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CONSUMPTION ESTIMATES OF FOOD CALORIES IN PORT HARCOURT HOUSEHOLDS, SOUTH-SOUTH NIGERIA: LA/AIDS APPROACH

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Abstract: This research analyzed the households in Port Harcourt city identified the demand patterns through survey and evaluated the effect of price, income and other factors on demand for food calories. Broadly this paper estimated the demand for calories consumed households by utilizing data sets that include household consumption amounts, food commodity prices and expenditures. The paper employs the Linear Approximate Almost Ideal Demand System (LA/AIDS) to estimates expenditure elasticities for the aggregate commodities: rice, yam, garri, and fufu, providing an insight into differences in calories consumption levels and patterns across households. Results of the survey shows that one year increase in the education of household head decreases the share of fufu by 0.378 per cent while that of rice and yam increases by 0.067 and 0.711 percentage respectively. Again, male headed households spend more on fufu (0.590) compared to their female headed counterparts, while it is 0.590 and -0.365 percent smaller for garri and yam. The coefficient of the variables for household size equivalence is negatively significant for garri (-0.897) and fufu (-0.976). Results of tests of homogeneity shows that homogeneity condition in the estimated demand system holds only for fufu, yam and rice. In this connection, it is recommended that greater capacity must be built for multi-disciplinary research and development. Such research and development efforts will undoubtedly reveal a host of calorie food-based products and alternative processing technologies that will enhance household consumption of the products.

Keywords: Urban, Households, Elasticities, Consumption, Gender, LA/LAIDS

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1. Introduction

Changes in the demand and availability of household food in Nigeria are primarily caused by shifts in income growth, urbanization, and patterns of food consumption. Due to the high rate of population growth in the nation, which averages 5 million new births annually at a rate of 2.4%, food needs are rising at a pace higher than 3.5% while food supply is increasing at a rate of over 2.1% (FAO, 2020). Evidence of this tendency has also been observed in China, Kenya, Nepal, and India (Gido et al., 2017; Korir et al., 2018; Zhao et al., 2022). Despite improvements in ensuring adequate supply of food in the last ten years, a sizable percentage of impoverished households still exist in developing nations, such as Nigeria. In order to prevent hunger and malnutrition, the majority of people must consume enough food to meet the minimum daily energy requirement of 2260 kcal per capita, as suggested by the Food and Agriculture Organization FAO (2017). The analysis from FAOSTAT indicates that per capita supply of calories has remained almost negatively skewed in Nigeria and has recently fallen in many homes due to economic recession, unemployment and inflation (Oladimeji et al., 2018). While the number of hungry individuals fell from almost one billion to less than 800 million, throughout this period, the average percentage per capital daily calorie consumption (kcal per capita per day) in developing countries climbed from 2151 in 1976 to 2850 in 2015 and estimated to reach 2980 by 2030 (FAO, 2003). However, this is below the 2500 kcal for men and 2000 kcal for women recommended by FAO and National Health Service NHS (2023) as the standard minimum daily requirement. The estimated 800 million undernourished people are chronically poor and will not be able to achieve food security unless dramatic steps are implemented to boost the incomes of the underprivileged while raising agricultural productivity and reducing reliance on food imports.

According to estimates, 795 million people worldwide lack access to food that is both sufficient and of the correct quality, and one in three of them are severely malnourished (Obalola et al., 2021). According to estimates, almost 40% of Nigerians are undernourished (Ashagidigbi et al., 2012). Most households' productivity is negatively impacted and their capacity to make the best use of food is hindered due to several types of deprivation of basic necessities. Three main variables influence the demand for food: population expansion, urbanization, and changes in consumption habits that lead to an increase in the number of people and an improvement in infrastructure (Pieters et al., 2013).

The need for calories to satisfy our daily productive schedules, particularly in the areas of health, labour, and food security, is the basis for demand estimates of household calorie intake (Aromolaran, 2004). Most definitions of enough food place more focus on the number of calories required for an active, healthy existence than on the necessity of merely surviving (Subramalan and Deaton, 1996). Food consumption has been demonstrated to have a high empirical correlation with productivity and human health from biblical views. Nuani et al. (2022) have noted that an individual is at risk for health problems and therefore unproductive if their lifetime calorie consumption is below a certain threshold. The Federal Government of Nigerian has established food policies and programmes, such as the Agricultural Transformation Agenda, the Agricultural Credit Guarantee, and the Microcredit Scheme for the production of root and tuber crops. These programmes were aimed at promoting the sustainable development of the country's agricultural sector in a bid to expedite import substitution while placing special emphasis on reducing food importation. Since the majority of demand estimates now in use are derived from time series data based on average consumer behaviour rather than the conduct of the homes of interest, they may not be sufficient for assessing the effects of these programmes. Inferentially, determining demand linkages from household surveys becomes imperative and critical for determining the actual situation of urban calories consumers.

The response of households to changes in socioeconomic features in low-income nations is a topic of much dispute; yet, the empirical evidence seems contradictory and layered. For example, estimates of household demand elasticities for food calories by Strauss (1984), Kormawa et al. (2002), and Nuani et al. (2022) are relatively high, supporting the idea that calorie consumption increases with economic expansion. However, estimates of elasticity's that are close to zero have been obtained by Musyoka et al. (2014) and Rozi et al. (2021), indicating that a rise in income will not likely result in a significant improvement in food consumption. They contend that, even among the most impoverished, households tend to substitute taste preferences, accessibility, and nutrient-free options as wealth grows, creating a flat income distribution.

Despite all of these findings, it is evident from the literature on demand analysis that relatively few researches have really looked at the factors influencing calorie intake in sub-Saharan Africa. This stands in contrast to the numerous empirical studies on the consumption of calories by households in South America, Europe, and Asia. Therefore, by closing the gaps in the empirical literature regarding food consumption trends in Nigeria, this paper adds to the present body of literature. The study adopts a unique data on households' characteristics in Port Harcourt, South-Southern Nigeria. The principal objective of this study is therefore aimed at investigating the relationship that exist between consumption expenditure and prices of garri, rice, yam and fufu (a major cassava product in Nigeria) in the study area.

The theory of calories is of paramount importance to this study. Baba et al. (1999) assert that calories are the primary factor in weight gain or loss and that "a calorie is a calorie" regardless of the source (for instance carbohydrates, fat, protein among others). A calorie is a calorie is a principle that is supported by most nutritionists, including Gillian McKeityh and Jack Groppell. According to this school of thinking, "calories in, calories out" determines how much weight is lost or gained. In other words, regardless of the source of the calories, weight loss will occur if an individual burns more calories than they consume. Conversely, weight gain will occur if someone consumes more calories than they burn each day. This idea is based on the observation that carbs and protein both contain around 4 calories per gram, and it doesn't matter where these calories come from. They base this on the many calories consumed daily; weight reduction is the outcome, and vice versa; if one consumes an additional x number of calories daily, weight gain results (Piatti et al., 1994). As a result, sufficient nourishment influences growth and efficiency, and healthy feeding promotes the body's natural development.

Another relevant theory is the Brink's unified theory of nutrition. A person's weight growth or loss is determined by their macronutrient ratio, not by their total calorie intake. According to studies based on this theory, people who follow a higher-protein, lower-carb diet lose roughly the same amount of weight as those who follow a higher-carb, lower-protein diet. This simple statement helps people understand the differences that some people experience when they consume the same number of calories but have very different ratios of fat, carbohydrate, and protein. However, according to Layman et al. (2005), the group following the higher protein diet lost less lean body mass (muscle) and more real fat. The study also shows that a higher protein diet may actually result in less weight loss than a lower protein, higher carbohydrate diet when the same number of calories are consumed but different macronutrient intakes are made. The lower carbohydrate, higher

protein diets actually result in more fat reduction. As one might anticipate, exercise generally has a greater impact.

2. Materials and Methods

The data collection procedure and scope of data for the present study came from a sample of urban household dwellers in the city of Port Harcourt, in Nigeria. This is stratification into strata at this first stage and then random selection. Therefore, 2-stage selection was adopted based on the kinds of homes and residential houses that is low-, medium-, and high-income households they occupied. Two hundred and forty (240) respondent households, drawn at random from each of the three income categories, make up the sample. Data on socioeconomic characteristics, expenditure share of the commodity consumed and products (garri, fufu, yam and rice) were collected from the houses using a well-designed questionnaire. Household heads who responded were asked to recall and state how much they spent, how much they consumed of each food item under consideration, how much they spent in naira, and how much food was physically consumed in the household over the course of the previous seven days.

The survey items included household consumption quantities, income, prices and total expenditure data on food commodities as well as demographic characteristics of each sampled household. In particular, data on age, sex, marital status, educational levels, and household size equivalence etc. were gathered. Other information collected in the surrey included major occupation of respondents and constraints limiting consumers in the area.

2.1. Model Specification and Estimation

In this study, we used an approximation of the Almost Ideal demand system, proposed by Deaton and Manlbaurer (1980) and employed in several food consumption studies such as Deaton and Muellbauer (1986), Edgerton (1997), Tsegai and Kormawa (2009), Bett et al. (2012), and Nuani et al. (2022) and it's applied to a system of three products namely garri, fufu, yam and rice. These three products are key food staples in Port Harcourt household diets. In this model, quantity demand is represented by the budget share of each commodity while price and income are expressed in logarithms. Household consumption expenditure were used in this analysis as a proxy for income because data on expenditures are generally more reliable than income data as questions of income are sensitive and is expected that households underestimate their income (Gibson,1995; Tsegai and Kormawa, 2009). To ensure a more accurate estimation we first used a multistage budgeting strategy, where the household first distributes its expenditure in terms of its total expenditure over broad categories of household commodities, such as food and non-food goods, in order to assure a more accurate estimation. After then, it divides the corresponding spending percentages across the several subcategories of the preceding broad categories (Bett et al., 2012).

Due to the model's practical qualities and adaptability, demand analysis has made extensive use of it. First, the predicted budget shares also add up to 0.1 if the system of equations is complete, meaning that the actual budget share sums up to 1.0. This is referred to as adding up. Once more, imposing or testing for symmetry in the cross-price items is not too difficult. Thirdly, the demand equation and its derivation from a well-behaved utility function are consistent with economic theory. In our analysis, the model aggregates the following variables: educational attainment, gender of the household head, married status of the household head, and family size (equivalence). To incorporate these demographic variables, the LA/AIDS (linear approximate almost ideal demand system) was specified as given in Equation 1:

$$W_it = \alpha_it\ P_ie + P_is + P_im + P_iq + \beta \log\left(\frac{Xt}{Pt^{*}}\right) + \sum_j Y_{ij} \log P_jt \quad (1)$$

where;

W_it = Expenditure share of the thy commodity at period t

α_i= Interceptive of the expenditure in the absence of price, income and other demographics

P_ie = Number of years spent in school

P_is = Gender of household head (male 1, otherwise = 0)

P_im = Marital status of household head (married=1, otherwise = 0)

P_iq = Household size equivalence derived as Es and given as in Equation 2:

$$Es = (A + ac)\ ^\wedge\ b \quad (2)$$

where;

Es = Household equivalence scale which divides household expenditure to obtain per capita expenditure

A = Number of adults in the individual household

C = Number of children in the individual household

b = Household economics of scale constant (0.80)

a = Child adult equivalence constant (0.54)

b = Expenditure coefficient (slope)

Xt = Total expenditure on all commodities under the study period

P_{jt} = Price of the jth commodity during period, t

P_t^{*} = Price index which makes the system linear (approximated using Stone's price index) and it's defined as given in Equation 3:

$$P^{*}_t = \sum WjwgPjt \quad (3)$$

where;

Wj = Expenditure share of the jth commodity

Yij = Coefficient of the row sums of prices and expenditure matrix (Homogeneity testing).

The equation applied to each of the three food commodities. The three equations can be estimated independently under two conditions.

a) If we use the same explanatory variable in each equation or
b) If we do not wish to impose any cross-equation on the system of equations (Gibson, 1995; Abdulai and

Aubert, 2004).

In this study the homogeneity condition is tested, the adding-up condition is imposed by the model and so it's not testable (Deaton and Muellbaurer, 1986). In the context of the LA/AIDS, testing or imposing the symmetry restriction is valid only when the theoretical price index, which is non-linear is used, and not when an approximation index (Stone's price index) is used. Since the theoretical price index is not used in this study, symmetry restrictions are neither tested nor imposed.

The idea behind the concept of household equivalency is that disposable income or expenditure needs to be adjusted in order to compare the dynamics, characteristics, and disparities of households. This is done by determining which age group each member of the household belongs to. This is especially important if we want to accurately assess the factors that affect the welfare and living standards of various households or anticipate behavioural patterns that are common to them (Easton, 2001). Converting the incomes to a per capita basis could be a straightforward adjustment, but that would neglect the impact on household economics of scale and the various characteristics of the population. According to USCB (2021) it is not true that two can live as cheaply as one but two living together are likely to spend less than if they live separately in order to attain the same standard of living.

3. Results and Discussion

The first LA/AIDS regression results as presented in Table 1 indicate that, all things being equal, a one-year increase in the household head's education lowers the share of fufu by 0.378 percent, while the shares of rice and yam increase by 0.067 and 0.711 percentages, respectively. Also, households headed by men spend 0.590 percent more on fufu than households headed by women; similarly, for garri and yam, the expenditures are 0.590 and -0.365 percent lower, respectively. Given that many of the female home heads are widows, it is possible that these discrepancies reflect shifts in the ages of the household heads rather than gender differences in taste.

Table 1 further shows that household size (equivalence) has well-determined effect on garri and fufu expenditures. The coefficient of the variable for household size equivalence is negatively significant for garri (-0.897) and fufu (-0.976) indicating that consumption of calories declines with increasing household size. This outcome is in line with the economic laws established by Engels and Bennett. According to Engels' law, the percentage of a budget allocated to food expenditures tends to decrease as income increases. Bennett's law, which asserts that consumers reallocate their food budget away from starchy staples like yam, rice garri, and maize and towards more expensive sources of calories like fruits, vegetables, and animal items, is a comparable pattern. Nuani et al. (2022) discovered that households with higher income levels have greater purchasing power, which allows them to vary their consumption habits to include wheat goods, fruits, meat products, and beverages. The finding also agrees with Rono et al. (2017), who found negative own-price elasticities for calories such as cassava and yam as expected *a priori*. On the contrary, Manyong et al. (2007) found a positive own price elasticities for cassava flour and *fufu*, confirming the prevalence of the existence of close substitutes.

The domestic demand for non-food items and services appears to be growing faster than the need for food as the economy expands and income levels rise. As a result, demand for fruits, vegetables, and animal products is increasing more quickly than that of grains and tubers. Given that Port Harcourt is Nigeria's third-biggest industrial and commercial hub after Lagos and Abuja, higher income levels are anticipated in the city relative to the nation's average per capita. According to Subramanian and Deaton (1996), even when comparing families with just adults, it is not expected that members of the household will choose to consume the same amount of calories given twice as many resources. On the other hand, economies of scale or shared public goods could free up resources to allow for higher food and calorie consumption. In addition, a home in an urban region seems to have fewer calories accessible than a household in a rural area.

Table 1. Summary of parameter estimates

Products	A	R^2	Pie	Pis	Pim	Piq
Garri (1)	-1.251	0.281	0.237	-0.374	-2.058	-0.897
	(-3.344)[k]		(2.010)	(-0.431)[k]	(-2.764)[k]	(-3.331)[k]
Fufu (2)	-3.181	0.362	-0.378	0.590	-5.233	-0.976
	(-1.442)		(-2.568)[k]	(1.077)	(-1.233)	(-6.047)[k]
Yam (3)	-1.061	0.413	0.711	-0.365	0.88	-0.152
	(-2.547)[k]		(4.744)[k]	(-0.371)	(1.071)	(-0.364)
Rice (4)	-3.053	0.6110	0.067	1.613	0.088	0.188
	(-2.389)[k]		(-2.021)[k]	(2.034)[m]	(0.931)	(8.011)[k]

The numbers in parenthesis are t-values while the dependent variables are presented as budget share; [k] significant at 1 percent level; [l] significant at 5 percent level; [m] significant at 10 percent level; α_i= interceptive of the expenditure in the absence of price, income and other demographic; P_ie = number of years spent in school; P_is= sex of household head (male 1, otherwise = 0); P_im = marital status of household head (married=1, otherwise = 0); P_iq = household size equivalence.

Table 2. Tests of homogeneity

Product	P	Yi1	Yi2	Yi3	Yi4	∑yij
Garri	1.621	-5.664	1.391	5.622	-1.026	3.401
	(15.156)[k]	(-2.068)[m]	(0.458)	(-1.614)[m]	(-2.149)[k]	(1.751)[m]
Yam	1.104	3.723	-0.511	2.052	0.688	3.384
	(16.733)[k]	(1.642)	(-0.138)	0.438	(0.133)	(0.147)
Fufu	6.369	7.233	5.394	5.277	1.241	-1.589
	(1.061)[k]	(6.514)[k]	(7.203)[k]	(5.536)	(5.312)	(1.238)
Rice	2.142	-3.747	-0.301	-0.490	-0.2352	(-5.722)
	(2.489)[k]	(-1.469)	(-0.841)	(-0.186)	(0.591)	(6.355)

The number in parenthesis are t-values while the dependent variables are presented as budget share; [k] significant at 1 percent level; [l] significant at 5 percent level; [m] significant at 10 percent level; Yij = coefficient of the row sums of prices and expenditure matrix (Homogeneity testing); P_t^* = Stone's price index.

Table 3. Expenditure estimates

Food	Expenditure			R^2
Categories	Coefficients (β)	t-stats	Elasticities	Values
Rice	2.134	(22.389)[k]	0.4963	0.5452
Yam	1.896	(16.632) [k]	0.6998	0.3483
Garri	1.469	(15.125) [k]	0.8011	0.2891
Fufu	0.543	(10.711) [k]	0.6252	0.3216

Results of tests of homogeneity are revealed and explained in Table 2. This table has the column headed ∑Yij, the row sums of the unconstrained matrix, which explains the absolute effect on each value share of a 1 percent rise in all prices and total share of household expenditure. The condition for homogeneity requires a zero value (or insignificant). Thus, increase in prices and expenditure will increase expenditure on garri. From the result, test of homogeneity condition in the estimated demand system holds only for fufu, yam and rice. It is assumed that some consumers, especially those who live in cities tend to perceive their wealth and income in nominal naira or dollar terms rather than realizing their actual value, adjusted for inflation. This suggests that money illusion may exist among the consumers. These findings emphasize the need for more superior data to support demand theory. According to research by Deaton and Muellbaurer (1980), Tsegai and Kormawa (2009), Almas et al. (2019), and Obalola et al. (2021) numerous food staples do not meet the homogeneity requirements.

Table 2 further indicates that some of the coefficients on the prices of the calories under consideration were not jointly statistically significant. Several factors such as spatial variation in the sample collection of the 240 respondents as well as wider variation in taste and preferences may be responsible for these visible disparities.

As shown in Table 3, the explanatory power of the independent variables was moderately weak, except in the case of rice. Based on the values of the R2, the equation explains 55% of the variation in rice budget shares, while on the contrary, equations of the other three commodities (yam, garri and fufu) explains 35%, 29% and 33% of the variation. This observed weakness on the values of the R^2 is consistent with some findings in literature (Addo, 2016; Zhao et al., 2022). On the other hand, the expenditure coefficient is statistically significant in all the five equations. Because the budget share (or share allocation) is the dependent variable, a positive and statistically significant expenditure coefficient implies that the share increases with total expenditure. Thus, when income increases, households will consume more of garri (0.801), yam (0.701), fufu (0.6252), and rice (0.4963). The implications of these findings are simple: when income increase by 1 percent, garri expenditure consequently increases by 0.801. There is also a positively increasing pattern that follows the share of yam, fufu and rice in descending order. This observed pattern implies that the expenditure elasticity of rice is more inelastic than the other commodities considered. This therefore means that rice is an income inelastic food and it therefore appears to be gaining grounds as a very essential food alternative in Port Harcourt households. This shows that rice is fast becoming a choice food staple and a necessity in Port Harcourt households. Few factors are perceived to be responsible for this finding; First, the increase in economic importance of rice as a major source of metabolic energy. Second, the increase in the welfare of households due to the growing livelihood options and inclining economic activities in the city, as well as the gradual increase in real income of household heads.

4. Conclusion

In Nigeria, particularly in Port Harcourt, the demand for food commodities, especially calories, has increased significantly during the past few years. This development is the result of a number of factors, including population growth, improved income levels, technological advancements, and improved production resource

requirements. This also includes the trade promotion policies of the federal government, and their exceptional quality of providing excellent sources of dietary energy. The subsector requires improved vertical coordination to increase the need for calories even further. Without better price signals, the subsector is unable to meet the population's demand for the kinds of items.

This paper employs both parametric and non-parametric estimation techniques to investigate the relationship between household calorie products consumption and per capita household expenditure and other socio demographic variables in Port Harcourt households. The result of the survey confirms that Port Harcourt households spend a significant share of their budgets on garri, yam, rice and fufu. In addition, one year increase in the education of household head decreases the share of fufu by 0.378 per cent while that of rice and yam increases by 0.067 and 0.711 percentage respectively, other thing being equal. In addition, households headed by men spend 0.590 percent more on fufu than households headed by women; similarly, for garri and yam, the expenditures are 0.374 and -0.365 percent lower, respectively. Overall, the findings imply that while development methods aimed at boosting economic growth might enhance diet quality, they might not be adequate to increase nutritional intake. The results of this study also imply that methodological issues, contextual features, and demographic differences are primarily to blame for Nigeria's variation in food calories and expenditure elasticity. The research, therefore, recommends that:

i. A problem facing Nigeria's food consumption subsector is a lack of budget which affect there expenditure patterns of calorie demand. Due to a lack of understanding of these factor, resources were inefficiently allocated to projects and investments that produced returns that were below optional. It is advised that more infrastructure be created to support multidisciplinary research and development in this regard. Undoubtedly, research and development initiatives of this kind will uncover a plethora of food goods low in calories and alternative processing methods that will increase the products' use in homes.

ii. The prospects in the utilization of food products lies in convincing the end users of the safety of the products and possible use in diversified forms, demonstrating and harnessing high quality products from their original farm gate produce. This will enhance the quality, and identify future areas of utilization.

iii. A variety of institutional and technical approaches could be used to guarantee better food access through agricultural transformation initiatives. These strategies will help to feed the growing population, lessen hunger, and enhance the lives of the poorest people, as well as to prevent or lessen the degradation of the planet's finite resources. Therefore, it is imperative to adjust to the socioeconomic and local conditions. Doing so might enhance planning and creation of strong connections to intelligent incentive packages that are sustainable and could boost agricultural production, food supply, and demand.

Author Contributions

The percentage of the author(s) contributions is presented below. All authors reviewed and approved the final version of the manuscript.

	M.E.	A.A.	G.O.	F.E.
C	30	20	20	30
D	35	25	20	20
S	30	30	20	20
DCP	30	30	20	20
DAI	30	30	20	20
L	30	30	20	20
W	35	30	15	20
CR	30	30	20	20
SR	35	35	10	20
PM	35	35	10	20
FA	30	30	20	20

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

This study obtained approval from the Ethics Committee of the University of Port Harcourt. The study participants were also informed about the purpose of the study and responded to the questionnaires anonymously, and they were allowed to skip any item they did not wish to answer.

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