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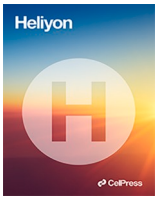

Research article

Annual consumption rate of fish types in Tanzania's Singida municipality during 2022

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ABSTRACT

This study assessed the annual fish consumption among the households in Singida Municipality. This was due to the long-time of unsatisfactory pupil performance in joining secondary schools which may be linked to a lack of Long-chain omega-3 polyunsaturated fatty acids. The study used a questionnaire based on a random household consumer survey of 204 households. The questionnaires were analyzed using SPSS statistical software version 27 and the results were reported using descriptive statistics including means, standard deviations, percentages, and frequency distributions. The results showed that the highest mean annual consumption was 25.92 kg and 23.00 kg per person for Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) respectively. Manyara tilapia (*Oreochromis amphimelus*) had a consumption rate of 22.27 kg annually per person. Nile perch (*Lates niloticus*) had the lowest consumption of 18.98 kg annually per person. The trend of respondents' perceptions on occurrences of non-communicable diseases was blood pressure, diabetes, stomach ulcers, marasmus, and inflammation of the lungs, epilepsy and Cancer. It was concluded that fish consumption in this study area varies with the type of fish and is higher than the national average fish consumption rate of 8.5 kg in 2020. Although unsatisfactory school performance may be attributed to other factors, more research should be conducted on fish omega-3 quantities from this study area.

1. Introduction

School pupil's performances are affected by many factors including gender, ethnicity, quality of school and school experience, nutrition, child health, and socioeconomic factors. Healthy eating behaviours adopted in maternal and childhood life are likely to continue throughout adolescence and may have positive effects throughout life [1]. Moreover, eating programs have been planned in many schools to promote good healthy [2]. However, not all types of food provide essential nutrients that are required by the body for the best cognitive performance and few school programs realize the potential available in fish [3]. Many fish species and some of plant products are sources of many essential nutrients of omega −3 [4]. Moreover, fish like Tilapia and African catfish contain high-quality protein and are rich in vitamin D and minerals like iodine and selenium. In addition, sea foods are high in omega-3 fatty acids (FAs) and the most important sources of these fatty acids and vitamin D in our diet [5]. Also, many studies have associated fish consumption with the benefits of getting Omega-3 polyunsaturated fatty acid (PUFA), especially docosahexaenoic acid (DHA) and eicosapentaenoic acid

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(EPA) [6]. Long-chain omega-3 PUFA is concentrated in grey matter and the visual elements of the retina. It is this fatty acid that cannot be synthesized by the human body but is mostly obtained through the consumption of fish, seafood, and in low contents various nuts.

Thus, frequent fish intake among people of different ages especially pregnant mothers and school-age children when the brain continues to develop and mature provides many benefits including good academic achievements. It also primarily reduces the blood clotting activity of platelets and the formation of plaques [6–8]. Eating fish gives body appropriate health benefits, making it a crucial component of a balanced diet all through life. High-quality proteins, vital amino acids, vitamins (including B2), and minerals (such iodine, zinc, iron, and selenium) are all found in abundance in fish. These nutrients are necessary for a number of body processes. According to a review study, males with the lowest abstract thinking scores were also the ones that consumed fish at the lowest level of consumption. Likewise, this review study discovered that higher consumption of red and processed meat was linked to lower academic achievement ratings in both males and female [9]. Additionally, although the specific benefits of eating fish vary based on the needs of the body and growth at each stage of life, fish intake should be encouraged because they apply to all age groups [10]. For example, fish consumption for infants and toddlers boosts immunity and improves the development of the brain and eyes. Beyond intellectual functions, children and adolescents have other benefits such as improved mental health, growth support, and enhanced cognitive function [5]. The appropriate consumption of fish during pregnancy appears to have had some positive impacts on the cognitive development of the offspring, particularly in the area of communication [11,12]. Additionally, it boosts cognitive function, encourages heart health, and helps individuals manage their weight. Furthermore, heart health is preserved, bone and joint health is enhanced, and cognitive decline is prevented in older persons [13]. Thus, Fish should be regarded as functional food because of its nutrient components that are very crucial to the body functions across all ages. Generally, fish contains lower levels of saturated fats compared to red meat and poultry. This makes it a heart-healthy choice, as excessive saturated fat intake can increase cholesterol levels and risk of heart disease [14]. Also, fish tend to be easier to digest compared to red meat, making it a good choice for individuals with digestive issues [15].

Although, the nutrition lifestyle has a greater link with non-communicable diseases [16] but researchers investigated the specific relationships between rates of certain non-communicable diseases and n-3 PUFA consumption. For example they discovered significant relationships between malnourished populations (consuming little n-3 PUFA) and an range of diseases and disorders such as cancer, hypertension, and diabetes [17]. Also, fish consumption has been shown to have numerous health benefits against diseases such as prevention of non-communicable diseases including hypertension, and cancer. Furthermore, research shows that fish has a high polyunsaturated fat content, especially the kind that is thought to lower blood cholesterol. Additionally, other research links fish oil, particularly fatty acids, may protect against kidney disorders. Meanwhile, Indications exist that specific fatty acids found in fish could offer defence against illnesses affecting the kidneys [18].Consequently, the quality of fish and timing of consumption especially when taken once or more than a week during pregnancy and within two decades of life has good neural development outcomes. The Omega −3 PUFA have vital function of neurodegeneration protections and possibly reduce the chance of developing cognitive impairments at later age [19] The high level of omega-3 source of food like fish have always been associated with good academic achievements and as a complimentary treatment of non-communicable disorders [20].Such benefits, especially intellectual development are mostly needed and built before birth and after birth in the early age of primary school which also will determine the higher school learning enrolments [21].

Singida Municipality is enclosed by numerous water bodies that are sources of fish within the Municipality. These water bodies are such as Lake Kindai, Lake Singidani, and Lake Munang [22]. Also there are many private ponds which are available within the area [11,12]. In the same region, Lake Kitangiri provides fish in this municipality the common types of fish obtained in this study area are African catfish, Nile tilapia, Manyara tilapia, and Nile perch from Lake Victoria [23]. Thus, due to the supply of fish in the area, it can be expected that the benefits of omega-3 PUFA are fully obtained for academic excellence apart from having other factors of school dropout such as early marriage, which have also affected other parts of Tanzania [24]. Household fish consumption patterns are influenced by a number of demographic parameters, including age, income, education, location, culture, and fish consumption patterns [25]. Increasing fish consumption can improve health and cognitive function, especially in children, by addressing these aspects through focused interventions at the home and school levels.

Meanwhile, Chemicals and other pollutants that are found in aquatic ecosystems may be due to natural phenomenon or through anthropogenic activities; these materials include; radionuclides, heavy metals, volatile organic compounds, polycyclic aromatic hydrocarbons and others. Agricultural activities, industrial activities, weathering are among the reasons of pollution in aquatic ecosystem [26]. Water contamination poses serious threats to fish population and aquatic ecosystems through bioaccumulation and bio magnification [27]. Contaminated water by pollutants such as pesticides, dioxin, heavy metals and others may have significant effects on fish. These effects may be in terms of toxicity where heavy metals (such as mercury, lead and cadmium) pesticides, industrial and pharmaceutical wastes can accumulate in fish to the noxious level [28]. This may impair different functions and systems of fish such as physiological functions, the immune system, metabolism functions, growth development, reproductive system and neurological functions [16,17]. Additionally, the effects such as morphological, histological and biochemical alterations in the tissues of fish may be caused by prolonged exposure to water pollutants even in very low concentrations which may critically influence fish quality [29,30]. Similarly, eating contaminated fish will have various physiological and biological effects to human being including brain and cardiovascular effects reproductive and developmental effects, cancer risk, immune suppression, endocrine disruption [31]. However, health effects of consuming contaminated fish can vary depending on factors such as the type and level of contamination, frequency of consumption, age, and health status of an individual [32].

Nevertheless, the Primary School Leaving Examination (PSLE), Singida ranked to the position of last but one out of twenty-one mainland regions for the year 2004 according to the Ministry of Education Council (MoEC) of 2004. In Singida Municipality there

were 659 primary students and in PSLE results, municipal Schools occupied the 76 position out of 11 8 in the same year. A research [33] revealed that in two conservative years 2016 through 2017, Singida among other regions has been categorized as a poor-performing region among ten regions studied. Thus, these results indicate that most pupils do not pass their exams, and few pupils continue with secondary school level. Another study [34] showed that varieties of fish species from Lake Victoria had recommendable omega-3 PUFA in different levels of their body parts such as in fish muscles of Nile perch (12.8), Nile tilapia (13.3) and catfish (11.0). Other types of fish omega-3 contents will depend on whether the fish is from fresh water or marine or the content will depend on their eating habits [35]. Fish consumption, frequency, and preferences are affected by consumers' geographic, social, and cultural characteristics [36]. These species are the one found in the Singida region especially within Singida municipality which can be involved in school feeding programs to increase fish per capita consumption. However, this proves that the nutritional value of fish varies by species, with some species being more beneficial than others [37].

Worldwide fish consumption increased at an average annual rate of 3.1 percent from 1961 to 2017, a rate twice that of annual world population growth (1.6 percent) for the same period, and higher than that of all other animal protein foods like meat, dairy and milk which increased by 2.1 percent per year. In developed countries, apparently fish consumption increased from 17.4 kg per capita in 1961 to 26.4 kg per capita in 2007 and gradually declined thereafter to reach 24.4 kg in 2017. In developing countries, apparently fish consumption significantly increased from 5.2 kg per capita in 1961 to 19.4 kg in 2017, at an average annual rate of 2.4 percent [19,20]. Meanwhile, in 2017 Tanzania had a per capita fish consumption level of 7 kg/year. Furthermore, annual fish consumption per capita increased to 8.5 kg in 2020 [38,39]. The increase in per capita fish consumption in Tanzania and worldwide has been attributed to the growth of the fisheries and aquaculture production sector. Tanzania's increased aquaculture knowledge through extension officers to farmers, development of technology and investment through public-private partisanship in seed and feed production may be among the factors that contribute to this statistical variation [40]. Thus, fish consumption per capita varies greatly across different regions and populations [41].

The World Health Organization (WHO) recommends a minimum of 1–2 servings (100–150 g) of fish per week for adults to maintain a healthy diet [42]. Fish consumption per capita data have many benefits in monitoring the health status and contamination levels from environmental pollutants [43]. However, these data have been generalized to the national level and few sub-regional data are available which would enable researchers to produce more precious data.

Furthermore, studies on fisheries and aquaculture development in Tanzania focus on the production and assessment of contaminants like chemical and microbial activity [25,26,44]. Thus, a review of existing literature on fisheries and aquaculture development in Tanzania shows a strong production focus, leaving many questions on consumption rate unanswered which would unveil the benefits and risk of fish consumption.

This study, therefore, assessed fish types and their annual consumption rate in Singida Municipality-Tanzania. Understanding fish consumption per capita in Singida Municipality is critical in addressing benefits and risks due to fish consumption. Data obtained from this study will therefore be useful to the upcoming research particularly health and environmental monitoring in this study area.

2. Materials and methods

2.1. Study design and sampling technique

This study was conducted as a cross-sectional survey using a questionnaire-based consumer survey (Refers to appendix1). Ten administrative wards of Singida Municipality were selected randomly to represent eighteen wards of Singida Municipality population. Thereafter, 204 households were picked randomly and asked to fill the survey questionnaire. The data collector and household representative were well informed before filling the questionnaires.

2.2. Data collection

Data were collected between May and June 2022 using a structured questionnaire. The inclusion criteria of data such as demographic characteristics (numbers of house hold members), frequency of fish consumptions (daily, weekly etc.), type of fish and quantity consumed, health status and perception of non-communicable diseases were used to ensure targeted data are captured. Furthermore, the questionnaires were designed in English but in the field, they were translated into Swahili which is the national language. The exclusion criteria of data were such as the young aged who could not elaborate the food consumption habits of the household, individual health conditions and restrictions which would not affect the entire household fish consumptions. The accuracy and reliability of the data were enhanced by making sure that the survey assistant and participants were knowledgeable, willing, and available to participate in the survey. The study was randomized to cover all sexes, adult age (head of the households), all education levels, marital status and number of households which determine kilograms of fish demanded.

2.3. Data analysis

Collected data were cleaned and analyzed using SPSS software version 27 through descriptive approach whereby means, standard deviations, percentage frequency distributions, and charts were used in describing the data pattern to meet the objective of the study. Further, inferential analysis was done using an independent sample *t*-test in comparing means at the significance level of 0.05.

2.4. Ethical considerations

The study was approved by the University Council, the Singida Regional Commissioner, and the Singida municipal authority. Informed consent was obtained from all participants before conducting the study.

3. Results and discussion

3.1. Socio demographic characteristics of the respondents

Table 1 presents the demographic characteristics of 204 respondents from Singida municipality who are the heads or assistants of households familiar with the food intake of the family. The socio-economic categories shows the ability to purchase goods including fish [45].

Table 1 presents the demographic characteristics of households in Singida municipality, based on a sample size of 204. Most household respondents were male (57.9 %) compared to female respondents (42.2 %). Regarding age distribution, the largest house hold respondent proportion fall within the 25–34 age group (43.1 %), followed by the 35–44 age group (34.3 %). The house hold respondent of 16–24 age groups constituted 13.7 % of the sample, while those aged 60 years and above were the smallest group at 7.8 %. This demographic profile of households in Singida municipality implies that, there is a balanced gender distribution, with slightly more male respondents. Moreover, the age distribution shows a concentration in the working-age groups, particularly those between 25 and 44 years old, indicating a potentially active workforce in the area. Meanwhile, the result shows that adult people consume more quantity and frequently fish probably for body building and disease prevention. Contrary, the teenagers and younger adults reported to have the lowest intakes in united kingdom [46]. Meanwhile, in terms of education, a substantial number of house hold respondents had college-level education (42.6 %), followed by secondary school education (32.7 %). Primary school-educated individuals comprised 11.9 % of the sample, with 12.8 % having informal education. Education levels in this study area varied, with a notable proportion having attained college education, suggesting a certain level of educational attainment which may prioritizes meat. The amount and frequency of higher fish consumption are influenced by many factors such as education level of this study area are in secondary school and college may be better informed about the health benefits of omega-3PUFA in which other researchers like [47] observed these factors.

Marital status indicated that a significant portion of the household respondents were married (62.4 %), followed by single individuals (35.7 %). Widows/Widowers were the smallest group with 2.0 %. The marital status distribution reflects a predominantly married population, which can have implications for household dynamics and economic activities. The family members determine the frequency and the amount of fish to be consumed. Regarding employment statuses, self-employment was the most common (58.8 %), followed by being employed (28.9 %). Thus marital status indicates the possibility of having an average number of family members who determine high quantity and frequency of fish consumptions. Furthermore, the employments determine the ability to buy goods like fish for family food security.

Retirees accounted for 5.2 % of the sample, while students comprised 7.2 %. The average household size was 4.03 members, with a minimum of 1 member and a maximum of 9 members, showing a standard deviation of 2.002. This result signifies that the possibility of consuming an average quantity and frequently since the amount purchased will be finished within average time. The result are in line

Table 1
Demographic characteristics of household in Singida municipality (n = 204).

Variable	Categories	Frequency	Percentage (%)
Gender	Male	118	57.9 %
	Female	86	42.2 %
Age	16–24	28	13.7 %
	25–34	88	43.1 %
	35–44	70	34.3 %
	45–59	2	1.0 %
	60+ years	16	7.8 %
Level of education	Primary school	24	11.9 %
	Secondary school	66	32.7 %
	College	86	42.6 %
	Informal education	26	12.8 %
Marital status	Married	126	62.4 %
	Single	72	35.7 %
	Widow/Widower	4	2.0 %
Job	Self-employment	114	58.8 %
	Employed	56	28.9 %
	Retired	10	5.2 %
	Students	14	7.2 %
Household size Mean	**Minimum**	**Maximum**	**Std. Deviation**
4.03	1	9	2.002

“This table shows the demographic factors that may affect the fish consumption preferences and their frequencies: Data collected from Research Survey 2022."

with research conducted by Ref. [48] in Mpwapwa region Tanzania that the fish consumption are positive correlated with social economic factors such as education and income but negatively correlate with age. The household size, with an average of about 4 members, is within a moderate range, indicating typical family structures in the municipality. Thus, with the good education, average economic well off and average house hold encourage the frequency and good quantity of fish consumption in Singida Municipality.

3.2. Economic characteristics of the respondent

Table 2 presents the economic characteristics of the household respondents based on their gender, with a sample size of one hundred and two. The table shows the average income and years of stay for male and female household respondents separately. Also it reveals the overall averages and standard deviations as well as the *t*-test for comparison of mean across males and females to observe the statistical variation existing among the given data.

Results indicate that, on average, male household respondents have a higher income mean of 292,387.82 (TZS) compared to female household respondent's mean of 216,165.58 (TZS) and the mean difference was statistically significant as indicated by the *t*-test result 9.427 and the.

(P-value = 0.001) which is less than the significant level of 0.05. Furthermore, the standard deviation for male household income is higher than that of female households, indicating that there is more variability in male income levels. This could suggest that there is a wider range of income levels among male household respondents, possibly due to factors such as differences in education, job sectors, or positions.

A study conducted in Nigeria found that fish consumption was positively associated with household income indicating that economic wealth plays a significant role in fish consumption. This implies that male headed household is likely to consume more fish than female-headed [49,50]. Furthermore, these results match with study conducted by Ref. [51] which shows that males prefer more protein and carbohydrate compared to female who prefers sweets like chocolates.

Thus, the demographic factors such as age, education, geographical location, family size and others, influences the frequency, quantities and types of fish consumed by individual in a year. However, the geographical location of Singida Municipality being surrounded by three Lakes favors the frequency, quantity and varieties of fish.

3.3. Fish consumption and other food types

3.3.1. Food groups

Table 3 presents the predominant food groups consumed in the research area and illustrates the consumption of different food groups. The results show that protein-rich foods were the most consumed food group, with 71.08 % of household participants reported consuming protein regularly. Carbohydrates were the second most frequently consumed food group, with 66.67 % of household participants indicating they consume carbohydrates frequently. Fruits were reported to be consumed by 56.37 % of household participants, and vegetables were the least frequently consumed food group, with only 53.43 % of household participants reporting regular consumption.

These findings align with the commonly recognized food groups, which are typically categorized as follows: carbohydrates, proteins, vitamins, and fats/oils. In terms of dietary recommendations, it is generally recommended that individuals should consume a balanced diet consisting of all groups of food in the right quantity and quality. Carbohydrates are essential macronutrients that provide energy for the body, and they are found in foods such as grains, bread, and pasta. Protein is important for building and repairing tissues in the body and is found in foods such as meat, fish, and legumes. Vitamins and minerals are commonly found in fruits and vegetables that are essential for body protection against diseases and maintain good body health. It is important to encourage individuals to consume more varieties of vegetables and fruits to ensure that they get more protections for their health [52]. Generally; this play great role in the prevention and treatment of some of common chronic diseases including NDC and improve intellectual development.

These findings suggest that the consumption of fish, which is one of the primary sources of protein, could potentially help to increase protein intake to people in Singida Municipality. Additionally, fish is known to be a healthy source of essential nutrients and trace elements, making it an important component of a balanced diet. Furthermore, these findings align with previous studies that highlighted about the importance of promoting the consumption of protein-rich foods, such as fish, in addressing malnutrition and promoting food security in low-income communities [53]. However; the municipality would do better by consuming more of vegetables and fruits followed by other groups of food in required amount. Furthermore, fish consumption should be considered as the first priority than other source of protein due to its nutrition values in all age group [54,55].

Table 2
Average monthly income and years of experience across Respondent's Gender (n = 204).

Sex	n	Average monthly income (TZS)	Standard Deviation	*t*-test	p-value
Male	107	292,387.82	213986.80		
Female	97	216,165.58	154756.84	9.427	0.001

"This table shows the demographic factors that may affect the fish consumption preferences and their frequencies: Data collected from Research Survey 2022."

Table 3
The dominant food group across the study area.

Food Group	Frequency	Percentage (%)
Carbohydrates	136	66.67
Protein	145	71.08
Fruits	115	56.37
Vegetables	109	53.43

"This table shows the main food group that the house hold prefers such as frequency, which implies the food group preference Data collected from Research Survey 2022."

3.3.2. Dominant family food consumption

Fig. 1 shows the frequency and percentage of the favorite food among families surveyed, with fish being the most preferred food by 72.5 % of the families. Beef and chicken were less preferred, with 19.6 % and 7.8 %, respectively. These results highlight the importance of fish as a preferred source of animal protein among families in Singida Municipality.

The high preferences for fish among the families in Singida Municipality could be due to the proximity of the area to Lake Munang, Singidani, and Kindai, which are among the major sources of fish in Singida.

3.3.3. Dietary fish consumption at Singida municipality

Table 4 shows the assessment of dietary Fish consumption in Singida Municipality, the assessment of dietary fish consumption among 204 households reveals several significant trends. Firstly, the factors that trigger fish consumption indicate that accessibility plays a pivotal role, with 20.1 % of respondents citing it as a key factor. This is closely followed by the plentiful supply of minerals and the perception of fish being full of nutrients, each influencing around 3.9 % of respondents. Interestingly, while affordability (cheapness) is a factor for only 2.9 % of respondents, it still contributes to the overall decision-making process regarding fish consumption.

When it comes to the frequency of fish consumption, data suggest that a considerable portion of individuals consume fish regularly. For instance, 10.3 % of respondents consume fish six times a week, and 6.4 % consume fish daily. This indicates a high level of fish consumption frequency among the surveyed population. Furthermore, family portion sizes also reflect a preference for larger quantities, with 21.6 % of respondents opting for 0.5 kilos of fish per meal, followed by 14.2 % choosing 1 kilo. Specifically, looking at the frequency of fish consumption, Nile Tilapia stands out with 10.3 % of respondents consuming it six times a week, 6.4 % consuming it daily, and 5.9 % consuming it twice a week. In contrast, other type of fish like African Catfish and Nile Perch have lower consumption rates in terms of frequency. Moreover, when considering family portion sizes, Nile Tilapia again emerges as the preferred choice. The

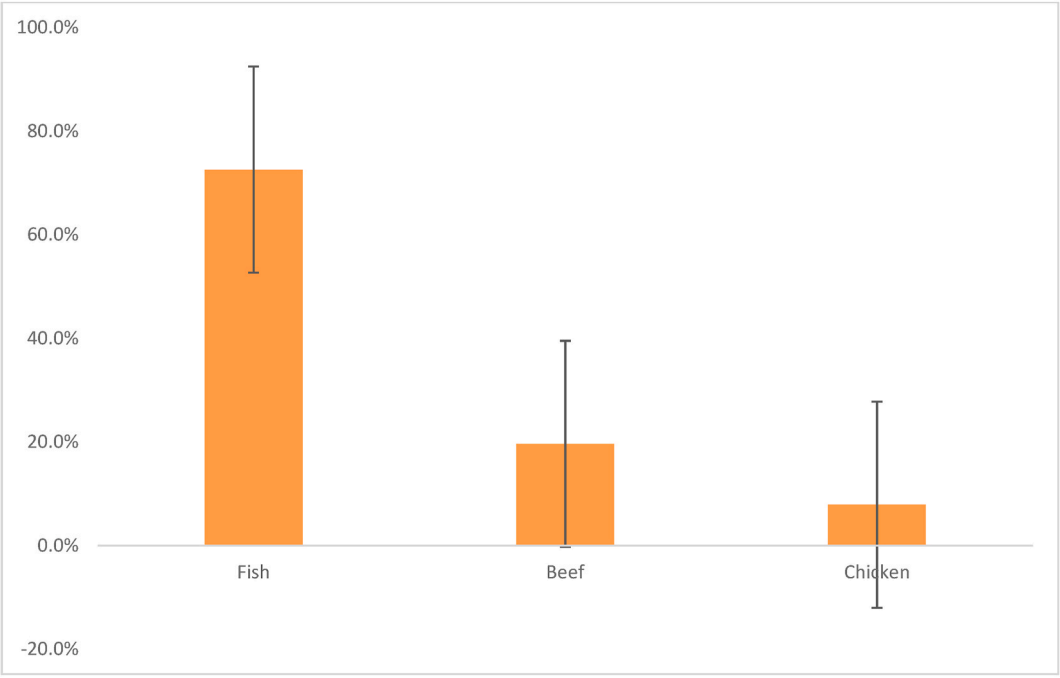

Fig. 1. The favorite food among families.
"This figure shows the percentage of meat type preferences where most families prefers Fish than beeef and chicken meat. Data collected from Research Survey 2022."

Table 4
Assessment of dietary Fish consumption in the Singida (n = 204).

Variable	Rate	African catfish	Nile Tilapia	Nile Perch	Manyara
Factors triggering for fish consumption	Accessible	41 (20.1 %)	15 (7.4 %)	26 (12.7 %)	3 (1.5 %)
	Plentifully supply of minerals	8 (3.9 %)	3 (1.5 %)	5 (2.5 %)	1 (0.5 %)
	Full of nutrients	8 (3.9 %)	3 (1.5 %)	2 (1 %)	2 (1 %)
	Cheap	6 (2.9 %)	2 (1 %)	3 (1.5 %)	1 (0.5 %)
Frequency of fish consumption	Six times a week	21 (10.3 %)	7 (3.4 %)	14 (6.9 %)	3 (1.5 %)
	Daily	13 (6.4 %)	4 (2 %)	6 (3 %)	1 (0.5 %)
	Once a week	8 (3.9 %)	3 (1.5 %)	4 (2 %)	0 (0 %)
	Once after three weeks	5 (2.5 %)	2 (1 %)	2 (1 %)	0 (0 %)
	Once per two weeks	5 (2.5 %)	2 (1 %)	2 (1 %)	1 (0.5 %)
	Thrice a week	18 (8.8 %)	6 (3 %)	6 (3 %)	1 (0.5 %)
	Twice a week	20 (9.8 %)	7 (3.4 %)	12 (5.9 %)	3 (1.5 %)
Family portion on meal portion	0.25 kilo	9 (4.4 %)	3 (1.5 %)	5 (2.5 %)	0 (0 %)
	0.5 kilo	44 (21.6 %)	16 (7.8 %)	18 (8.8 %)	5 (2.5 %)
	1 kilo	29 (14.2 %)	10 (4.9 %)	14 (6.9 %)	3 (1.5 %)
	1.5 kilos	5 (2.5 %)	2 (1 %)	2 (1 %)	0 (0 %)
	2 kilos	11 (5.4 %)	4 (2 %)	5 (2.5 %)	2 (1 %)
	3 kilos	3 (1.5 %)	1 (0.5 %)	1 (0.5 %)	0 (0 %)
	4 kilos	3 (1.5 %)	1 (0.5 %)	2 (1 %)	0 (0 %)
	6 kilos	1 (0.5 %)	0 (0 %)	1 (0.5 %)	0 (0 %)
Days to complete the whole Fish	1 day	126 (61.8 %)	42 (20.6 %)	66 (32.4 %)	9 (4.4 %)
	2 days	36 (17.6 %)	12 (5.9 %)	16 (7.8 %)	4 (2 %)
	3 days	24 (11.8 %)	8 (3.9 %)	10 (4.9 %)	2 (1 %)
	5 days	12 (5.9 %)	4 (2 %)	4 (2 %)	2 (1 %)
	6 days	6 (2.9 %)	2 (1 %)	2 (1 %)	1 (0.5 %)
	After 7 days	0 (0 %)	0 (0 %)	0 (0 %)	0 (0 %)

"This table shows the fish types and family consumption variables such as frequency, quantity and time used to complete whole purchase Data collected from Research Survey 2022."

data show that 21.6 % of respondents opt for 0.5 kilos of Nile Tilapia per purchase, followed by 14.2 % choosing 1 kilo of Nile Tilapia. In terms of time taken to complete a purchased fish, most respondents (61.8 %) reported consuming whole purchased kilograms of fish within a day, showcasing a preference for fresh fish. This is followed by 17.6 % who consume fish within two days [20].

Considering that the WHO advises consuming 100–150g (0.1–0.15 kg) of fish per week in 1–2 servings [42], the average consumption in this study area is between 0.5 and 1 kg for four average family members. The majority of these households may, in fact, adhere to this guideline, but children are probably not eating as much as this. Moreover, the findings indicate that accessibility is more important than fish's nutritional worth, so more information about the benefits of eating fish should be made available at family and school levels.

3.4. Average fish consumption in Singida municipality

Results from Table 5 show per capita fish consumption in kg per day and per year for four diverse types of fish based on a survey conducted in 2022 with a sample size of 204. The table shows that in average, the overall per capita fish consumption is 0.064 kg per day or 23.36 kg per year. Among the four types of fish, Nile Tilapia is the most consumed fish, with a mean consumption of 0.071 kg per day or 25.92 kg per year. African catfish is the second most consumed fish with a mean consumption of 0.063 kg per day or 23.00 kg per year, followed by Manyara tilapia with a mean consumption of 0.061 kg per day or 22.27 kg per year, and Nile perch 0.052 kg per day or 18.98 kg per year, respectively.

Nile tilapia is the most consumed fish, with a mean daily consumption of 0.067 kg per capita. These findings are in line with previous research which has shown that Nile tilapia is a popular fish in many regions due to its good taste, benefits, and availability. Also, Nile Tilapia is a lean source of protein and is low in saturated fat, making it a healthier alternative to red meat. The consumption of tilapia has been associated with a reduced risk of cardiovascular disease and improved lipid profiles [51]. However, it is important to note that fish are also associated with a higher risk of exposure to environmental pollutants, such as polychlorinated biphenyls (PCBs)

Table 5
Fish per capita consumption in kg (n = 204).

Fish type	Mean per day	Standard Error of Mean	Mean per annual
African catfish	0.063	0.001	23.00
Manyara Tilapia	0.061	0.008	22.27
Nile Tilapia	0.071	0.006	25.92
Nile perch	0.052	0.010	18.98
Overall Consumption	0.064	0.003	23.36

"This table shows the fish types and their mean consumptions where Nile tilapia is preferred mostly and the least being Nile perch which is outsourced from Lake Victoria. Data collected from Research Survey 2022."

and dioxins. Meanwhile, fish is rich in omega-3 fatty acids, which are beneficial for brain functions, heart health, and immune system functions [56,57]. Thus, fish like tilapia, African catfish are also associated with exposure to environmental pollutants [58]. Consequently, the frequency and amount of fish taken per day indicate necessity of doing research to evaluate the risk and benefits. Forex ample if fish they consume are contaminated then the risk level will be high.

Manyara Tilapia and Nile perch have lower consumption rates than Nile tilapia and African catfish, with mean daily consumption rates of 0.061 kg and 0.052 kg per capita, respectively. Manyara tilapia has been associated with benefits such as improving brain functions. In terms of types of fish, tilapia and African catfish are widely consumed in many African countries due to their availability and affordability. A study conducted in Kenya found that tilapia was the most preferred fish among consumers due to its taste, affordability, and availability [12]. African catfish is also a popular fish in Nigeria, and its consumption has been associated with various health benefits [59].

3.5. Perception of respondents

3.5.1. Non -communicable disease prevalence at Singida municipality

Table 6 presents the respondents' perception of non-communicable diseases in Singida municipality, where a total of one hundred and two households participated. However, the table shows the frequency and percentage distribution of non-communicable diseases in the study area. Table 6 shows that the most common non-communicable diseases reported by the respondents were diabetes and blood pressure, with frequencies of 53 and 68, respectively, and percentages of 25.98 % and 33.33 %, respectively. These findings suggest that diabetes and hypertension are significant public health concerns in the study area, and both are diseases caused by lifestyle, meaning that they can be prevented through the adoption of healthy lifestyle behaviours, such as regular exercise, healthy diets, and stress management.

Furthermore, Table 6 shows that stomach ulcers were the third most frequently reported non-communicable disease, with frequency of 46 and percentage of 22.6 % which is closer to the percentage reported on diabetes. The low frequency of epilepsy and lung diseases and Marasmus with frequency of 9,11 and 13 with percentage of 4.41 %,5.39 % and 6.37 % respectively may indicate that the study area has a low prevalence of non -communicable diseases. Finally, cancer was the least reported non-communicable disease, with a frequency of only 4 households and a percentage of 1.96 %. These findings show that cancer is not a significant public health problem in the study area, however, more research should be done. Nutrition interventions are essential in managing the risk of non-communicable diseases [60].

4. Conclusion and recommendation

The frequency, amounts, and kinds of fish that an individual consumes over the course of a year are influenced by demographic factors, including age, education, accessibility and family size. In this study area most family prefers Nile tilapia fish potion size of (0.5–1) kg to be completed within a week of four family members in average. However, the geographical location of Singida Municipality being surrounded by three Lakes (accessibility) favours the frequency, quantity and varieties of fish. Thus, most of the consumed fishes are from the study area contributed by the availability of different water bodies and including private ponds. The per capita consumption of fish varies across different types of fish, with Nile tilapia, Manyara tilapia, and African catfish being the most widely consumed fish in the surveyed population. Fish consumption in this study area is higher than the average of national fish consumption rate which was 8.5 kg in 2020. Overall, the study's findings indicate that individuals eat fish mostly for convenience rather than for its nutritional worth, and they favour meat and carbohydrate over fruits and vegetables. The trend of respondents' perceptions on occurrences of non-communicable diseases was blood pressure, diabetes, stomach ulcers, marasmus, inflammation of lungs, epilepsy and Cancer. It was concluded that fish consumption in this study area varies with type of fish and it is higher than the national average fish consumption rate which was 8.5 kg in 2020.

The amount and type of fish consumed can be improved further by increasing the supply of fish through more aquaculture projects at the household and school levels. Outsourcing fish from other water sources like the Indian Ocean and consuming omega-3 supplements can help alleviate fish omega −3 deficiency in the research area. Increasing awareness of the timing, fish nutritional value, quality, and quantity of fish consumption plus quality sleep may increase the cognitive development of school-age children and prevent non-communicable disease among individuals. However, people from this study area should eat more fruits and vegetables with protein and carbohydrates in required amount. Nonetheless, in order to prevent cloistral issues, the preference for fish meat over red meat as a protein source should be maintained. More research on fish omega-3 concentrations from this study area is necessary, even if other reasons may lead to unsatisfactory academic achievement.

CRediT authorship contribution statement

Amin R. Kazoka: Writing – original draft, Visualization, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jilisa Mwalilino:** Writing – review & editing, Supervision, Project administration. **Paul Mtoni:** Writing – review & editing, Validation, Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to

Table 6
Respondent's perception on non-communicable disease occurrences by percentage at the study area (n = 204).

Non-communicable disease in the area	Frequency	Percentage %
Diabetes	53	25.98
Hypertension	68	33.33
Stomach ulcers	46	22.55
Epilepsy	9	4.41
Marasmus	13	6.37
Inflammation of lungs	11	5.39
Cancer	4	1.96

"This table shows the types of non-communicable diseases and their occurrences perception in Singida municipality where hypertension scored high percentage and cancer being the least. Data collected from Research Survey 2022."

influence the work reported in this paper.

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Appendices.

Appendix 1: Research Questionnaire

Section One: Personal information

Fill the blanks and put mark √ most correct answer according to your opinions

Q1. Where is your residence?

Singida Municipality ☐ Out of Singida municipality ☐

Q2. Respondent's gender? Male ☐ Female ☐

Q3. Respondent's age ……..……Height……. Weight……BMI……

Q4. Respondent's level of education? Primary school ☐ Secondary school ☐ University ☐

Informal education ☐

Q5. Marital status ……

Q6. Respondent daily work or activities…….....

Q7. Which is your employment among the following categories?

Self ☐ Employed ☐ Retired ☐ Student ☐

Q8.Respondent monthly income in Tanzanian Shillings……..

Q9. Respondent number of family members……..

Q10.Respondent experiences in Singida Municipality……

Section two: Food consumptions per year (Head of the family or assistant)

Fill the blanks and put mark √ in most correct answer according to your opinions

Q11.Choose foods groups and write down at least three preferences

Carbohydrate List 1……2…… 3……

Sources List 1……2…… 3 …… …

Fruits List 1……2…… 3 ……..

Vegetables List 1……2…… 3 ……..

Q12.Your family prefers which source among the listed above in question List……..……..Why do you prefer the listed sources in question (12) ……..

Q 13.Which type of fish do you prefer to eat frequently?

African catfish ☐ Nile tilapia ☐ Nile perch ☐ Manyara tila ☐

Q14.In short which amount of fish listed in question 13you consume once.

Fish type	Assume the amount of fish in kg per meal	Where do they come from?
African catfish		
Nile tilapia		
Manyara tilapia		
Nile perch		

Q15. How many times do you eat mentioned types of fish in question 14?
Once a day ☐ Three time a week ☐ Twice a week ☐
Once a week ☐ Once after two weeks ☐ Three times after three weeks ☐
Qn16 How many kilograms of fish do you take at home usually once you buy? ……
Q17. This amount in question 16, how long does it take to finish before buying another one……
Q18. Which cooking method do you prefer……
Q19. According to your experience which non communicable disease appears to disturb people in this area often?
1……2……3……
Q20. People of which gender are usually get these diseases mentioned in question 19.
Male ☐
Female ☐
All ☐
Q21. People of which age get these communicable diseases question 19 in your area?
Old ☐ Adult ☐ Youth ☐ Children ☐ All ☐
22. Which effects arises by suffering from these diseases mentioned in question 18
1……2……3……...
Q23.What do you do to control such diseases mentioned in question 18.
1……2…… 3……
Q24. Can you guess that diseases listed in question 19 are caused by which life style? List
1……2……3……

. (*continued*).

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