Fish Consumption Patterns and Contribution of Fish to Diets of Rural Households in a Fishing Region in Zambia.

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ABSTRACT

Fish provides high-quality proteins and essential micronutrients, which can help reduce undernutrition. However, little is known about fish consumption patterns and its contribution to rural household diets. This study aims to assess fish consumption patterns and the contribution of fish to rural household diets in the Luwingu district of Zambia.

A cross-sectional study was conducted among 132 households selected using a multi-stage sampling method from a fishing area in Luwingu district. Data were collected on women of reproductive age (15-49 years), children (6-59 months), and men (18-64 years) in the selected households. The households were surveyed using a 24-hour dietary recall and a 7-day dietary recall for the consumption of animal-source foods.

A 24-hour dietary recall and a 7-day dietary recall showed that fish was the most consumed animal-source food, with 75.8% and 100% of households consuming fish, respectively. In children under five years of age, the average quantities of fish consumed per day were 60.4 ± 35.2 g (6-12 months), 73.8 ± 51.0 g (13-36 months), and 87.9 ± 45.7 g (37-59 months). Women and men had mean daily intakes of 162.1 ± 86.0 g and 176.3 ± 70.0 g of fish, respectively.

A significant difference in protein intake ($p = 0.042$) was observed among children. In adults, differences in intake were noted in proteins ($p = 0.028$) and iron ($p = 0.008$). Compared to other foods, fish contributed more to protein and calcium intake in children, women, and men, while it contributed less to iron and vitamin A intake across all sub-categories of study participants' diets.

The results of this study demonstrate that fish play a critical role in the household diets of Luwingu district. It can be used as a strategy to improve food and nutrition security, ultimately contributing to the reduction of undernutrition.

Keywords: Fish, nutrient intake, food consumption, undernutrition, Zambia

INTRODUCTION

Fish is a vital component of the global food system, accounting for approximately 17% of the animal protein consumed worldwide (FAO, 2018b). Approximately 3.2 billion people obtain nearly 20% of their per capita animal protein intake from fish (FAO, 2018b). Adequate fish consumption enhances the micronutrient density of diets, helping to prevent deficiencies that can impair health and development, particularly during pregnancy, lactation, and early childhood (Kawarazuka & Béné, 2010).

Children aged six months and above require nutrient-rich complementary foods that supply vitamins, minerals, essential fatty acids, and high-quality proteins, nutrients readily available in animal-source foods such as fish

(Dewey, 2013). Despite this, nearly half of children under two years old globally do not consume sufficient amounts of animal-source foods (UNICEF, 2019).

Globally, one in three children under five experiences stunted growth, while one in two suffers from at least one micronutrient deficiency (UNICEF, 2019). The Joint Child Malnutrition Estimates (2024) report that 23.2% of children under five are stunted and 6.6% are wasted, underscoring the continuing burden of malnutrition worldwide (UNICEF et al., 2025).

In Africa, fish is a cornerstone of food and nutrition security, providing essential proteins to over 400 million people (WorldFish Centre, 2009). It contributes about 22% of total protein intake in sub-Saharan Africa (Béné & Heck, 2005). However, per capita fish consumption remained low at 9.1 kg per year in 2010, less than half the global average of 20.2 kg (AUC-NEPAD, 2014; FAO, 2018b).

Diets across sub-Saharan Africa often lack diversity. Many children do not consume foods from the minimum five food groups required to meet dietary adequacy (UNICEF, 2019). In low-income countries, where diets are dominated by calorie-dense staples, fish serves as an affordable and locally available source of nutrients that can enhance dietary diversity (O'Meara et al., 2021; FAO, 2018b).

The malnutrition burden in Africa remains high, with 43% of children under five stunted and 27% wasted, both above global averages (UNICEF et al., 2025). Increasing fish consumption among vulnerable populations could help reduce undernutrition, micronutrient deficiencies, and disease burdens (Benson, 2008; Genschick et al., 2017; WorldFish Center, 2011). Yet, data on fish consumption and its nutritional contributions remain scarce and underrepresented in national statistics (Kawarazuka & Béné, 2010). Consequently, the role of fish in food and nutrition security has been underestimated in many African policy frameworks (Kolding et al., 2016; Roos et al., 2003).

In Zambia, fish is the most consumed animal-source food, contributing over 20% of dietary animal protein (NFDS Africa, 2016; NFNC, 2009). In the Northern Province, fish contributes approximately 26% of dietary protein for women and 16% for children aged 6–59 months (Alaofe et al., 2014). Despite the province's proximity to major water bodies, including Lakes Bangweulu, Tanganyika, Chila, and Mweru-Wantipa, as well as extensive swamps and wetlands, diets remain deficient in vitamin A, iron, and calcium, nutrients abundant in fish (Alaofe et al., 2014; Ministry of Fisheries and Livestock & Central Statistics Office, 2019).

Nationally, 32% of children under five are stunted, 12% underweight, and 3% wasted (Zambia Statistics Agency et al., 2024). Micronutrient deficiencies are widespread: vitamin A deficiency affects 26.2% of children under five, and anaemia affects 60.9% of women of childbearing age and 28% of children aged 6–59 months. Iron deficiency affects 12.6% of children and 19% of women (NFNC et al., 2024).

The Northern Province records some of the highest rates of malnutrition in the country, with 42.6% of children stunted, 29.1% vitamin A deficient, and 37.7% anaemic. Among women of reproductive age, 26.5% are anaemic (Zambia Statistics Agency et al., 2024; NFNC et al., 2024). Although fish is increasingly recognised for its nutritional importance (Béné et al., 2015; Gibson et al., 2020; Sam et al., 2015), data on its consumption patterns remain limited. Existing studies have largely focused on urban settings (Marinda et al., 2018; Genschick et al., 2018; Hichaambwa, 2012) with little information available for rural households (Nsonga, 2015).

Given its nutrient density and accessibility, fish holds an important place in food-based nutrition strategies. Expanding its consumption could help reduce undernutrition and micronutrient deficiencies, especially among the poor (Kawarazuka & Béné, 2010; Béné et al., 2015). However, the lack of disaggregated consumption data, particularly at the rural household level, has limited its inclusion in national nutrition policies and development programs (Béné et al., 2015).

The current study aimed to establish the fish consumption patterns and their contribution to rural household diets in Zambia. The specific objectives of the study were: (1) to establish the consumption patterns of fish and other animal-source foods among rural households, (2) to determine the intake of fish among rural households, and (3) to determine the nutritional contribution of fish to rural household diets.

MATERIALS AND METHODS

Study setting

The study was conducted in Luwingu district of Northern Province in Zambia. This site was purposively selected as a study area because it is a rural district with high fishing activity. It has abundant streams, wetlands, and 500 square kilometres of Lake Bangweulu situated within its boundaries. The district was also reported to have

limited information on fish consumption (Nsonga, 2015) and most of its population is vulnerable to food insecurity. Among the wards in Luwingu, Ibale ward was purposively selected because of its proximity to water bodies. A ward is the smallest political administrative unit in Zambia.

Study design

A cross-sectional study design was used to carry out the household survey, which established the consumption patterns of animal-source foods in Ibale ward of Luwingu district, with a detailed focus on fish consumption patterns and its nutritional contribution to diets of women of reproductive age (15-49 years), children aged 6-59 months, and men (18-64 years) who were the target population.

Sample size determination and Sampling procedures

The sample size of households was determined using the Cochran's formula (Cochran, 1963), for calculating the sample size

$$n = Z^2pq / e^2$$

where: n is the sample size, Z is the critical value of desired confidence level of 95% (corresponding z-score value is 1.96), p is the proportion of an attribute that is present in the population estimated to be 9%, contribution of fish to a meals in Northern Province (Alaofe et al., 2014) and q = 1–p, and e desired level of precision of 5% (0.05). The calculated sample size of 126 was adjusted for attrition and non-response rate at 5% to obtain the optimal sample size of 132 households. A total of 132 households were surveyed in the study, which comprised of 132 women of childbearing age (15-49 years), 132 children (6-59 months), and 46 men (18-64 years).

Multi-stage sampling was used in this study. First, Ibale ward was purposively selected as the operational area for the project. A list of villages was generated from Ibale ward with the help of Fisheries Officers from the Ministry of Fisheries, and simple random sampling was used to select three villages (Lundu, Chanika and Munsambwa) out of the 33 villages in Ibale ward. With the assistance of the village headmen from the selected villages, lists of households with women of reproductive age (15-49 years), children (6-59 months), and men (18-64 years) were generated. This formed the sampling frame.

Using a determined sampling interval, systematic random sampling was used to select 44 households from each of the three villages that met the inclusion criteria from the sampling frame. The first household that met the inclusion criteria was randomly selected and subsequent households were selected using the sampling interval. This procedure was followed until the required number of 132 households was obtained.

Separate lists of replacement households were prepared and eligible households that declined to participate in the study and those who were not available during the first days of interviews were replaced by households from the replacement lists which comprised 10 households from each village.

Data collection tool and procedures

Two questionnaires were used to collect data, a semi-structured questionnaire and a food frequency questionnaire (FFQ). The questionnaires comprised of sections on demographics and socio-economic information, 24-hour dietary recall, frequency of consumption of animal-source foods, household members' preference for fish with regard to size and the preferred method of processing.

A 24-hour dietary recall was employed to capture information on food consumption in the 24 hours preceding the data collection exercise. A non-consecutive repeat 24-hour dietary recall was conducted among the participants to estimate their usual dietary intake. During data collection, participants were asked about the types of food consumed, cooking methods, and quantities of food eaten in the past 24 hours. When conducting the 24-hour recall, quantities of food consumed were estimated by measuring food models using common household measures, including kitchen scales, graduated measuring cups, and spoons. Furthermore, pictures with estimated quantities from a 'carbs and calorie counter' book (Cheyette & Balolia, 2016) were used to estimate the quantity of some common foods that are consumed in the region and are similar to those found in the 'carbs and calorie counter' book. The quantities of the weighed foods were recorded in grams.

After administering the 24-hour dietary recall, the food frequency questionnaire (FFQ) with a 7-day recall period adapted from FAO (FAO, 2018a) with modification, was used to capture data on frequency of consumption of any type of fish or other animal-source foods only consumed 7 days prior to the interview at household level. The purpose of FFQ in this study was to establish the frequency of consumption of fish and other animal-source foods by children, women and men residing in selected households. Further, information about the size of fish and methods of processing (fresh, sun-dried, smoked, or salted fish) of the fish consumed was also collected.

The data collection tools were translated into Bemba, a local language that is spoken in Northern Province.

The data collection exercise was conducted in October 2019. The main respondents were mothers/caregivers of reproductive age, responsible for meal preparation within the households. They provided information on their individual food consumption as well as that of children (6-59 months) and at the household level. Men provided information about their individual food consumption.

Data analysis

Data were analysed using IBM Statistical Package for Social Sciences (SPSS) for Windows, version 22.0 (IBM Corporation, Armonk, NY, USA) and Microsoft Excel 2013. Nutrisurvey 2007 version was used for nutrient analysis.

Descriptive statistics (means and frequencies) were used to summarise and describe various sample socio-economic and demographic characteristics, as well as to summarise data on food consumption patterns, such as the most consumed animal-source foods, the proportion of participants who consumed fish, and the frequency of consumption of fish and other animal-source foods.

The nutrient contents of fish and other foods consumed were estimated using Nutrisurvey 2007 software. Prior to data entry in the software, the local fish species and other foods that were not in the Nutrisurvey food database were added manually using the Zambian and West African food composition tables (Nyirenda et al., 2009; Stadlmayr et al., 2012). The following information was added: names of foods (including preparation/cooking methods), nutrients found in those foods, and their quantities.

During data entry in Nutrisurvey, the age category for each individual study participant was selected, and the names of the foods consumed were entered along with the appropriate preparation/cooking methods and quantities consumed. Following this, an analysis of food records for all 132 women, 132 children aged 6-59 months, and 46 men was conducted. A Microsoft Excel sheet was generated detailing the quantities of nutrients for all foods consumed and nutrients per food item entered in the software for each participant.

To ensure accurate calculations of the contribution of fish to diets of household members, those who did not consume fish as determined by the 24-hour dietary recall, were eliminated from the list prior to calculating the mean intakes of fish and other foods. Thereafter, mean intakes and standard deviations were calculated using the Microsoft Excel sheet generated for participants who consumed only fish and other foods.

The contribution of fish to diets and contribution of diets to the recommended nutrient intake (RNI) was determined using the nutrient contribution ratio (NCR) as explained by Roos et al. (2003) with modification. The NCR expresses the intake of a nutrient of interest from fish estimated to be consumed by the study population in a day as a percentage of intake of that nutrient from the estimated overall diet (NCR = mean nutrient consumed from fish / mean nutrient from diets X 100).

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Analysis of variance (ANOVA) was used to establish the differences in mean nutrient intake and quantities of fish consumed among the age groups of children. An independent t–test was used to establish the differences in mean nutrient intake and quantity of fish consumed between women and men. The normality test for continuous variables was conducted using Kolmogorov-Smirnov (K-S) (with Lilliefors correction) for participants less than 50 (Elliott & Woodward, 2007). All statistical tests were performed at a critical value of $p < 0.05$.

Ethical considerations

Ethical approval was sought and obtained from the Tropical Diseases Research Centre (TDRC) Ethics Committee (00003729). The permission to collect data in the area was obtained from the District Administrative Officer, District Agriculture Coordinator, and village headmen. Informed consent was obtained from participants by signing the consent forms or using thumbprints for those who could not sign. Participants were informed of their freedom to choose whether to participate in the study or not. They were also assured that the information provided would be treated as confidential.

RESULTS

Demographic and socio-economic characteristics of participants

The study enrolled 132 households, comprising 132 women of reproductive age, 132 children aged 6–59 months, and 46 men who were available during the first day of interviews. The age of the main respondents (mothers/caregivers) ranged from 16 to 45 years, with a mean age of 28.9 ± 7.6 years. Household size varied between two and thirteen members. Other demographic and socio-economic characteristics are presented in Table 1.

Most of the main respondents (88.6%, n = 117) were married. Overall, education levels were low, with 78.0% (n = 103) having attained only primary education (Grades 1–7). Most respondents (79.5%, n = 105) were engaged in informal employment such as fish mongering and shopkeeping, while others participated in seasonal or small-scale trading activities, including the sale of agricultural products such as maize, cassava, and groundnuts from their own production.

More than two-thirds of households (70.5%, n = 93) reported a monthly income below K250 (approximately US$17.8), and the majority (93.0%, n = 124) spent less than K200 (approximately US$14.2) on food. Further analysis revealed that about 69.7% (n = 92) of households spent less than K50 (approximately US$3.6) per month on fish for home consumption.[1]132 women, (132 children) and 46 men

Table 1. Demographic and socio-economic characteristics of participants[1]

Characteristic	Number of respondents (n)	Percent[2] of respondents (%)
Education level of the respondents		
No formal education	11	8.3
Primary	103	78.0
Secondary	18	13.6
Occupation		
Formal	2	1.5
Informal	105	79.5
Unpaid family member	25	18.9
Marital status of respondents		
Married	117	88.6
Single	9	6.8
Separated	2	1.5
Divorced	4	3.0
Household Monthly Income (ZMK[3])		
Less than 250	93	70.5

250 to 500	37	28.0
Above 500	2	1.5
Proportion of income spent on food (ZMK)		
Less than 200	124	93.0
200 to 500	8	6.1
Proportion of income spent on fish in a month (ZMK)		
Less than 50	92	69.7
51 to 100	10	7.6
101 to 200	3	2.3
Above 200	1	0.8
Caught by self / did not buy	26	19.7

[1]132 women, (132 children) and 46 men

[2]Percentage calculated as n/N x 100 and presented as %; N – Total number of households interviewed (N=132 households)

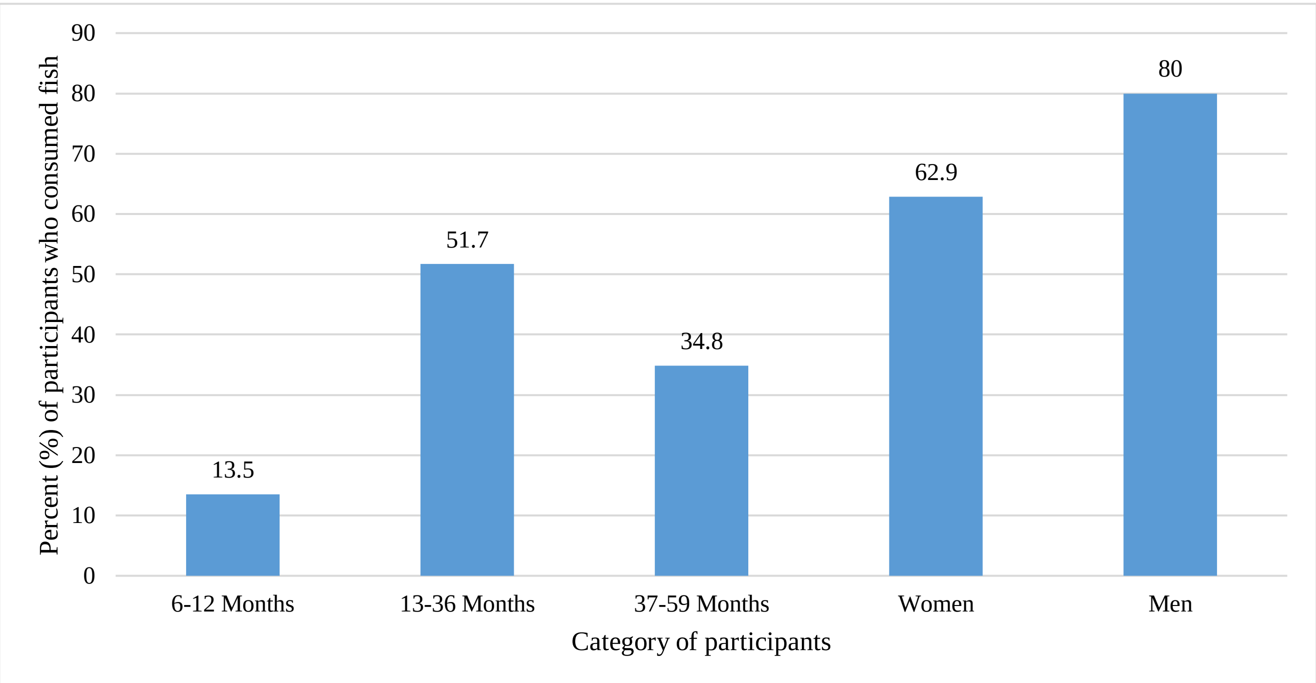
[3]ZMK – Zambian currency (Kwacha); Exchange rate 1USD = ZMK14.074

Consumption patterns of fish and other animal-source foods

Consumption data of fish and other animal-source foods was captured using a 24-hour dietary recall. It was established that 75.8% (n=100) of the households consumed fish.

The fish consumption patterns of participants were assessed for children (6–59 months), women of childbearing age, and men based on their dietary intake within the 24 hours preceding data collection. Overall, 67.4% (n = 89) of children consumed fish during this period. Among them, a smaller proportion (13.5%, n = 12) of children aged 6–12 months consumed fish compared to those aged 13–36 months (51.7%, n = 46) and 37–59 months (34.8%, n = 31). Among adults, 62.9% (n = 83) of women of childbearing age and 80.0% (n = 36) of men reported consuming fish, as illustrated in Figure 1.

Figure 1. The proportion of participants who consumed fish in 24 hours.



Values above bars indicate percentage of participants that consumed fish.

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Quantity of fish consumed by household members

The quantities of fish consumed by different household members within the 24-hour reference period are presented in Table 2. On average, older children aged 37–59 months consumed more fish (87.9 ± 45.7 g/day) compared to younger children aged 6–12 months (60.4 ± 35.2 g/day). Children aged 13–36 months had a mean consumption of 73.8 ± 51.0 g/day. The differences in mean fish intake among the three child age groups were statistically significant (p = 0.001). Among adults, the mean fish intake was 162.1 ± 86.0 g/day for women and 173.3 ± 70.0 g/day for men, with no statistically significant difference observed between the two groups (p = 0.278).

Table 2. Daily fish consumption among different age categories of participants.

Category of participants	Mean intake of fish (g/day)[1]	P-value[2]
6-12 months	60.4 ± 35.2	0.001
13-36 months	73.8 ± 51.0	
37-59 moths	87.9 ± 45.7	
Women (15-49 years)	162.1 ± 86.0	0.278
Men (18-64 years)	173.3 ± 70.0	

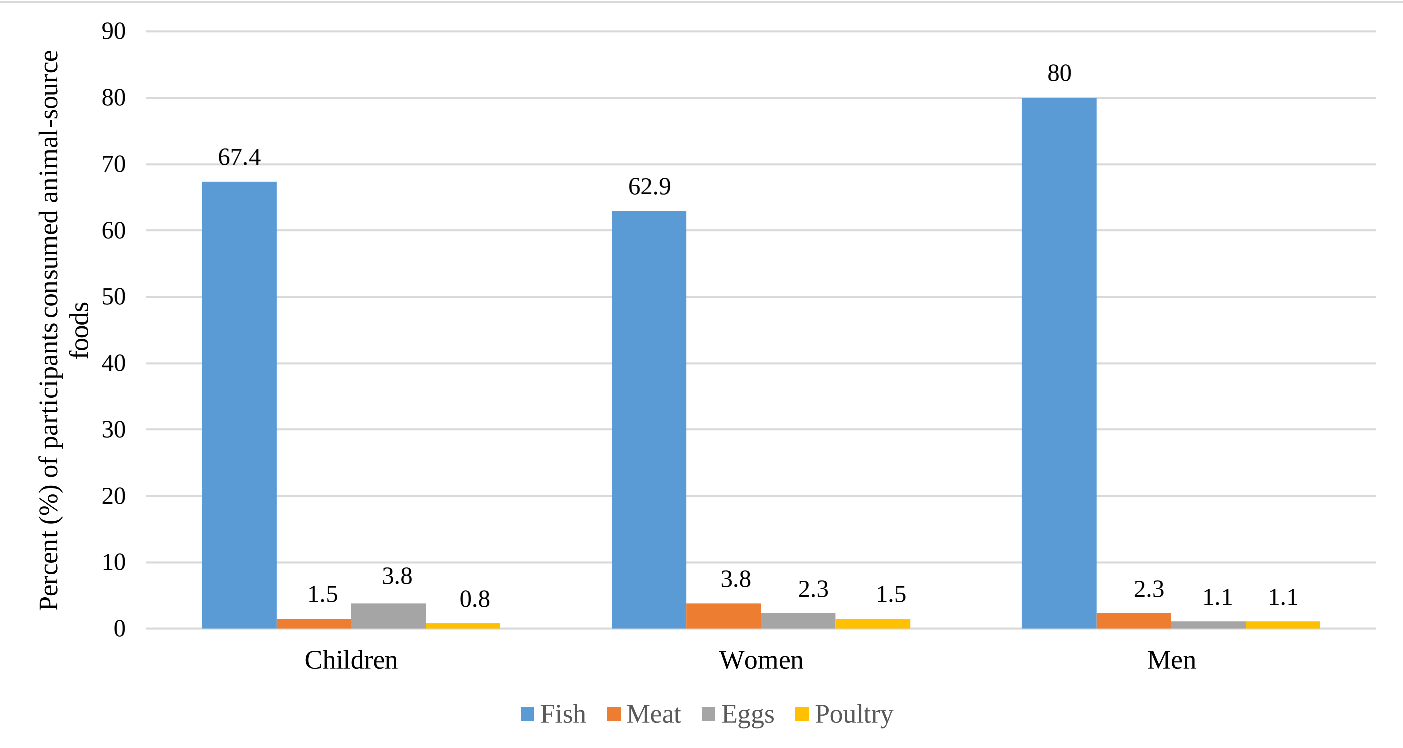
[1] Results are expressed as means ± standard deviation (SD) OR mean values ± standard deviation (SD)

[2] p-values from analysis of variance to establish differences in mean intakes among different age groups of children and an independent t-test to establish differences in mean intakes of men and women.

Consumption of fish and other animal-source foods

This study established that the most consumed animal-source food by participants in 24 hours was fish. A large proportion of men (80%) consumed fish, followed by children (67.4%) and women (62.9%). Generally, the proportion of participants who consumed eggs, meat and poultry were below 4% for all categories of participants (Figure 2).

Figure 2. Consumption of animal-source foods 24 hours prior to the interview by children, women, and men.



Values above bars indicate percentage of participants who consumed animal source foods.

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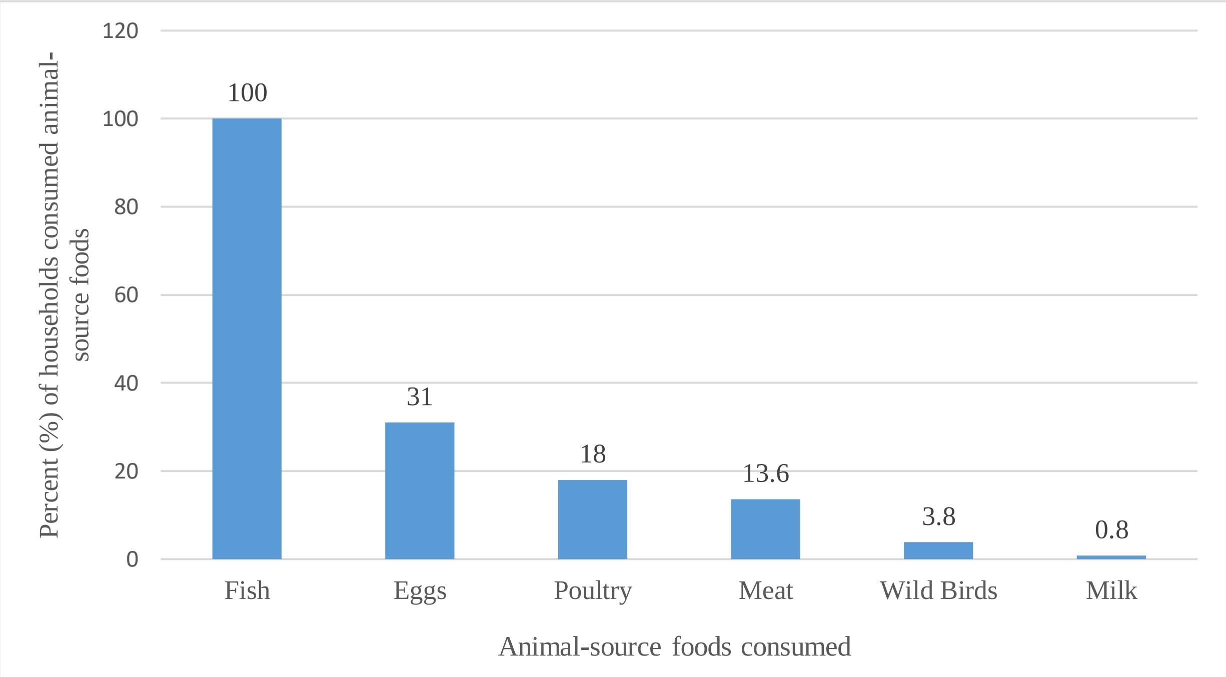
Frequency of consumption of fish and other animal-source foods

Data on the frequency of consumption of fish and other animal-source foods were collected using a food frequency questionnaire, focusing on household consumption within the seven days preceding the interview. Fish emerged as the most frequently consumed animal-source food. All surveyed households (100%, n = 132) reported having prepared and consumed fish during this period. Eggs were consumed by 31.0% (n = 41) of households, while other animal-source foods included poultry (18.0%, n = 24), beef (13.6%, n = 18), wild birds (3.8%, n = 5), and milk (0.8%, n = 1) (Figure 3).

Figure 3. Household fish consumption in relation to other **animal-source foods** 7 days prior to the interview.



Values above the bars indicate the percentage of households that consumed fish and other animal-source foods.

Data on fish consumption in relation to the method of processing and size showed that few households (2.3%, n=3) consumed small-sized fish more than once per day, which was the highest frequency of consumption reported (Table 3). The small fish consumed included Chisense (Stolothrissa miodon), Kapenta (Limnothrissa miodon), and Kasepa (Petrocephalus sims). Regardless of this category's low frequency of consumption per day, it had the largest proportion of households consuming fish in seven days, and this was mostly consumed as fresh.

For medium-sized fish, the highest consumption was three to four days, reported by 8.3% (n=11) households. Some types of fish consumed included Amatuku (Tilapia spermanii), Bomba (Clarias stampersii boulenger), Milonge (Clarias theodorae), Mintesa (Marcusenius macrolepidotus), Impende (Sargochromis giardii), and Polwe (Serranochromis Angusticeps). while for large-sized fish, the highest frequency of consumption was three to four days per week reported by 0.8% (n=1) households, Bomba (Clarias stampersii boulenger), Milonge (Clarias theodorae), Impende (Sargochromis giardii), and Polwe (Serranochromis Angusticeps) were the large-sized fish reported to be consumed.

Table 3. Frequency of fish consumption based on the size of fish and processing methods used.

Fish size	Every day more than once		Every day once a day		Three to four days		One to two days		Total	
	n	%	n	%	n	%	n	%	n	%
Fresh										
Small fish	3	2.3	3	2.3	23	17.4	56	42.4	85	64.4
Medium	1	0.8	0	0	11	8.3	37	28.0	83	62.0
Large	0	0	0	0	0	0	5	3.8	5	3.8
Sun-dried										

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Small fish	1	0.8	0	0	3	2.3	47	35.6	51	38.6
Medium	0	0	0	0	4	3.0	14	10.6	18	13.6
Large	0	0	0	0	1	0.8	2	1.5	3	2.3
Smoked										
Small	3	2.3	4	3.0	13	9.8	16	12.1	36	27.3
Medium	0	0	0	0	2	1.5	0	0	2	1.5

n-Number of households that consumed fish; % - corresponding percentage of households that consumed fish.

While on the frequency of consumption of other animal-source foods, the current study revealed that some households consumed these foods, such as eggs (27%, n=36) and poultry (16%, n=21), one or two days in the week before the interview. Very few households consumed meat (1%, n=1), eggs (3%, n=4), and poultry (1%, n=1) for three to four days within that same week. Overall, there was a low frequency of consumption of other animal-source foods.

Contribution of fish to the diets of study participants

Data obtained from the 24-hour recall revealed that the diets of the study participants were predominantly plant-based, with fish being the main animal-source food consumed. The food groups included roots and tubers, which comprised cassava tubers (81%, n=106) and sweet potatoes (25.3%, n=33), as well as vegetables such as cassava leaves (katapa) (60%, n=79), bean leaves (chimpapila) (20%, n=26), sweet potato leaves (kalembula) (24.5%, n=32), and pumpkin leaves (chibwabwa) (37.5%, n=50). Other vegetables included rape (17.5%, n=23), Chinese cabbage (Brassica rapa) (30%, n=40), and okra (13%, n=17). In the group of pulses, legumes, and nuts, the consumed foods included beans (35.1%, n=46), groundnuts (38.5%, n=51), and cowpeas (10.4%, n=14). Other groups included cereals, such as nshima from maize (43%, n=57), pumpkins (15.0%, n=20), fish (75.8%, n=100), eggs (3.8%, n=5), and meat and poultry (meat (2.3%, n=3) and chicken (1.5%, n=2)).

The foods described constituted the overall diets of household members and were used to calculate the mean intake of nutrients from the diets of children, women, and men (Table 4).

Table 4. Mean intake of nutrients[Y] from fish and other foods[X] among the study participants

Nutrients	Children				Adults		
	6-12 months	13-36 months	37-59 months	P[*] value	Women	Men	P value
Nutrient intake from fish consumed (based on 24-hour recall)							
Protein (g/day)[1]	10.4 ± 5.9 (2.4-17.6)	11.6 ± 5.8 (3.2-24.0)	13.2 ± 5.9 (4.0-24.0)	0.042	30.9 ± 16.5 (4.3-67.0)	41.3 ± 25.9 (10.7-134.0)	0.028
Iron (mg/day)[1]	1.0 ± 0.7 (0.1-2.2)	1.1 ± 0.9 (0.1-3.0)	1.2 ± 0.8 (0.1-3.0)	0.479	2.3 ± 1.6 (0.1-6.0)	2.8 ± 2.8 (0.3-12.0)	0.008
Calcium (mg/day)[1]	24.8 ± 18.1 (2.5-55.0)	28.0 ± 21.2 (2.5-75.0)	31.7 ± 18.8 (3.4-75.0)	0.544	56.1 ± 40.3 (3.4-150)	55.6 ± 38.1 (8.5-150.0)	0.919
Vitamin A (µg/day)[1]	4.6 ± 2.6 (1.0-7.7)	5.5 ± 3.3 (1.4-16.0)	7.0 ± 3.7 (1.8-17.7)	0.222	12.2 ± 6.9 (1.8-22.5)	14.4 ± 6.0 (4.5-27.5)	0.161
Nutrient intake from the entire diet (based on 24-hour recall)							
Protein g/day[2]	25.7 ± 21.1 (4.6-88.5)	25.5 ± 10.4 (1.6-55.5)	32.0 ± 21.0 (6.9-109.1)		64.7 ± 25.2 (25.7-170.1)	80.0 ± 34.3 (27.1-207.4)	
Iron mg/day[2]	6.8 ± 7.6 (1.7-32.4)	6.7 ± 2.5 (0.8-12.6)	7.5 ± 3.7 (2.6-17.6)		18.1 ± 5.9 (8.6-39.0)	19.7 ± 5.6 (10.7-35.9)	

Calcium mg/day[2]	91.4 ± 45.5 (30.8-206.5)	93.4 ± 57.0 (7.45-258.0)	99.7 ± 50.0 (40.3-214.3)	293.7 ± 230.9 (75.2-146.2)	234.9 ± 122.5 (64.9-673.9)
Vitamin A µg/day[2]	63.2 ± 56.0 (5.1-163.9)	64.2 ± 60.0 (3.9-199.6)	63.7 ± 69.0 (4.1-254.2)	170.2 ± 212.1 (2.4-1580.8)	139.5 ± 163 (10.7-677.8)

Results presented as means ± standard deviation (Range); [Y]grams / day; [X]Foods assessed.

[1]Nutrients in fish consumed based on 24-hour recall: [2]Nutrients in the entire diet.

[*]p-values from analysis of variance comparing mean intake in different age groups of children and independent t-test comparing mean intake of nutrients from fish among women and men.

Percentage Contribution of fish to diets of study participants

The percentage contribution of fish to the overall diets consumed by children, women, and men was analysed for proteins and selected micronutrients such as vitamin A, calcium, and iron, as these were reported to be inadequate in the diets of households in Northern Province (Alaofe et al., 2014). Due to differences in nutrient requirements, children aged 6-59 months were categorised into various age groups according to the WHO (World Health Organisation & Food and Agriculture Organisation of the United Nations, 2004), and the contribution was calculated for each age group. The contribution of fish to diets was assessed in terms of the selected nutrients.

Protein intake from fish was determined for all participant groups, revealing that among children, the mean protein intake from fish was higher in older children than in younger ones (Table 5). Among adults, men had a higher mean intake of protein from fish compared to women. The study observed a statistically significant difference in intake among different groups of children ($p = 0.042$) and among adults ($p = 0.028$). Fish contributed about 40% of the protein in the diets of children and women, while a 50% contribution was observed among men (Table 5).

Table 5. Percentage contribution of fish to diets in relation to overall diet consumed by study participants

Nutrient	Children								
	6-12 Months			13-36 Months			37-59 Months		
	Diet	Fish	% Contr	Diet	Fish	% Contr	Diet	Fish	% Contr
Protein g/day	25.7	10.4	40.9	25.5	11.6	45.5	32.7	13.2	40.3
Iron mg/day	6.8	1.0	14.7	6.7	1.1	16.4	7.5	1.2	16.0
Calcium mg/day	91.4	24.8	27.1	93.4	28.0	30.0	99.7	31.7	31.6
Vitamin A µg/day	63.2	4.6	7.3	64.2	5.5	8.7	63.7	7.0	11.0

	Adults					
	Women			Men		
	Diet	Fish	%Contr	Diet	Fish	contr
Protein g/day	64.7	30.9	47.8	80.0	41.3	51.6
Iron mg/day	18.1	2.3	12.7	19.7	2.8	14.2
Calcium mg/day	293.7	56.1	19.1	234.9	55.6	23.7
Vitamin A µg/day	170.2	12.2	7.1	139.5	14.4	10.3

[1]Contr- contribution; Contribution is equal to the mean nutrient consumed from fish divided by mean nutrient from diets multiplied by 100 (Roos et al., 2003) with modification.

Vitamin A intake increased with age among the children, with the lowest intake observed in those aged 6-12 months. Among adults, men had a higher vitamin A intake from fish than women (Table 5). Regardless of the differences in intake, no significant difference was observed among children ($p = 0.22$) and among adults ($p = 0.161$). The contribution of fish to dietary vitamin A also increased with age among children, with the highest contribution noted in the age group of 37-59 months. Among adults, the contribution of fish to vitamin A was lower in women than in men.

Calcium intake from fish was highest among children aged 37-59 months and lowest in the 6-12 month age group, similar to the pattern observed with other nutrients. Men and women had almost the same intake of calcium from fish (Table 5). Despite the variations in intake, the calcium intake was not significantly different among children ($p = 0.544$) or between men and women ($p = 0.919$). Further analysis indicated that the contribution of fish to calcium intake in children ranged from 27.1% to 31%, with the highest contribution in those aged 37-59 months. In adults, fish contributed more calcium to men's diets (23.7%) than to women's diets (19.1%) (Table 6).

Iron intake was nearly the same among children aged 6-12 months and those in the 13-36 month category. In adults, the intake among women was lower than that among men (Table 5). There was no significant difference in iron intake among children ($p = 0.479$), while a significant difference was observed between men and women in adults ($p = 0.008$). The contribution of fish to dietary iron was lowest among children aged 6-12 months, while in older children, the percentage contribution was similar. In adults, fish contributed more iron to men's diets than to women's diets (Table 6).

Micronutrient contribution of diets to the Recommended Nutrient Intake (RNI) among study participants

The study further examined how the diets consumed by participants contributed to the RNI in terms of micronutrients, specifically vitamin A, calcium, and iron. The contribution of diets to the RNI in children was low for vitamin A and calcium; however, for iron, the dietary intake exceeded the RNI for all age groups of children (Table 7).

Among adults, the nutrient contribution of diets to the RNI was low for calcium and vitamin A, although variations were observed in vitamin A, with contributions exceeding 50% in women and approaching 50% in men. The dietary contribution of iron in women was close to meeting the recommended intake, while in men, it exceeded the RNI (Table 6).

Table 6. Mean intakes of Micronutrients and their contribution to RNI*

Nutrients	Children								
	6-12 Months			13-36 Months			37-59 Months		
	Diet	RNI	% Contr[1]	Diet	RNI	% Contr	Diet	RNI	% Contr
Vitamin A µg/day	63.2	190	33.3	64.2	200	32.1	63.7	200	31.8
Calcium mg/day	91.4	400	22.9	93.4	500	18.7	99.7	600	16.6
Iron mg/day	6.8	6.2	109.7	6.7	3.9	171.8	7.5	4.2	178.5

	Adults					
	Women			Men		
	Diet	RNI	% Contr	Diet	RNI	% Contr
Vitamin A µg/day	170.2	270	63.0	139.5	300	46.5
Calcium mg/day	293.7	1000	29.4	234.9	1000	23.5
Iron mg/day	18.1	19.6	92.3	19.7	9.1	216

RNI*=Recommended Nutrient Intake, % Contr[1] = Contribution to RNI, NCR = the intake of a nutrient from

diet divided FAO/WHO recommended intake multiply by 100 (Roos et al., 2003)

Limitations of this study

This study has limitations that should be acknowledged. First, the cross-sectional design provides a snapshot of dietary patterns at a single point in time, thereby constraining the ability to establish causal relationships between fish consumption and nutritional outcomes. Second, the study was conducted within one ward (Ibale), which may limit the generalizability of the findings to the wider Luwingu District. Finally, the Zambian Food Composition Tables contained insufficient data on the nutrient composition of certain locally available foods, necessitating the use of the West African Food Composition Tables, which offer more comprehensive nutrient information on similar foods.

DISCUSSION

This study aimed to assess fish consumption patterns and the contribution of fish to household diets in a rural setting in Zambia. The findings indicated that fish plays a critical role in the diets of rural households in Zambia. This was evident from the 24-hour dietary recall and 7-day food frequency recall data. The data showed that 75.8% of households consumed fish within 24 hours prior to the interview, and all (100%) households surveyed consumed fish at least once within the 7 days prior to the interview. Similar studies were conducted in urban Lusaka, Zambia, Ghana, and Malawi by Marinda et al. (2018), Bandoh & Kenu (2017), and Mlauzi & Mzengereza (2017), respectively, reported that 81%, 78%, and more than 50% of households consumed fish within 24 hours before data collection.

The quantitative estimates of fish consumption by household members revealed that among children, the quantities consumed increased with age. The lowest consumption was observed in children aged 6-12 months, which may be attributed to the fact that children in this age group are not often fed fish due to concerns about bones, which are a choking hazard compared to older children (Marinda et al., 2018). It is worth noting that most households interviewed in the present study showed a higher frequency of consumption of small-sized fish (which are often eaten whole, including both flesh and bones), posing a potential danger to smaller children. Interestingly, a relationship between an increase in age with increased fish consumption was observed. This may be because as children grow older, they become more aware of the potential dangers posed by bony fish. Generally, children aged 6-12 months tend to consume smaller quantities of food (Gibson et al., 2010), resulting in lower amounts of food as seen in this study. Additionally, most children in this age group are still breast-fed and are just beginning to be introduced to newer and easier-to-digest foods. A related study conducted in Bangladesh confirmed the trend of reduced food consumption in this age group (Thorne-Lyman et al., 2017).

This current study also revealed that men consumed more fish compared to other participants. These findings are in line with the study conducted by Marinda et al. (2018), which revealed that men, in urban Lusaka, consumed more fish (110.3 g/day) than women (91.4 g/day). This disparity in consumption patterns was also observed in a study by Gomna and Rana (2007) in Nigeria, which revealed that male household heads consumed larger quantities of fish compared to their wives and children. Gomna and Rana further explained that when a single fish was shared, there was a tendency to apportion the fish body to the men, the tail to their wives, and the head to the children.

The skewed fish consumption pattern towards men, compared to other household members, may be attributed to the social structure common in African rural areas. In these settings, men are often given larger quantities of food because they are heads of households and engage in manual labour, which requires more energy. This practice occurs at the expense of children and women of reproductive age, who are more vulnerable to nutrient deficiencies due to physiological changes and increased nutrient requirements. Although this was not investigated in the present study, it may explain the proportional disparity seen among rural households in Luwingu between men and other household members.

Children aged 24-59 months consumed more fish (49.0 g/day) than those aged 6-24 months (36.9 g/day). However, the study by Marinda et al. (2028) reported lower quantities consumed by participants compared to the present study, confirming that rural households consumed more fish than urban households (Hichaambwa, 2012). This could be attributed to the proximity to water bodies in Luwingu, which made fish more accessible than in urban Lusaka.

In the current study, fish consumption was compared with other animal-source foods consumed 24 hours prior to the interview, revealing that fish was the most consumed animal-source food among household members in rural Luwingu. These findings are consistent with the National Nutrition Surveillance survey in Zambia conducted by the NFNC, which established that fish was the most consumed animal-source food nationwide (41%) in the 24 hours prior to data collection (NFNC, 2009). Another related study conducted in Indonesia by Gibson et al. (2020) revealed that fish was the most consumed animal-source food, with approximately 90% of women consuming fish 24 hours prior to data collection.

The study found that fresh fish was the most consumed form of fish by households, compared to processed or preserved fish. Regarding the size of fish consumed, small-sized fish were the most frequently consumed by households, followed by medium-sized fish, while large-sized fish were the least consumed. In a related study Genschick et al. (2018) found that small fish were the most consumed in Zambian urban areas.

Among the small-sized fish, the current study also revealed that most consumed small fish were fresh in contrast to the study by Genschick et al., (2018) which established that sun-dried small fish were the most consumed in urban Lusaka, Zambia. It is worth noting that households in Luwingu are located close to water bodies, which allows them easier access to small fresh fish compared to households in Lusaka. However, transporting fresh fish to urban areas requires refrigeration and reliable transport systems. As a result, it is often more profitable to extend the shelf life of small fish through methods such as sun-drying, smoking, or other preservation techniques before transporting them to urban centres, including Lusaka, which are far from the water bodies. Typically, micronutrients are concentrated in bones and viscera, so the consumption of whole small fish plays a critical role in micronutrient intake. Small fish are also affordable and can be evenly divided among household members (Kawarazuka & Béné, 2011; Nölle et al., 2020).

This study further established the proportion of households consuming fish in relation to other animal-source foods seven days prior to the interview. The findings revealed that fish was the most frequently consumed animal-source food by households, followed by eggs, while meat and poultry were the least consumed. Other animal-source foods included wild birds and milk. The seven-day frequency of consumption findings are consistent with the 24-hour recall data, where fish was the most consumed animal-source food, followed by eggs, and meat and poultry were the least consumed. In related studies conducted by Roos et al., (2003), Mlauzi & Mzengereza, (2017) and Gibson et al., (2020) established that fish had the highest frequency of consumption compared to other animal-source foods in Bangladesh, Malawi and Indonesia, respectively.

The present study also determined the intake and contribution of fish to diets in terms of selected micronutrients (vitamin A, calcium, and iron) and proteins. Variations in micronutrient intake were observed, increasing with age among the children. Regardless of these variations, there were no statistically significant differences in the intake of all selected micronutrients among children based on their age categories; however, notable differences were observed in protein intake among the children.

In adults, variations were observed between men and women. A significant statistical difference in intake was found for proteins and iron, while no significant difference was observed for vitamin A and calcium between men and women. Therefore, the large quantities of fish consumed by men translated into higher nutrient intakes for proteins and iron.

Apart from the consumption of animal-source foods, especially fish, the current study also found that more households were consuming dark green leafy vegetables, which are good sources of pro-vitamin A carotenoids such as β-carotene. Cassava tubers were predominantly consumed and therefore provided a significant amount of calcium and iron as these are high in cassava (Bayata, 2019). Other foods that contributed to proteins and micronutrients included soya beans, beans, and sweet potatoes.

Considering the contribution of fish to diets, this study further revealed that fish contributed more to diets in terms of proteins and calcium while the lowest contribution was observed in iron and vitamin A across all study participants. Studies conducted by Bogard et al. (2015) and Roos et al. (2003) revealed that calcium, vitamin A, and iron were much higher in fish, which serves as an important source of vitamin A and calcium. Kawarazuka & Béné (2011) also established that fish was the major source of micronutrients and, therefore, it could contribute significantly to diets.

Furthermore, this study established a low contribution of diets to the RNI for the selected micronutrients (vitamin A and calcium), except for iron, which exceeded the RNI in most participants. Although iron intake exceeded the RNI, the district has higher levels of anaemia, which may be attributed to the largest contribution of iron from plant sources (non-heme iron), which is less bioavailable to the body compared to the heme iron found in animal-source foods, which is well absorbed (Kawarazuka & Béné, 2010). Another reason could be that anaemia is also caused by infectious diseases such as malaria (Ncogo et al., 2017).

The diets of the participants did not meet the recommended intake for vitamin A and calcium, similar to the study conducted in the Northern Province of Zambia by Alaofe et al. (2014) which revealed that household diets in the Northern Province were deficient in vitamin A and calcium. This predisposes children and women to nutrient deficiencies and low height for age (stunting), which has a positive relationship with fish consumption among children aged 6-23 months (Marinda et al., 2018). On the contrary, infants may have met their recommended nutrient intake through breast milk, which was not captured in the current study, although the iron content in breast milk is low at the complementary food stage (Gibson et al., 2010).

CONCLUSION

This study established that fish is an important part of the diets of most households in rural communities of Ibale ward in Luwingu district, Zambia. It is also the most consumed animal-source food compared to other animal-source foods. Small fish species are the most consumed in this region. Fish contributes significantly to the much-needed micronutrients and proteins from animal-source foods, especially for children aged 6-59 months and women of reproductive age. However, its contribution to the recommended nutrient intake (RNI) is low in terms of vitamin A and calcium. The high proportion of households consuming fish and its role in the diets of rural communities clearly indicates its importance. Therefore, fish consumption should be actively promoted not only as a good source of protein, but also as a rich source of vitamin A and minerals. This will enhance food security among fish-consuming households and ultimately reduce micronutrient deficiencies in Luwingu district and other similar rural areas.

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DECLARATION OF INTEREST

The authors declare no competing interest regarding the publication of this manuscript. All authors have reviewed and approved the final manuscript and affirm that there are no known conflicts of interest associated with this publication.

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