



Fish consumption patterns and diets of rural and urban Nigerians

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We have a global presence across 20 countries in Asia, Africa and the Pacific with 460 staff of 30 nationalities deployed where the greatest sustainable development challenges can be addressed through holistic aquatic food systems solutions.

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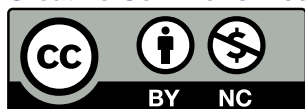
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List of acronyms

LGA	Local government areas
USAID	The United States Agency for International Development
UNICEF	The United Nations Children's Fund
CDC	The Centers for Disease Control and Prevention of the United States
MPI	Multidimensional poverty index
NHREC	National Health Research Ethics Committee of Nigeria
ODK tool	Open data kit tool
PCA	Principal component analysis
FAO	Food and Agriculture Organization of the United Nations
WHO	World Health Organization
FGD	Focus group discussion
MDD	Minimum dietary diversity

Key Messages

Fish is the most commonly consumed animal-source food in Nigeria, thus supply must be maintained to keep pace with population growth, and consumption must be encouraged, especially to crowd out low-nutrient, processed foods.

- Among women and children, fish is the most consumed animal-source food across all wealth quintiles of the surveyed households.
- Catfish, followed by Mackerel, were the most commonly consumed fish by pregnant and lactating women, and children under two – highlighting the importance of these species to the first 1,000 day critical period of growth. Crayfish was the third most consumed fish across all three life stages.
- The consumption of highly-processed snack foods and sugary beverages is high across all sub-categories of women and children – this is concerning as Nigeria moves through the nutrition transition and faces more burdens of malnutrition.

Catfish, mackerel, crayfish, and tilapia are all important fish to the Nigerian diet, but improvements could be made on diversity of consumption of fish types, particularly in the Northern states.

- Among all households, Catfish, in various forms, ranked as a highly consumed fish in all sub-categories.
- Crayfish, a nutrient-dense aquatic food was a commonly consumed fish in Southern households, but not among Northern households.
- Tilapia is a relatively more important fish for diets in households in the North.
- Mackerel, an imported marine pelagic fish, is a highly consumed fish in the Southern lower wealth households. The supply chain of this important fish for lower wealth households is likely to be disrupted by the COVID-19 pandemic, and thus the quality of the diets in these households may suffer.
- Households reported consuming most of the parts of the fish, thus the micronutrient contribution of fish to these diets extends beyond the nutritional quality of the fish flesh.

Reported access to fish in markets is high across households, but access needs to be improved in the Northern states, where malnutrition is the highest.

- Many households claimed that they can access fish/seafood 'always' or 'most of time.' The lowest access was reported in the lower wealth households in the rural Northern States, where only 50% of respondents reported access to fish/seafood 'always' or 'most of the time.'

Households spent more of their animal-source food budget on fish than meat, eggs, dairy, and pork. This trend should be preserved as incomes rise, as the production of fish is more environmentally-friendly than the production of red meat.

- Spending on fish made up 40% of the household spending on animal-source foods, and households spent an average of 295 Naira (0.76 USD) per person per week on fish.

Campaigns educating consumers about the safety of farmed fish are needed as aquaculture expands.

- Households reported a good trust in the fish in markets in the quantitative survey, but food safety concerns regarding farmed fish arose in focus group discussions.

A note on COVID-19

This study was designed, and data were collected in 2019, prior to the COVID-19 pandemic. However, the data were analyzed, and the report was written, in the midst of the pandemic. Thus, the findings in this report attempt to consider the rapidly changing environment due to COVID-19, but this was done in a post-hoc manner. However, we believe the findings give a relevant pre-COVID-19 picture and provide a useful starting point for considering how the food system will change in response to COVID-19.

Background

Nigeria is a country highly reliant on marine and inland fish for economic activity and food and nutrition security (Kolding, Van Zwieten, Marttin, & Poulain, 2019; Selig et al., 2018), while aquaculture is a growing sector. Nigerians consume fish fairly frequently (IPSOS, 2017), but less is known about the role of fish in individual diets, the types of fish, and the forms of fish consumed in different regions.

Though fish consumption is frequent, the burdens of malnutrition remain high in Nigeria (National Population Commission, 2019). The average rate of childhood stunting is 37%, but this average obfuscates a large degree of variation between states (Kinyoki et al., 2020). Anemia was recently found to afflict 68% of infants and children, and 58% of women of reproductive age, though not all cases of anemia are attributable to nutrient deficiencies (Byrd et al., 2018). However, many fish are a rich source of bioavailable iron, providing an important food for addressing the nutritional determinants of anemia (Byrd, Thilsted, & Fiorella, 2020)

There is some evidence that Nigerians do not consume *enough* fish. While the Global Burden of Disease study does not make a recommendation for fish per se, experts do recommend that people consume omega-3 fatty acids daily, and a common source of omega-3s is fatty acid is fish. Current estimates of the Nigerian diet indicate that the adult population falls short of this recommendation (The Global Nutrition Report Stakeholder's group, 2020). It is unclear if this estimate is due to an underestimation of the omega 3 fatty acids in the current fish supply, as the nutrient content is missing for some key fish species (Bradley et al., 2020), or if people really are consuming inadequate omega-3s. However, the estimate does provide an indicator that while Nigerians consume fish frequently, the amount could be increased to improve nutrition outcomes.

Given that fish is an accepted food in Nigeria, promoting both continued and increased consumption may contribute to reducing the burdens of malnutrition Nigeria is currently facing. Fish and other aquatic foods are the most nutrient dense food group after vegetables (Beal, Massiot, Arsenault, Smith, & Hijmans, 2017), and the nutrients in fish are highly bioavailable (Michaelsen et al., 2009). The COVID-19 pandemic has the potential to push more people into food insecurity, due to economic downturns and supply chain disruptions (High Level Panel of Experts on Food Security and Nutrition (HLPE), 2020). Understanding what fish people are commonly consuming, and the source of those fish, will be key to mitigating rising food insecurity in a post-COVID world.

This study is intended to bridge the gap between previous studies of consumer patterns, such as the study conducted recently in two seasons (IPSOS, 2017) and the national nutrition study funded by the Bill & Melinda Gates Foundation (BMGF), the United States Agency for International Development (USAID), the United Nations Children's Fund (UNICEF), and the Centers for Disease Control and Prevention of the United States (CDC) that is currently

underway. Neither of these studies had a focus on fish and aquatic foods, and details about regional and individual fish consumption in Nigeria are lacking. We conducted this survey to determine regional patterns of fish consumption, the role fish play in the overall diet of Nigerians, and the potential of fish production in improving the overall quality of diets.

Methodology

Study design

We conducted a cross-sectional survey of Nigerian consumers as a part of a larger scoping study of Nigeria, which included an aquaculture system performance survey, and a value chain survey. In consultation with stakeholders, including local and federal level government officials and researchers at local universities, we selected nine states for the survey, representing diverse agro-ecological zones and Local Government Areas (LGAs), listed in Table 1. We selected eight Nigerian states for the survey by employing a set of criteria which consisted of: i) the number of operational aquaculture farms in each state, ii) allowable access to the state considering security issues, iii) poverty level as expressed by Multidimensional Poverty Index (MPI), and iv) by considering the prevalence of stunting in each of the states. Regional representation was also considered when finalizing the states for the surveys. An additional state, Kebbi, was chosen for the consumer survey due to the high prevalence of stunting.

Within each state, a set of rural and urban LGAs were selected for the household survey to maintain a balanced cross-section of rural and urban. Rural households were defined as living in communities in LGAs with little to no modern infrastructures, did not have a clinic or post office (i.e., had to rely on neighboring towns or villages for such amenities), and were mainly agricultural. The households in each LGA were selected using snowball sampling, within the sampling frame. The sampling frame included 16 aquaculture households, 10-20 households with pregnant women, and 40 households with children under five, which added up to a total of approximately 80 households per state (Table 1). No income criteria were included to give a full cross-section of incomes/wealth in Nigeria. These data cannot be considered nationally representative as we oversampled aquaculture households, households with young children, and households with pregnant and lactating women. Nevertheless, the data provide a useful characterization of fish consumption patterns and how aquaculture might positively influence fish consumption in Nigeria.

To measure household consumption and purchasing patterns, we asked the member of the household responsible for shopping and preparing meals about the species of fish consumed by the household, and the form in which the fish was purchased.

Ethical approval for this study was provided by the National Health Research Ethics Committee of Nigeria (NHREC), approval number NHREC/01/01/2007-24/06/2019.

Data collection

Data collection was conducted between the months of August – October 2019, which is when most of Nigeria is reaching the end of the rainy season and approaching the lean season. The household survey was co-designed with Nigerian stakeholders, including university professors and aquaculture producers. The survey questionnaire was programmed into KoBo toolbox for electronic data collection. In June of 2019, the study team was trained on the household survey administration, principles of quantitative and qualitative data collection, and on the use of mobile phone tablets for data collection. The pre-designed surveys and tools used for the training was piloted and tested in one week in a non-study LGA for the enumerators to gain confidence with the survey. Prior to the commencement of the piloting, a WhatsApp group was formed to facilitate communication with the lead scientists and the data collection teams. Debriefing meetings were held which allowed us to address any aberrations in the data collection, or any concerns from the field teams. Piloting the survey also provided useful information for refining the questionnaire. A professor from a Nigerian university oversaw actual data collection in each state. The team of trained enumerators conducted computer-assisted personal interviews (CAPI), which commenced in August and completed in October 2019.

Data were collected at the household and intra-household level. A household was defined as people who for the 6 months preceding the interview normally lived in the same residence, ate together, and recognized the same head. The woman head of household was considered the primary respondent, while the male head of household was also interviewed for a subsection of questions if he was available. A spouse or child that is based elsewhere (for work or school) was included in the household roster.

Data quality control was carried out by the lead author. Enumerators uploaded (electronically to a password-protected server) completed questionnaires at the end of each day (or when internet became available) and the data were downloaded weekly for review. Any discrepancies were resolved, and the lead author provided written feedback to the teams for the first month of data collection.

State	No. of Households	Agro-ecological zone	LGAs selected for consumer survey
Ogun	97	South-West	Aboekuta South, Odeda, Ijebu ode
Oyo	97	South-West	Oyo East, Lagelu
Niger	92	North- Central	Bosso, Paikoro
Delta	81	South-South	Oshimili South, Isoko South
Rivers	82	South-South	Ikwere, Obio/Akpor
Anambra	87	South-East	Idemili North, Nnewi North
Kano	80	North-West	Kura, Kumbotso
Lagos	79	South-West	Ikeja, Badagry
Kebbi	80	North-West	Arugungu, Dando, Aliero, Maiyama, Yauri, Wasagu/Danko
Total	765		

Table 1. List of Nigerian States included in this study.

Quantitative data analysis

Once the final dataset was obtained, data were cleaned and checked for abnormalities. Continuous variables were checked for normality and transformed into interval variables if necessary. Outliers were set to missing if the value was implausible.

Wealth was calculated using principal component analysis (PCA), relying on questions from the Simple Poverty Scorecard for Nigeria (Schreiner, 2015). The components of the PCA consisted of household source of cooking fuel, household floor materials, drinking water source, access to electricity, type of toilet, and the number of rooms, televisions, mattresses, and mobile phones owned by the household. From this index the sample was divided into five wealth quintiles, with one being the poorest, and five being the richest. A score of 1 in the wealth quintile indicates the household is likely to live in poverty.

To investigate patterns of fish consumption by household wealth, we present the households in the 'lower wealth' and 'higher wealth' categories based on the principal component analysis. If a household was within quintile one or two, we categorized that household as lower wealth. If the household was within quintile three, four, or five, we categorized that house as higher wealth. Minimum dietary diversity for women was calculated according to the most recent FAO guidelines (FAO & FHI 360, 2016), and child dietary diversity was calculated using the most recent WHO guidelines, which includes breastmilk as a food group (World Health Organization, 2014).

Data analysis was conducted using Stata 14.

Qualitative data collection

Focus group discussions (FGD) guides were developed in English with Nigerian colleagues, and pilot-tested in the nearby community. Questions which were confusing or misleading were re-written.

FGDs were conducted in the states listed in Table 2. Sixteen FGDs were conducted with the four FGDs in each state including one with urban men, urban women, rural men, and rural women separately.

State	Agro-Ecological Zone	No. of FGDs
Kano	North-west	4
Oyo	South-west	4
Anambra	South-east	4
Rivers	South-south	4
Total	16	5

Table 2. Geographic distribution of focus groups discussions (FGDs).

A trained Nigerian main facilitator was assisted by a note-taker to conduct the FGDs. The FGDs were recorded and were transcribed within 24 hours of the interview. The transcriptions were then translated in English within one week of the interview and sent to the research assistant. A debrief meeting on the transcription was held remotely for any questions and clarifications needed on the translation of the FGD. The transcriptions were then coded into themes and salient quotes were recorded.

Quantitative Results

Findings below in Table 3 are presented for 700 households, as 65 households were excluded where the survey time was less than 30 minutes, rendering the data untrustworthy.

Variable	
Households (n)	700
Northern households (n)	243 (35% of 700)
Rural households (n)	315 (45% of 700)
Men (n)	560
Women (n)	700
Children under 6-23 months (n)	295
Education level of the household head	
Completed primary school or less	15%
Partial or completed secondary school	48%
Greater than secondary school	37%
Average household size, mean (SD)	
Average rural household size	5.6 (2.3)
Average urban household size	5.0 (2.1)
Christian households	52%
Muslim households	48%
Occupation of the head of household (percent of sample)	
Aquaculture	17
Other farming	12
Skilled salaried employment	20
Unskilled salaried employment	7
Petty trading and services	16
Pension	2
Wholesale/retail trade	11
Manufacturing	7
Fisherfolk	2
Other	6

Table 3. Household characteristics in the surveyed areas.

Fish consumption and spending among households in Nigeria

We found high rates of consumption of fish in the households in all nine States. The majority (92%) of households reported consuming fish in the previous seven days, and this was consistent across all wealth quintiles.

To estimate the amount of fish purchased for the household in the previous seven days, respondents were asked about spending on fish, in addition to other animal-source foods (Table 4).

Money spent in past seven days on: median (Q1, Q3) ¹	Naira (₦)	US Dollars ²
Meat	1200 (500, 2,000)	3.10 (1.30, 5.18)
Eggs	400 (200, 580)	1.04 (0.52, 1.50)
Milk	450 (200, 800)	1.17 (0.52, 2.07)
Fish	1565 (1,000, 2,600)	4.05 (2.59, 6.73)

¹ The spending variables were not normally distributed so the medians, quartile 1 (Q1) and quartile 3 (Q3) are presented

² Exchange rate used was 1 USD =386.1 Naira

Table 4. Spending on animal-source foods in the previous seven days.

In the previous seven days, households spent more on fish than meat, eggs, and milk, which is in line with the consumption figures. The median amount spent on fish represents 40% of the total budget spent on animal-source foods. This estimate is close to that reported in literature (e.g., Liverpool-Tasie et al., 2021). Given that the median spending on fish is 1,565 Naira, and the average household size of our survey is 5.3, Nigerians spend an average of 295 Naira (0.75 USD) on fish per person per week.

From this dataset, the calculation of spending on each fish separately is not possible, however it does allow for the analysis of expenditure of the 102 households who purchased only Catfish in the previous seven days. Table 5 shows the average spending broken down by the three forms of purchased Catfish.

Money spent in past seven days on: median (Q1, Q3)	Naira (₦) ¹	US Dollars
Fresh Catfish (n = 48)	2,000 (1,500, 3,250)	5.18 (3.89, 8.42)
Dried Catfish (n = 20)	1,100 (1,000, 1,700)	2.85 (2.59, 4.40)
Smoked Catfish (n = 33)	2,000 (1,000, 2,500)	5.18 (2.59, 6.48)

¹The spending variables were not normally distributed so the medians, quartile 1 (Q1) and quartile 3 (Q3) are presented

Table 5. Spending in the previous seven days on Catfish (102 households reported purchasing only Catfish).

The average household size of the Catfish-only purchasing households was 5.8 people. Considering a median amount of 2,000 Naira in the previous seven days, it was calculated that each person in the household had a serving of fresh or smoked catfish worth approximately 354 Naira (USD 0.91) over the previous week. Based on price data observed during the study period of approximately 600 Naira/kg of fresh Catfish, and 4,000 Naira/kg of smoked catfish, these expenditures translate into 0.6 kgs (600 grams) of fresh catfish and 0.08 kgs (80 grams) of smoked catfish per person over the course of the week. For dried Catfish, household members consumed an average a serving worth 190 Naira over the previous week (price data for dried catfish was not collected). However, these weights are inclusive of the inedible parts, such as bones and intestines. Thus, using the edible conversion factor from the west Africa food composition table of 0.52, we estimate that household members consume approximately 300 grams of catfish over the course of the week, or a median of 43 grams per day. (cite west African food composition table).

Of the households who reported purchasing only Tilapia in the previous seven days (n = 17), the average amount spent on fish was 1,411 Naira, or 3.66 US dollars. The average household size of this group was seven, and thus an average person in the household had consumed 201 Naira (USD 0.51) worth of Tilapia over the previous week, in fresh, dried, and smoked forms. Using the price of 720 Naira/kg observed during the survey period for fresh tilapia, the serving size per person per week can be estimated at 0.28 kgs (280 grams), inclusive of inedible parts. Thus, based on an edible conversion factor of 0.65, the median amount consumed per person per day of households purchasing tilapia is 24.8 grams.

Among the households who reported purchasing only Mackerel (n = 48), 36 of those fish were purchased fresh (assumed thawed from a frozen state). We report that the median (Q1, Q3) amount spent on fresh Mackerel was 1,000 (700, 1,750) Naira, or 2.56 (1.79, 4.48) US dollars. These households were five in size on average, meaning that an average person had likely consumed 200 Naira worth of mackerel over the previous week. Using observed price data of 600 Naira/kg of mackerel, this translates into 0.33 kg (330 grams) per person over the previous

week, inclusive of inedible parts. Again using the edible conversion ratio for Mackerel of 0.71, the median serving size per person is 33.5.

Considering the 36 households who purchased only saltwater Sardines in the previous seven days, the average amount spent was 1,605 Naira, or 4.10 US dollars. The average household size was 9, indicating that an average person in the household had consumed 178 Naira worth of saltwater Sardines in the past seven days. Thirteen households reported purchasing fresh, and spent an average of 1,481 Naira or 3.78 USD, and 12 reported purchasing already fried Sardines, spending an average of 1,617 Naira, or 4.13 USD per household. Price data was not collected on saltwater Sardines, and thus cost-portions per week cannot be estimated.

Overall, if households purchase non-Catfish, they spend approximately 200 Naira (approximately 0.51 USD) per person per week on non-Catfish, and if they purchase fresh or smoked Catfish, they spend 354 Naira (0.91 USD) per person per week.

Fish consumption and purchasing patterns by state

The following sections break down the household consumption and purchasing patterns by region (Northern and Southern), and by wealth groups.

Southern households - Lower wealth, rural

The 75 lower wealth rural households surveyed in the South, reported consuming at least 22 diverse fish species and aquatic animals during the previous week of the survey (Figure 1). Mackerel was the most consumed fish, which is an imported fish – highlighting the dependence of Nigerian households on fish imports. However, the second most consumed was Catfish, a fish that is cultured in Nigeria, and Crayfish, a small indigenous species rich in micronutrients. Both Catfish and Crayfish made up 17% each of all the fish reported.

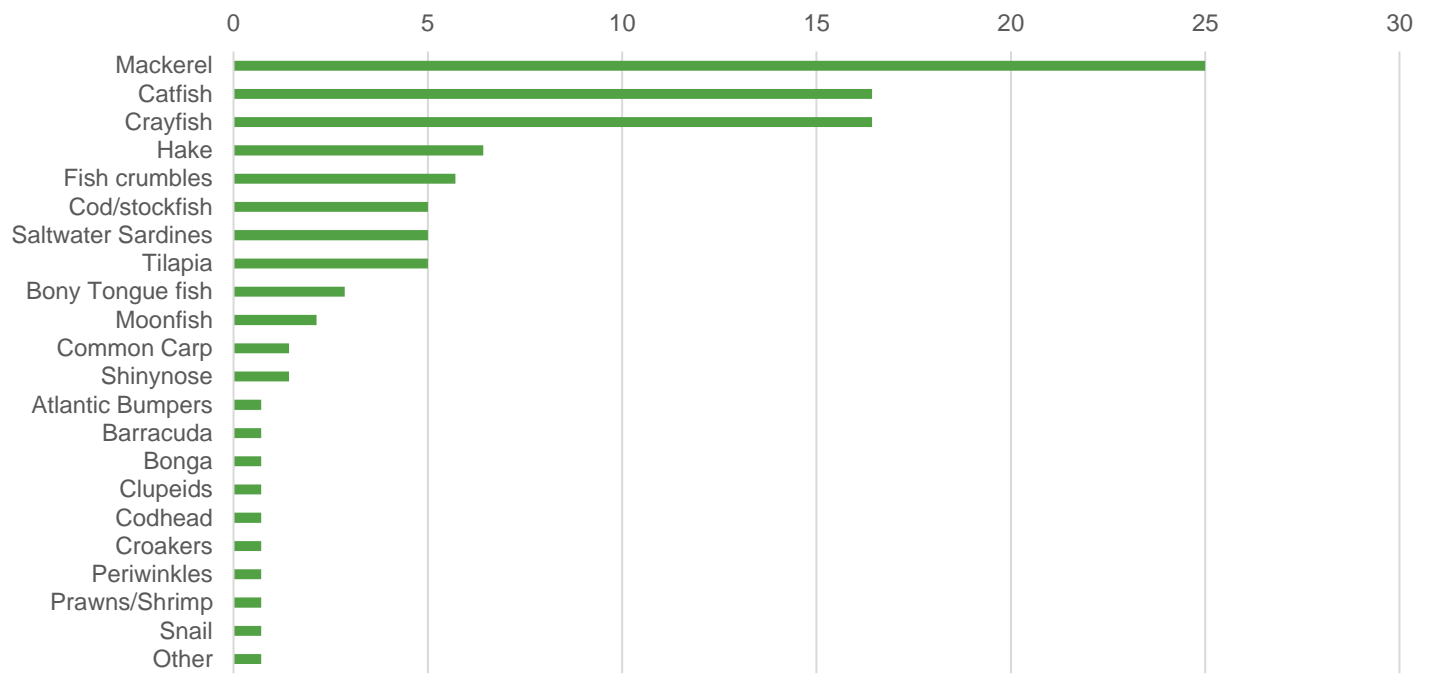


Figure 1. The frequency (%) of fish/aquatic animals consumed by lower wealth rural households in the South, in the previous seven days (n = 75 households).

In the 75 lower wealth rural households surveyed in the South, fresh fish was the most common form of fish purchased, followed by dried (Figure 2). The most common fresh fish purchased were Catfish and Mackerel, while Crayfish was the most common dried fish (supplementary appendix A1).

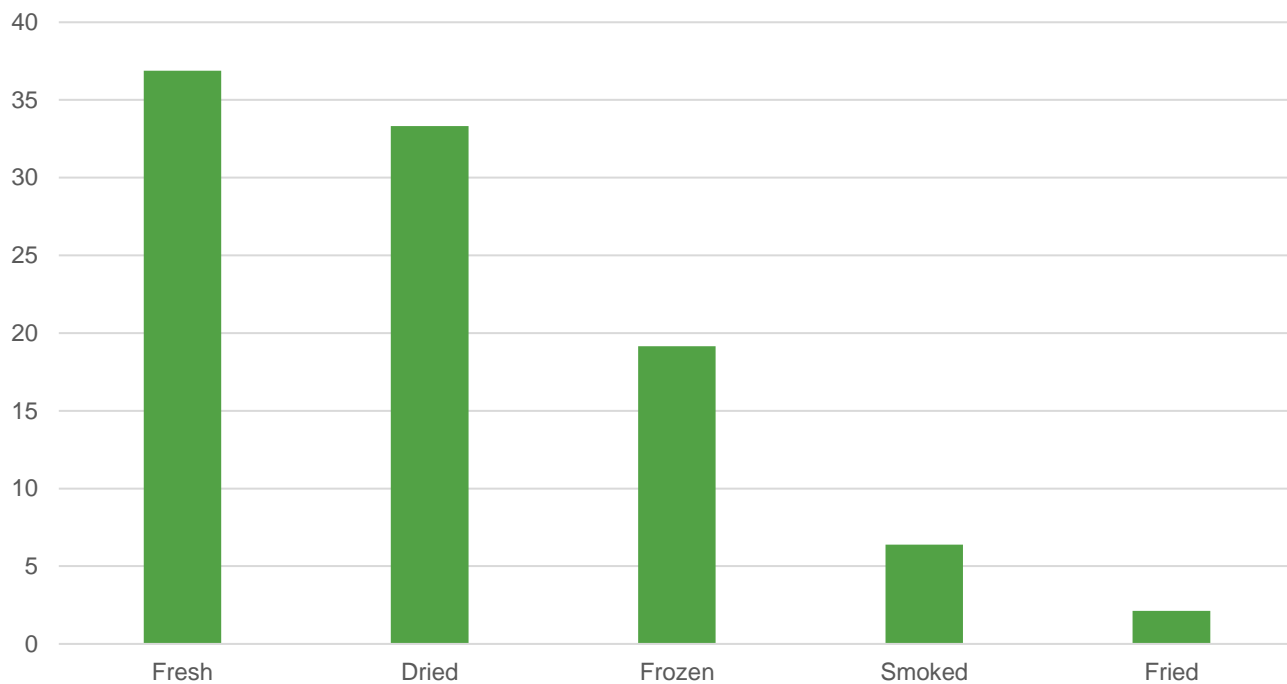


Figure 2. The frequency (%) of fish/aquatic animal forms purchased by lower wealth rural households in the South, in the previous seven days. (n = 75 households).

Southern households - lower wealth, urban

Among the 96 lower wealth urban households surveyed in the South, there is a similar consumption patterns to the rural households, however urban households appear to consume more Catfish than Mackerel (Figure 3). Urban households reported consuming slightly more types of fish, at 24 in total, with one category being other (unspecified).

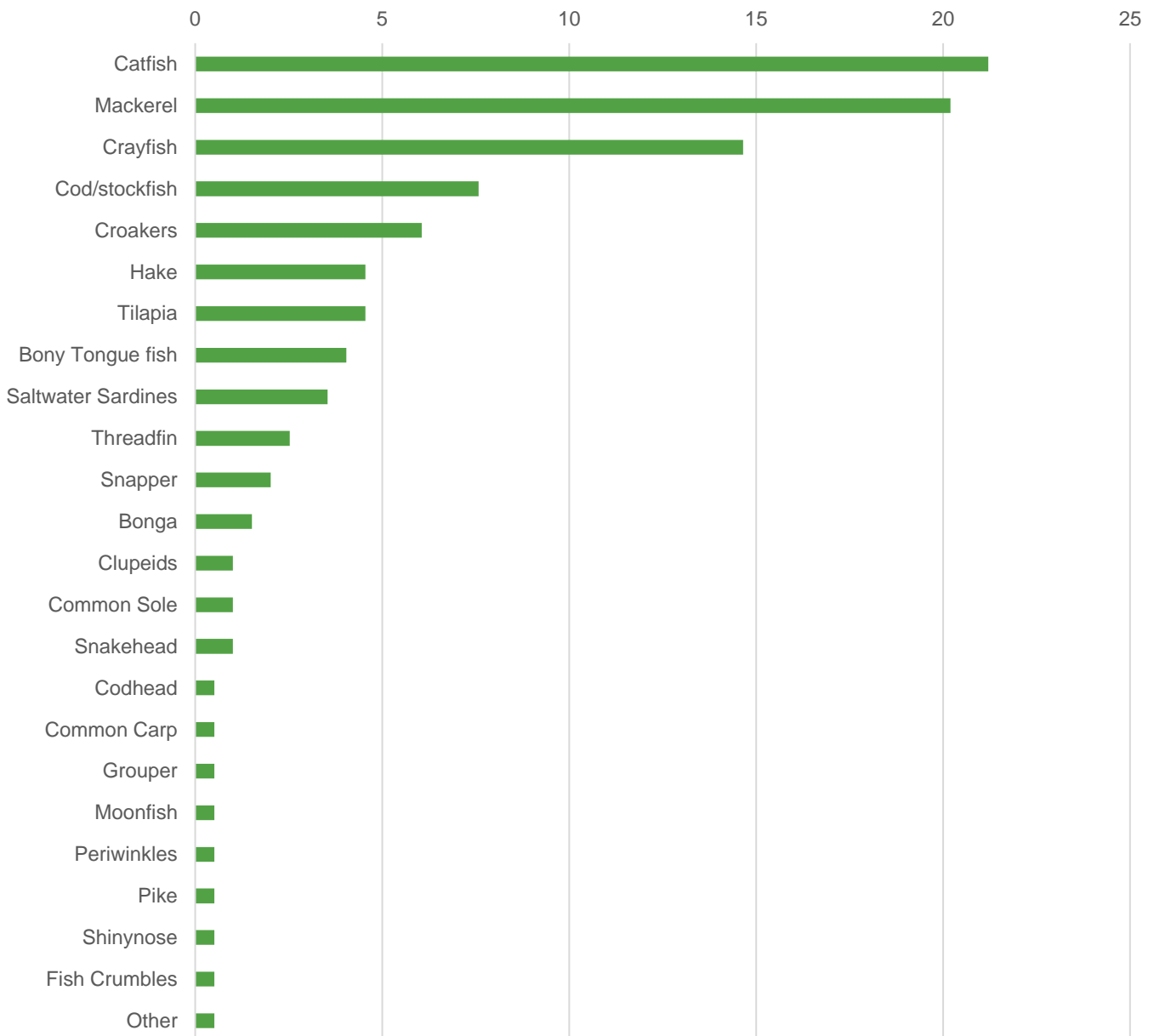


Figure 3. The frequency (%) of fish/aquatic animals consumed by lower wealth urban households in the South, in the previous seven days. (n = 96 households).

Among the 96 lower wealth urban households surveyed in the South, we again see a similar purchasing pattern of fish forms to those purchased in the rural households, but the urban households purchase more fresh fish, and fewer dried (Figure 4) compared to the rural Southern households. Fresh fish is by far the dominant form of fish purchased. Like the rural households, the most common fresh fish purchased are Catfish and Mackerel, while the most common dried fish was Crayfish (supplementary appendix **A2**).

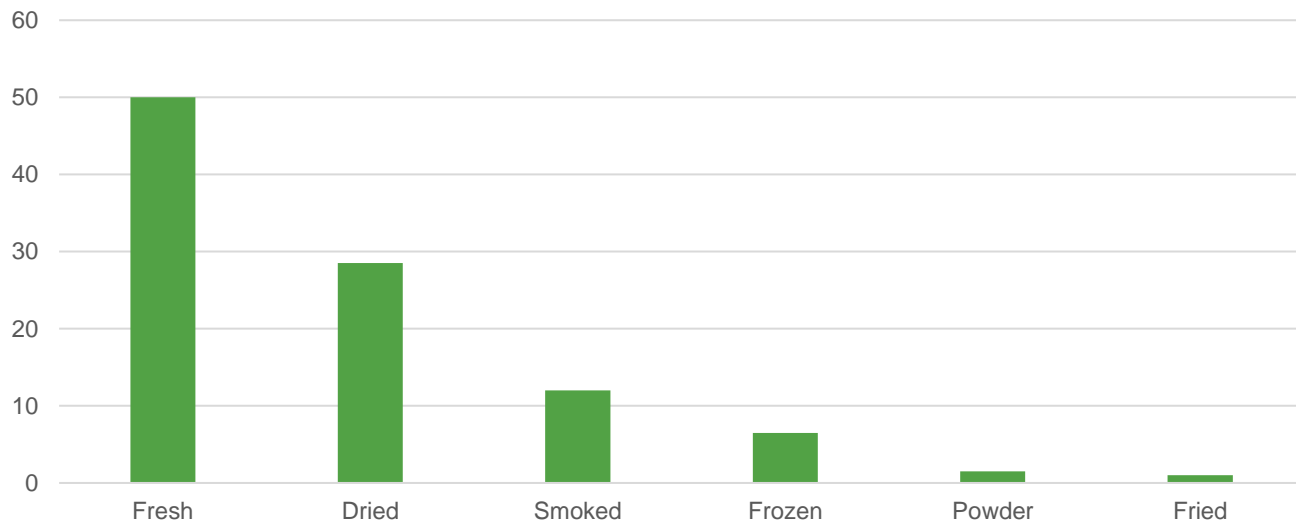


Figure 4. The frequency (%) of fish/aquatic animal forms purchased by lower wealth urban households in the South, in the previous seven days. (n = 96 households).

Southern higher wealth households (urban and rural)

A total of 257 higher wealth households were surveyed in the south (a mix of urban and rural). We found that these households consumed Catfish and Crayfish more commonly than the lower wealth rural households. Mackerel was the third most consumed fish (Figure 5). The higher wealth households consumed a greater variety of fish types, at 27 total types of fish reported, compared to their lower wealth counterparts.

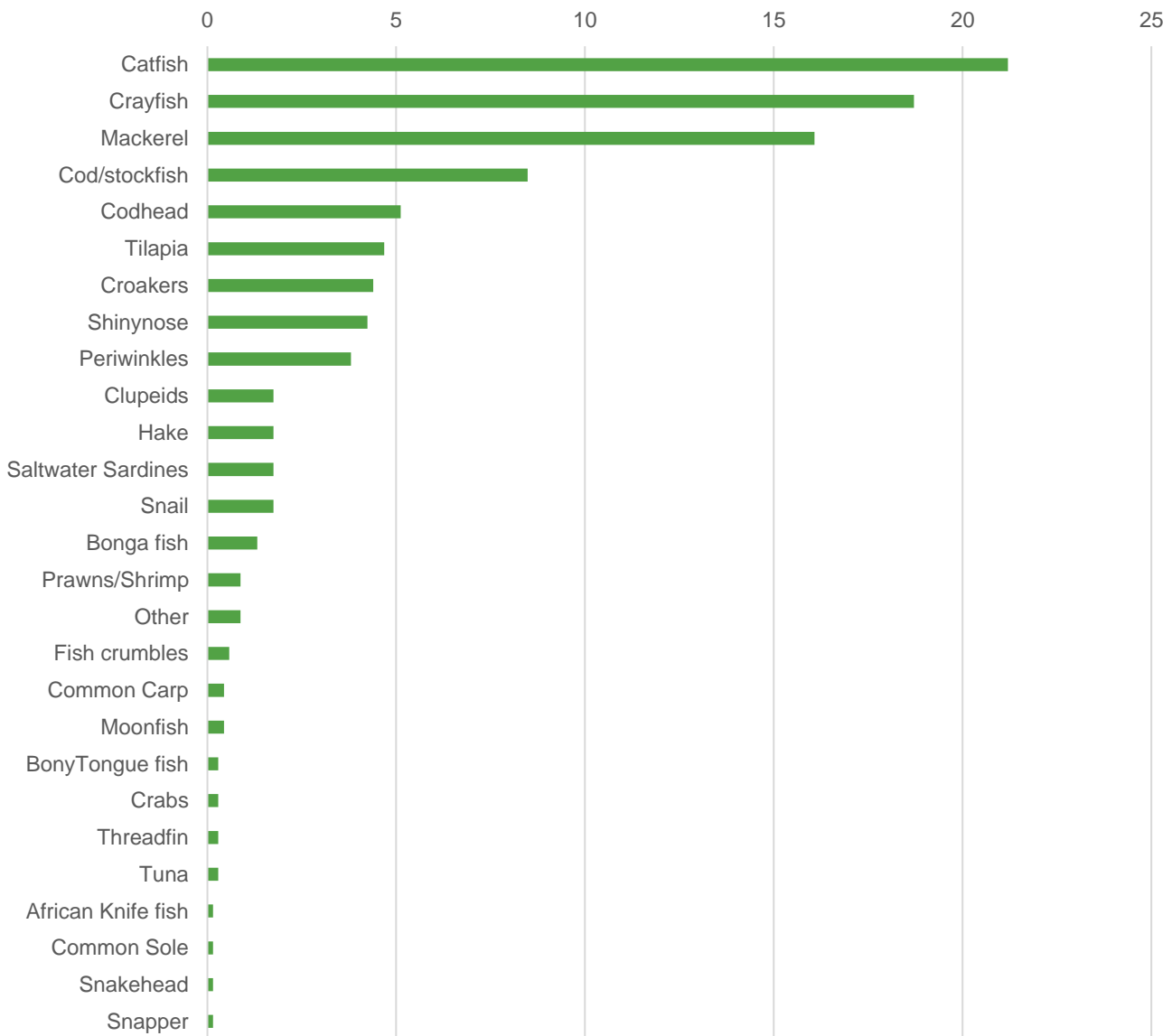


Figure 5. The frequency (%) of fish/aquatic animals consumed by higher wealth households in the South, in the previous seven days (n = 257 households).

The higher wealth households surveyed in the South purchased dried fish most often, where fresh fish was a close second (Figure 6). No households reported purchasing fish powder. Dried Crayfish was the most purchased dried fish. Catfish was the most consumed fresh fish, while Mackerel was the most consumed frozen fish (supplementary appendix **A3**)

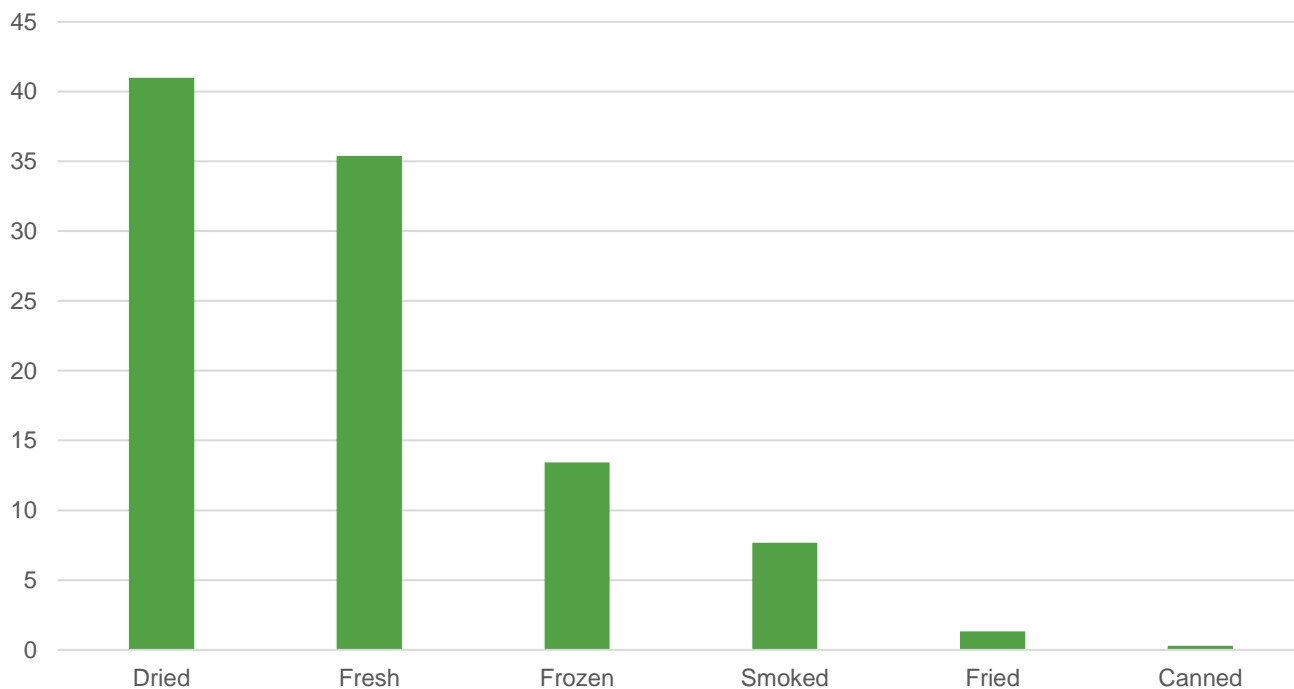


Figure 6. The frequency (%) of fish/aquatic animal forms purchased by higher wealth households in the South, in the previous seven days (n = 248 households).

Northern households - lower wealth, rural

The lower wealth rural households surveyed in the North reported purchasing a smaller number of fish categories than the lower wealth households in the South, in both rural and urban areas, reporting just 11 fish (Figure 7). Among these households, Catfish is by far the most consumed fish, followed by Tilapia.

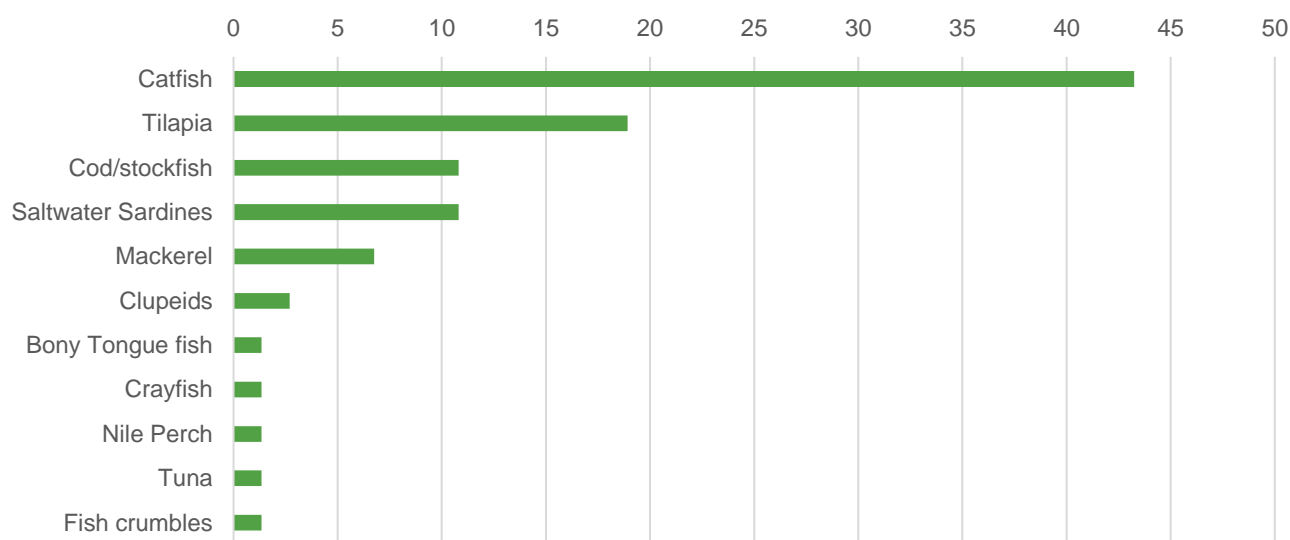


Figure 7. The frequency (%) of fish/aquatic animals purchased by lower wealth rural households in the North, in the previous seven days. (n = 63 households).

Among the lower wealth rural households surveyed in the North, fresh fish was the most purchased form of fish (Figure 8). Catfish was the most purchased fresh fish, with Tilapia the second most common fresh fish (supplementary appendix A4). Catfish was also the most purchased dried and smoked fish. Fish purchased already fried also made up 15% of fish form purchases, with fried Codfish being the most reported.

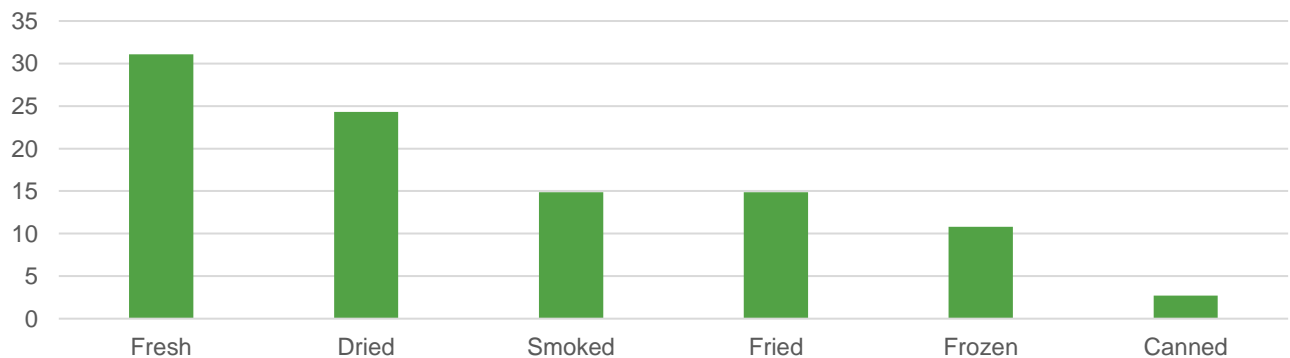


Figure 8. The frequency (%) of fish/aquatic animal forms purchased by lower wealth rural households in the North, in the previous seven days. (n = 63 households).

Northern households - lower wealth, urban

The 38 lower wealth urban households surveyed in the North had similar consumption patterns to the lower wealth rural households (Figure 9). They also reported purchasing a small number of fish types, reporting just 7 specific different types purchased in the previous week, with 2% of households reporting a fish that could not be identified (other).

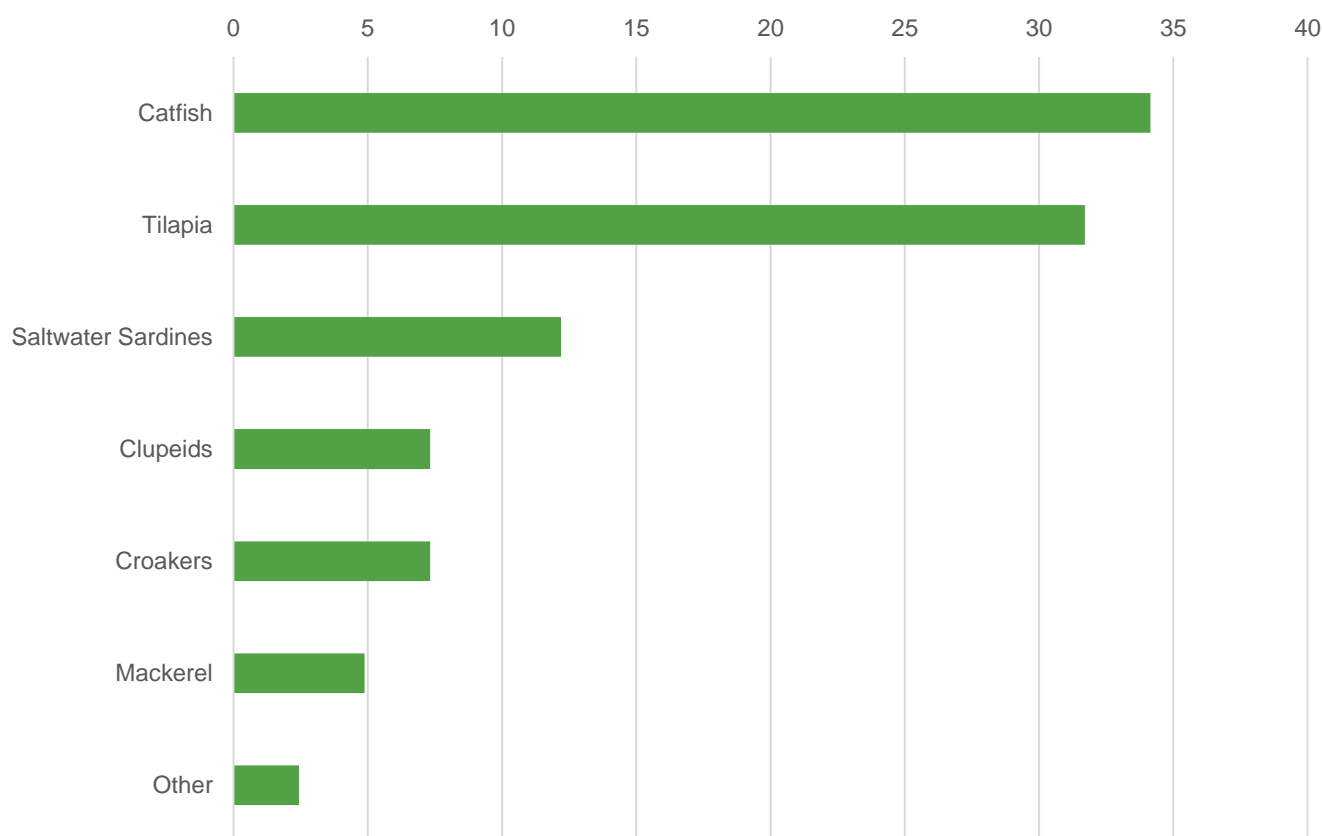


Figure 9. The frequency (%) of fish/aquatic animals consumed by lower wealth urban households in the North, in the previous seven days. (n = 38 households).

Among the lower wealth urban households surveyed in the North, fresh fish was the most purchased form of fish, like the lower wealth rural households (Figure 10). Fresh Catfish was the most commonly purchased, followed by fresh Tilapia. Fish purchased already fried made up fewer of the purchases in the urban setting, at 10% of fish forms purchased. Additional details about fish types combined with fish forms can be found in supplementary appendix **A5**.

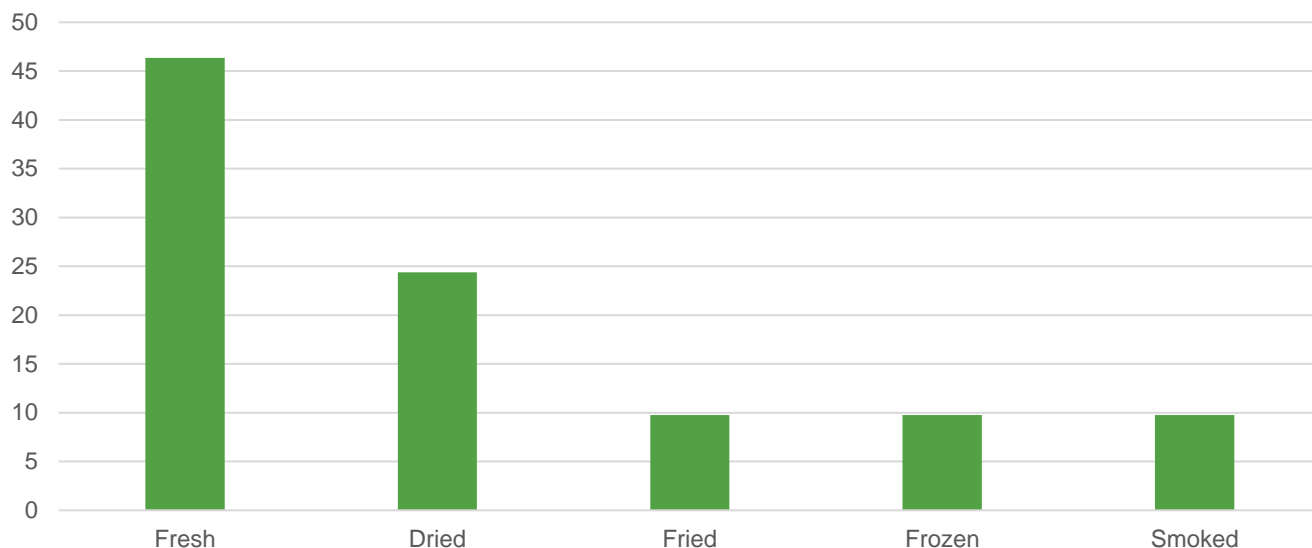


Figure 10. The frequency (%) of fish/aquatic animal forms purchased by lower income urban households in the North, in the previous seven days. (n = 38 households).

Northern higher wealth households (urban and rural)

The 122 higher wealth households surveyed in the North (a mix of urban and rural), consumed a greater diversity of types of fish as compared to the lower wealth households, with at least 12 different fish categories reported (Figure 11). Households overwhelmingly consumed Catfish as compared with other types of fish. Like the lower wealth households, Tilapia was the second most consumed fish.

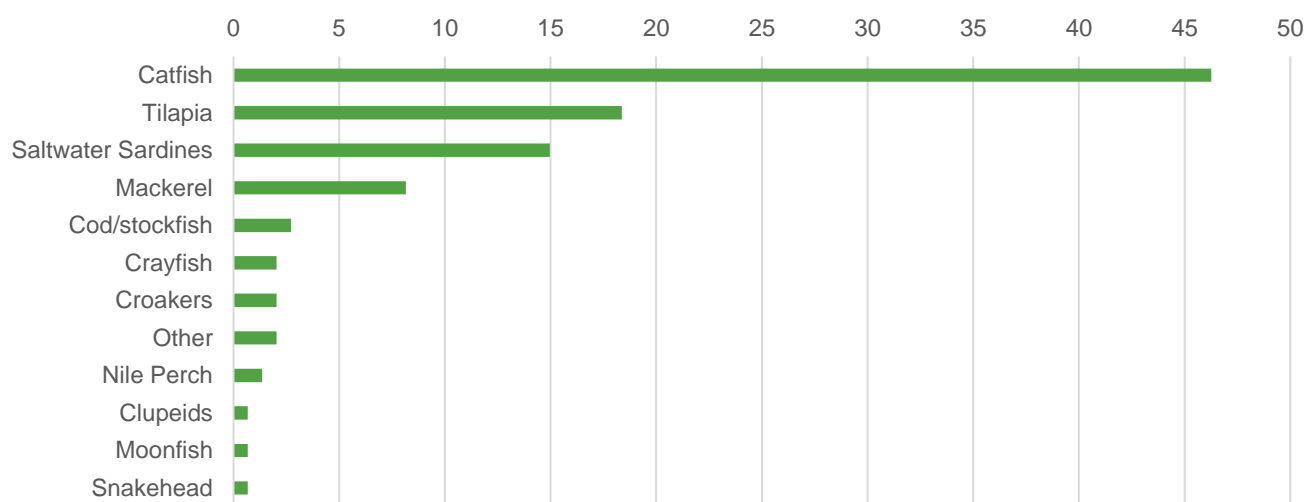


Figure 11. The frequency (%) of fish/aquatic animals consumed by higher wealth households in the North, in the previous seven days. (n = 122 households).

Among the higher wealth households surveyed in the North, fresh fish was the most purchased form of fish, like the lower wealth households (Figure 12). Households also purchased 8% of their fish fried, a practice which is relatively common in the North, and non-existent in the South. The most purchased fresh and dried fish in the Northern higher wealth households was Catfish, with Tilapia the second most purchased fresh fish (supplementary appendix A6). The most common fried fish purchased was saltwater Sardines.

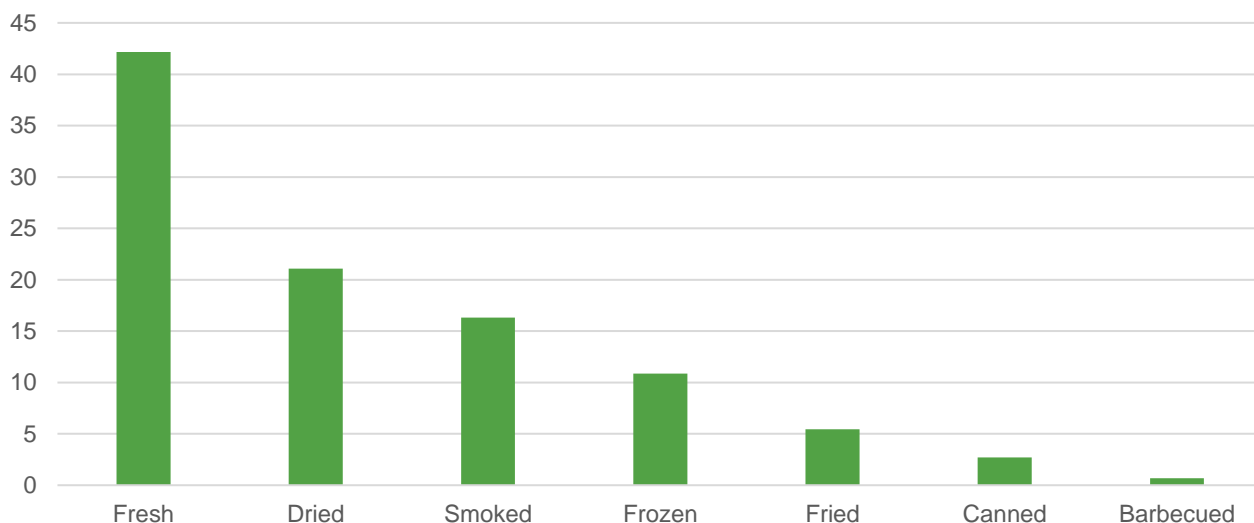


Figure 12. The frequency (%) of fish/aquatic animal forms purchased by higher wealth households in the North, in the previous seven days (n=122 households).

Consumption of fish by pregnant and lactating women

Below we have split the consumption patterns by pregnancy and lactation. Catfish was the most commonly consumed fish by both pregnant and lactating women, indicating the importance of this fish during the period of growth of the fetus and then infant. Mackerel was the second most consumed fish during this life stage, but interestingly, crayfish did not appear to be as commonly consumed during pregnancy, as compared with the lactation stage. Crayfish consumption was reported at 7% for pregnant women (Figure 13), 16% for lactating women (Figure 14).

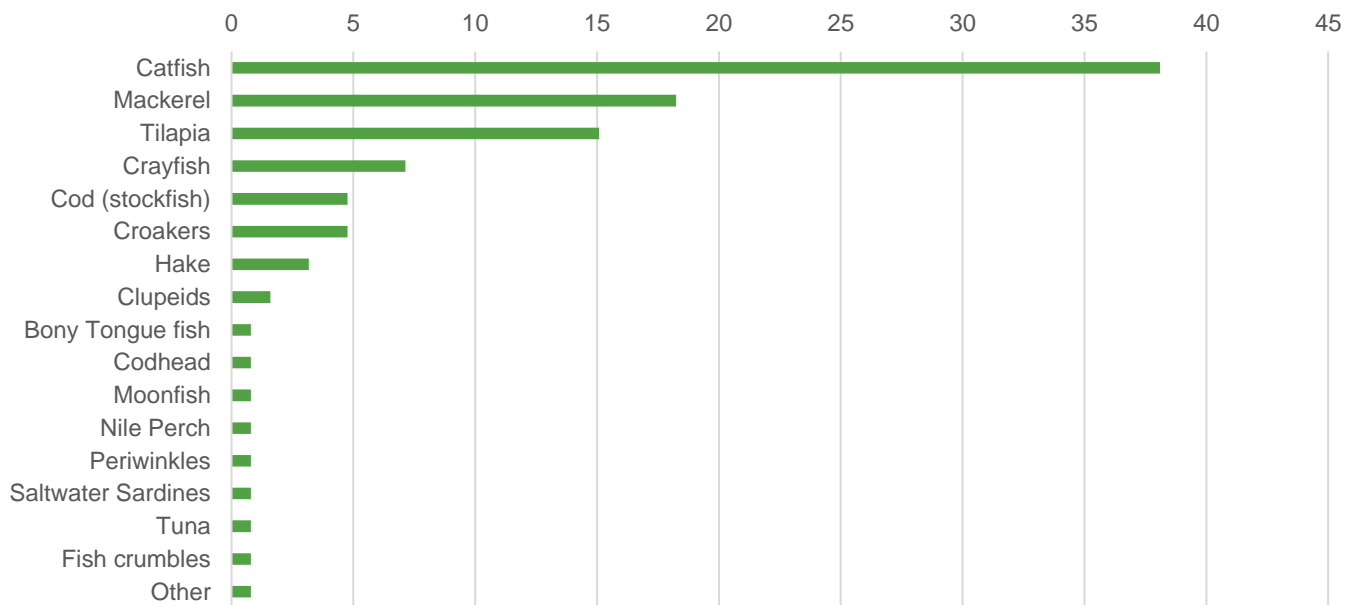


Figure 13. The frequency (%) of fish/aquatic animals consumed by pregnant women in the previous 24 hours (n = 150 households).

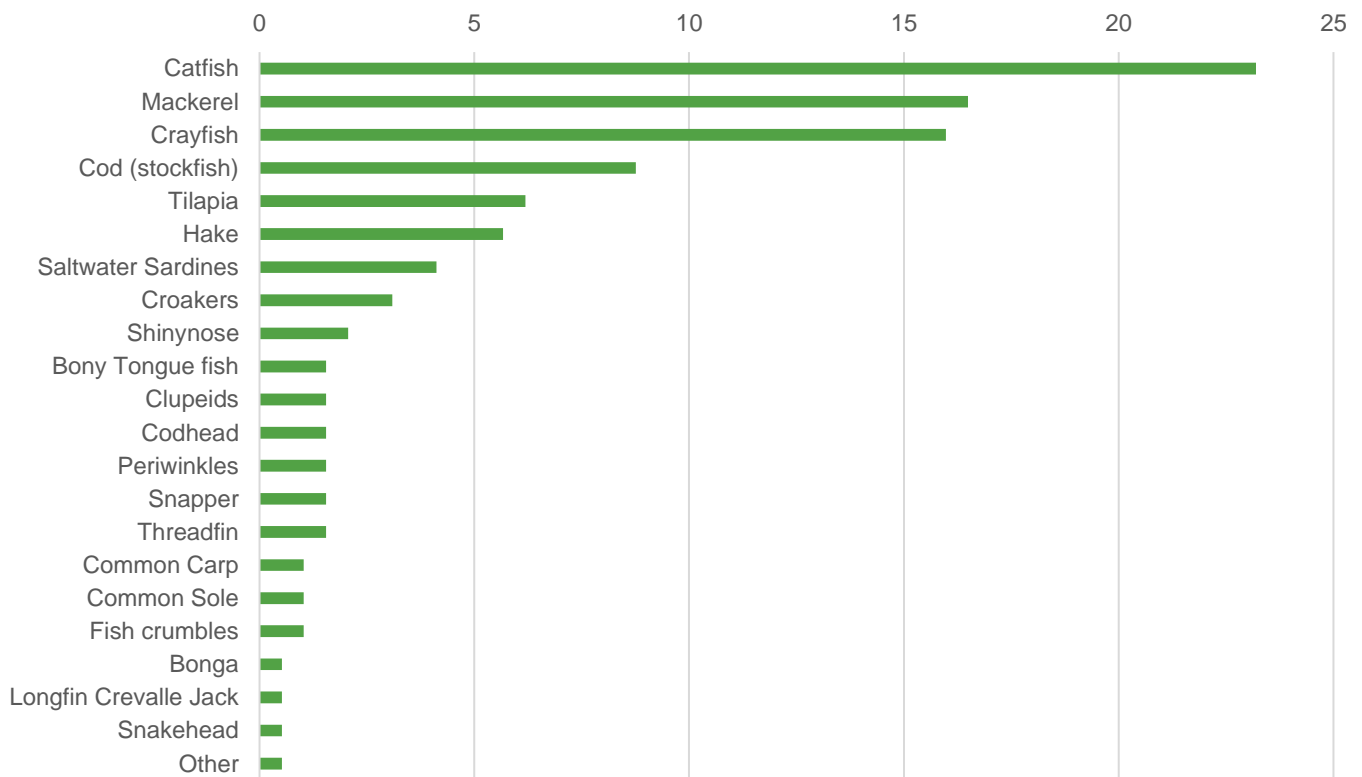


Figure 14. The frequency (%) of fish/aquatic animals consumed by lactating women in the previous 24 hours. (n = 239 households).

Consumption of fish by children under two

Catfish was the most consumed fish by young children. Mackerel also came in as the second most consumed fish. 12% of caregivers reported giving Crayfish to children the previous day (Figure 15). This indicates that all these fish are important sources of micronutrients in infancy and early childhood.

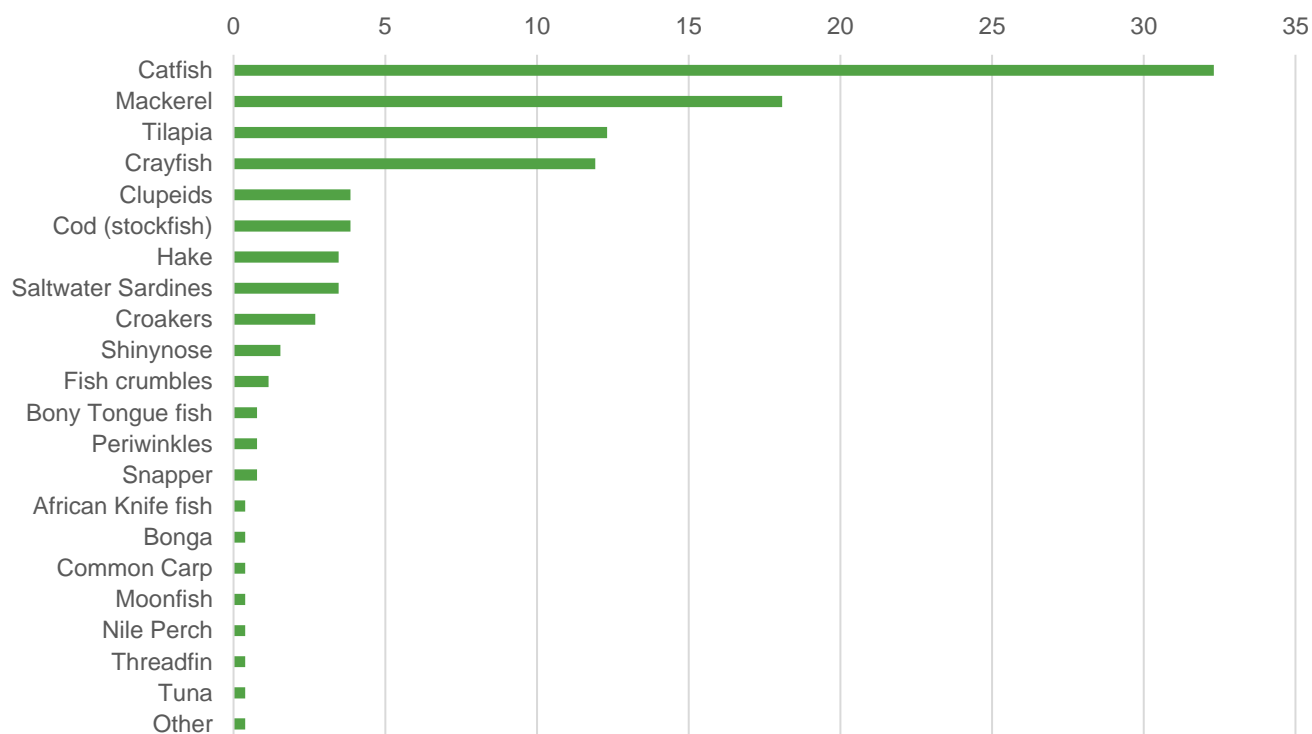


Figure 15. The frequency (%) of fish/aquatic animals consumed by infants and young children in the previous 24 hours (n = 295 households).

Findings on gender – intra-household allocation

Of the 645 (92%) households that reported consuming fish during the previous seven days, 43% indicated they divided up the fish differently within the household. When considering the 347 households that reported consuming Catfish in the previous seven days, 141 (40%) said they divided the Catfish up differently among the household members. The frequencies of the different parts of the Catfish reported as being given to each of the members of the family are listed in Figure 16.

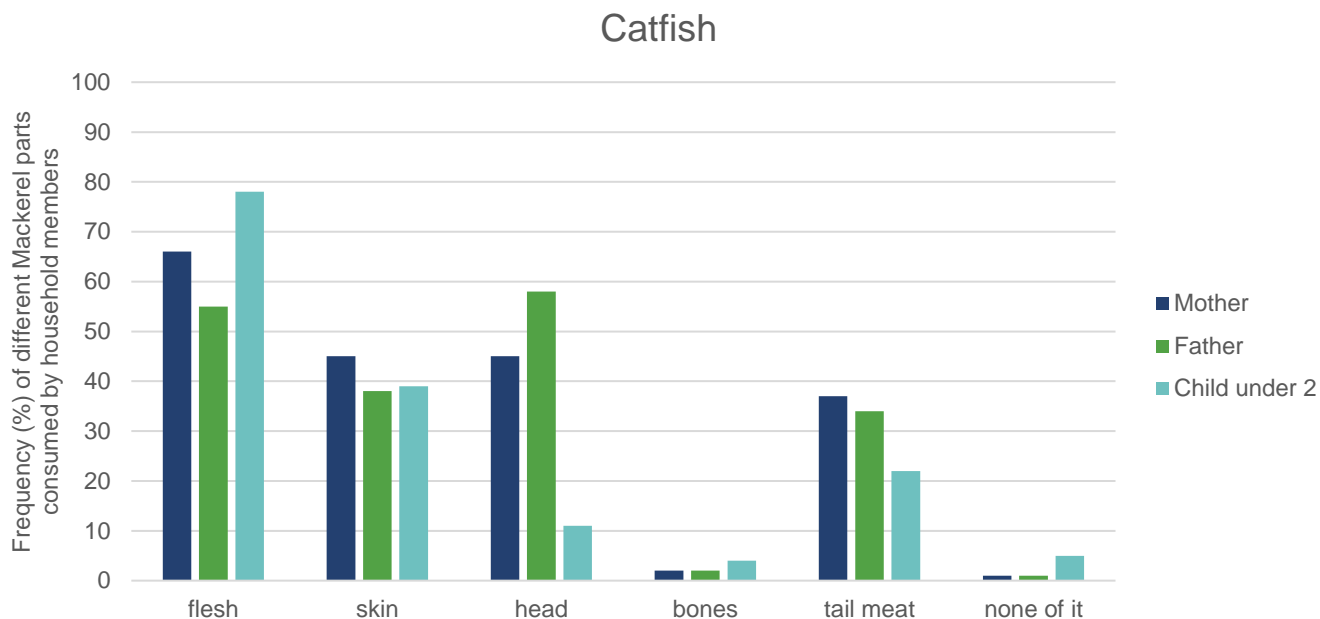


Figure 16. Household division of Catfish.

Of the 215 households that reported consumption of Mackerel in the previous seven days, 84 (40%) said they divided the Mackerel differently among the household members. The frequency of the different parts of the Mackerel reported as given to each of the members of the family are presented in Figure 17.

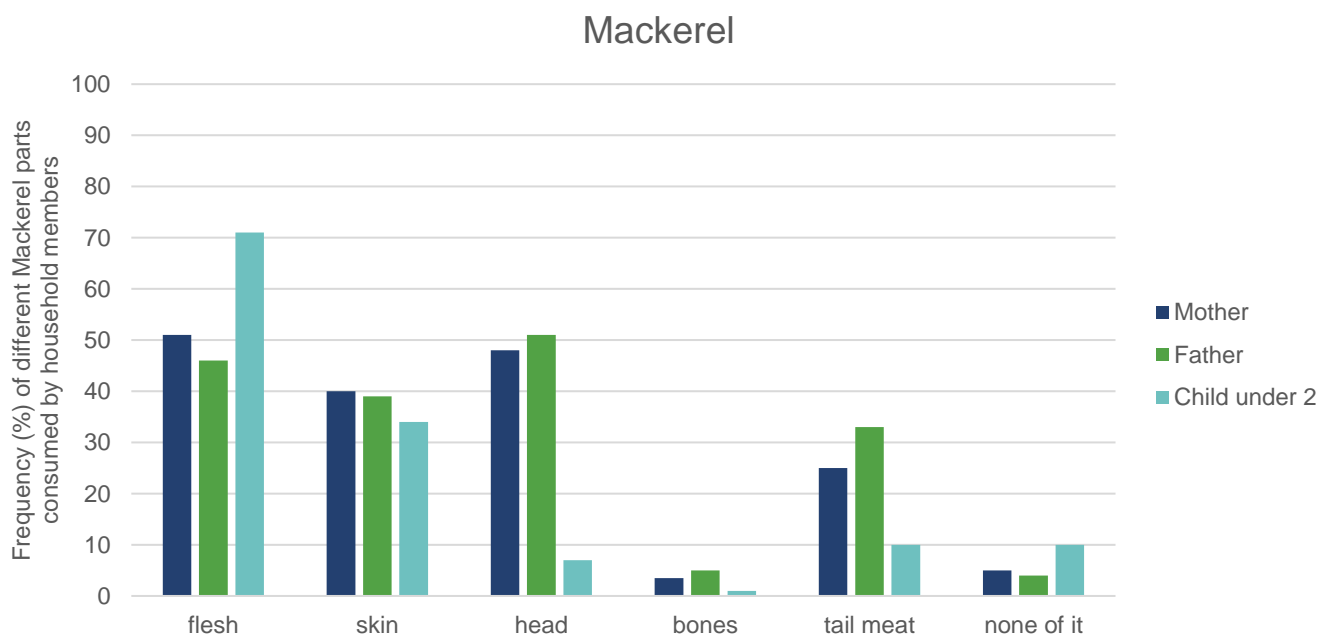


Figure 17. Household division of Mackerel.

Overall, the majority (57%) of households do not purposely divide fish up by household member. However, when Catfish and Mackerel were divided, slightly more women and children consumed the flesh, while more men consumed the head. In rare instances, both Catfish and Mackerel were withheld from children under two.

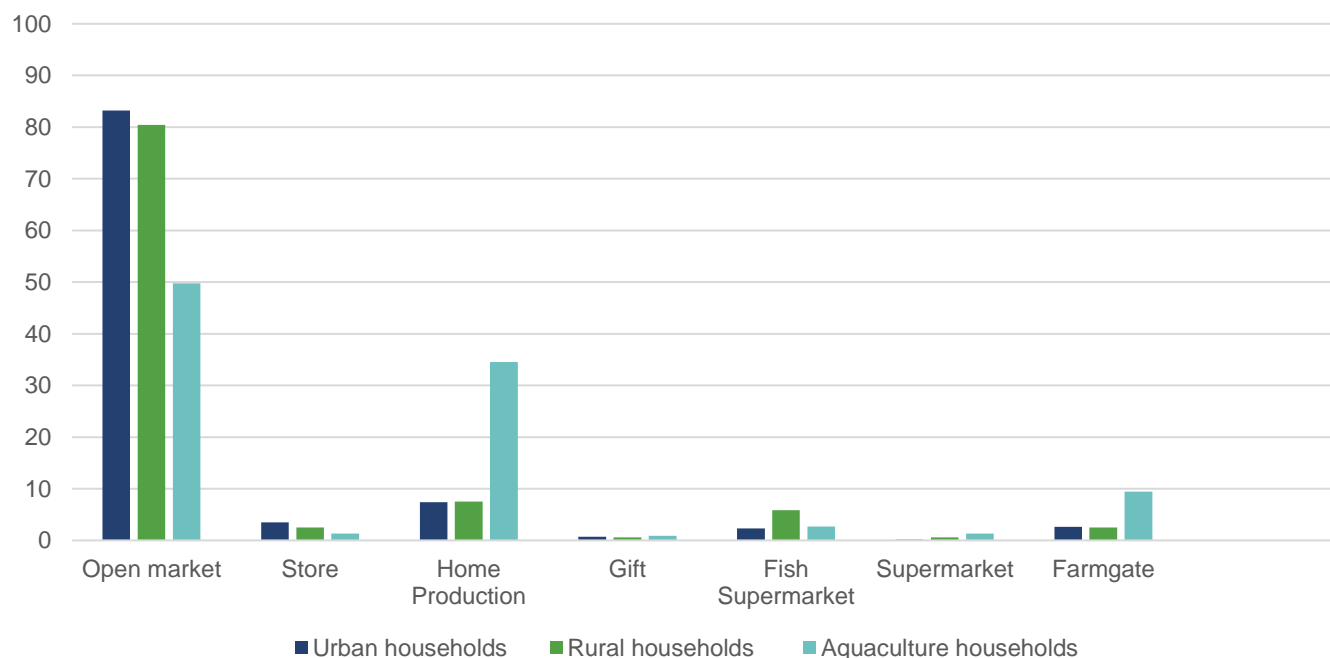


Figure 18. Sources of fish in household by rural/urban households, and by aquaculture households.

Most households in Nigeria purchased their fish from the open market (Figure 18). Even aquaculture households purchased fish from the open market more frequently than consuming their own fish. Purchasing fish from the fish market was slightly more frequent in rural households; purchasing fish from the farmgate was slightly more common in aquaculture households.

Fish market behaviors

The majority of respondents take a motorcycle or walk to the market, and the food market is relatively accessible in both rural and urban settings (Table 6). Only 16% of the sample reported traveling to a separate fish market to purchase their fish.

Most common form of transportation to food market – n (%)	
Walk	142 (24%)
Bicycle	12 (2%)
Motorcycle	299 (34%)
Tricycle (keke)	95 (16%)
Shared vehicle	83 (14%)
Private vehicle	61 (10%)
Minutes to food market by primary mode of transportation – mean (SD)	
Urban	14.7 (12.0)
Rural	16.8 (13.1)
Percentage of households who reported visiting a separate fish market	15%
Minutes to fish market by most identified form of transportation	24.5 (41.0)

Table 6. Market behaviors of households.

Fish waste and loss

Only 7% of household reported that the fish they purchased was lost due to spoilage in the past 30 days. Additionally, very little of the fish was left behind as plate waste. Many households reported consuming the head of the fish (Table 7), and sometimes even the bones. 41% of the time households leave none of the fish behind.

Fish part	Frequency (%)
Tail meat	99
Flesh	99
Skin	99
Head	93
Bones	42
Whole fish (nothing is left behind)	41

Table 7. Frequency that the following fish parts are consumed.

Gender-Disaggregated Findings

There was general agreement among gender-disaggregated findings, though men appeared to trust aquaculture a bit more as compared with women (Table 8). Over half of women and 60% of men spontaneously reported that fish was an important food to consume during pregnancy, which was reflected in the high proportion of pregnant women who had consumed fish the day prior.

Question	Women (%)	Men (%)
Respondents who said they can access fish/seafood “always/most of the time”	83	84
Respondents who agreed that “most of the time, the fish available in the market nearest to me is not spoilt/diseased”	90	88
Respondents who agreed that “farmed Tilapia is of better quality than captured Tilapia”	26	32
Respondents who agreed that “farmed Catfish is of better quality than captured Catfish”	27	33

Respondents who reported that fish is an important food to consume during pregnancy	55	60
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Table 8. Fish-related responses by gender.

State-Disaggregated Findings

In addition to the gender-disaggregated findings, there was also a general agreement between the Northern and Southern households on many beliefs (Table 9). Overall, 72% of the households in the Northern region reported that they could access fish always or most of the time, however, when looking at the sub-set of rural, lower wealth households in the Northern region, only 51% of households reported that they could access fish always or most of the time. Surprisingly however, more households in Northern states believe that farmed fish is better than captured, when compared with the Southern households.

Question	Southern Households (%)	Northern Households (%)
Respondents who said they can access fish/seafood “always/most of the time”	87	72
Respondents who agreed that “most of the time, the fish available in the market nearest to me is not spoilt/diseased”	90	88
Respondents who agreed that “farmed Tilapia is of better quality than captured Tilapia”	20	35
Respondents who agreed that “farmed Catfish is of better quality than captured Catfish”	24	37
Respondents who reported that fish is an important food to consume during pregnancy	57	51

Table 9. Fish-related responses by the primary respondent (usually the female head of house) by region.

Consumption patterns of women

Fish was the most consumed animal-source food among women in all categories, aside from the higher wealth households, where meat was the most common (Table 10). Most women met the minimum dietary diversity score, with the lowest proportion in the women in lower wealth quintiles at 75%. This could be in part due to the frequent, but scant dairy consumption (IPSOS, 2017), which may contribute to the high consumption data reported. Unhealthy food consumption was also relatively common across all sub-categories.

Food Consumption (%)	% Total (n = 700)	% Lower wealth women (n = 264)	% Higher wealth women (n = 394)	% Pregnant women (n = 138)	% Lactating women (n = 183)
Grains	94	94	94	97	95
Vitamin A vegetables	35	33	35	44	37
Roots and tubers	63	59	65	56	63
Green vegetables	75	72	77	80	78
Vitamin A fruit	23	22	24	30	22
Meat or poultry	66	54	72	65	63
Eggs	45	38	50	44	50
Fish	79	78	80	82	75
Dairy	64	58	67	68	70
Insects	1	2	1	1	1
Red palm oil	96	94	95	97	96
Packaged snack foods	50	42	54	40	52
Sugar-sweetened beverages	40	31	45	33	38
Instant noodles	25	20	27	17	27
Cocoa-based drinks (e.g. Milo)	49	42	53	49	52
Average food group consumption out of 10 – mean (SD)	6.2 (1.9)	5.8 (2.0)	6.4 (1.8)	6.4 (1.6)	6.3 (2.0)
Proportion of women achieving minimum dietary diversity (MDD)	81	74	85	88	81

Table 10. Food groups consumption of women of reproductive age.

Consumption patterns of children

Fish was the most common animal-source food among all children aged six to 23 months, even among the higher wealth households (Table 12). Most children achieved the minimum dietary diversity (MDD), however snack food consumption was also quite high. Breastfeeding prevalence was low at 40% across all sub-categories

Food Group Consumption (%)	% Total (n = 295)	% in Lower Wealth Households (n = 148)	% in Higher Wealth Households (n = 134)
Breastmilk	40	38	44
Grains	85	81	89
Vitamin A vegetables	23	26	18
Roots and tubers	32	31	31
Green vegetables	56	59	54
Vitamin A fruit	14	16	11
Meat or poultry	36	27	46
Eggs	49	47	50
Fish	73	76	70
Dairy	75	72	77
Insects	0	1	0
Red palm oil	81	82	80
Packaged snack foods	68	66	70
Sugar-sweetened beverages	20	16	25
Instant noodles	30	31	30
Cocoa-based drinks (i.e. Milo)	51	51	51
Average food group consumption out of 8 – mean (SD)	5.0 (1.7)	4.9 (1.6)	5.1 (1.8)
Proportion of children achieving minimum dietary diversity (MDD)	70	67	72

Table 12. Food group consumption of children aged 6-23 months.

Fish and complementary foods

Table 13 lists what the primary respondent (i.e. the female head of house) provided to questions about when it is okay to give different animal-source foods to infants/children.

Animal-source food	Perceived appropriate age of introduction in months – mean (SD)
Fish	8.18 (5.66)
Eggs	7.70 (3.92)
Milk	6.90 (4.62)
Meat	12.70 (7.21)

Table 13. Average responses to when it is appropriate to introduce animal-source foods to infants and young children.

While fish and eggs were considered appropriate at a younger age than fish, fish was considered appropriate at an earlier age than meat. Thus, fish is an important animal-flesh food that can be introduced in infants.

However, less than half of respondents (45%) reported that it was appropriate to give fish at six months – 10% reported that it was appropriate to give fish earlier, while the remaining 45% reported that fish should be given later. Increasing the number of caregivers who believe that fish should be given starting at six months could be a target to achieve for breaking the cycle of malnutrition

Findings from Focus Group Discussions

Many participants in the Southern states mentioned fish as a favorite food, and a food consumed during festive periods. Indeed, smoked Catfish is so valued it is often given as gifts. A woman in the Anambra FGD stated that “we specially smoke Catfish for preservation which we give out as gifts to our visitors.” One man in Anambra said that his favorite meal is bitterleaf soup and fresh fish, and “because they are farmers it gives them strength and holds hunger.” However, only three men in urban Kano (Northern state) mentioned fish as a favorite food, and no one mentioned consuming fish during the festive period.

In discussions regarding farmed fish, most participants did not have concerns, though in Rivers and Oyo states particularly, there were concerns regarding the safety of the chemicals used in the farming process. In two FGDs, the word ‘slime’ was used to describe farmed fish. However, most reported eating farmed fish, despite concerns. In an Oyo urban men FGD, men reported eating farmed fish, but cautiously.

There were fewer concerns regarding captured fish as compared to farmed, and one man from urban Anambra stated “I do not have worries with captured fish because it is from the natural, it tastes good.” However, one group brought up that dynamite may be used to kill the fish, and that the fish spoil easily. Two groups brought up that captured fish was too expensive.

Approximately half of the groups brought up concerns with imported fish, though all liked to eat it. The Oyo urban men brought up the affordability of the fish, while the Rivers rural women stated that imported fish was expensive. Five of the groups were concerned with the safety of the fish.

On small fish that can be consumed whole, most FGDs reported eating them, however the Anambra urban women, some from the Kano and Oyo urban men reported that they did not like small fish. One man in Kano reported that “our little problem is that they don’t clean the fishes properly before they fried to sale.” However, most groups mentioned that they like eating small fish, and that they are affordable.

Discussion

This study provides nuanced information across nine States in Nigeria regarding fish purchase and consumption details, and to our knowledge, it is the first study to do so. Based on household-reported spending habits, Nigerians spend approximately 295 Naira (0.76 USD) per person per week on fish, though estimates varies greatly by household, and by fish type. Regardless of the type of fish however, we found that Nigerians spend more on fish than on any other animal-source food, with relatively small amounts on eggs and dairy. This finding is in agreement with a previous study from IPSOS that found that most Nigerians only use scant amounts of dairy (IPSOS, 2017). While there is currently less spending on beef than on fish, research shows that as incomes rise, demand for red meat tends to increase (Milford, Le Mouël, Bodirsky, & Rolinski, 2019). Thus as incomes in Nigeria increase, the demand for fish should be maintained through clear multi-sectoral guidance and social behavior change communication programs. Not only are fish an important piece of a high-quality diet, the production of fish is relatively better for the environment than the production of meat and has immense contribution to poverty reduction and women empowerment (e.g., Nasr-Allah et al. 2019). Thus, maintaining or increasing fish consumption in Nigeria is good for both human and environmental health (Willett et al., 2019).

Catfish, in various forms, ranked as a highly consumed fish across states and all wealth quintiles, indicating the centrality of catfish to the Nigerian diet and the role of catfish aquaculture in sustaining domestic fish supply in Nigeria. Mackerel, an imported marine pelagic fish, was the most purchased fish among the lower wealth households in the Southern region. Crayfish, a nutrient-dense small indigenous aquatic food was a commonly purchased fish in Southern households, but not among Northern households. This is in agreement with previous

studies of recipes in Nigeria (Ene-Obong et al., 2013). Tilapia is a relatively more important fish for households in the North.

All of these species provide important micronutrients to the diets of Nigerians, and given that little household waste of the fish was reported, the micronutrient contribution likely extends beyond just the nutritional value of the flesh. This is important, as key micronutrients such as iron and vitamin A are found in the head of the fish (Roos, Leth, Jakobsen, & Thilsted, 2002), and highly bioavailable calcium is found in the bones (Isaacs, 2016).

Dietary species richness is associated with greater micronutrient intakes in the diet (Lachat et al., 2018). The specific richness of fish consumed could be improved, particularly in the Northern states. The diversity of species purchased in the Southern households was higher than in the Northern households in this season (August – October 2019). The low intakes of the types of fish likely has to do with access. The lowest access was reported in the lower wealth households in the rural Northern States, where only 50% of respondents said they could access it 'always' or 'most of the time.'

Fish in Nigeria is an especially important animal-source food for the period of the first 1,000 days (from pregnancy up to two years of life). We found that among women, fish was the most consumed animal-source food, while in children, fish consumption was second to dairy. We found that 80% of women reported consuming fish in the previous 24 hours, and 73% of caregivers reported giving fish to children under two in the previous 24 hours. Our findings are in agreement with a study of households in Kebbi, Benue, Cross River and Niger States, where fish was the most frequently consumed animal-source food at the household level (SPRING, 2018). Catfish, followed by Mackerel, were the most consumed fish by pregnant and lactating women, and children under two – highlighting the importance of these species to the first 1,000-day critical period of growth. Crayfish was the third most consumed fish across all three life stages.

The high fish consumption is likely in part that households trust the fish in the market. Most reported a high degree of trust, however, findings from FGDs illustrated that some consumers have food safety concerns about farmed fish, captured fish, and imported fish. These issues likely need to be addressed separately, but the concern for farmed fish will only grow as aquaculture increases. Thus, promoting the adoption of aquaculture best management practices among farmers combined with campaigns to educate consumers about how fish are produced, and the safety of those procedures, will increase consumer trust, and thus consumption.

Despite the fact that fish in diets in Nigeria was high at the time of our study, the situation is in constant flux. Nigeria is undergoing an economic, and thus a nutrition transition, whereby more populations will increasingly consume highly processed foods, high-sugar and high fat snacks (Brauw and Herskowitz, 2020). Thus, they are facing a public health problem called the double burden of malnutrition (i.e. the co-existence of undernutrition and overnutrition within individuals,

households, or populations) which leads to an increased risk for non-communicable diseases such as heart disease, diabetes, and cancer. The high prevalence of both women and children consuming packaged snacks and sugary beverages is of concern. One study conducted in Lagos State found that there are some cases of maternal overweight and child stunting in the same household (Senbanjo, Senbanjo, Afolabi, & Olayiwola, 2019), providing evidence that the problem of the double-burden of malnutrition is already a problem in Nigeria.

An IPSOS study conducted in Nigeria found that many respondents reported that cocoa-based drinks ‘help children to study better’ (IPSOS, 2017). This may explain the relatively high proportion of children across income quintiles who had consumed a cocoa-based drink the day prior, and also indicates the success of the company’s marketing their products. However, there is no evidence that a sugary, cocoa-based drink will help children study well, and the product may be contributing to the double burden of nutrition in Nigeria.

Given that maternal obesity concurrent with childhood stunting is a problem in Nigeria (Senbanjo et al., 2019), the high prevalence of junk food consumption among women is of particular concern. Common junk foods in Nigeria include Indomie noodles, and other snacks. A high prevalence of consumption of snack foods and junk food in Nigeria was also found among young children.

Conclusions and next steps

Fish is the most commonly consumed animal-source food in Nigeria; thus the supply of fish must be maintained in Nigeria to keep pace with population growth, and consumption should be encouraged, especially to crowd out low-nutrient, processed foods. An alarming frequency of processed foods and sugary beverages were found among children and women, across all wealth quintiles. The deteriorating quality of Nigerians is an issue that needs to be urgently addressed.

In addition to maintaining the place of fish on the plate of Nigerians, the types of fish in the diets should be either preserved or increased. Catfish, mackerel, crayfish, and tilapia are all important fish to the Nigerian diet, but improvements could be made on diversity of consumption of fish types, particularly in the Northern states.

COVID-19 is likely going to disrupt supply chains, and this could lead to increased intake of fish among Nigerians, which would deteriorate dietary quality further. Mackerel, an imported marine pelagic fish, is a highly consumed fish in the Southern lower wealth households, and is commonly consumed by pregnant and lactating women. Increasing the production of fish in Nigeria, and strengthening value chains to get more fish and fish products to Northern Nigeria, can work to maintain the fish as an important piece in Nigerian diets, or increase fish consumption where needed. In addition, securing the public trust in farmed fish as part of a

social and behavior change campaign to increase fish consumption, would allow consumers to feel more comfortable with aquaculture in Nigeria.

Policies, programs, and investments to increase the supply and consumption of fish must be done from a food systems perspective for sustainable change. This can be done by marketing fish consumption in a fresh or processing form, promoting adoption of safety and quality improvement practices along the value chain, continuing to encourage the consumption of fish within the first 1,000 day period, and investing in value chain solutions to increase fish supply the North, which is the hardest hit by undernutrition. Goals such as these are aligned with government priorities, and the Sustainable Development Goals, and will make for a healthier, more sustainable Nigeria.

References

- Beal, T., Massiot, E., Arsenault, J. E., Smith, M. R., & Hijmans, R. J. (2017). Global trends in dietary micronutrient supplies and estimated prevalence of inadequate intakes. *PLoS One*, 12(4), e0175554.
- Bradley, B., Byrd, K., Atkins, M., Ihiabe, S. I., Akintola, S. L., Fakoya, K. A., ... Thilsted, S. H. (2020). *Fish in Nigerian food systems: A review* (Program Report: 2020-06). Penang, Malaysia.
- Brau, A., Herskowitz, S., 2020. Income Variability, Evolving Diets, and Elasticity Estimation of Demand for Processed Foods in Nigeria. *American Journal of Agricultural Economics*. Byrd, K. A., Thilsted, S. H., & Fiorella, K. J. (2020). Fish nutrient composition: a review of global data from poorly assessed inland and marine species. *Public Health Nutrition*, 1–11. <https://doi.org/DOI: 10.1017/S1368980020003857>
- Byrd, K. A., Williams, T. N., Lin, A., Pickering, A. J., Arnold, B. F., Arnold, C. D., ... Stewart, C. P. (2018). Sickle Cell and α -Thalassemia Traits Influence the Association between Ferritin and Hepcidin in Rural Kenyan Children Aged 14–26 Months. *The Journal of Nutrition*, 148(12), 1903–1910. <https://doi.org/10.1093/jn/nxy229>
- Ene-Obong, H. N., Sanusi, R. A., Udent, E. A., Williams, I. O., Anigo, K. M., Chibuzo, E. C., ... Davidson, G. I. (2013). Data collection and assessment of commonly consumed foods and recipes in six geo-political zones in Nigeria: Important for the development of a National Food Composition Database and Dietary Assessment. *Food Chemistry*, 140(3), 539–546. <https://doi.org/10.1016/j.foodchem.2013.01.102>
- FAO, & FHI 360. (2016). *Minimum Dietary Diversity for Women A Guide to Measurement*. Rome, Italy.
- High Level Panel of Experts on Food Security and Nutrition (HLPE). (2020). *Impact of COVID-19 on Food Security and Nutrition (FSN)*. Retrieved from <http://www.fao.org/cfs/cfs-hlpe>
- IPSOS. (2017). *Food consumption and spending in Nigeria*.

Isaacs, M. (2016). The humble sardine (small pelagics): Fish as food or fodder. *Agriculture and Food Security*, 5(1), 1–14. <https://doi.org/10.1186/s40066-016-0073-5>

Kinyoki, D. K., Osgood-Zimmerman, A. E., Pickering, B. V., Schaeffer, L. E., Marczak, L. B., Lazzar-Atwood, A., ... Hay, S. I. (2020). Mapping child growth failure across low- and middle-income countries. *Nature*, 577(7789), 231–234.

Kolding, J., Van Zwieten, P., Marttin, F., & Poulain, F. (2019). *Freshwater small pelagic fish and their fisheries in the major African lakes and reservoirs in relation to food security and nutrition*. Rome: FAO. Retrieved from www.fao.org/publications

Lachat, C., Raneri, J. E., Smith, K. W., Kolsteren, P., Van Damme, P., Verzelen, K., ... Termote, C. (2018). Dietary species richness as a measure of food biodiversity and nutritional quality of diets. *Proceedings of the National Academy of Sciences*, 115(1), 127–132. <https://doi.org/10.1073/pnas.1709194115>

Liverpool-Tasie, L.S.O., Sanou, A., Readon, T., and Belton, B., 2021. Demand for imported versus domestic fish in Nigeria. *Journal of Agricultural Economics*, d01:10.1111/1477-9552.12423.

Michaelsen, K. F., Hoppe, C., Roos, N., Kaestel, P., Stougaard, M., Lauritzen, L., ... Friis, H. (2009). Choice of foods and ingredients for moderately malnourished children 6 months to 5 years of age. *Food and Nutrition Bulletin*, 30(3 Suppl), S343-404. <https://doi.org/10.1177/15648265090303S303>

Milford, A. B., Le Mouël, C., Bodirsky, B. L., & Rolinski, S. (2019). Drivers of meat consumption. *Appetite*, 141, 104313.

Nasr-Allah, A., Gasparatos, A., Karanja, A., Dompok, E.B., Murphy, S., Rossignoli, C.M., Phillips, M., and Karisa, H.C., 2020. *Aquaculture*, 520(15), 734940.

National Population Commission. (2019). *Nigeria demographic and health survey 2018 Key Indicators Report*. ... , MD: National Population Commission and ORC Retrieved from <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Nigeria+Demographic+And+Health+Survey#0>

Roos, N., Leth, T., Jakobsen, J., & Thilsted, S. H. (2002). High vitamin A content in some small indigenous fish species in Bangladesh: check this reference. *International Journal of Food Sciences and Nutrition*.

Schreiner, M. (2015). *Simple Poverty Scorecard. Poverty Assessment Tool for Nigeria*.

Selig, E. R., Hole, D. G., Allison, E. H., Arkema, K. K., McKinnon, M. C., Chu, J., ... Zvoleff, A. (2018). Mapping global human dependence on marine ecosystems. *Conservation Letters*, (May 2018), 1–10.

Senbanjo, I. O., Senbanjo, C. O., Afolabi, W. A., & Olayiwola, I. O. (2019). Co-existence of

maternal overweight and obesity with childhood undernutrition in rural and urban communities of Lagos State, Nigeria. *Acta Biomedica*, 90(3), 266–274. <https://doi.org/10.23750/abm.v90i3.7685>

SPRING. (2018). *Assessing drivers of malnutrition in Nigeria: A report on findings from Kebbi, Niger, Benue, and Cross River to inform food security investments (January 2018)*. Arlington, VA. Retrieved from www.spring-nutrition.org

The Global Nutrition Report stakeholder's group. (2020). Nigeria Nutrition Profile. Retrieved May 18, 2020, from <https://globalnutritionreport.org/resources/nutrition-profiles/africa/western-africa/nigeria/#profile>

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., ... Murray, C. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *Lancet*, 6736(18), 3–49. [https://doi.org/10.1016/S0140-6736\(18\)31788-4](https://doi.org/10.1016/S0140-6736(18)31788-4)

World Health Organization. (2014). *Operational guidance for tracking progress in meeting targets for 2025*. Retrieved from www.who.int/nutrition

Supplementary appendix

A1. Southern lower wealth rural households (n = 75 households)

Fish and form purchased	Frequency reported
Dried Crayfish	22
Frozen Mackerel	20
Fresh Catfish	12
Fresh Mackerel	12
Dried Catfish	9
Fresh Hake	7
Dried fish crumbles	6
Fresh Tilapia	5
Fresh Croaker	5
Fresh bony tongue	4
Frozen saltwater Sardines	3
Dried Codfish	3

Fried Codfish	3
Smoked Mackerel	3
Dried Croaker	3
Fresh saltwater Sardines	3

A2. Southern lower wealth urban households (n = 96 households)

Fish and form purchased	Frequency reported
Fresh Catfish	31
Fresh Mackerel	26
Dried Crayfish	23
Frozen Mackerel	9
Fresh Tilapia	9
Fresh Croaker	8
Dried Catfish	7
Fresh Codfish (probably frozen)	6
Smoked Codfish	5
Smoked Mackerel	5
Fresh saltwater Sardines	5
Dried bony tongue fish	5
Smoked Catfish	4
Smoked Crayfish	4
Dried Threadfin	4
Dried Croaker	4
Smoked Hake	4
Dried Snapper	4
Fresh bony tongue fish	3

A3. Southern wealthier higher wealth households (n = 257 households)

Fish and Form reported	Frequency
Dried Crayfish	124
Fresh Catfish	78
Frozen Mackerel	54
Dried Catfish	49
Fresh Mackerel	46
Dried Codhead	34
Dried Codfish	35
Fresh Periwinkles	23
Frozen Shinynose fish	16
Fresh Tilapia	16
Smoked Catfish	18
Fresh Codfish	13
Dried Tilapia	12
Fresh clupeids	11
Fresh snail	11
Smoked Shinynose fish	10
Fresh Croakers	14
Frozen Croakers	10
Frozen saltwater Sardines	9
Fresh Hake	7
Smoked Mackerel	5
Smoked Codfish	5
Dried Croakers	4
Fresh prawns/shrimp	3
Dried Fish crumbles	3
Dried Bonga	4
Fresh Shinynose fish	3

Fried Codfish	3
Smoked Crayfish	3
Smoked Hake	4
Boiled Periwinkles	3
Smoked Tilapia	3
Frozen Bonga	3

A4. Northern lower wealth rural households (n = 63 households)

Fish and Form reported	Frequency
Fresh Catfish	14
Smoked Catfish	10
Dried Catfish	7
Dried Tilapia	6
Fresh Tilapia	6
Fried Sardines	5
Frozen Codfish	5
Fried Codfish	3

A5. Northern lower wealth urban households (n = 38 households)

Fish and Form reported	Frequency
Fresh Catfish	8
Fresh Tilapia	7
Dried Tilapia	4
Dried Catfish	3
Smoked Catfish	3
Fried saltwater Sardines	3
Dried clupeids	3

A6. Northern higher wealth households (n = 122 households)

Fish and Form reported	Frequency
Fresh Catfish	32
Smoked Catfish	20
Dried Catfish	16
Fresh Tilapia	15
Fried saltwater Sardines	6
Dried Tilapia	6
Frozen saltwater Sardines	8
Fresh saltwater Sardines	7
Frozen Mackerel	6
Fresh Mackerel	3
Smoked Tilapia	3
Canned Mackerel	3
Dried Crayfish	3

About WorldFish

WorldFish is a nonprofit research and innovation institution that creates, advances and translates scientific research on aquatic food systems into scalable solutions with transformational impact on human well-being and the environment. Our research data, evidence and insights shape better practices, policies and investment decisions for sustainable development in low- and middle-income countries.

We have a global presence across 20 countries in Asia, Africa and the Pacific with 460 staff of 30 nationalities deployed where the greatest sustainable development challenges can be addressed through holistic aquatic food systems solutions.

Our research and innovation work spans climate change, food security and nutrition, sustainable fisheries and aquaculture, the blue economy and ocean governance, One Health, genetics and AgriTech, and it integrates evidence and perspectives on gender, youth and social inclusion. Our approach empowers people for change over the long term: research excellence and engagement with national and international partners are at the heart of our efforts to set new agendas, build capacities and support better decision-making on the critical issues of our times.

WorldFish is part of One CGIAR, the world's largest agricultural innovation network.

For more information, please visit www.worldfishcenter.org