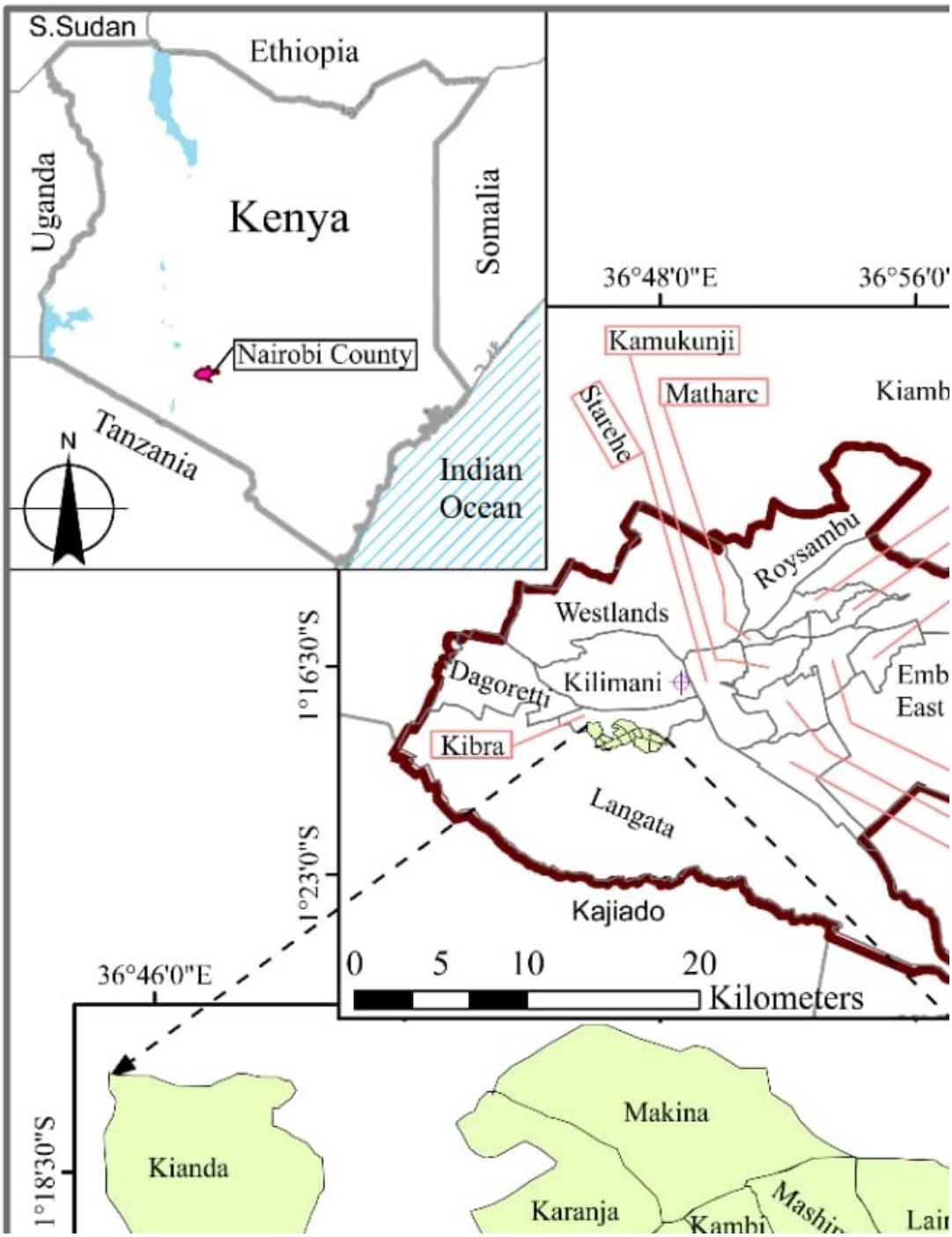

Figure 1. Map of the Study Area, Kibera Informal Settlement-Kenya

2.2 Research design

This study was carried out using a cross-section research design, suited for population-based surveys. The cross-sectional research design was suitable for this study because much of the data in the study was collected in a relatively shorter period, and it allowed for the data to be collected at one point in time from various respondents.

A multi-stage sampling technic was applied for the study. It included clustering Kibera into 14 villages but only 12 were suitable for the study since two had insecurity issues at the time of the study. The study also incorporated personal digital assistants and a random selection of the sampled population. The sorting out of the population was made possible by the random movement of the trained enumerators from one point to another. Landmarks were used to cluster the starting points for easy access to the targeted areas. Landmarks included schools, churches, mosques, and health facilities.

Sample size determination

The target population for this study was households consuming fish. They included male and female food decision-makers and were to be residents of Kibera. A total of 385 households were targeted for the study, as represented (Kothari, 2004).

$$n = \frac{z^2 \times p \times q}{e^2} \quad \ldots\ldots (1)$$

where, n = sample size; z = confidence level of (α=0.05), which gives 1.96; p = population proportion of interest (fish consumers) set at 0.5. Statistically, a proportion of 0.5 leads to reliable and sufficient sample size, especially when dealing with infinite population; q = weighting variable estimated as 1-p, and e = precision rate set at 5% or 0.05% significance (acceptable error) to eliminate 95% sampling biases. This formula results in 385 respondents computed as follows;

$$n = \frac{z^2 \times p \times q}{e^2} = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2} = 384.16 \cong 385 \quad \ldots\ldots (2)$$

2.3 Method

This objective focuses on analyzing the diversity of fish species consumed. This was measured using a count variable by identifying the number of species consumed in the household regardless of type. Count data are normally analyzed using a Poisson regression model which assumes that all events have an equal probability of occurrence. Therefore, the likelihood of consuming various species could differ based on their characteristics, including previous experience and whether the expected benefits are short or long-term. On the other hand, specific consumers tend to combine different species to increase the utility hence, are more versed in the benefits of consuming fish than non-consumers or those who consume a single or few species. The constraints involving factors influencing the species of fish consumed may differ from one factor to the other, hence differentiated probabilities of consuming various species. Species diversity (number of fish species consumed) was considered as an ordinal variable by grouping the number of species consumed without considering the type of species, according to the intensity of consumption (0-4) species and an ordered probit model, which allows estimating the relationship between an ordinal dependent variable and a set of independent variables (Kpandonou *et al*., 2017; Musafiri *et al*., 2022).

This model allowed for estimating determinants of ordinal variable species diversity (number of fish species consumed 0,1, 2, 3 & 4. with each value representing the number of species consumed). Therefore, the ordered dependent variable could be assessed as a latent variable Y*, where Y* is the unobservable measure of species diversity, as shown below.

$$y_i^* = x_i'\beta + u_i \quad \ldots\ldots (3)$$

For the i^{th} consumer, where the regressor x, does not include an intercept, the number of fish consumed increases with Y^*. The probability of observing an outcome is described in the equation below.

$$\text{pr}(\text{outcome } j = i) = \text{pr}(n_{i-1} < x_i'\beta + u_i \leq \alpha_i) \quad \ldots\ldots (4)$$

The coefficients $\beta_1, \beta_2, \ldots, \beta_{i-1}$ were jointly determined with the cut points $\alpha_1, \alpha_2, \ldots \alpha_i$ where i signifies the number of possible outcomes. U_j was perceived to be normally distributed with a standard normal cumulative distribution function.

Table 1. Variable characteristics

Variable characteristics	Mean	Standard Deviation
Age of food decision maker (count)	36.787	11.778
Gender of the food decision maker (1=male)	0.46	0.499
Household size (count)	4.67	1.845
Years in school of food decision maker (count)	9.618	3.456
Total monthly household income (Ksh)	12158.65	9344.641
Migration to Kibera (1= migrated from western Kenya)	1.377	0.485
Total monthly price of fish (Ksh)	1820.818	95.718
Neighborhood effect (%)	44.382	24.383
Time taken to the nearest fish outlet (walking minutes)	12.073	9.257
Number of outlets within 100 m radius (count)	7.257	6.145
Cultural influence on food choices (%)	34.273	29.065
Influence of religion on food choices (%)	13.545	24.454
Number of meals consumed in a day (count)	2.443	0.593

Findings

Out of the 385 households, 98% had consumed fish in the last 3 months from the time the research was done, while only 2% did not consume any species in the same period, as presented in Table 2. The majority of households preferred to consume Silver cyprinid (*Rastrineobola argentea*) (51%), Nile tilapia (*Oreochromi)* (34%), Nile perch (*Lates niloticus*) (12%) and Common carp (*Cyprinus carpio*) (0.3%). This is because consumers prefer specific species based on various preferences and past experiences, hence the variation in the species diversity consumed among households.

Table 2. Species diversity

Number of species consumed	Frequency	Per cent	Cumulative
None consumers	7	1.82	1.82
Nile tilapia	132	34.29	36.10
Silver cyprinid	198	51.43	87.53
Nile perch	47	12.21	99.74
Common carp	1	0.26	100.00
Total	385	100.00	

Findings from the ordered probit model, as shown in Table 3, reveal that Log pseudo-likelihood = -377.68559, indicates how the model converges. The Wald chi^2 value for the model was 59.44, Prob > chi^2 0.000 and Pseudo R^2 0.069, revealing that the model fully and significantly fits the data.

The household total income had a positive and statistically significant implication (10%) on the number of fish species consumed. This revealed that an increment in household income increases the number of fish species consumed. This is in line with Thompson (2021), where the likelihood of consuming fish was influenced by a reduction in price and an increase in income. Consequently, Rahman and Islam (2020) found that equally, low- and high-income categories had no remarkable association with fish consumption. For consumers with slightly less income, their choices for food consumption are mostly limited to their financial capabilities compared to consumers with higher income margins. All the same, Wenaty *et al*. (2018) showed that various species were expensive for lower-income families hence, difficult to afford. Additionally, high-income consumers consumed high-quality foods, unlike low-income consumers, who are perceived to procure low-quality food categories.

The price of fish was negative and statistically significant (1%) with the number of fish species consumed in the Kibera informal settlement. This implied that a unit increase in the price of a particular species reduces the number at which households consume that fish species. This concurs with the findings by Johnson *et al.* (2020); Rahman and Reza (2020), where most consumers believe that higher fish consumption rates result from reduced prices since the demand for fish reduces with increased prices. On the contrary, Sogn-Grundvåg *et al*. (2021), found that an increase in price increases the fish consumption rate since price is associated with quality hence higher prices reflect a higher quality of fish.

The neighborhood effect was positive and statistically significant (10%) with the number of fish species consumed. This finding implied that as the number of households sharing the same tribal origin increases, the consumption of various species increases due to existing social networks since members can share sociocultural norms on specific fish species hence an increase in their consumption rate. This has further been elaborated by Ayuya *et al.* (2021), where neighbors influence fish consumption decisions through sharing similar cultural backgrounds. Therefore, most consumers are influenced by their neighbors' perception of the consumption of different fish species which makes it easy for most consumers to be positively influenced when deciding to consume food including fish.

There was a positive and statistical significance (5%) between cultural influence on food choices and the number of fish species consumed in the Kibera informal settlement. This implied that as cultural beliefs increase among consumers, so do their choices and perceptions of the type of food they consume. Gwladys *et al*. (2020) found that traditional food habits grounded in origins have been appreciated as the key determining factor of food purchase. The results further established that traditional food systems and knowledge about food influence food acquisition mechanisms. On the other hand, cultural norms among communities have implications on food choices, especially in the Maasai community, its culture does not promote eating fish because it is considered culturally unfit to be eaten. Therefore, the nutritional benefits associated with fish will be limited among consumers (Chege *et al*., 2015).

Religion was negative and statistically significant (1%) to the number of fish species consumed. This signifies that as consumers lean towards their religious beliefs that hinder fish consumption, the number of species consumed, especially among the households in the informal settlement, will be reduced. This concurs with findings by Ayuya *et al*. (2021); Musyoka *et al*. (2023) where laws governing the Seventh-day Adventist church do not allow its members to feed on fish that do not have scales and fins including African catfish. On the contrary, Onumah *et al*. (2020) detailed that Christians spend more on fish consumption compared to Muslim believers who have been restricted from consuming some fish species, including those that do not have scales. Therefore, this reduces the consumption of non-scaled fish species due to certain religious beliefs.

Information from neighbors was positive and statistically significant (1%) on the number of fish species consumed by households. This implied that increased information sharing among neighbors promotes fish consumption for the households. Therefore, consumers who get information from neighbors, friends, relatives, and family members have a high chance of being convinced to consume more fish products, hence improving the general consumption rate of various fish species (Marinac *et al*., 2023). This has been triggered by distrust from fish vendors especially in urban areas where consumers prefer sourcing fish from trusted people including those in rural areas through their neighbors whom they trust and who have a proper understanding of good quality fish (Tezzo *et al*., 2021).

The number of fish species consumed by the households was positively and statistically significant (5%) to the number of meals consumed in a day. This implied that an increase in the number of meals consumed by households per day increases the chance of consuming more variety of fish. The results further show that consumers who eat more than one meal a day have a higher chance of improving their nutritional diversity through fish consumption (Nguka, 2020).

Conclusion and recommendation

Findings reveal that 98% of the surveyed households consumed different types of fish. The impact of socioeconomic and institutional factors in influencing the diversity of fish species consumed showed that total household income, Neighborhood effect, cultural influence on food choices, information from neighbors and the number of meals consumed in a day positively impacted species of fish consumed. The most consumed fish species were silver cyprinid (*Rastrinaebola Orgentae*) (51%), Nile tilapia (*Oreocromis Niloticus*) (34%), Nile perch (*Lates Niloticus*) (12%) and Common carp (*Cyprinus carpio*) (0.3%). Policy directives on the need to improve the nutritional diversity of fish need to consider sensitization of consumers on the nutritional importance of consuming both large and small species. The small undermined species including, silver cyprinid (*Rastrinaebola Orgentae*) are largely considered as of low quality yet their nutrient content is higher compared to some large species that are considered of good quality as described in literature.

The influence of socioeconomic and institutional characteristics on the diversity of fish species consumed must be enhanced through increased income-generating activities in informal settlements. This would, in turn, increase the consumption of nutritious fish since the majority of the informal settlements experience high dependency on the role of culture, neighborhood effect, and income to make decisions on food consumption.

These socioeconomic and institutional characteristics need to be promoted to improve food and nutritional security, especially among the urban poor.

Table 1: Ordered probit model results on determinants of fish species diversity

Fish species	Coefficient.	Robust std Error	p-value
Socio-economic characteristics			
Age of food decision-maker	-0.001	0.005	0.844
Gender of the food decision-maker	-0.080	0.145	0.581
Years in School for the food decision-maker	-0.007	0.017	0.686
Household size	-0.033	0.031	0.297
Total household income	0.131*	0.075	0.078
Institutional characteristics			
Total monthly price of fish	-0.002**	0.001	0.005
Group membership by the food decision-maker	-0.182	0.122	0.134
Neighborhood effect	0.004*	0.002	0.093
Cultural influence on food choices	0.005**	0.002	0.015
Migration (1= Move from the western to Kibera)	-0.132	0.124	0.285
Religion's Influence on Food Choices	-0.007***	0.002	0.002
Time taken to reach the fish outlet (in walking minutes)	0.010	0.007	0.139
Number of fish outlets within a 100 m radius	-0.001	0.011	0.940
Information from neighbors	0.391***	0.122	0.001
Number of meals in a day	0.240**	0.102	0.019
Number of observations 385			
Wald chi^2 (15) 59.44			
Prob > chi^2 0.000			
Pseudo R^2 0.069			
Log pseudo-likelihood = -377.68559			

***, **, * = significant at 1%, 5%, and 10%, respectively.

Further research

The study focused on fish consumers in the informal settlements; hence, the need to extend further to fish vendors for a better understanding of the performance of fish markets in the informal settlements, for improved food and nutrition security. There is also a need for a similar study to be done in other informal settlements within Kenya, for easy understanding of the general fish consumption patterns among the households in the informal settlements.

Acknowledgements

Much gratitude goes to the Center of Excellence in Sustainable Agriculture and Agribusiness Management (CESAAM) at Egerton University for financial support throughout my study. The authors would also like to acknowledge the Wageningen University and Research (WUR) Programme on "Food Security and Valuing Water" which is supported by the Dutch Ministry of Agriculture, Nature and Food Security, in a project called “Feeding Cities and Migration Settlements” (2282700540) for the support throughout the data collection exercise.

Conflict of interest

The authors declare no conflict of interest.

Informed Consent Statement

Informed consent was obtained from all the respondents in the study.

Authors contributions

The manuscript was conceptualized, designed, and written by Ferdinand Kamidi Isabu. Dr. Oscar Ingasia Ayuya and Dr. Eric Obedy Gido reviewed the manuscript. All authors read and agreed to publish the manuscript.

Funding

The first author, Ferdinand Kamidi Isabu, was financially supported by the Center of Excellence in Sustainable Agriculture and Agribusiness Management (CESAAM) of Egerton University, Kenya.

Data availability

The data shall be available upon request from the corresponding author.

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