ANALYSIS OF FISH CONSUMPTION PATTERNS IN INFORMAL SETTLEMENT: CASE OF KIBERA IN KENYA

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A Thesis Submitted to the Graduate School in Partial Fulfilment of the Requirements for the Master of Science Degree in Agribusiness Management of Egerton University

EGERTON UNIVERSITY

OCTOBER, 2024

DECLARATION AND RECOMMENDATION

Declaration

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

Signature Date 14/09/2023

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Recommendation

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

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DEDICATION

I dedicate this work to my loving parents, Mrs. Hellen Isabu and the late Mr. Samuel Isabu, my brother Elvis, and sisters Maximillah, Edelqueen and Christabel, as well as my guardians for their sincere support throughout my studies.

ACKNOWLEDGEMENT

I would like to sincerely thank God for the care and protection throughout my studies despite the many challenges I encountered. I also want to acknowledge the Centre of Excellence in Sustainable Agriculture and Agribusiness Management (CESAAM) secretariat for the scholarship offered to me in pursuance of a Master's degree course and financial support, including research funds and school fees, which enabled me to accomplish studies. Exceptionally, I also would like to thank my university supervisors, Dr. Oscar Ingasia Ayuya and Dr. Eric Obedy Gido, sincerely for their tireless supervision, guidance and support throughout my study period. Additionally, I would like to express my appreciation to the staff of the Department of Agriculture Economics and Agribusiness Management at Egerton University. The moral and financial support from my family is highly appreciated. My colleagues also appreciated sharing useful ideas with me during the entire period of study and research. Finally, I wish to thank the enumerators who assisted me during the data collection exercise.

ABSTRACT

The increasing urban population has resulted in the emergence of informal settlements, which are characterised by poor sanitation, low income and food and nutrition insecurity. Kenya, among many developing nations, experience the challenge of hunger and malnutrition deficiency, especially among the urban poor. To mitigate the issue of food and nutrition insecurity, fish consumption has been reminiscent of addressing protein deficiency since the majority of the informal settlements are facing nutrition deficiency. This is due to inadequate income to support their well-being, which makes it difficult to afford a well-balanced diet. Thus, the objective of this study was to understand the contribution of fish in enhancing food and nutrition security among households in informal settlements. The study was conducted in the Kibera informal settlement. A two-stage sampling procedure was used to select 385 households where food decision-makers were interviewed using a pretested structured questionnaire. Ordered probit was used to analyse both objectives one and two while a Linear Approximate Almost Ideal Demand System (LA-AIDS) model was used in analysis objective three. The results indicated that the frequency of fish consumption was influenced by gender, years in school, income, migration, price, neighbourhood effect, time taken to reach the fish outlet, and the number of outlets within a 100-metre radius. More than half (57%) of consumers consumed fish 2-3 times a day. Income, price, culture, religion, neighbourhood effect, number of meals and information from neighbours influenced the number of species of fish consumed by consumers. The number of species consumed were silver cyprinid (*Rastrineobola argentea*) (51%), Nile tilapia (*Oreochromi)* (34%), Nile perch (*Lates niloticus*) (12%) and Common carp (*Cyprinus carpio*) (<1%). Finally, age, gender, household size and education level significantly influence the demand for fish. Nile tilapia was elastic and hence considered a luxury food category to consumers. Silver cyprinid was inelastic and therefore regarded as a necessary food, while Nile perch was an inelastic and inferior category food among fish consumers. There is a need to increase the fish consumption frequency, especially for the small species of silver cyprinid (*Rastrineobola argentea*), which has been seen to be the most consumed among households in the informal settlement because of its affordability. The increasing demand for various species consumed needs to be enhanced since fish is important in improving nutrition security; hence, an increase in the availability of affordable fish in the informal settlement will improve both food and nutritional security, especially in the Kibera informal settlement.

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AIDS	Almost Ideal Demand System
ESP	Economic Stimulus Programme
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GHI	Global Hunger Index
IMR	Inverse Mills Ratio
LA/AIDS	Linearized Approximate Almost Ideal Demand System
QUAIDS	Quadratic Almost Ideal Demand System
MDGs	Millennium Development Goals
MT	Metric Tonnes
OECD	Organization for Economic Co-operation and Development
SDGs	Sustainable Development Goals
SIS	Small Indigenous Species
SPSS	Statistical Package for Social Science
STATA	General Purpose Statistical Software Package
SURE	Seemingly Unrelated Regression
UN	United Nations
UNICEF	The United Nations Children’s Fund

CHAPTER ONE
INTRODUCTION

1.1 Background Information

One of the major challenges that the world faces is the difficulty of providing adequate food for the rising population. The prevalence of undernourishment rose from 8% in 2019 to 9.8% in 2021, with an estimated 278 million Africans experiencing hunger in 2021. This increase, especially in 2021, was due to the outbreak of COVID-19. The Russia-Ukraine war also escalated the issue of food and nutrition insecurities, hence making it difficult for the world to achieve the Second Sustainable Development Goal (SDG2) objective of eradicating hunger in the world (EOCD-FAO, 2022). Close to a billion people around the globe experience deficiencies in nutrition as well as food insecurity, hence giving rise to diseases that are related to diet complexities (Obiero *et al.,* 2019). This provides insight into the need to ensure proper feeding habits that guarantee the current human population better access to nutrient-dense foods with important nutrients, such as fish.

Globally, hidden hunger, which is associated with the deficiency in multiple micronutrients, especially zinc, iron, vitamin A, and iodine, has affected the majority of people, hence leading to poor health, retarded growth, low productivity, mental impairment, unexpected death (Ekholuenetales *et al.,* 2020). The increase in access to and consumption of micronutrient-dense foods, especially fortified foods, has been recognised as one of the measures taken to reduce the 'hidden hunger,' especially among vulnerable households. Kenya's micronutrient intake has been poor, with only 22% of children consuming a proper diet (2014 Kenya Demographic and Health Survey) (WFP, 2016).

Population growth due to urbanisation, increased income, and health benefits from fish has accelerated fish consumption (Anderson *et al*., 2017). The global fish consumption rates have been growing, providing about 17% of the total animal protein intake across the globe. The importance of fish as an important source of food and nutrition makes it an easily available source of nutrients across the world. Fish consumption has also proven to provide important health benefits, which include protection against viral and bacterial infections, healing of wounds, reducing inflammation, and acting as an antioxidant to the human body; hence, frequent consumption of fish more than two times a week helps in the reduction of cardiovascular diseases (Chen *et al.,* 2022; Lannotti *et al.,* 2022). Fish also represents an important source of animal protein, which is essential in improving human health since the consumption of fatty fish reduces visual impairment and severe vision loss among the elderly (Béné *et al*., 2016; Fan & Song, 2022).

Kenya's social and economic development has been improved through the fisheries sector, which comprises both capture and farmed fisheries. Although the fish sector contributed about 0.54% of Kenya's GDP in 2013, the consumption rate has been reducing significantly in the recent past, from 6% in 2000 to 4.5 % in 2011 (FAO, 2016). It also represents an easily available and cheap source of diversified nutrition among many developing countries whose diets are dependent on a limited choice of staple foods (Hicks *et al*., 2019). In the recent past, the well-being of consuming fish has been greatly appreciated due to its potential contribution to food security, especially in improving micronutrient sufficiency among women, infants, and young children (Béné *et al*., 2015; Thilsted *et al.*, 2016).

Therea has been a projection that the average global per capita fish consumption will increase from 20.5 kg (2018-2020) to an average of 21.2 kg in 2030. Additionally, this projected increase will be slower compared to the previous decade, where there was a 1.1% per annum increase, unlike the expected 0.4% per annum. Africa is expected to experience a decrease (-2.2%) in per capita fish consumption, with a further decline (-5.6%) expected due to the increasing population, which will be more than the fish supplied in the market, hence increasing the nutritional deficiency (OECD/FAO, 2021). Only Uganda's fish consumption of 12.5 kg has been higher than the East Africa region, which experiences extremely lower levels at an average of 5.1 kgs/person/year compared to the rest of African countries at an average of 10.1 kg, and global level of 19.8 kg (Alemayehu & Tamiru, 2019).

Kenya's annual per capita fish consumption has been lower, with the current consumption rate being lower than 5kg/person/year compared to the global consumption average of about 20kg/person/year (Munguti *et al*., 2021). This was lower than Tanzania's annual per capita fish consumption, which increased from 7.4kg to 7.7 kg between 2012 and 2015. Further, the global increase of 20.5 kg in yearly per capita consumption rate has also been experienced between 2019-2021, and this was the highest compared to previous years (FAO, 2022). Further projections reveal that global per capita fish consumption will increase to 21.4 kg by the year 2031 compared to the previous 20.5 kg between 2019 and 2021 with Africa expected to encounter the least growth (OECD-FAO, 2022). This estimated decline in fish consumption frequencies across sub-Saharan Africa raises concern, especially when addressing the issue of food and nutritional insecurities since the region has experienced higher levels of undernourishment and food insecurity.

The average reduction in the fish consumption rate in Sub-Saharan Africa has been due to almost 90% of fish products consumed being from Inland fisheries. After all, marine catches are mainly for export, and this presents an important role in meeting the continental demand for fish (Wenaty *et al.*, 2018). The current annual fish production in Kenya is 400,000 tonnes, while the annual demand is 600,000 tonnes. In addition to this sizable production deficit, the fish consumption level is only 4 kg per capita per year, which is far below the global average of 20 kg per capita. To increase the fish consumption level and curb undernutrition, it is important to create awareness of the health benefits of fish, especially for women and children, as fish contains high levels of beneficial nutrients like zinc and iron.

Food is highly related to human culture (Kittler *et al.,* 2011) in that culture is essential in influencing human behaviour hence the assumption that cultural beliefs are a reflection of the behaviour of individuals. These cultural beliefs often affect people's diet and food intake. Food and its consumer culture are critical for the survival of human beings as they create a better understanding and more strong relationships among people. Studies on consumption behaviour through cultural and ethnic representation have been done in the past and established that the enactment of adapting to particular social groups is important to individuals' use and display of ethnic consumption (Cova, 1997).

Population in informal settlements is rapidly increasing as people migrate from rural to urban areas while searching for employment and a better life. Most of the immigrant's encounter challenges and end up settling in these areas due to their social and economic status. This urban migration further leads to urbanisation, which then results in the challenges of food shortages, increased slums, and water and air pollution. Therefore, these urban poor form part of the millions facing hunger in the world (FAO *et al.,* 2019). Kenyans' informal settlement is faced with similar challenges, and accessing food and other basic needs is a major challenge. Residents of these informal settlements, Kibera included, heavily rely on buying food, making it difficult for them to save for the future.

To cope with these challenges, migrants choose where to settle based on their socioeconomic status because they believe that those who had earlier settled in these areas have better information about this new location than the current immigrants lack (Epstein, 2010). This is evident in the informal settlements where residents settle in groups based on their cultural and ethnic compositions, making it easy for them to adapt to the new lifestyle.

1.2 Statement of the problem

Currently, global food and nutrition insecurity has been on the increase due to the increasing global population. It is, therefore, important to ensure that the available food is sufficient and able to sustain the human population. Kibera, as an informal settlement that has experienced an increase in population over time due to rural-urban migration, search for employment, and better living standards, is still struggling to have sufficient and sustainable food for its residents. Challenges related to the consumption of some foods like red meat have been on the rise; hence, consumers are shifting to the consumption of white meat, which includes fish, which has been seen to reduce the mortality rates and other diseases related to red meat consumption. Therefore, much literature on fish consumption patterns in informal settlements must be ascertained, especially factors influencing fish consumption frequency, species diversity, and demand for fish. This study aims to fill the knowledge gap by analysing household behaviours related to fish consumption in Kibera informal settlements.

1.3 General objectives

To contribute towards enhanced food and nutrition security in informal settlements by analysing the consumption patterns of fish in Kibera informal settlements.

1.3.1 Specific objectives

i. To assess factors influencing fish consumption frequency among households in Kibera informal settlement.
ii. To determine the roles of socioeconomic and institutional factors in influencing the diversity of fish consumed among households in Kibera informal settlement.
iii. To determine the influence of demographic factors, price, and expenditure elasticities on demand for fish among households in Kibera informal settlement.

1.3.2 Research questions

i. What factors influence fish consumption frequency among households in Kibera informal settlement?
ii. What are the roles of socioeconomic and institutional factors in influencing the diversity of fish consumed among households in Kibera informal settlement?
iii. What are the influences of demographic factors and price and expenditure elasticities on fish demand among households in Kibera informal settlements?

1.4 Justification

Fish is an important source of minerals, animal proteins, and micronutrients across Africa, where over 200 million people have been seen to regularly feed on fish. Lately, unlike other continents, Africa has experienced a diet transformation toward increasing demand for animal source products such as red and white meat. Generally, consumption of fish was on the rise between 25% and 50% from the year 2007 to 2015 across many African countries (Tran *et al.*, 2018). This gradual increase in Africa's fish demand has been driven by the growth in population and income, as well as increasing awareness of the health benefits of fish consumption. Fish consumption has also been seen to accelerate urbanisation across the world. Kenya's effort to achieve food and nutrition security by 2022 did not materialise since the country is still among those listed as food insecure by the Global Hunger Index (GHI) Report, 2019. More than half of Kenya's urban residents live in poverty, with the majority residing in adjacent urban areas where surviving is basically on inadequate incomes and unhealthy and overcrowded environments. Nairobi is home to 45% of Kenya's urban population, and about 60% of the population lives in slums (Beyer *et al*., 2016). Generally, the push and pull factors like the search for job opportunities and hope for a better life have contributed to the increasing population, especially in Kibera, where rural-urban migration has been on the rise (Mukeku, 2018). This is due to the assumption that there is a readily available surplus of cheap labour in urban areas. However, this is not always the case since most of the income earned among the migrants goes towards daily expenses and supporting their many dependents both in the rural area or within the urban slums.

People living in informal settlements have not been able to properly practice personal hygiene due to their limited access to water, sanitation, and hygiene (WASH) facilities (Kim *et al*., 2022), which can lead to serious public health concerns in urban informal settlements. They are compounded by challenges related to climate change, job insecurity, crime, changes in food prices, insecurity of the land tenure system, health issues and orphaned children. The residents experience limited access to proteins in the diet despite it being a key component for nutritional health (Ayuya *et al*., 2021). These urban poor not only experience inadequate income and resources to ensure proper well-being, but they often face difficulties in accessing basic services, minimum labour opportunities, and poor social development. It has also been estimated that by 2035, the majority of individuals in extreme poverty will live in urban areas. This, therefore, needs proper planning that will ensure adequate access to better nutrition and food systems in the informal settlements. The unhygienic and crowded living environments with poor access to public services worsen the effects on urban informal dwellers' food security (WFP, 2016).

The importance of fish as a source of nutritious food with high-quality animal protein cannot be easily substituted by other food commodities (Béné *et al*., 2015). This is because fisheries (capture and farmed) have a significant influence in contributing to the objective of minimising food and nutrition insecurity, promoting income growth, reducing poverty, and enhancing employment among consumers (Chan *et al*., 2019). This study, therefore, is in line with Vision

2030 and the Kenya Big Four agendas which emphasises the need to ensure all Kenyans experience food and nutritional security, as stipulated in the third medium-term plan (MTP III) 2018–2022 of Vision 2030, which identifies the blue economy as one of the priority areas with high capability of increasing inclusive economic growth and development across Kenya.

1.5 Scope and limitation of the study

The study focused on fish consumption patterns in Kibera informal settlements. It was based on data collected in August 2021 under the project “Feeding Cities and Migration Settlements” in the Kibera slum. Respondents were interviewed in their households so that they could provide their information regarding personal experience with fish. All fish species consumed in the households were considered for the study. Agriculture not being the main economic activity in Kibera, and sustainability in terms of food is mainly dependent on other regions, hence, Kibera was the ideal area for this study. However, the accuracy of the results was limited to the fact that there were minimum records for proper reference, hence, thorough probing was conducted during the survey, which minimised the effect of the lack of records.

1.6 Definition of terms

Capture fish: These fish are fish obtained from the wild, including rivers, lakes, oceans, and the sea.

Consumption frequency: Refers to the number of times fish is consumed in a month.

Culture: A way of life of a group of people; their behaviour, beliefs, values, and symbols that they accept, generally without thinking about them, and that are passed along by communication and imitation from one generation to the next.

Demand: This is the desire of the consumer to purchase a commodity (fish) and the willingness to pay a price for it.

Farmed fish: These fish are obtained from culture farms, such as fish ponds and fish cages.

Food security: This is the state where all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

Hidden hunger: This is the presence of multiple micronutrient deficiencies (particularly iron, zinc, iodine, and vitamin A), which can occur without a deficit in energy intake as a result of consuming an energy-dense but nutrient-poor diet.

Household: Consists of one or several persons who live in the same dwelling and share meals.

Migration: This is the movement of people from one permanent home to another. This movement changes the population of a place.

Species diversity: This is the type of fish consumed among households.

CHAPTER TWO

LITERATURE REVIEW

2.1 Role of fish in addressing food and nutrition security

One of the major objectives of the Sustainable Development Goals under Vision 2030 is aimed at ending hunger, achieving food security, and improving nutrition. This goal has experienced challenges, especially in Africa, where over 100 million people are still experiencing food and nutrition insecurities. Fish has been key in ensuring this goal is achieved since it comprises between 16% and 21% protein. It is also important in the provision of minerals, including zinc, iodine, iron, phosphorus, and calcium, which are key to proper human health. The presence of omega-3 fatty acids helps reduce the risks of high blood pressure heart attacks and hence improves the immune system (Maurya *et al*., 2018; Muringai *et al*., 2021).

Food and nutrition insecurity is a complex phenomenon that requires proper policies that promote food production, trade, and enhancement of other food production systems that can contribute to the existing food supplies. Therefore, the fisheries sector is one of the food production systems which has been recognised for its important contribution to promoting socioeconomic growth, enhancing food and nutrition security, and improving the livelihoods of marginalised communities. *Per capita,* fish consumption projections indicate that fish consumption is expected to increase on all continents except in Africa as population growth outpaces fish supply. Fish consumption *per capita* has been estimated to drop by 3% from 9.9 kg in 2015–2017 to 9.6 kg in 2027, with a more substantial decrease expected to be experienced in SSA (Muringai *et al*., 2022).

In economically developed countries, consumers are often advised to eat more fish to improve their diets, especially due to its health benefits and omega-3 fatty acids. It has also been recognised that fish is a valuable food compared to meat, poultry, and eggs. It is low in saturated fatty acids and a good source of protein. Oily fish, on the other hand, is an excellent source of long-chain omega-3 fatty acids (Brunner *et al*., 2009). Therefore, fish plays a major role in promoting food and nutrition security (Béné *et al*., 2015; Thilsted *et al*., 2016).

Fish, including finfish and shellfish, contribute about 17% of the total animal protein and 7% of all proteins, respectively. This is very important for over 3 billion people in dire need of nutritious foods in developing countries across the world (FAO, 2018). Fish is a source of amino acids, vitamins, minerals, zinc, and omega-3 fatty acids, which are usually in bioavailable forms that necessitate improved human health (Golden *et al*., 2016).

The micronutrient composition of fish varies across species. Iron content ranges from 0.34 to 19 mg/100 g raw edible parts; zinc from 0.6 mg/100g to 4.7 mg/100 g; calcium from

8.6 to 1900 mg/100 g; vitamin A from 0 to 2503 mg retinal activity equivalent/100g; and vitamin B_{12} from 0.50 µg/100 g to 14 µg/100 g. 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).

2.2 Fish consumption in Kenya

The aquaculture industry in Kenya has been stuck since its inception in the 1920s. Systems defining aquaculture include well-dug ponds, tanks, and dams. Nile tilapia (*Oreochromis niloticus*) has been leading among the cultured species, representing about 75% of production, with African catfish (*Clarias gariepinus*) contributing about 21%. In comparison, other species, including Common carp (*Cyprinus carpio*), comprise the remaining 4%. The government invested about KES 22 billion in anticipation of increasing the production of fish and opening up more areas of the country to aquaculture farming between 2009 and 2013 through the economic stimulus programme (ESP). Through this ESP, there was an increase in aquaculture production from 1000 metric tonnes (MT) per year in 2000 to 12,000 MT per year in 2013; this was equivalent to 7% of national fish production (Musyoka & Mutia, 2016).

Fish consumption in Kenya relies heavily on capture fisheries, with Lake Victoria producing more than 70% of the total. However, various factors, including overfishing, pollution and the use of illegal fishing equipment, have reduced the quantities of fish harvested. This challenge is still being experienced, even with more efforts from the government to regulate the fisheries sector. Currently, Kenya's population is rapidly increasing, and the demand for freshwater fish is also growing, creating a demand and supply shortage (Lattice Consulting, 2016).

Kenya has been classified as the fourth producer of farmed fish in sub-Saharan Africa. This increase in production is mainly linked with the engagement of the government through the intersectoral economic stimulus programme of 2009, where approximately 283 million dollars was invested in major quarters between 2009 and 2012. The annual *per capita* fish consumption in 2010 was estimated at 5 kgs/person/year, which was still below the recommended 20 kgs/person/year by FAO (Rothuis *et al*., 2011).

Preference for farmed fish over captured fish due to concerns about pollution residues experienced from capture fisheries has been a major concern by consumers who consider quality standards and the safety of food as a priority in their diets (Obiero *et al*., 2014). Population increase is leading to a rise in the demand for fish since there is a shift in the eating habits among many consumers where the majority are adopting the consumption of white meat because of its health benefits over red meat, which has been seen to cause more harm than benefit to the human health. Therefore, Kenya imports about 5900 MT annually from different countries, including Uganda, Japan, Pakistan, India, Korea, and China, to reduce the deficit between local fish production and the increasing demand for fish (Opiyo *et al.*, 2018). In 2013, most of the fish that was imported was frozen tilapia (14%) originating from China. Nile tilapia imports between 2013 and 2014 increased from 14% to 30%, with the total imports reaching 5853 MT in 2014 (Lattice Consulting, 2016).

2.3 Factors influencing fish consumption frequency

Consumers' social-cultural and geographic characteristics affect the frequency with which they consume fish (Can *et al.*, 2015). Carlucci *et al.* (2015) identified that the frequency of fish consumption was affected by several factors, including perception of price, senses, beliefs, convenience, eating habits, health benefits, self-efficacy, and availability of fish. It is also believed that consumers who are health-orientated or reside in a social context that supports the consumption of fish will have to consume fish more frequently (Samoggia & Castellini, 2018).

Households with teenagers experience a negative correlation with fish consumption since teenagers perceive fish to have a bad smell and taste, hence reducing its consumption rates (Verbeke & Vackier, 2005). Contrary to this, fish consumption is positively influenced by age in that elderly consumers tend to consume fish more frequently than younger people. This is because of the perception that elderly people are more concerned about the health benefits of food, unlike the younger generations. Therefore, as consumers increase in age, they tend to become more aware of the health benefits associated with fish consumption, which suppresses diet-related diseases (Birch & Lawley, 2012). Wenaty *et al.* (2018) observed that there was a positive significance between age and consumption of fish since elderly people tend to be more conscious of healthy diets, unlike younger people.

Additionally, it has been noted that a price increase has a negative influence on fish consumption since fish, being white meat, is mostly considered an expensive source of proteins compared to other red meat due to its health benefits (Neale *et al.*, 2012). Contrary to this, an increase in income results in an increase in fish consumption among households. This is associated with the fact that fish is still considered a high-value food among many people; hence, it is preferred regardless of the price (Zhou *et al.*, 2015). Hansen and Grung (2016) also found that the quantity of fish consumed increases in relation to an increase in income, which increases the quantity of fish consumed. Further, findings also reveal that low-income earners tend to consume less fish because of financial hindrances that affect their choices in consumption behaviour. In contrast, high-income earners can diversify their feeding behaviour since they have several alternatives to choose from based on their financial capabilities. Another study done by Esilaba *et al*. (2017) found that income levels were significant to the consumption of a specific kind of fish. Therefore, consumers with higher incomes tend to frequently consume Nile tilapia and Nile perch, unlike those consumers with lower income levels.

Verbeke and Vackier (2005) found out that gender also influences fish consumption in a way that the majority of female consumers tend to consume more fish (more than once a week or more) compared to male fish consumers. In contrast, Rahman and Islam (2020) observed that males consume double the amount of fish consumed by females. This is evident in the way that male consumers are perceived to be more involved in purchasing food since they are the household heads; hence, they end up eating more food, including fish, compared to female consumers, where the majority are known to engage more in preparation of food, including fish for household consumption (Dasgupta *et al*., 2017).

Culture, described as the family norm among families that do not consume fish, has been seen to influence the frequency of consuming fish, where an increase in the household size decreases the rate at which fish is consumed. This has been experienced in households with younger children (Verbeke & Vackier, 2005). Cultural norms, as well as family traditions, have influenced the frequency of consuming fish (Devlin *et al*., 2012). These results have been emphasised by Hermida and Costa (2020) on fish consumption habits whereby childhood exposure to various foods tends to influence the way some foods are consumed through the behaviours that are acquired over a longer period (Wadhera *et al*., 2015). Therefore, the consumption of various foods reflects some traditions where consumption trends are transferred across generations.

Findings from the study on migration reveal that variations in diets sometimes lead to unhealthy changes in diets, especially among those involved since these changes contribute to the diversification of the diets among those involved in the host environment (Gilbert & Khokhar, 2008). This concurs with a study in Belgium, where the consumption of healthy foods increased with an increase in migration (Perez-Cueto *et al*., 2009). The results also revealed that an increase in nutritional knowledge due to exposure to host culture through media, friendship, and work environment led those involved to adapt to healthier diets.

Neighbours also play a role in making consumption decisions among households in that ethnic concentration within a region can influence food consumption decisions based on neighbours' social ties and the transmission of food-eating habits through the existing social networks, as members have the opportunity to share sociocultural norms. Thus, the household preference for the consumption of various fish species is influenced by their neighbour's appraisal since the majority will opt for fish that neighbours positively appraise (MEA, 2018).

2.4 Determinant of fish demand among household

Botrel *et al*. (2007) showed that factors like freshness, nutrition, price, taste, and quality of fish, to a great extent, influenced the demand for fish among consumers. Price had both positive and negative influences on fish consumption since some consumers perceived expensive fish as being of good quality. In contrast, others perceived high prices as a hindrance to increased fish consumption since their incomes were limited to high fish prices. Consumers perceived fish to be more expensive than meat (Brunsø *et al*., 2009). This makes it difficult for consumers to buy fish due to the higher prices, and hence consumers rarely consume fish.

The taste of fish and bones was also the major component of why consumers preferred fish (Pieniak *et al*., 2008). There was a difference in perception of fish price, smell, and bones compared to the health benefits associated with fish consumption among consumers (Verbeke & Vackier, 2005). Leek *et al*. (2000) identified some challenges associated with reduced fish consumption, where fish bones have reduced consumption frequency for a long time when preparing and consuming, and many consumers feel it is time-consuming to remove the bones. The dangers associated with fish bones during consumption also hinder some consumers from consuming fish, especially in households with young children.

A study carried out by McManus *et al*. (2007) relating to fish consumption and factors influencing it found that all children among the respondents of the study had consumed fish, with some even starting the practice at an early age. Other important factors have contributed a lot to the frequency of fish consumption and the diversity of both purchase and consumption. Anticipated availability or accessibility of fresh fish, level of confidence to prepare a meal that is appropriate to family members, and the cost of fish were also determinants of whether fish was to be consumed in the households or not.

A study done by Onuma *et al*. (2020) on fish consumption behaviour found that there was a positive and significant relationship between household size and the amount spent on fish consumption. Therefore, a larger household tends to consume more fish compared to that with few members due to individual household demand. Religion was also positively influenced by household expenditure since religious beliefs play a key role in establishing the quantity of fish for consumption among the households, with Christians being the major consumers compared to Muslims, who have some restrictions that hinder them from consuming some species of fish, including those without scales (Gadegbeku *et al*., 2013).

A study by Bogard *et al*. (2015) revealed that fish diversity influences nutrition intake, especially in captured small Indigenous species, providing higher nutrition to individuals at risk of nutritional deficiency compared to farmed species. This is because small Indigenous species are consumed wholly, including bones and heads, that are rich in nutrients, including vitamin A, zinc, calcium, iodine, and iron. FAO *et al.* (2018) emphasises that oily fish have a chance of reducing the dangers associated with death caused by heart disease. On the other hand, Siddhnath *et al*. (2022) also found that dried fish increases food and nutrition security among households since it is an important source of fats and proteins.

2.5 Theoretical framework

Several theories explain consumer behaviour regarding food consumption. This study examines different theories, including the farm household theory that incorporates both the production and consumption behaviour among households. Utility maximisation theory and planned behaviour theory have been used to address the agricultural household consumption model.

2.5.1 Theory of Consumption Value (TCV)

The TCV, as a multi-dimensional approach, examines consumption value from a behavioural perspective and provides perceived-value typologies (Boksberger & Melsen, 2011). It offers more information on the factors that contribute to the motivation of consumption behaviour through consumption values among consumers, Tanrikulu (2021). This theory clarifies the motivation for consumption behaviour and explains choice behaviour by focusing on consumption values. Sheth *et al*. (1991) used a wide range of disciplines, such as economics, marketing, consumer behaviour, sociology, and psychology, to develop the theory and its values; thus, the TCV provides a multidisciplinary view for studies examining consumer choice behaviour. The practical context of the theory is limited to individual, systematic, and voluntary decision-making; hence, the theory is argued not to cover a choice context such as dyadic or group, random or stochastic, and mandatory or involuntary.

It is built on three-person axiomatic propositions (Sheth *et al*., 1991), “Consumer choice is a function of multiple consumption values; the consumption values make a differential contribution in any given choice situation, and the consumption values are independent.” The proposed consumption values were defined in the TCV by Sheth *et al*. (1991) as follows:

Functional value: The perceived utility is acquired from an alternative's capacity for functional, utilitarian, or physical performance. An alternative acquires functional value through the possession of salient functional, utilitarian, or physical attributes. Functional value is measured on a profile of choice attributes.

Social value: The perceived utility acquired from an alternative's association with one or more specific social groups. An alternative acquires social value through association with positively or negatively stereotyped demographic, socioeconomic, and cultural/ethnic groups. Social value is measured on a profile of choice imagery.

Emotional value: The perceived utility acquired from an alternative's capacity to arouse feelings or affective states. An alternative acquires emotional value when associated with specific feelings or when precipitating or perpetuating those feelings. Emotional value is measured on a profile of feelings associated with the alternative.

Epistemic value: The perceived utility acquired from an alternative's capacity to arouse curiosity, provide novelty, and satisfy a desire for knowledge. An alternative acquires epistemic value through questionnaire items referring to curiosity, novelty, and knowledge.

Conditional value: The perceived utility acquired by an alternative as the result of the specific situation or set of circumstances facing the choice maker. An alternative acquires conditional value in the presence of antecedent physical or social contingencies that enhance its functional or social value. Conditional value is measured on a profile of choice contingencies.

2.5.2 Theory of Planned Behaviour (TPB)

Previously, TPB has been successfully applied to help in acknowledging and predicting behaviours related to food, as well as consuming green food, dietary behaviour, and innovative products, including functional food and healthy eating (Netemeyer *et al*., 1991; Pandey *et al*., 2021). This theory also tries to outline some influencing factors that make an individual carry out certain intentions, like consuming fish. The intention has been defined as the conscious plan to perform a certain behaviour and the motivation to carry it out. The intention is determined from three visionary self-sufficient constructs that include subjective norms, attitudes, and perceived behavioural control. Attitude, as described by Netemeyer *et al*. (1991), is the degree to which an individual likes or dislikes certain aspects of the behaviour. Attitudes are decided by certain behavioural beliefs regarding the operationalisation of a specific behaviour as well as other beliefs that, when performed, might lead to the evaluation of certain results.

Subjective norms are described as the anticipated social pressure to either execute or not a specific habit. These subjective norms are resolved by peer influence and beliefs from other important individuals as well as those who encourage others to conform to social pressure. Additionally, perceived behavioural control is the ability to perform a certain behaviour with either ease or difficulty. It is decided by the probability of external factors involved in carrying out a particular behaviour. Consumers with a positive attitude towards a certain habit tend to embrace social pressure to carry out the habit. They also tend to believe that, to a great extent, they are in charge of their decisions when executing a certain behaviour. In the case where these three constructs are much more favourable, then it makes it easy for the individuals to carry out the behaviour as found by (Jayasinghe *et al*., 2019).

2.5.3 Utility maximisation theory

Consumer behaviour theories entail how consumers allocate their income over various commodities to maximise their utility (Oseni *et al*., 2023). It also affirms that the consumer, as a rational person, strives to spend their income on products and services that produce the highest satisfaction or utility. This study focuses on the household decision on how fish is consumed among the informal settlers under the utility maximisation framework. A random utility theory (RUT) is used to understand this concept, as it explains and quantifies consumer preferences based on a finite set of alternatives. Therefore, the privilege resulting from whether or not to consume fish was imagined to impact their decision. In the case where u_i and u_j represent a household's utility of whether or not to consume fish, the following formula is used:

$$u_t = \beta_n X_n + \varepsilon_i \text{ and } U_j = \beta_n X_n + \varepsilon_j \quad (1)$$

where U_i and U_j are anticipated utilisation of choices for both consumers and non-consumers and j, respectively, x_n refers to the vector of predictor variables that affect the anticipated engagement of each choice. β_i and β_j are variables to be evaluated, ε_i and ε_j are error terms assumed to be singly and equally scattered (Greene, 2000). In the case a household opts to consume fish (option i), then the anticipated utility from choice I, is larger than the utility from option j (not to consume), which is described as shown below;

$$u_{ni} = (\beta_i X_n + \varepsilon_i) > (U_{nj}(\beta_j X_n + \varepsilon_j))\ I \neq j \quad (2)$$

The probability that a consumer decides to adopt possibility I instead of j is represented as;

$$\left.\begin{array}{l} P\,(Y = 1/X) = P\,(U_{ni} > U_{nj}) \\ P\,(\beta^{*}X_n + \varepsilon_i - \beta^{*}{}_j\,X_n + \varepsilon_j > 0/X) \\ P\,(\beta^{*}{}_iX_n - \beta^{*}{}_jX_n + \varepsilon_i - \varepsilon_j > 0/x) \\ P\,(X^{*}{}_i\,X_n + \varepsilon^{*} > 0/X = F\,(\,\beta X_n)) \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

where P represents the likelihood function, U_{ni} , U_{nj} refers to a household's utility for the two options, and $X_n$is the vector of independent variables that affect the anticipated shock of each option, Ɛ*=ε_i-refers to the random disturbance term, β*= (β_i-β_j), represents the net effect of the vector of independent variables influencing the patterns of consuming fish, and F(β*X_n) is a collective distribution outcome of ε* estimated at β* X_n. The distribution of the random disturbance term, ε*, is dependent on the true distribution of F. Based on the assumed distribution that the random disturbance term follows, various qualitative options of models can be determined (Greene, 2003).

Since farm household theory incorporated household production and consumption, it does not properly fit this study because it focusses only on consumption. The theory of planned behaviour considers normative effects, making it difficult to incorporate the economic factors that might impact an individual's intention to carry out a certain behaviour. Therefore, this study adapts utility maximisation theory since it assumes that human beings are rational and, hence, can make decisions based on the highest level of satisfaction or utility.

2.6 Conceptual framework

Figure 1 highlights the conceptual framework for various factors influencing fish consumption frequency and how they affect the demand for fish. Socio-economic factors, institutional factors, culture, and migration are explanatory variables directly impacting the following dependent variables: consumption frequency, preference for various fish species, and household demand for fish. These explanatory variables may encourage or limit the household from consuming multiple species of fish. In addition, product attributes such as type, quality, size, taste, and smell sometimes have either positive or negative results on consumption frequency. When handling the consumption frequency, the dependent variable predicts how many times households consume fish to achieve nutritional goals. The frequency of consumption will influence how households develop a budgetary allocation schedule for fish, and this will help achieve the goal of improved food and nutrition security.

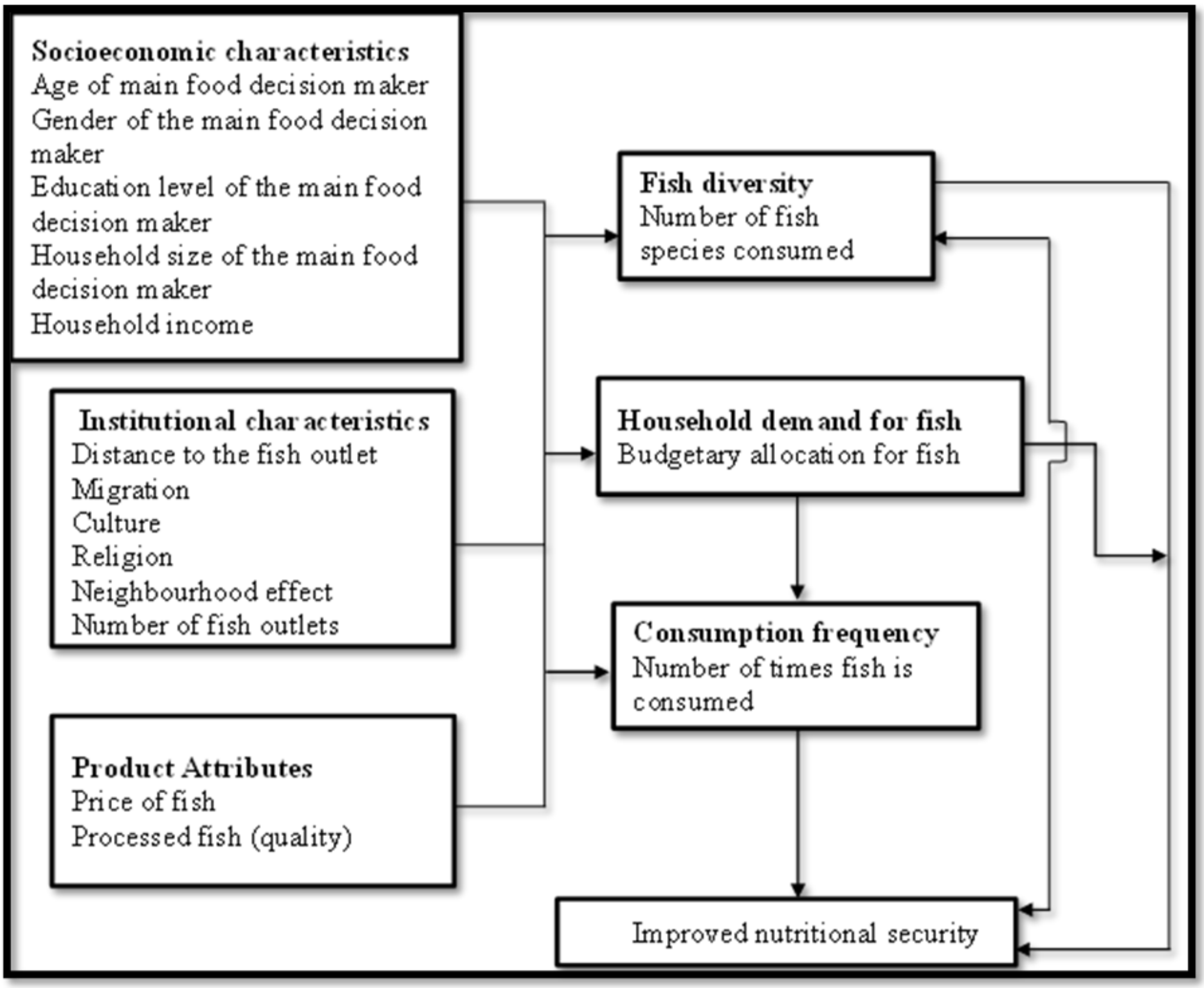

Figure 1: Conceptual Framework

CHAPTER THREE
METHODOLOGY

3.1 Description of study area

This study was carried out in the Kibera informal settlement, Nairobi-Kenya. Kibera is situated about 6.6 kilometres southwest of Nairobi, Kenya's capital city, as shown in Figure 2. Kibera was chosen for this study because it is the largest informal settlement in Kenya and it 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 charitable organisations and well-wishers. Access to food is another challenge that increases the issue of nutritional deficiency, especially protein intake.

The informal settlement is mostly dominated by Luo and Luhya communities from western Kenya, and these inhabitants consider fish to be an important meal in their diets. The country’s fish consumption has increased, and communities that are traditionally not known to be consumers of fish have increased their uptake of fish. Most of the fish consumed in Kibera come mainly from Lake Victoria. Still, in the recent past, some other farmed fish species, including those from China, Nyeri fish farmers cooperative, and victory farms that supply caged fish, have found their market in Kibera (Ayuya *et al*., 2021).

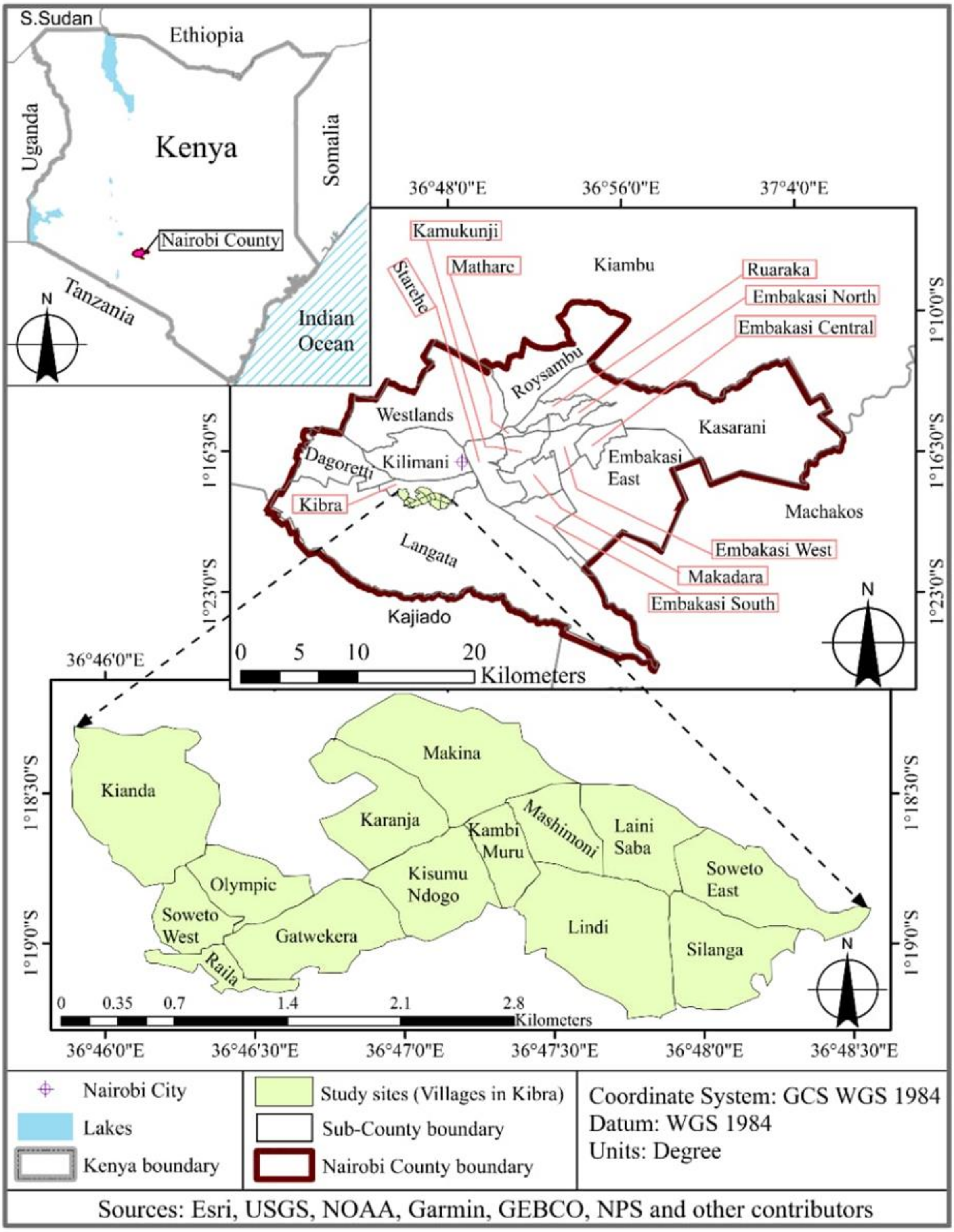

Figure 2: Map of the study area, Kibera informal settlement.

3.2 Research design

This study was carried out using a cross-sectional research design, which is best suited for population-based surveys. The cross-sectional research design was best suited for this study because much of the data in the study was required to be collected in a relatively shorter period, and it allowed for the data to be collected at one point in time from various respondents. A two-stage cluster sample design was appropriate for the study, and it included choosing clusters, households, and suitable respondents. In the first stage, Kibera was clustered into 14 villages. There was an exclusion of two villages from the targeted 14 due to security reasons at the time of the study; hence, the remaining 12 villages were sampled for the final research. The selection of the same number of respondents from every village was made possible through a simple random sampling technique. The second stage incorporated the use of personal digital assistants and a random selection of respondents was done from 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 and meeting points for easy access to the targeted areas. These landmarks included schools, churches or mosques, and health facilities, among others.

3.3 Target population

The target population for this study was households consuming fish in Kibera informal settlements. They included both male and female food decision-makers and were to be residents of Kibera. A total of 385 households were targeted for the study, which was represented by a determined sample size formula (Kothari, 2004).

3.3.1 Sampling unit

The unit of study was adult food decision-makers in fish-consuming households within the Kibera informal settlement.

3.3.2 Sample size determination

The determination of the sample size was based on the formula given by Kothari (2004), as shown in equation 5 for an infinite population.

$$n = \frac{z^2 \times p \times q}{e^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

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 an 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;

$$n = \frac{z^2 \times p \times q}{e^2} = \frac{(1.96)^2 \times 0.5 \times 0.5}{(0.05)^2} = 384.16 \cong 385 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

3.4 Data collection

This study used secondary data which was obtained from household food decision-makers in the Kibera informal settlement in August 2021, under the project named "Feeding Cities and Migration Settlements" by the Wageningen University Research (WUR) programme on "Food Security and Valuing Water," which was supported by the Dutch Ministry of Agriculture, Nature and Food Security. A pilot study was conducted in Kaptembwa, Nakuru County, Kenya, to test the reliability of the data collection instruments before the main exercise began. 39 households were involved in the pre-test, which was approximately 10% of the required sample size for the study. Findings from the pre-test were used to correct and adjust the final questionnaire before being administered for the study in the Kibera Informal settlement. The questionnaire covered information on household and household head characteristics, connection to rural areas, diversity of fish consumed, purchase decisions, and food and nutrition security (see Annex 1).

3.5 Data analysis

The data for the study were processed and analysed using both Statistical Package for Social Science (SPSS) and Stata statistical software.

3.6 Analytical framework

3.6.1 Objective 1: To assess factors influencing fish consumption frequency among households in Kibera informal settlement

Both descriptive statistics and regression models analysed the data collected. Previous studies on the influence of attitudes on consumer choices have mostly been analysed using regression models (Aikman *et al*., 2006; Ham *et al*., 2015; Schäufele & Janssen, 2021; Wang *et al*., 2020). The number of times that fish was consumed by the households in a month, regardless of the type, was a measure of the consumption frequency used in this study. Therefore, (1 = less than once a week, 2 = once a week, 3 = two to three times a week, 4 = four to six times a week, 5 = once a day, and 6 = twice or more a day) were the categories involved in determining the frequency of fish consumed by various households in a month, as described in Table 1. Based on these categories of natural ordering, the ordered probit model was more suitable for application to the variables (McKelvey *et al*., 1975).

The ordered probit model can be specified from the unobserved independent variable. Y_I^* (Güney *et al*., 2022),

$$Y_i^* = x_i^{''} + e_i \quad \ldots\ldots (6)$$

where i (i =1, 2…, N) represents frequency, x_i signifies the direction of the independent variable, β which represents the vector of the unknown relationship of coefficients and e_i refer to the unobserved individuals' error term with the standard logistic distribution. The lower levels of Y_i^* This signifies an increase in the consumption frequency of a household. When comparing, the higher levels of Y_i^* Referred to the lower consumption frequency of an individual. Therefore, the dependent variable in this model was classified according to the values of the latent variable (Y_i^*) occupied within a particular group of values that ranges from T_k:

$$Y_i = \begin{cases} 1, & '\text{zero times a week}' & \text{if } T_0 < Y_i^* \le T_1 \\ 2, & '\text{once a week}' & \text{if } T_1 < Y_i^* \le T_2 \\ 3, & '\text{Two or three times a week}' & \text{if } T_2 < Y_i^* \le T_3 \\ 4, & '\text{four to six times a week}' & \text{if } T_3 < Y_i^* \le T_4 \\ 5, & '\text{once a day}' & \text{if } T_3 < Y_i^* \le T_5 \\ 6, & '\text{twice or more a day}' & \text{if } T_5 < Y_i^* \le T_6 \end{cases} \quad \ldots\ldots (7)$$

where T_k (K = 1,2,3,4,5 & 6) represents various consumption frequency levels of each household. Additionally, the probability of selecting a specific household's consumption frequency is as follows:

$$\begin{aligned} P(Y_i = j/x_i, \beta) &= p(T_{j-1} < Y_i^* \le T_j) \\ &= p(T_{j-1} < x_i'\beta + \varepsilon_i \le T_j) \\ &= p(T_{j-1} - < x_i'\beta < +\varepsilon_i \le T_j - x_i'\beta) \quad \ldots\ldots (8) \\ &= K(T_j - x_i'\beta) - K(T_{j-1} - x_i'\beta) \end{aligned}$$

where K signifies the function of the cumulative distribution of e_i. The derivative distribution elaborated in equation (9) was used when computing the independent variables' results on each individual's preference likelihood. The maximum likelihood method was used to estimate the ordered probit model, and the logarithm likelihood function was expressed using the following equation (10).

$$\ln L(\beta, T/y, x) = \sum_{j=1}^{j} \sum_{Y_{i=j}} \ln\left[K(T_j - x_i'\beta) - K(T_{j-1} - x_i'\beta)\right] \ldots\ldots (9)$$

Table 1: **Description of variables for factors influencing fish consumption frequency**

Variable	Description and measurement	Expected sign
	Dependent variable	
Consumption Frequency	The number of times a household consumes fish in a week (1 = less than once a week, 2 = once a week, 3 = Two to three times a week, 4 = four to six times a week, 5 = once a day, 6 = twice a day or more).	
	Independent variables	
Age	Age of the household food decision-maker in years (continuous)	±
Gender	Gender of the household food decision-maker (Dummy) 1 = male; 0 = female	-
Education level	Years in school for the food decision-maker (continuous)	±
Household size	Number of dependants in a household (continuous)	+
Income	Total monthly household income (Kenyan shillings)	±
Migration	Migration to Kibera (1 = migrated from western Kenya) (categorical)	+
Food culture	Influence of culture on food choices (%)	±
Neighbourhood effect	Neighbours sharing the same cultural values (%)	±
Number of outlets	Number of fish outlets within a 100m radius (continuous)	-
Time to the fish outlet	Time taken to reach the nearest fish outlet (in walking minutes)	±
Religion	Religions influence of food choices (%)	±
DKI	Dietary Knowledge Index (composite score of between 1 and 45)	-

3.6.2 Objective 2: To determine the role played by socioeconomic factors and institutional factors in influencing the consumption diversity of fish species among households in Kibera informal settlement.

This objective focuses on analysing the number 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 analysed using a Poisson regression model with the underlying assumption that all events have the same probability of occurrence. In this case, the likelihood of consuming various species of fish could differ based on their characteristics, including previous experience and whether the expected benefits are in either the short or long term. On the other hand, specific consumers tend to combine different species to increase the utility. They, hence, are more versed in the benefits than those who do not consume or consume either a single or few species. The constraints involving factors influencing the species of fish consumed may be different from one factor to the other, hence leading to differentiated probabilities of consuming various species of fish. Species diversity (number of fish species consumed) was considered 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.

$$y_i^* = x_i'\beta + u_i \quad \text{……………………………………………………………..…} (10)$$

For the i^{th} consumer, where normalisation is the regressor x and 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.

$$pr(\text{ outcome } j = i) = pr(n_{i-1} < x_i'\beta + u_i \le \alpha_i) \quad \text{……………………………………..}(11)$$

The coefficients β_1 , β_2, ... β_{i-1} were jointly determined with the cut points, $\alpha_1, \alpha_2, ... \alpha_i$ where i signifies the number of possible outcomes. U_j was perceived to be normally distributed with a standard normal cumulative distribution function.

Table 2: Description of determinants of consumption diversity of fish species

Variable	Description and measurement	Expected sign
	Dependent variable	
Species diversity	The number of fish species consumed (0 = Zero species consumed, 1 = One species, 2 = Two species, 3 = Three species, 4 = Four species).	
	Independent variables	
Socio-economic factors		
Age	Age of the household food decision-maker in years (continuous)	±
Gende	Gender of the household food decision-maker (Dummy) 1 = male; 0 = female	-
Education	Years in school (continuous)	±
Household size	Number of dependants in a household (continuous)	+
Income	Total monthly household income (KES) (continuous)	+
Institutional factors		
Price	Total price of fish per meal (continuous)	+
Migration	Migration to Kibera (1= Move from western Kenya to Kibera) (categorical)	+
Food culture	Influence of culture on food consumption (%)	+
Time taken to reach outlet	Time taken to reach the nearest fish outlet (in walking minutes)	±
Neighbourhood effect	Neighbours sharing the same cultural values (%)	-
Number of outlets	Number of fish outlets within a 100m radius (continuous)	-
Information from neighbours	Information from neighbours (%)	-
Meals a day	Number of meals a day (continuous)	-

3.6.3 Objective 3: To determine the influence of demographic factors, price, and expenditure elasticities on demand for fish among households in the Kibera informal settlement

Household food consumption patterns are not only affected by their income and product prices but also depend on household preferences and demographic characteristics. Including demographic factors in the demand, systems allows researchers to obtain better estimates of demand parameters (Mazzocchi, 2003).

To examine the demand for fish, the study adopted a linear, approximate, almost ideal demand system model (LAAIDS) and multi-stage budgeting was also applied. This linear approximate version is preferred because of its flexibility and ease of determination and interpretation (Alston & Chalfant, 1993; Taljaard *et al.*, 2004). The allocation of income by households, based on the overall expenses over a wide range of commodities, has been greatly enhanced. Additionally, the households further allocate their respective income categories to various sub-groups of their expenditures (Bett *et al*., 2012; Edgerton, 1997).

The LA/AIDS model has incorporated specific contributions made by Deaton and Muellbauer (1980), and due to the infrequent consumption of fish, the estimation included two stages. The probit model was estimated in stage one to determine the purchase decision. This was followed by the second stage, which involved using an inverse Mills ratio (IMR), which was determined using the probit parameters. This was done to correct the possible biases that may arise by the presence of zero chance of consuming fish. The estimated inverse Mills ratios (IMRs) were incorporated into the LA/AIDS model as shown in equation 13.

$$W_i = \alpha_i + \sum_j y_{ij} \text{In}(P_j) + \beta_i \text{In}\left(\frac{x}{p}\right) + \sum_k y_k Z_k + \omega_i \text{IMR}_i + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots (12)$$

where w_i, is the budgetary allocation of the i^{th} fish-derived as $w_i = p_i q_i / x$, ij represents various fish species, q_i, is the quantity of fish i purchased, p_j refers to the prices of the j^{th} fish, and x is the total expenditure of all the fish species. Z_k represents the product attributes and socio-economic characteristics, IMR_i is the inverse mill's ratio, ε_i which is the random variable with a zero mean and a constant variance. P is the stone price index for aggregate food. This stone price index is corrected for units of measurement invariance by Moschini (1995) and is represented as;

$$\text{In}(p) = \sum_i \bar{w}\, \text{In}(p_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

$\bar{w}$ is the mean budget share for every fish species demanded; therefore, to obey the fundamentals of demand theory, adding up, homogeneity, and Slutsky symmetry restrictions are enforced as follows;

$\sum_i \alpha = 1, \sum_i Yij = 0, \sum_i \beta_i = 0, \sum_i \omega_i = 0$…………… …………………..…….. (14)

$\sum_i k_{ki} = 0, j = 1, \dots, n$ (Adding up)………………...……………………...…..… (15)

Adding-up restriction guarantees that the expenditure shares were always equal to unity.

$\sum_i Y\ jk = 0, j = 1, \dots, n$ (Homogeneity condition) ………………..…………...... (16)

The homogeneity restriction ensured that consumption quantities did not change when all prices and income changed by the same rate.

$Y_{ij} = y_{ji}$ (Symmetry condition) ……………………………… …………..…. (17)

After the determination of the compensated price elasticities, negativity is then tested (Green & Alston, 1990). Therefore, the expenditure elasticities are estimated as follows;

$e_i = 1 + \left(\frac{1}{\overline{w}_i}\right)\left(\frac{\partial \overline{w}}{\partial \log x}\right) = 1 + \left(\frac{\beta_i}{\overline{w}_i}\right)$…………………………… ………………. (18)

The Marshallian /uncompensated price elasticities are estimated as follows;

$S_{ii}^{M} = -1 + \left(\frac{Y_{ii}}{\overline{w}_i}\right) - \beta_i$ (Own-price elasticity) ……………….……………….…… (19)

$$s_{ij}^{M} = -\delta_{ij} + \left(\frac{y_{ij}}{\overline{w}_i}\right) - \left(\frac{\beta_{ij}}{\overline{w}i}\right)\overline{w}_j$$

$\forall i, j + 1 \dots n$ (Cross-price elasticity) ……………………………...………… (20)

where δij is a Kronecker delta which equals 1, for i=j, otherwise zero, while the Hicksian elasticities are got from, $s_{ij}^{H} = S_{ij}^{M} + e_i\overline{w}_i$ and $s_{ij}^{H} + e_i\overline{w}_j$

$s_{ii}^{H} = -1 + \left(\frac{y_{ii}}{\overline{w}_i}\right) - \overline{w}_i$ (own-price elasticity) ………………………………..…… (21)

$s_{ij}^{H} = -\delta_{ij} + \left(\frac{y_{ij}}{\overline{w}_i}\right)\ j + 1, \dots, n$

$\forall i, j + 1 \dots n$ (cross-price elasticity) …… ……………………..………………...... (22)

The estimation was done through seemingly unrelated regression (SURE), which is a repetitive model of estimation (Zellner, 1962). The SURE model is a generalised multivariate regression that uses a vectorised parameter model. Y matrix is therefore vectorised by vertical concatenation, y^{ij}. The design matrix δ is formed as a block diagonal with the J^{th}design matrix, X_j, on the j^{th} diagonal block of the matrix.

Although the budget shares are equivalent to one in the demand system, one of the fish equations will be dropped to get rid of the singularity matrix error. This ensures that there is the recovery of the dropped equation from the established restrictions on the LA/AIDS model. The estimation of the SURE system parameter was obtained by the use of STATA software under constrained, repeated, seemingly unrelated regression methods (Goodwin, 2008). The inclusion of variables in the model alongside their expected influence will be selected from past studies (Ashagidigbi *et al*., 2012; Kostakis, 2014; Tankari & Badiane, 2015). Findings for the adoption of this model are presented in Table 3.

Table 3: Description of model variable for objective three

Variable	**Description and measurement**	**Expected sign**
	Dependent variable	
Wi	Budget share the i^{th} fish species	
	Independent variables	
Socio-economic factors		
Age	Age of the household food decision-maker in years (continuous)	±
Gender	Gender of the household food decision-maker (Dummy) 1=male;0=female	-
Education	Years in school (continuous)	±
Household size	Number of dependants in a household (continuous)	±
Income	Total monthly household income (KES)	+
Expenditure	Monthly expenditure on fish (KES/Kg)	±
P1	Price of Nile Tilapia (KES/Kg)	±
P2	Price of Silver cyprinid (KES/Kg)	±
P3	Price of Nile perch (KES/Kg)	±

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

The findings and discussion of the study are elaborated in this section. It is subdivided into three different sections, where the first section entails the diagnostic tests for the data used in the study. The second section involves descriptive statistics of fish consumers in informal settlements, which include socio-economic and institutional characteristics. The third section involved findings from the models used in the study.

4.2 Diagnostic test

Diagnostic tests were carried out before the analysis was done to check for outliers, correlation, heteroskedasticity, and multicollinearity. Variance inflation factor and correlation matrix were used to test for multicollinearity, while the Breusch Pagan test was used to test the data for heteroskedasticity (Semykina & Wooldridge, 2010).

4.2.1 Test for multi-collinearity using correlation coefficient

Findings from the pairwise correlation test were done between discrete variables, and the results, as shown in Table 4, revealed that the explanatory variables had coefficients of not more than 0.14. This signified that multicollinearity among the categorical independent variables was not present. Therefore, all these variables were suitable for the regression analysis since in the case where one of the correlation coefficients had a value higher than 0.80 in absolute terms, the correlation between the two explanatory variables would be higher, the presence of multicollinearity.

Table 4: **Pairwise correlation test results of categorical explanatory variables**

Variable	Gender	Education level	Group membership	Migrate to Kibera	Neighbourhood Information	Processed fish
Gender	1.0000					
Education level	0.1383	1.0000				
Group membership	-0.0465	-0.1210	1.0000			
Migration to Kibera	-0.0377	0.0370	-0.0068	1.0000		
Neighbourhood Information	0.0357	-0.0174	-0.0095	0.0215	1.0000	
Processed fish	0.0190	-0.0437	-0.0774	-0.0194	0.0701	1.0000

4.2.2 Testing for multi-collinearity in continuous variables

This test is calculated using the Variance Inflation Factor (VIF).

$$VIFx_i = \left(\frac{1}{1-R_j^2}\right) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (24)$$

x_i represents the j^{th} continuous independent variable regressed on the other independent variables. R_j^2 represents the coefficient of determination obtained when regress x_j On the remaining explanatory variables. In the case where x_j, is nearly related to the remaining explanatory variables, R_j^2 is small and the VIF is approximate to unity, while if x_j is nearly linearly dependent on some subset of the remaining explanatory variables, R_j^2 is close to unity and the VIF is large. Gujarati (1995) explained that in the case where the VIF of an input variable is more than 10 (R^2 exceeds 0.90), then the variable will be considered as being highly collinear, hence signifying the presence of multicollinearity. The results for this test are described in Table 5, where the highest individual VIF value was 2.967, with a mean of 1.439.

This revealed that the individual VIF for the continuous explanatory variable was less than 10; hence, there was no presence of multi-collinearity among the explanatory variables. Gujarati (1995), therefore, identified no serious multi-collinearity problem.

Table 5: Variance Inflation Factor (VIF) for continuous explanatory variables

Variable	VIF	1/VIF
Dependent on income	2.967	0.337
Household size	2.811	0.356
Food culture	1.237	0.808
Number of outlets within a 100m radius	1.208	0.828
Household total income	1.12	0.893
Religion	1.111	0.900
Price of fish	1.11	0.901
Dietary knowledge index	1.095	0.913
Number of meals a day	1.073	0.932
Time taken to reach the fish outlet in walking minutes	1.057	0.946
Neighbourhood effect	1.04	0.961
Mean VIF	**1.439**	

The white test was used to test for heteroskedasticity, as shown in the results in Table 6. The white test was preferred because it considers the magnitude and direction of change for a non-linear form of heteroskedasticity. The results below revealed that the variance of the error term was not constant. The problem of heteroskedasticity was corrected through the use of robust standard errors.

Table 6: Test for heteroskedasticity

Source	Chi^2	Degree of freedom	P-value
Heteroskedasticity	134.22	149	0.8015
Skewness	29.22	16	0.0225
Kurtosis	11.09	1	0.0009
Total	174.54	166	0.3095
$Chi^2(149) = 134.2$	Prob > $chi^2 = 0.8015$		

4.3 Descriptive statistics

The findings in Table 7 present the socioeconomic characteristics of the household, which revealed that the youngest household food decision-maker was 18 years old. In comparison, the oldest food decision maker was 71 years old, with the average age of the food decision-maker being 37 years. This signifies that the majority of the household food decision-makers were early middle-aged. Further findings reveal that, the majority of food decision-makers had spent an average of 10 years in school, with the highest being 16 years, which is equivalent to a college/university level of education. The average number of dependants on the income of the food decision maker was 5 dependants, with the lowest dependants being 1 and the highest being 14 dependants. Additionally, the average household size was 5 members per household, with the lowest household having one member and the highest having 9 members. The average household monthly income was approximately KES 12,010.

Table 7: Socio-economic characteristics

Variable	Mean	standard Deviation
Age of food decision-maker	36.787	11.778
Years in School	9.618	3.456
Dependents on income	5.234	2.13
Household size	4.67	1.845
Total monthly income	12010.6	8783.332

Findings presented in Table 8 reveal that the average distance to the nearest fish outlet within a 100-metre radius from the household was 7 metres, with the furthest distance being 25 metres. This means that the majority of households were closer to fish markets/vendors, hence making it easy for them to access the intended fish for household consumption. The time taken to reach the nearest fish outlet (in walking minutes) was estimated at an average of 12 minutes, with the furthest outlet taking approximately 45 minutes. The percentage of neighbours sharing the same cultural practices with the household food decision-maker was about 44%, meaning that close to half of the household food decision-makers in the Kibera informal settlement share the same cultural practices. The influence of religious beliefs in determining the type of food to consume among households was estimated at 14%, meaning that a smaller percentage of households were affected by their religious beliefs when it comes to food consumption, including fish. Being a member of any organisation had a mean of one, meaning that the majority of respondents were not members of a group or organisation; therefore, this makes it difficult to get some information on food consumption, especially fish, since sources of information are minimal unlike if they belonged to organisations.

Table 8: Institutional characteristics

Variable	Mean	standard dev
Number of outlets (100m radius)	7.257	6.145
Time taken to reach the nearest fish outlet (walking minutes)	12.073	9.257
Neighbourhood effect (%)	44.382	24.383
Dietary knowledge index (Composite score between 1 to 45)	31.2	3.267
Religion (%)	13.545	24.454
Food culture (%)	34.273	29.065

4.4 Households consuming fish

The number of households that were reported to consume fish in the past 12 months from the time of the study revealed that 379 households consumed fish compared to 6 who had not consumed fish in the Kibera informal settlement from the time the study was carried out.

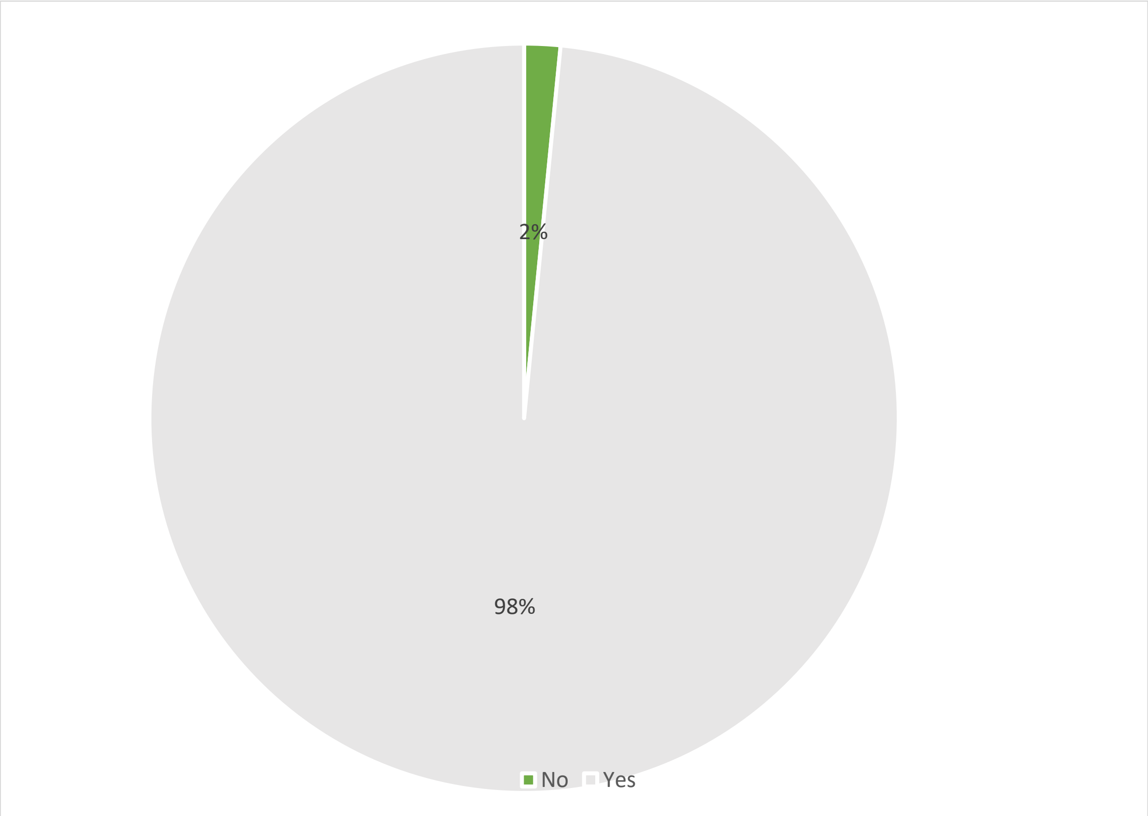

Figure 3: Households consuming fish

Table 9. presents the weekly fish consumption among households in Kibera informal settlement. More than half (58%) of the households consumed fish more than 2-3 times a week compared to those who consumed fish once a week (16%). Additionally, a significant number of households (27%) could not consume fish for a whole week, with a small percentage of

households (0.5%) being able to consume fish daily. This signifies that fish, a highly nutritious food component rich in protein, is expensive; hence, the low consumption rates experienced in Kibera. However, fish as an important meal experienced a significantly higher consumption rate (41%) in the Kibera informal settlement. This is because fish as a nutrient-dense food motivates households to try and ensure they consume fish at least 2-3 times a week, with a further 16% of households consuming fish 4-6 times a week.

Table 9: Fish frequency

Number of days fish is consumed in a week	Frequency	Per cent
Zero times a week	103	26.75
Once a week	61	15.84
2-3 times a week	157	40.78
4-6 times a week	62	16.10
Once a day	2	0.52
Total	385	100.00

Out of the 385 households, 98% had consumed various species of fish in the last 3 months from the time the research was done, with only 2% having not consumed any species in the same period, as presented in Table 10. The majority of households consumed Silver cyprinid (51%), and Nile tilapia (34%), Nile perch (12%), and the least consuming species was common carp (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 10: 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	

Analysis of consumption of processed fish among households revealed that the majority of consumers (90%) preferred processed fish compared to 10% of the surveyed households who did not consider processed fish as a factor when choosing fish for consumption, as presented in Table 11.

Table 11: Consumption of processed fish

Buying processed fish	Frequency	Per cent
Yes	348	90.39
No	37	9.61
Total	385	100

4.5 To assess factors influencing fish consumption frequency among households in Kibera informal settlement.

The results of the ordered probit, as shown in Table 12, reveal that Log pseudo-likelihood = -472.675, which indicates how the model converges. The Wald Chi^2 value for the model was 86.54, Prob > Chi^2 0 .000, and Pseudo-R^2 0.078, revealing that the model fully and significantly fits the data well.

Findings on the influence of the gender of the household head on the frequency of consuming fish revealed that gender had a negative coefficient and was statistically significant (5%) to the frequency of fish consumption. This implies that an increase in the number of male-headed households reduces the frequency of consuming fish in Kibera informal settlements. This is in line with the findings by Hermida and Costa (2020) where there was a higher frequency of fish consumption among women since women have been seen to be more health-conscious than men; hence, they tend to consume highly nutritious foods and are also involved in food consumption decisions, including preparation, compared to men, who are not directly involved in food decisions but provide income for household food consumption.

Additionally, there was negative statistical significance (10%) between years spent in school for the food decision-maker and fish consumption frequency. This means that, as the education level of the food decision-maker increases, the frequency of fish consumption reduces. Therefore, this study is in line with the results by Lucas *et al*. (2016), which found that education does not positively influence the rate at which fish is consumed, especially among a special group of consumers, including pregnant women, who might find taste as more important to increased fish consumption regardless of the knowledge on the health benefits associated with fish consumption. This is contrary to other studies, including Bakre *et al*. (2018); Govzman *et al.* (2021); Marinac *et al*. (2022), which established that higher education level was a major determinant for higher fish consumption among the population since it has been presumed that an increase in education tends to broaden the knowledge capacity, hence promoting the understanding of the desired health benefits and nutritional knowledge associated with fish consumption. This is because those with higher years in school tend to believe that fish has a lot of health benefits, hence increasing consumption rates.

Analysis of the influence of income further revealed that as the income of the household increases, the frequency of fish consumption increases. This is in line with other studies that relate an increase in income to an increase in fish consumption rates. Erdoğan *et al*. (2011) found that income was a major factor affecting the frequency of fish consumption, whereby those individuals who consumed fish more frequently twice a week had higher incomes compared to those who consumed fish less than once a month. Therefore, income is an important determinant of consumption; hence, as income increases, the rate at which food is consumed also increases. Another study by Lee and Nam (2019) established that respondents with higher incomes were more likely to consume fish more often than those who consumed two or three times a month; hence, an increase in income increases fish consumption rates among households.

Processed fish positively and significantly (1%) influenced fish consumption frequency. This implies that an increase in the availability of processed fish leads to an increase in the frequency at which fish is consumed among households in Kibera. Abusin *et al.* (2022) also found that most consumers preferred processed fish for their consumption, which was more influenced by age and income. Another interesting result by Erdogan *et al*. (2011) established that a very high percentage of consumers preferred to consume fresh fish over processed fish.

This study found that price is negative and statistically significant (1%) to the frequency of consuming fish. This means that an increase in the cost of fish reduces the frequency at which fish is consumed. This is in line with the findings by Terim (2019), where households considering the price of fish to be high will reduce their households' fish consumption, hence increasing the likelihood of not consuming fish. Supartini *et al*. (2018) noted that pricing was among the most determining factors in fish consumption since low prices lead to an increase in the rate at which fish is consumed among households. Additionally, Aydin (2020) emphasised the importance of selling fish from cheap and affordable outlets, increasing the consumption rate.

Migration was negative and statistically significant (10%) to the frequency of fish consumption among households in the informal settlements. This is interpreted to mean that even though consumers from western Kenya who share the same origin are perceived to be the major consumers of fish in the country, their increase in Kibera due to migration does not increase the frequency of consuming fish. This is because no new trait can make the existing consumers consume more than they are used to consuming; instead, the rate at which fish is consumed reduces because many consumers who have migrated to Kibera want to try other foods that they are not used to consuming, fish included. Hence, the reason for the negative influence.

The neighbourhood effect was measured as the percentage of neighbours sharing the same tribe. Results showed that the neighbourhood effect had a positive coefficient and was statistically significant (10%) in terms of fish consumption frequency. This signified that as households sharing the same cultural background increase, the frequency of fish consumption also increases. This correlates with the findings by Ayuya *et al*. (2021), where ethical concentration can influence food consumption decisions based on neighbour-social relationships and the transmission of food-eating habits through existing social networks. This is because members have the opportunity to share sociocultural norms; hence, the majority of consumers tend to assimilate what is positively appraised by neighbours (MEA, 2018).

Time taken to reach the nearest fish outlets positively and statistically significant (5%) influenced fish consumption frequency. Therefore, these results show that as the distance to get to the outlet increases, the frequency of fish consumption also increases among the households. These results conform to those of Erasmus *et al.* (2021), which acknowledge that a longer distance to get to the nearest fish outlet hinders the fish consumption frequency since much time is spent trying to get the fish compared to a shorter distance, which is equivalent to the little time, hence minimising the logistical challenges leading to regular fish consumptions due to reduced time spent while accessing the fish outlet.

There was positive statistical significance between the number of outlets within a 100-metre radius (10%) and the frequency of fish consumption. This showed that with an increase in the number of outlets within a 100-m radius, the frequency of consuming fish also increased. This is because little time is spent moving from one outlet to another; hence, the shorter the time, the more convenient it is to get access to fish, leading to an increase in the consumption frequency. The results complement the findings by Kariuki (2011), where consumers' preference for fish was encouraged by the ease of availability due to the increased number of outlets, hence motivating consumers to increase fish consumption rates because there is less time spent accessing fish outlet.

Table 12: Ordered probit model results on factors influencing fish consumption frequency

Frequency of fish Consumption	Coefficient	Robust Standard err	P>/Z/
Age of food decision-maker	0.003	0.004	0.562
Gender of the food decision-maker	-0.229**	0.114	0.046
Household size	-0.002	0.030	0.952
Years in the education of food decision-maker	-0.031*	0.018	0.078
Total monthly household income	0.146**	0.073	0.044
Migration to Kibera (1= migrated from western Kenya)	-0.204*	0.123	0.097
Occupation of the food decision-maker	-0.251	0.176	0.153
Processed fish	0.726***	0.213	0.001
The total price of fish	-0.003***	0.001	0.000
Neighbourhood effect	0.004*	0.002	0.081
Time taken to the nearest fish outlet (walking minutes)	0.011*	0.006	0.081
Number of outlets within a 100m radius	0.018*	0.010	0.079
Cultural influence on food choice0073	0.002	0.002	0.358
Dietary knowledge index	-0.013	0.019	0.478
Religion's Influence on Food Choices	-0.001	0.002	0.604

Number of observations = 385 Log pseudo likelihood = 473.05648

Prob > chi^2 = 0.0000 Pseudo R^2 = 0.0774 Wald chi^2 (15) = 86.46

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

4.6 To determine the role played by socioeconomic and institutional factors in influencing the consumption diversity of fish species among households in Kibera informal settlement.

The results of the ordered probit, as shown in Table 13, reveal that Log pseudo-likelihood = -377.68559, which 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 well.

The household total income had a positive and statistically significant (10%) implication on the number of fish species consumed. This shows that as household income increases, the number of fish consumed also increases. This is in line with the findings by

Thompson (2021), where the choice of fish preference is influenced by the price among the households, and this is to income where the likelihood of consuming fish increases as income increases. Consequently, the study by 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 those consumers with higher income margins since they have choices to choose from when deciding to purchase food based on their finances. All the same, a study by Wenaty *et al*. (2018) shows that various species were reported to be very expensive for most lower-income families and, hence, difficult to afford. Additionally, consumers with higher incomes were seen to consume high-quality foods, unlike low-income consumers, who are perceived to procure low-quality food categories.

Price was negative and statistically significant (1%) to the number of fish species consumed among the households in the Kibera informal settlement. This implies that a unit increase in the price of various fish species consumed reduces the number at which households consume fish species. This concerns the findings by Rahman and Reza (2020) where the majority of the consumers believed that higher fish consumption rates were a result of lower. Another study by Johnson *et al.* (2020) also highlighted that an increase in price lowers the consumers' demand for fish, hence reducing the diversity of species consumed since consumers tend to refrain from those species perceived to be expensive over those that are affordable.

The neighbourhood effect was positive and statistically significant (10%) in terms of the number of fish species consumed. The results implied that as the number of households sharing the same tribal origin increases, the consumption of various species of fish also increases due to existing social networks since members can share sociocultural norms on various species of fish, hence increasing their consumption rate. This has further been elaborated by Ayuya *et al.* (2021), where neighbours influence fish consumption decisions among those households sharing similar cultural backgrounds. Therefore, most households are influenced by their neighbours' perception of the consumption of various species; hence, this makes it easy for the majority to be positively influenced by their neighbours' input, especially in the choice of preference for various foods consumed, including fish.

Findings revealed that there was a positive and statistical significance (5%) between cultural influence on food choices and the number of fish species consumed by consumers in the Kibera informal settlement. This implies that as cultural beliefs increase among consumers, so do their choices and perceptions of the amount 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 the predisposition of traditional food systems and knowledge about food influence food acquisition mechanisms. On the other hand, the Maasai culture does not promote eating fish since it is considered to be culturally unfit to be eaten. This is regardless of the nutritional benefit associated with fish consumption. Just like fish, the Maasai community does not consume chicken because it is also considered a bird and hence forbidden for consumption. Green vegetables are considered livestock feed and, therefore, are not consumed either (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 is similar to the discoveries by Ayuya *et al*. (2021), which highlighted believers of the Seventh Day Adventist Church (SDA) have been discouraged from consuming African catfish; hence, this reduces the consumption of this species based on religious grounds. On the contrary, Onumah *et al*. (2019) detailed that Christians spent 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 neighbours was positively and statistically significant (1%) to the number of fish species consumed by households. This implied that an increase in households sharing information on fish consumption with their neighbours tends to promote the consumption of fish among the households. Therefore, consumers who get information from friends, relatives, and family members who might be their neighbours 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 is because information from trusted people is perceived to be more reliable than from strangers, hence increasing the consumption rate of various species of fish.

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 implies that a unit increase in the number of meals consumed by households per day increases the chance of consuming more species of fish. The results further show that consumers who manage to consume more than one meal a day have a higher chance of increasing their nutritional diversity through the consumption of fish (Nguka, 2020).

Table 13: Ordered probit model results on determinants of fish species consumption

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
The education level of the food decision-maker (Years in School)	-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 fish price	-0.002**	0.001	0.005
Group membership by the food decision-maker	-0.182	0.122	0.134
Neighbourhood effect	0.004*	0.002	0.093
Cultural influence on food choices	0.005**	0.002	0.015
Migration (Move from the western region 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 in a 100m radius	-0.001	0.011	0.940
Information from neighbours	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.

4.7 To determine the influence of socio-economic factors, price, and expenditure elasticities on fish demand among households in the Kibera informal settlement

Studies concerning demand support the utilisation of either systems or a single equation approach. This is because this approach of the single-equation has been seen to be less superior compared to the systems approach (Nuani *et al*., 2022). Therefore, the systems approach was the main focus of this study because it encompasses various equations, hence enabling the substitution effect of the commodity. Modelled of this approach has been seen to be effective using the Almost Ideal Demand System (AIDS), Quadratic Almost Ideal Demand System (QUAIDS), and Linear Expenditure System (LES). When analysing the demand to consumption patterns, an Almost Ideal Demand Systems (AIDS) model by Deaton and Muellbauer (1980) was adopted because the model approves the estimated combination of consumers while holding on to the flexibility of important theoretical aspects (Bett *et al*., 2012).

Additionally, the Linear Approximation Almost Ideal Demand System (LA-AIDS) model has gathered approval; hence, it is broadly applied in demand analysis compared to AIDS because it is highly bearable, adaptable, and effortless to estimate and explain (Bett *et al*., 2012; Me-Nsope & Larkins, 2016; Nuani *et al*., 2022). The linearisation of Engels curve criticises the AIDS model over QUAIDS because QUAIDS solves linearisation concerns. Therefore, there are variations in linear estimation systems over non-linear systems in empirical studies. This makes it possible for the uninterrupted adoption of LA/AIDS (Nuani *et al*., 2022).

Table 14. presents the household fish expenditure on a single purchase. The sum of all the mean budget shares for the three species of fish consumed under the adding-up restriction was equal to one. Nile tilapia had the highest budget share compared to silver cyprinid and Nile perch because of the perceived superior quality and taste; hence, consumers are willing to spend more on Nile Tilapia than other species. On the other hand, the participation rate was highest in silver cyprinid, Nile tilapia and Nile perch, respectively. This is because silver cyprinid is affordable for the majority of households compared to other species.

Table 14: Household expenditure on fish

Fish Category	**Mean budget shares**	**Mean expenditure {Price/kg (KES)}**	**Participation rate**
Nile tilapia	0.544	420.29	72.99
Silver cyprinid	0.367	174	83.64
Nile perch	0.090	343	16.88

4.7.1 Demographic and socio-economic effects

Table 15. Illustrate the estimation of the maximum likelihood for socio-economic results. The results of the chi-square test for the three fish species were all statistically significant at 1%. R^2 for the fish species under the study were Nile tilapia (34.43), Silver Cyprinid (71.04), and Nile perch (62.61), respectively. From the above results, the lack of good fit was due to the irregular purchase of specific categories of fish. Those variables that significantly influence fish consumption patterns in Kibera informal settlement include household size, age, gender, Inverse Mills Ratio and education.

Household food decision makers' age positively significantly (10%) influenced the shares of Nile perch. The gender of the food decision maker was also positive and statistically significant (5%) in influencing Nile perch consumption. There was a negative and statistically significant correlation (10%) between the education level of the household food decision-maker and the consumption of Nile perch. This is because Nile perch is not considered to be of high quality and good taste compared to other species like Nile tilapia; hence, as one gets more educated, one tends to consume a species that is of more quality and more nutritious. Household size, on the other hand, was negative and statistically significant (1%) to Nile tilapia compared to silver cyprinid and Nile perch, whose significance levels (1%) were all positive. Nile tilapia was negative because, as the household size increased, the quantity of Nile tilapia demanded decreased. After all, it is expensive compared to other species; hence, the households opt to consume the different species that are affordable, including silver cyprinid and Nile perch. Finally, the Inverse mill's ratio (IMR) was positively significant (1%) in influencing silver cyprinid and negative significance (1%) in influencing Nile perch, respectively. This, therefore, makes it difficult to ignore non-consumers for both silver cyprinid and Nile perch when estimating LA/AIDS parameters since the results would be biased and inconsistent.

Table 15: Maximum likelihood estimations for the household socio-economic effects determined from LA/AIDS

Fish species	Age	Gender	Education	Household size	Income	IMR
Nile tilapia	0.023	0.003	0.001	-0.132***	0.010	0.001
	(0.049)	(0.038)	(0.013)	(0.034)	(0.019)	(0.016)
Silver cyprinid	0.046	-0.021	0.012	0.089***	-0.000	0.210***
	(0.032)	(0.025)	(0.009)	(0.023)	(0.013)	(0.019)
Nile perch	0.051*	0.050**	-0.013*	0.072***	-0.006	-0.330***
	(0.022)	(0.017)	(0.006)	(0.016)	(0.009)	(0.014)

***, **, *, showing 1%, 5%, and 10%, significance level, respectively.

4.7.2 Coefficients for Price and expenditure elasticities

The estimates for the maximum likelihood coefficient for price and expenditure elasticities using the LA/AIDS model are shown in Table 16. There was no outstanding significance of the cross-price to the budget share of any of the three fish categories. The expenditure elasticities for all three fish categories were positive ($P \leq 0.01$). This shows that Silver Cyprinid and Nile perch's budget shares significantly increased.

Table 16: Maximum likelihood coefficients for price and expenditure elasticities using LA/AIDS

	α_I	Prices			β_{ij}
Shares	**Intercept**	**Nile tilapia**	**Silver cyprinid**	**Nile perch**	**Expenditure Coefficients**
Nile tilapia	-0.342	0.410	0.018	-0.428	0.259***
	(0.265)	(0.374)	(0.043)	(0.385)	(0.019)
Silver cyprinid	0.830***	-0.403	-0.008	0.410	-0.301***
	(0.178)	(0.368)	(0.033)	(0.374)	(0.012)
Nile perch	1.133***	-0.008	-0.010	0.018	-0.200***
	(0.127)	(0.033)	(0.024)	(0.043)	(0.014)

***, **, * Showing 1%, 5%, and 10% significance levels, respectively.

4.7.3 Elasticities for price and expenditure

Table 17. shows the cross-price, own-price, and expenditure elasticities. Matrices of elasticities of price constitute both Marshallian and Hicksian. These results further revealed

that there were negative and not greater than zero own-price Marshallian elasticities for various species consumed, hence conforming to utility theory. Hicksian own-price elasticities for Nile tilapia, silver cyprinid and Nile perch were a priori. The three categories of fish were considered inelastic because they all had price elasticities of less than unity (<1). The requirement of the utility function to be concave has been satisfied due to negative compensation for all three categories of fish, hence corresponding to the negative semi-definite requirement by the Slutsky matrix. All categories of fish consumed had elasticities that ranged from both positive and negative. This signifies that there were normal and inferior fish categories in the Kibera informal settlement; hence, the determination of elasticities using total fish expenditures was made due to conditional elasticities.

4.7.4 Effects of demographic, expenditure and price on budget shares

Food decision makers' age positively and statistically significant (10%) influenced Nile perch shares. This revealed that households with younger food decision-makers consumed less Nile perch than those with older decision-makers. This was because most of the consumers in Kibera had inadequate income to purchase enough food. Still, since Nile perch can be purchased in small portions, it is easily affordable compared to Nile tilapia, which is bought in whole. This is elaborated by Kostakis (2014), who states that elderly consumers spend much of their income on food that is healthy and expensive compared to young consumers. The elderly also spend much of their time in the house and hence tend to consume more than the younger consumers. This was also revealed by Aung *et al*. (2022), where fish consumption was higher among households with older food decision-makers compared to those with younger food decision-makers.

There was a positive and significant (5%) influence of gender on Nile perch consumption. This demonstrates that men have been seen to be more aware and knowledgeable about fish, hence increasing the consumption rate of both silver cyprinid and Nile perch within households. This is contrary to the findings by Ali and Rahut (2018), where females were perceived to be more aware and knowledgeable about functional foods, hence increasing their consumption rates. Musyoka *et al*. (2010) also found the contrary in that the gender of the household head did not dictate the decisions concerning food uptake, even though it may be affected by the household's disposable income.

There was a negative and statistically significant (10%) influence on the education level of the household food decision-maker on Nile perch. This signifies that the demand for Nile perch will be reduced with an increase in the education of the food decision-maker. On the contrary, Dalhatu and Ala (2010) showed that the level of education positively influenced the demand for fish. Therefore, the higher education level of the consumer results in an increase in fish demand due to the increased realization of the nutritional value of fish as a contributor to protein.

Food decision makers' household size was negative and statistically significant (1%) to Nile tilapia. These findings reveal that a reduction in the consumption of Nile tilapia is based on an increase in household dependants. Household size of the food decision maker had a positive and statistically significant (1%) correlation on both silver cyprinid and Nile perch. This is because Nile tilapia is considered more expensive compared to silver cyprinid and Nile perch; hence, its uptake is reduced with an increase in household size. Therefore, the ingestion of silver cyprinid and Nile perch increased with an increase in prices of other fish categories that are considered expensive, including Nile tilapia. This was because households in Kibera are characterised by low income and high poverty levels; hence, most of them tend to consume fish that are considered cheap since this is presumed to be enough for the increasing household size. As households increase in size, expenditure on fish also increases. This conforms to the results by Onumah *et al*. 2019) which showed that as household size increases, more fish is needed to satisfy the increased demand; hence, much income is required to meet the large quantities of fish needed for consumption.

4.7.5 Uncompensated/Marshallian price elasticities

Findings revealed that elasticity coefficients conform to the economic theory a priori because the price elasticities were all negative; hence, Nile tilapia, silver cyprinid and Nile perch elasticities were less than one. Nile perch had the least own-price elasticity (-0.916), which showed that as the price of fish uniformly increased, the Nile perch would be allocated more income. Nile tilapia and silver cyprinid elasticities were -2.046 and -1.797, respectively; hence, these two are price inelastic. Changes in prices for the majority of fish were insensitive to the quantity demanded, as shown by the elasticities. An increase in fish price results in a narrow or no change at all in the fish demand. In the case of a 10% reduction in the price of silver cyprinid, there would be a rise in demand by 17.97%; hence, the effect price would account for 17.32 %. The income effect, on the other hand, would contribute to 0.65% due to a price reduction. An increase in *per capita* income by 10% with a comparable 10% reduction in the price of silver cyprinid tends to raise the demand to 2.43% because of the 014.46% additional correspondent expenditure elasticity, as shown in Table 17.

In absolute terms, as demand for Nile tilapia increases by about 20.46% due to a decrease in price by 10%, the income effect contributes 8.03%, while the price effect contributes 12.43%. This, therefore, signifies that as *per capita* income increases by 10% alongside a reduction of the price of Nile tilapia at 10% would lead to a 22.79% increase in demand. This is a result of an 8.03% increment in income, which affects the additional 8.03% of the related expenditure elasticity (12.38%), as described in Table 17.

All the Marshallian cross-price elasticities were positive; thus, the corresponding fish categories were substitutes. This was due to an increase in demand for fish categories as a result of the rise in prices of a particular category of fish. An increase in the demand for a single fish category would lead to a reduction in the cost of the other category since the fish categories are complements, as revealed by the negative cross-price elasticities. These results are in line with those of Prokeinova and Hanova (2016) who model consumer behaviour regarding meat consumption in Slovakia.

4.7.6 Compensated price elasticities

All three categories of fish in the Kibera informal settlement had a negative compensated own-price elasticity as expected, hence, a priori. These fish categories had inelastic prices since their elasticities were less than unity. Nile perch had the lowest own-price elasticity of -1.027, and silver cyprinid and Nile tilapia elasticities had -1.732 and -1.243, respectively, the price inelastic. This explanation was in line with that of Siami-Namini (2017) when determining the household's final consumption expenditure. For cross-price elasticities, the observation was the same as those of Marshallian demand. The substitution effect was due to positive price elasticity; at the same time, the negative cross-price elasticity was because of the complementary effect (less than zero). This is harmonious with (Musyoka *et al*., 2010) on the properties and structure of the demand for food in Nairobi's urban households. Taking into account the substitution for various groups of fish, Hicksian demand yields better results because of the exclusive substitution effect that is different from the Marshallian demand that involves substitution and income effects, hence providing values that are not fully efficient.

4.7.7 Expenditure elasticities

This study shows that there were mixed signs in expenditure elasticities for the three fish categories. Nile tilapia's expenditure elasticity was 1.476, hence greater than unity and therefore regarded as a luxury fish category. This was because as income increases, the consumption rate of the Nile tilapia also increases. Silver cyprinid's expenditure elasticity was less than unity (0.178); hence, it was inelastic and, therefore, regarded a s a necessity food. This was in line with, (Selvanathan *et al*., 2015), where fish as the food was a luxury, unlike other products like beef and chicken, which were necessity foods. On the contrary, the negative elasticities for Nile perch (-1.238) signified that Nile perch was inelastic and inferior category of fish, whereby as income increases, it leads to a reduction in the quantity demanded.

For the necessary fish category, Silver cyprinid, an expenditure elasticity of 0.178 signifies that a 10% increase in income increases its demand by 1.78%. For luxury fish, Nile tilapia, the expenditure elasticity of 1.476, signifies that an income increases by 10% increases the demand its demand income increases the demand for Nile tilapia by as income increases by 10%, then the demand for Nile tilapia also increases at a rate of 14.76%. Lastly, Nile perch, an inferior fish category, expenditure elasticities of -1.378 show that as income increases by 10%, then the demand would decrease by 13.78%. This finding is contrary to those of Basarir (2013) where it was found that, in case of an increase in household income, then more income would be allocated to the purchase of fish in future.

Table 17: Own price, cross-price, and expenditure elasticities

Expenditure share category	Nile tilapia	Silver cyprinid	Nile perch
Marshallian/uncompensated elasticities			
Nile tilapia	-2.046	0.580	-0.009
Silver cyprinid	1.566	-1.797	0.053
Nile perch	1.419	0.734	-0.916
Hicksian /compensated elasticities			
Nile tilapia	-1.243	1.121	0.123
Silver cyprinid	1.663	-1.732	0.069
Nile perch	0.746	0.281	-1.027
Expenditure elasticities			
	-1.238	1.476	0.178

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The consumption patterns of fish among households in informal settlements are highlighted in this chapter. Eating fish is a primary way to consume high-nutrient meals that have been shown to help prevent disease and improve human health worldwide. The summary, findings, suggested policies, and opportunities for additional research are all included in this chapter. Regarding the person making the food decisions, gender has a significant role. According to the survey, when choosing which meal to eat, female decision-makers (79%) outnumbered male decision-makers (21%). The average age of those who made food decisions was about 37 years old, and most of them had completed between class eight and secondary education. Five persons lived in each home on average, with (44%) of the neighbours sharing the same cultural values. Outlets within a 100m radius were 7 outlets, meaning households were closer to the proximity of the outlets, hence increasing the frequency of consuming fish since less time is spent accessing the market. Monthly income was seen to be at an average of KES12010, with the price of fish ranging from KES 149 to KES 396 per kilogram.

Findings on frequency of fish consumption revealed that the majority of households (41%) consumed fish 2-3 times a week, with only 1% consuming once a day. The study determined that preference for processed fish, neighbourhood effect, time taken to reach the nearest fish outlet and the number of outlets within a 100m radius had a positive influence on fish consumption frequency. Analysis of the impact of socioeconomic and institutional factors influencing the species of fish consumed revealed that total household income, Neighbourhood effect, cultural influence on food choices, information from neighbours and the number of meals consumed in a day had a positive impact on 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%).

Additionally, results on the factors influencing the demand for fish revealed that the age of the household food decision maker and the gender of the food decision maker had a positive influence on the market for fish in the Kibera informal settlement. The price and expenditure elasticities were all negative, hence conforming to utility theory.

5.2 Conclusions

The study aimed to identify factors affecting fish consumption patterns in informal settlements, such as the Kibera informal settlement in Nairobi, Kenya. Findings from the study led to the following conclusions:

i. Frequency of consuming fish was positively influenced by total monthly income, neighbouring effect, nearness to the fish outlets, and the number of fish outlets within a 100m radius. However, there was low consumption of fish among households in the Kibera informal settlement since most (41%) of them consumed between 2-3 times a week, with very few (1%) consuming fish once a day. This implies that fish, as a major source of proteins in the informal settlements, was not easily affordable due to various challenges, including the cost of fish in the local market. This, therefore, makes it difficult for the households to afford, leading to low consumption rates and low income among the households in the informal settlements.

ii. Socioeconomic and institutional characteristics were seen to influence the diversity of fish consumption. Household total monthly income, neighbourhood effect, the influence of culture on food consumption, information from neighbours, and the number of meals consumed in a day were found to be positively influencing the number of fish species consumed. The implication of this observation is relevant in providing interventions to promote diversity of fish consumption among those residing in informal settlements.

iii. Determining the influence of demographic factors, price, and expenditure elasticities on demand for fish showed that consumption of Nile tilapia increased proportionately with an increase in income. Further, an increase in the price of other fish categories increased the demand for silver cyprinid because it is regarded as cheap and, hence, affordable among consumers. Additionally, Nile perch was inelastic, thus an inferior category of fish since an increase in income reduces its demand.

5.3 Recommendations

i. To increase the frequency of fish consumption among households in informal settlements, there is a need to increase the availability of affordable fish in the nearby markets within the informal settlements. Further, there is a need for the government to increase employment among urban dwellers, especially the informal settlers, who are mostly affected by high unemployment rates, hence increasing the cases of food and nutrition insecurity due to lower incomes.

ii. The influence of socioeconomic and institutional characteristics on the diversity of fish species consumed needs to 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, with neighbours sharing the same origin and information from neighbours to make decisions, including food consumption. These socioeconomic and institutional characteristics need to be promoted in order to improve food and nutritional security, especially among the urban poor.

iii. Several factors, including demographic characteristics and price and expenditure elasticities, influenced fish demand. Therefore, there is a need to increase the availability of affordable fish among the markets in the informal settlements since an increase in the price of fish has been seen to reduce the demand for various fish species in general. Further, there is a need to increase the intake of nutritious fish regardless of taste since some fish are regarded as inferior, necessary, or even luxurious compared to other species. This leads to variations in the intake of fish, hence the need to promote highly nutritious fish, which in turn reduces the issue of food and nutrition insecurity among the informal settlements.

5.4 Areas of further research

The main purpose of this study was to investigate the consumption patterns of fish among households in Kibera informal settlements. This would then lead to the improvement of the resiliency of food and nutrition security in Kibera through the exploration of all factors involved in enhancing fish consumption. However, other areas that need to be explored include;

i. The study mainly focused on fish consumers in the informal settlements; therefore, there is a need to extend further to fish vendors for a better understanding of the performance of fish markets in the informal settlements, hence improving food and nutrition security.

ii. There is a need for a similar study to be done in other informal settlements within Nairobi, Kenya, for easy understanding of the fish consumption patterns among the households in the informal settlements.

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APPENDICES

Appendix A: Household Questionnaire

Hello. My name is ------------ and I am from Egerton University.

We are conducting a survey on food security in Kibera and we are particularly interested in fish consumption. The survey will take about 1 hour. Participation in this survey is voluntary, and if we should come to any question, you do not want to answer, just let me know and I will go to the next question, or you can stop the interview at any time. However, i hope that you will participate in this survey since your views are important in informing relevant policies and interventions to enhance food security in Kibera. If you agree to participate, we can start the interview.

SECTION A: SOCIO-ECONOMIC CHARACTERISTICS OF HOUSEHOLD AND HOUSEHOLD FOOD DECISION MAKER

Q1. Are you the person in your household who makes the decisions concerning food consumption?

1= yes [] 0= No [ ]

Q2. What is the position of the household food decision maker in the household?

1 = Husband [ ] 2 = Wife [ ] 3 = Other ………….

Q3. What is the age of the household food decision maker?............. Or, do not know [ ]

Q4. What is the gender of the household food decision maker?

1= Male [ ] 0 = Female [ ]

Q5. What is the level of education of the household food decision maker?

0 = none, or pre-school [ ] 1= primary standard . 1-6 [ ] 2= primary standard 7 [ ]

3 = primary standard 8, or secondary forms 1-3 [ ] 4 = secondary form 4 [ ]

5 = College or higher [ ] 6 = other, specify …………….

SECTION A (ii). HOUSEHOLD HEAD CHARACTERISTICS

Q1. What is the position of the household head in the household?

1 = Husband [ ] 2 = Wife [ ] 3 = Other ………….

Q2. What is the age of the household head? .... Or, do not know [ ]

Q3. What is the gender of the household head?

1= Male [ ] 0 = Female [ ]

Q4. What is the level of education of the household head?

0 = none, or pre-school [ ]   1= primary standard 1-6 [ ] 2= primary standard 7 [ ]

3 = primary standard 8, or secondary forms 1-3 [ ]   4 = secondary form 4 [ ]

5 = College or higher [ ]   6 = other, specify …………….

Q5. What is the marital status of the household head?

1 = single [ ]   2 = divorced [ ]   3 = Married [ ]

4=Widow/ Widower [ ]   5 = Other, Specify ……………………

Q6. How many people have lived in your households for the last 6 months? ………….

Q7. How many of these people are children in your household? …………..

Q8. How many people generate an income for the household? ....

Q9. How many people depend on the household income? .....

Q10. What is the main occupation of the household head?

1= Food Vendor [ ]   2= other commodity sales [ ]   3= Industry (Casual labour) [ ]

4= Housekeeping [ ]   5= Child Care [ ]   6= Teaching [ ]

7= Hospital [ ]   8= other, specify …………….

Q11. Does the household head have another occupation?

1= yes [ ]   0= No [ ]

If yes, please specify other occupation…………………………………………….

Q12. From what sources does your household earn its income?

1= Self-employment   2= Informal employment   3= Receive remittance

4= Employed formally in an organization, firm, public sector

5= receive income from renting out   6= Other income source

Q12. How many years has the household head lived in Kibera? ……or Do not know [ ]

Q13. Has the household head lived in Kibera since Birth?

1= Yes [ ]   2= No [ ]   3= Do not know [ ]

Q14. What percentage of your neighbours share your same cultural practices? ………..

Q15. What village in Kibera do you live in? (CHOOSE ONE)

1= Makina [ ]   2= Lindi [ ]   3= Mashimoni [ ]   4= Laini Saba [ ]

5= Kianda [ ]   6= Kisumu ndogo [ ]   7= Soweto East [ ]   8= Gatwereka [ ]

9= Raila [ ]   10= Kambi Muru [ ]   11= Olympic [ ]   12= Karanja [ ]

Q16. Which tribe(s) does your household belong to? Please specify other tribes.

1= Luo [ ]   2= Luhya [ ]   3= Kikuyu [ ]   4= Kalenjin [ ]

5= Kamba [ ]   6= Nubian [ ]   7= others, specify…………

SECTION B: INSTITUTIONAL CHARACTERISTICS

Q1. Where did you live before moving to Kibera? (**Tick one**)

1= From within Nairobi [ ] 2= Western Kenya [ ] 3= Rift valley [ ]

4= Coastal Kenya [ ] 5= Central Kenya [ ] 6=Eastern Kenya [ ]

7=North Eastern Kenya [ ] 8= Outside of Kenya [ ] 9 = other, specify ……

Q2. How many years did you live there? ……………………

Q3. Which rural area do you connect with? (**Tick one**)

1= From within Nairobi [ ] 2= Western Kenya [ ] 3= Rift valley [ ]

4= Coastal Kenya [ ] 5= Central Kenya [ ] 6=Eastern Kenya [ ]

7=North Eastern Kenya [ ] 8= Outside of Kenya [ ] 9 = other, specify ……..

Q4. How do you connect with your tribe?

1= through birth [ ] 2= through marriage [ ]

Q5. Does your household ever consume fish?

1= Yes [ ] 0= No [ ]

Q6. In what ways does your culture influence your decisions on fish consumption?

1= it is my tribe tradition to eat fish [ ] 2= it is my tribe tradition NOT to eat fish [ ]

3= Kibera has influenced me to eat fish [ ] 4= Kibera has NOT influenced me to consume fish [ ] 5= others, specify ……

Q7. At which location do you buy fish?

1= Vendors at the road/street in the neighbourhood [ ]

2= Vendors at the road/street outside the neighbourhood [ ] 3= Vendors close by your household [ ] 4= after making order by mobile phone call [ ] 5= at the mall [ ]

6= Supermarkets [ ] 7= Elsewhere in Nairobi [ ] 8= Eaten at hotels outside Kibera [ ]

9=Eaten at cafe outside Kibera [ ] 10 = others, specify………..

Q8. What is the distance from your house to where you mostly purchase fish in walking minutes? ......

Q9. What is the number of fish outlets in your neighbourhood? (Within 100 meters from your household) …………

Q10. What is the source of information on where you buy fish?

1=Neighbourhood [ ] 2= community lead [ ] 3= Kibera network of young people [ ] 4= on-line [ ] 5= TV [ ] 6= newspaper [ ] 7= other, specify….

SECTION C: PRODUCT ATTRIBUTES AND DEMAND CHARACTERISTICS

Q1. How important are the following attributes in your decision to purchase fish? (Tick where applicable)

Attribute	Not important	Slightly important	Neutral	Importa nt	Very important
price of fish					
Quality (Processed)					

Q2. Is the fish always available when you go to buy it?

1= Yes 0= No

If yes, go to Q4

If No, go to Q3

Q3. Compared to one year ago, how can you judge the change in the availability of fish in your village? .....

Q4. Do you have a specific source of fish preferable to you? **(Select multiple)**

1= I have no source preference [ ] 2= Lake Victoria [ ] 3=Lake Naivasha [ ]

4= Masinga Dam [ ] 5= Nyeri county [ ] 6= Aquaculture company [ ]

7= Victory farms [ ] 8= Imported fish e.g. Chinese fish [ ] 9= others, specify ….

Q5. Do you buy processed fish?

1= Yes 0= No

SECTION D: SPECIES DIVERSITY

Q1. Which type of fish do you purchase?

1= Tilapia [ ] 2= Catfish [ ] 3= Silver cyprinid [ ]

4= Common carp [ ] 5= Nile perch [ ] 6= other, specify …..

Q2. Quantity purchased

	Tilapia	**Catfish**	**Silver cyprinid**	**Common carp**	**Nile perch**	**Other**
How many kilograms do you purchase per time for your household? (KGS)						
How much does it cost per single purchase? (KSH)						
What is the price per kilogram? (KSH)						

How many meals does the fish purchase at a time provide?						
How many times a month do you purchase fish?						
Which size of fish do you normally purchase? (KGS)						
Explain the portion size						
Other sizes, specify…						

SECTION E: FREQUENCY AND NUTRITIONAL CHARACTERISTICS

Q1. How many days do you consume fish in a month?

1=less than once a week [ ] 2= once a week [ ] 3=Two to three times a week [ ]

4= four to six times a week [ ] 5= once a day [ ] 6= twice a day or more [ ]

Q2. Who mainly decides on the household fish consumption?

1= Father [ ] 2= Mother [ ] 3= Grandfather [ ] 4= Grandmother [ ]

5= the child who does the shopping [ ] 6= others, specify...

Q3. When did your household start consuming fish?

1=we always had fish in the rural area [ ] 2= we always had fish in Kibera [ ]

3= since we arrived in Kibera [ ] 4= since we learnt about fish in Kibera [ ]

5= since we experienced hunger and had no choice but to eat fish [ ]

6= other, specify...

Q4. How many kilograms of fish does your household consume per meal? (KGS) ….

Q5. On average, how much does the fish for a meal cost? (KSH)….

Q6. What are the main reasons why your household eats fish?

1= need of protein [ ] 2= ensure health [ ] 3= hunger [ ]

4=easily accessible [ ] 5= cheap source of food [ ] 6= tradition [ ]

7 = other, specify.

Appendix B: Conference Presentation

Tropentag, September 20-22, 2023, hybrid conference

"Competing pathways for equitable food systems transformation: Trade-offs and synergies"

Assessing the factors influencing fish consumption frequency among households in kibera informal settlement

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Abstract

Global food and nutrition insecurity has been increasing and hence making it difficult to manage the growing population, especially in urban areas. This urban growth has led to the rise of informal settlements, nutrition insecurity, poor sanitation and food shortage. Fish as an important source of animal proteins, omega^{-3} fatty acids, vitamins, and minerals necessary for normal body functioning has been proven to boost food security and reduce undernutrition among developing countries. Health concern over the consumption of red meat has been on the rise hence consumers are shifting to the consumption of white meat, including fish. This study assessed the factors influencing the frequency of consuming fish among households in informal settlements using the ordered logit model. A sample unit of 385 households was selected through a pre-tested structured questionnaire using a stratified random sampling technique. Consumption frequency was measured by the number of times fish was consumed in a month. Empirical results showed that the majority of households 40.78 %, consumed fish between 2–3 times a week, 26.75 % at less than once a week, 16.10 % at 4–6 times a week while 15.84 % consumed once a week. The least consumers at 0.52 % consumed once a day. Gender, education level, monthly income, occupation, migration, processed fish, price, neighbourhood effect, time taken to the nearest outlet and number of outlets within a 100-metre radius influenced the frequency of fish consumption. The frequency of consuming fish was seen to be low among the majority of the consumers since only 0.52 % of households were able to consume fish at least once a day compared to those who consumed fish between 2–3 times a week at 40.78 %. This implies that fish is relatively expensive since very few households can afford it daily. To increase the frequency of fish consumed in the informal settlements, there is a need to increase the availability of high-quality fish processed in the market and also increase the income sources since this increases the rate at which fish is consumed. There is also a need to increase awareness of the health benefits associated with fish consumption among consumers.

Keywords: Fish consumption, food security, frequency of fish consumption, informal settlements, Kibera- Kenya

Appendix C: Paper Abstract

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

www.iiste.org

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

Appendix D: Research Licence

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **128127**

Date of Issue: **11/May/2023**

RESEARCH LICENSE

This is to Certify that Mr.. FERDINAND KAMIDI ISABU of Egerton University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nairobi on the topic: ANALYSIS OF FISH CONSUMPTION PATTERNS IN KIBERA INFORMAL SETTLEMENT, KENYA for the period ending : 11/May/2024.

License No: **NACOSTI/P/23/25756**

128127

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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See overleaf for conditions

Appendix E: Ethical Approval Permit

EGERTON UNIVERSITY

TEL: (051) 2217808 P. O. BOX 536 FAX: 051-2217942 EGERTON

EGERTON UNIVERSITY INSTITUTIONAL SCIENTIFIC AND ETHICS REVIEW COMMITTEE

EU/RE/DIR/009
Approval No. EUISERC/APP/252/2023 ***19th June*** **2023**

Ferdinand Kamidi Isabu
P.O Box 536-20115,
Egerton
Telephone: 0722577829
E-mail: kamidi.ferdinand@gmail.com

Dear Ferdinand,
RE: ETHICAL APPROVAL: ANALYSIS OF FISH CONSUMPTION PATTERNS IN KIBERA INFORMAL SETTLEMENT, KENYA.

This is to inform you that *Egerton University Institutional* ***Scientific and Ethics Review Committee*** has reviewed and approved your above research proposal. Your application approval number is ***EUISERC/APP/252/2023.*** The approval period is ***19th June, 2023 –20th June, 2024***

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by ***Egerton University Institutional Scientific and Ethics Review Committee***.
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ***Egerton University Institutional Scientific and Ethics Review Committee*** within 72 hours of notification iv. Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to ***Egerton University Institutional Scientific and Ethics Review Committee*** within 72 hours.
v. Clearance for Material Transfer of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.

“Transforming Lives through Quality Education”

vii. Submission of an executive summary report within 90 days upon completion of the study to ***Egerton University Institutional Scientific and Ethics Review Committee***.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely.

EGERTON UNIVERSITY
Date. 19/06/2023
RESEARCH ETHICS

Prof. Raphael M. Ngure

CHAIRMAN, EGERTON UNIVERSITY INSTITUTIONAL SCIENTIFIC AND ETHICS REVIEW COMMITTEE

RMN/BK/

“Transforming Lives through Quality Education”

Appendix F: Model One Results

Ordered probit regression

Number of obs = 385

Wald chi2(15) = 86.46

Prob > chi2 = 0.0000

Log pseudolikelihood = -473.05648

Pseudo R2 = 0.0774

frequency_fish	Coefficient	Robust std. err.	z	P>|z|	[95% conf. interval]	
Age_1	.002544	.0043891	0.58	0.562	-.0060585	.0111465
hhh_gender	-.2289165	.1144712	-2.00	0.046	-.4532758	-.0045571
H_size_1	-.0018165	.0302823	-0.06	0.952	-.0611688	.0575358
YearsinSchool	-.0309448	.0175548	-1.76	0.078	-.0653515	.0034619
lnHTotal_Income_1	.1458136	.0725029	2.01	0.044	.0037106	.2879167
Migrate_kibera	-.2035018	.1227807	-1.66	0.097	-.4441476	.037144
Occupation	-.2507574	.175634	-1.43	0.153	-.5949937	.093479
processed_fish	.7256727	.2126551	3.41	0.001	.3088764	1.142469
Totalprice_fish	-.0033448	.0006092	-5.49	0.000	-.0045387	-.0021508
neighborhood_effect	.0041435	.0023745	1.74	0.081	-.0005105	.0087975
Time_tonerestfishoutlet	.0105261	.0060395	1.74	0.081	-.0013111	.0223632
Number_outlet_1	.0178048	.0101224	1.76	0.079	-.0020348	.0376444
Food_culture	.0018738	.0020396	0.92	0.358	-.0021238	.0058714
dki	-.0132821	.0187061	-0.71	0.478	-.0499453	.0233811
Religion	-.0012527	.0024144	-0.52	0.604	-.0059849	.0034794
/cut1	-5.8377	1.48688			-8.751931	-2.92347
/cut2	-5.335746	1.481562			-8.239554	-2.431937
/cut3	-4.028414	1.473635			-6.916686	-1.140142
/cut4	-2.345046	1.455674			-5.198115	.5080225

Appendix G: Model Two Results

Ordered probit regression

Number of obs = 385

Prob > chi2 = 0.0000

Log pseudolikelihood = -377.01277

Pseudo R2 = 0.0710

Species_fish	Coefficient	std. err.	z	P>|z|	[95% conf. interval]	
Age_1	-.0003338	.0051263	-0.07	0.948	-.0103812	.0097135
Gender	-.089162	.1454951	-0.61	0.540	-.3743271	.1960031
YearsinSchool	-.0062786	.0166836	-0.38	0.707	-.0389778	.0264207
H_size_1	-.03371	.0313526	-1.08	0.282	-.09516	.02774
lnHTotal_Income_1	.1353703	.0746724	1.81	0.070	-.0109849	.2817256
Totalfish_price	-.0017813	.0006315	-2.82	0.005	-.003019	-.0005436
Group_membership	-.1862948	.1229757	-1.51	0.130	-.4273228	.0547331
Remmitance	-.6007353	.4021663	-1.49	0.135	-1.388967	.1874961
neighborhood_effect	.0038862	.002291	1.70	0.090	-.0006042	.0083765
Food_culture	.0054872	.0022314	2.46	0.014	.0011136	.0098607
Migrate_kibera	-.1130394	.1247868	-0.91	0.365	-.3576171	.1315383
Religion	-.0066074	.0021335	-3.10	0.002	-.010789	-.0024258
Time_tonerestfishoutlet	.0104382	.0069893	1.49	0.135	-.0032606	.024137
Number_outlet_1	-.0012903	.0113929	-0.11	0.910	-.02362	.0210395
Neighbourhood	.385769	.1228803	3.14	0.002	.144928	.6266099
meals_aday	.2428675	.1035003	2.35	0.019	.0400107	.4457243
Loan	.0248152	.1228112	0.20	0.840	-.2158904	.2655208
/cut1	-3.838766	1.53971			-6.856541	-.8209905
/cut2	-1.954144	1.528273			-4.949504	1.041215
/cut3	-.2925001	1.525337			-3.282107	2.697106
/cut4	1.497186	1.454213			-1.353019	4.34739

Appendix H: Model Three Results

w_Tilapia	Coefficient	Std. err.	t	P>|t|	[95% conf. interval]	
lnv_price_Nileperch_1	5.580453	.7363875	7.58	0.000	4.132475	7.028432
lnv_price_Tilapia_1	-4.418012	.6282598	-7.03	0.000	-5.653377	-3.182648
lnv_price_Omena_1	.0753562	.0516644	1.46	0.146	-.026233	.1769454
lnExp	.2816558	.0190208	14.81	0.000	.2442546	.319057
Gender	.0156788	.0363225	0.43	0.666	-.0557432	.0871008
Educ_level	-.0067504	.0122639	-0.55	0.582	-.0308653	.0173645
ln_hhsize	-.1301987	.0330189	-3.94	0.000	-.1951247	-.0652726
ln_age	.0422089	.0476183	0.89	0.376	-.0514242	.135842
ln_HTIncome	.0035343	.0184098	0.19	0.848	-.0326655	.039734
vimw_Tilapia	-.0616798	.02098	-2.94	0.003	-.1029334	-.0204262
_cons	-7.702515	1.232512	-6.25	0.000	-10.12604	-5.278992