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Determinants of households' dietary diversity score in southwest Benin

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Abstract

Dietary diversity exists when a household has access to a variety of foods, which positively impacts the nutrient adequacy of their members' diets. This study aimed to explore the drivers of household dietary diversity based on 12 food groups consumed daily. Binomial models (logit, probit) and multinomial models (with several modalities) were used to analyze data gathered from 558 households selected randomly in 40 villages in Bopa (a commune in the prefecture of the Mono department, South-west Republic of Benin) in December 2020. The results showed a dependency between the household's dietary diversity score and the area of residence, the household's coverage rate of basic needs, and the religion of the head of the household and that of his/her spouse. These results suggested that improving the household livelihood diversification has a direct impact on food availability and purchasing power to cover basic needs.

1. Introduction

The fight against hunger and food insecurity remains a global priority. For decades, approximately one billion people worldwide have suffered from hunger (Shulla and Leal-Filho, 2023). Achieving "Zero Hunger" by 2030, as stipulated by the Sustainable Development Goal (SDG) - Goal 2, remains the primary objective for developing countries striving to ensure food security, improve nutrition, and promote sustainable agriculture. Dietary diversity measures the variety of food consumption (FAO, 2010). The Household Dietary Diversity Score (HDDS) has been validated as an indicator of household energy availability (Hoddinott and Yohannes, 2002) and provides indications of vulnerability levels. A more diversified household diet correlates with calorie and protein adequacy, the percentage of protein from animal sources, and household income (Swindale and Bilinsky, 2006).

In the Republic of Benin, West Africa, the rural economy primarily relies on agricultural outcomes. Less diversified agriculture is vulnerable to climate change impacts, which limit crop yields. Given the positive relationship between agricultural production and household diets, dietary diversity is not assured in rural areas. These areas are exposed to malnutrition, affecting physical health and psychological well-being. Inadequate daily food intake has irreversible consequences for children under the age of two. Therefore, previous researchers have focused on analyzing the determinants of Household Dietary Diversity Score (HDDS) based on social ecosystem, household and individual characteristics.

Social ecosystem drivers of HDDS include livelihoods, food production, processing, transportation, prices and seasonality, supply chain, and media exposure. Trends in food consumption scores, access to land, and the extent of livelihoods correlate with dietary diversity within households. Ayenew *et al.* (2018) found that food production diversity and dietary diversity are linked to seasonal variations in rural Nigeria. Aweke *et al.* (2020) demonstrated that in Babille district (East Hararghe, Ethiopia), households with adequate food consumption tend to produce more crops, own more livestock, and earn higher cash incomes seasonally. Agbugba *et al*. (2022) examined how seasonality and area shape household dietary diversity in Sierra Leone. In rural areas, dietary quality deteriorates during lean seasons, whereas households with better market access in urban areas consume more varied diets. Additionally, Forde and Decker (2022) acknowledged that food transportation and processing at any level can have adverse health effects due to thermal degradation of vitamins; toxin formation, such as acrylamide; or excessive intakes of salt, sugar, and fat. Benson (2015) and Mekonnen *et al*. (2022) respectively demonstrated that irrigation plays a crucial role in reducing seasonality

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in household dietary diversity, and small-scale irrigation significantly affects household economic access to food and nutritional outcomes for women and children. Harris *et al*. (2020) observed trends in food supply, prices, household food expenditures, diets, and nutrition outcomes in Vietnam, concluding that the country is experiencing a nutritional transition. Despite adequate vegetable and fruit supply, vegetable consumption has declined, and increased meat and milk consumption have led to nutritional challenges, such as rising obesity and nutrition-related chronic diseases. The COVID-19 pandemic disrupted food supplies, impacting resilience-building efforts. Saydullaeva (2023) confirmed that rural households in Uzbekistan showed increased dietary diversity among those exposed to specialized culinary television and radio programs compared to those who did not follow such programs. Household crop diversification was higher among those who had attended cooking classes compared to those who had not.

Household dietary diversity depends on several factors (Vaitla *et al.*, 2015): area of residence, household characteristics, coverage rate of basic needs, livelihoods, post-harvest losses, bargaining power, market and cooking fuel access, shocks, stress, coping strategies, food taboos, water, and sanitation. In Australia, a systematic literature review by Needham *et al*. (2020) found a positive association between the healthiness of food retail environments and dietary diversity among people with obesity. Similarly, Vilar-Compte *et al*. (2021) identified urban factors affecting access to healthy food, noting that low-income urban neighborhoods have limited access to nutritious foods, with supermarkets in poorer urban areas offering fewer varieties of healthy products, often of lower quality. For these authors, corner shops mainly offer ultra-processed foods; lack of public transportation access for the poorest people limits their shopping outside of residential areas; and the deficiency of social networks in urban areas does not help them access or share food during difficult times. Comparing food prices, food security, and dietary diversity in Ghana and Cameroon, Kc *et al*. (2018) concluded that smaller, better-educated, and wealthier households exhibit higher dietary diversity and effectively cope with higher food prices by adjusting diets or altering purchasing patterns. Using multivariable linear regression, Drisdelle *et al*. (2020) confirmed that household food security, food access, and shopping behaviors are associated with fruit and vegetable intake among residents of a low-income neighborhood. Increasing dietary diversity is linked to socio-economic status and household food security (Huluka, 2019). In Kenya, Mutea *et al*. (2019) demonstrated that households in humid agro-ecological zones are less food secure than those in semi-humid and semi-arid zones, with factors such as ownership of hand tools for production, off-farm income, consumption of self-produced food, agro-ecological zone type, and farm income influencing household food security. Singh *et al*. (2023) explored the associations between agricultural and socio-economic factors and dietary diversity among farming households in India, finding that distance to food markets, cropping intensity, wealth index, and crop diversity significantly affect HDDS. Post-harvest losses contribute to poor food security during lean seasons in Nepal (Arun and Ghimire, 2019), Burkina Faso (Sanou *et al*., 2018), and during pre-harvest (March to June) and post-harvest seasons (September to December) in Sidama, Ethiopia (Belayneh *et al*., 2021). In the Paute River Basin, Azuay province, Ecuador, Cordero-Ahiman *et al*. (2021) used a Poisson regression model to determine the relationship between HDDS and socio-demographic variables, including housing size, household size, per capita food expenditure, cultivated land area, education level, and marital status of the household head.

Shocks, stress and coping strategies influence household diet quality, characterized by lower overall diet quality and quantity, reduced fruit and vegetable consumption, increased fast-food intake, difficulties in maintaining healthy eating habits, reliance on credit for food purchases, and taking loans (Michels *et al*., 2020; Oskorouchi and Sousa-Poza, 2021). Maggiulli *et al*. (2022) highlighted that food taboos among pregnant women in Africa, Asia and Eurasia restrict access to sufficient, safe, and acceptable quality food, negatively impacting dietary diversity and birth weight. Non-agricultural taboos often exclude foods of non-domesticated animal origin without considering physiological factors. Kihiu and Amuakwa-Mensah (2021) demonstrated that improving women's and men's access to well-functioning agricultural markets enhances household dietary diversity outcomes in Kenya using an inverse probability weighted treatment effect estimator. Usman and Haile (2022) confirmed the association between market access and household dietary diversity, consumption expenditure, and food security in Ethiopia and Tanzania using panel data. In Malawi, Matita *et al*. (2021) used Poisson regression on 400 households to support these findings and noted seasonal limitations during post-harvest and lean seasons.

In Cameroon, Anyanwu *et al*. (2022) observed that inadequate water and sanitation facilities were associated with limited intake of various food groups among older infants and toddlers. Although anemia prevalence was high, there were no significant differences in water and sanitation services. In Tigania, Meru County, Kenya, Waswa *et al*. (2020) examined the relationship between declining availability of firewood, household cooking,

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and eating patterns, which ultimately impact nutritional status by reducing daily cooking sessions and energy demand.

Regarding individual and sociodemographic factors, diet quality varies in Mexico based on age, sex, socioeconomic status, urban/rural area, and region of residence (Pérez-Tepayo *et al*., 2020). Ghanbari Movahed *et al*. (2022) used a multinomial regression model to demonstrate that the household head gender, education level, monthly income, nutritional knowledge, employment status, livestock ownership and access to credit significantly influenced dietary diversity during the COVID-19 pandemic. Although these studies have approached the subject differently, many have limitations, and none were conducted in Benin. This study employs a quantitative approach to identify associated factors (environmental, collective and individual) influencing Household Dietary Diversity Score (HDDS) in southwest Benin.

2. Materials and methods

2.1 Data source

A dataset comprising 558 heads of household and community members was compiled from November 20 to December 11, 2020, in Bopa Commune, Republic of Benin.

The sampling followed a two-stage cluster random sampling method: in the first stage, 40 clusters (villages) were selected randomly within the commune; in the second stage, 17 households were randomly selected per cluster (village), thus 680 households were targeted. The data gathering covered an 82.1% response rate, which means 558 households out of 680.

2.2 Methods

The Household Dietary Diversity Score (HDDS) focuses on dietary diversity, based on 12 food groups. Each food group receives a score of 1 if consumed or 0 if not. The household's score ranges from 0 to 12, reflecting the total number of food groups consumed by the household in the last 24 h (Swindale and Bilinsky, 2006). Consuming 5 to 6 food groups during the leanest period of a non-exceptional period is considered moderate, while consuming 4 or fewer food groups during the same period is considered severe.

In this study, the dependent variable was an unordered categorical variable with 3 possible categories (0-> 0 to 2; 1-> 3 to 4; 2-> More than 5). The literature indicates that extending binomial models (logit, probit) to discrete variables with more than two modalities was achieved using multinomial models. In a dichotomous logit model, only one parameter vector β is required to determine the two probabilities, since Pr(yi = 0) + Pr(yi = 1) = 1 (Hausman and McFadden 1984; El-Habil, 2012). In the multinomial case, a different parameter vector βj is needed for each alternative. For a multinomial logit model with m+1 modalities, m probabilities are estimated:

$$P_j = Pr\,(y = j|X) = \frac{\exp\,(X\beta j)}{1+\sum_{k=1}^{m}\exp\,(X\beta_k)} \quad ; \text{for } j = 1,2, \ldots, m$$

and a reference probability

$$P_o = Pr\,(y = m+1|X) = \frac{1}{1+\sum_{k=1}^{m}\exp\,(X\beta_k)} \quad \text{with} \quad \sum_{j=0}^{m} p_j = 1$$

Another key feature of the multinomial logit is the Independence of Irrelevant Alternatives, where the ratio of probabilities associated with two possibilities, j and i is independent of other possibilities:

$$\frac{P_j}{P_i} = \frac{Pr\,(y = j|X)}{Pr\,(y = i|X)} = \exp\big(X(\beta j - \beta i)\big).$$

The estimation of the parameters of the model is performed using maximum likelihood algorithms. The coefficients' values are not directly interpretable in terms of marginal propensity; rather, their signs indicate whether the variable has a positive or negative effect on the relative probability of choosing j over 0 (Hausman and McFadden1984; El-Habil, 2012). Model estimation results are evaluated similarly to other models:

- Significance of coefficients using the z-statistic ratios,
- Overall goodness of fit using the likelihood ratio (LR) statistic, where under the null hypothesis: H_0: $\beta_1 = \beta_2 = \beta_3 = \ldots = \beta_k = 0$, LR = -2(Ln(LR) - Ln (LU)) follows a chi-squared ($\chi 2$) distribution with k degrees of freedom.
- Pseudo-R^2 is given by: $R^2 = 1 - \frac{\ln\,(LU)}{\ln\,(LR)}$

In this study, the mathematical model takes the form: HDDS = f(X), where:

- HDDS: Household Dietary Diversity Score (dependent variable),
- X: Independent variables include Subdivision of residence of the household; religion of the head of household; rate of coverage of the household's basic needs; religion of the wife of the head of household; age of the head of household, profession of the head of household; economically active people in the household, area of residence, number of years spent in the locality.

3. Results

Among surveyed households, 137 are urban, and 421 are rural. In terms of gender, 82.97% of the heads of

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household were men, compared to 17.03% who were women. Table 1 shows that 87% of households have a diversified diet. Within 24 h before the survey, only 13% of households consumed fewer than 5 food groups. The analysis demonstrates a dependency between the dietary diversity score and the area of residence, the rate of coverage of basic needs, and the religion of the head of household or his/her spouse. Households with an HDDS of 0-2 are primarily located in Gbakpodji, while those with a score of 3-4 are more likely found in Yegodoe and Badazouin. Bopa, Possotome, Agbodji and Lobogo host households with an HDDS above 5.

Table 1. HDDS results according to thresholds.

Household dietary diversity score	Frequency	Percent
0 to 2	9	1.61
3 to 4	64	11.47
5 and +	485	86.92
Total	558	100.00

Source: Applied Anthropology Research Group (2020).

Regarding meeting basic needs, the first category covers less than 25% of the household's basic needs, while more than 50% of these needs are covered for those with an HDDS greater than 5. Despite the diversified diet revealed by the results, its quality was very poor. The food consumed by surveyed households contains few nutritional and energy inputs. Their diet mainly consists of cereals (90%), spices and condiments (93%), vegetables (86%), seafood (80%) and oils and fats (85%). It includes a few white roots and tubers (51%) and fruit (50%), and very little meat (11%), eggs (11%), and milk and dairy products (6%). The average monthly income of three out of five households was below US$67.

According to the econometric model, there was a significant linkage between the household dietary diversity score and the number of years spent in the locality, the area of residence, the religion of the head of household, the rate of coverage of basic needs, and the occupation of the head of household. In terms of housing, 57% of households are owners and have already spent over 10 years in the area. The statistics showed that the number of years spent in the locality reduces the probability of a household being ranked between 3 to 4 by 47% (0.529 - 1), compared to the 0-2 score range. Similarly, living in rural areas (Yegodoe, Badazouin; Bobodji, Gbakpodji) reduces by 16% the probability of a household being ranked in the 5-12 threshold, compared to the 0-2 score class. The religion of the head of household increases by 24.4% the probability of a household having a score between 5 and 12, compared to the 0-2 score class. Catholic (93.2%) and Evangelical (91.8%) religions have the highest household relative proportion in the threshold 5 to 12 score diversity. Similarly, the higher rate of coverage of household basic needs increases by 38.5% the probability of a household having an HDDS score over 5, compared to the 0-2 score class. Additionally, the occupation of the head of the household reduces by 7.5% the probability of a household having a score between 5 and 12, compared to the 0-2 score class.

4. Discussion

In this study, household dietary diversity determinants found are similar to those highlighted by previous analysis: religion of the head/spouse of the household, area and length of residence, rate of coverage of basic needs, and age range of the head of household.

The religion of the household's head and his or her spouse has a significant impact on their diet. During the COVID-19 period, Akhlaq *et al*. (2022) demonstrated that religion and spirituality were dominant factors influencing treatment and diet choices among survivors. The excessive consumption of nitrogen and phosphorus (N and P), two vital nutrients for living organisms, is associated with negative environmental and health impacts. Using 2013 data, Dhar *et al*. (2021) analyzed the food nitrogen footprint of Hindus, Muslims, Christians, and Buddhists, confirming the impact of individual dietary choices on N and P food footprints and advocating for dietary practices consistent with religious food cultures. Religious rituals profoundly influence dietary behaviors and food selections. Studying food intake among Lebanese adults during the fasting month of Ramadan and compared to other times of the year, Shatila *et al*. (2021) found lower intakes of cereals, pasta, eggs, nuts, seeds, milk, dairy, and fats, and higher intakes of vegetables, dried fruit, Arabic sweets, cakes, and sugar-sweetened beverages during Ramadan.

The area of residence influences the dietary habits, as found in our study. Indonesia, experiencing a rapid economic growth and urbanization over the last few decades, was examined by Colozza *et al*. (2019) to assess changes in food expenditures and dietary diversity associated with transitioning from rural to urban living. Their findings indicated increased acquisitions of animal -source and packaged foods, although traditional food practices remain dominant across rural and urban areas, suggesting minimal impact of rural-to-urban transition on food expenditures or dietary habits.

In this study, dietary diversity correlates with length of residence, a factor not extensively explored in the literature. However, longevity of residence fosters familiarity with local diets and contexts, underscoring the pivotal role of dietary habits in acculturation and adaptation. Food consumption patterns reflect human

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adaptability.

Coverage rate of basic needs is seldom scrutinized by researchers, yet it is crucially impacted household dietary diversity. A household's ability to cover basic needs correlates with its income relative to the country's minimum wage or SMIG. In our 2020 survey, conducted when Benin's minimum wage was US$67 per month, this income fell short of meeting overall food basket needs. Penne and Goedemé (2021) present evidence highlighting insufficient household income and inadequate minimum income policies as barriers to accessing a healthy diet across 24 European countries, aligned with national dietary guidelines. Similarly, Obayelu and Osho (2020) examined dietary diversity among low-income urban households in Nigeria, finding that inadequate access to diverse diets predominated among male-headed households. Poggiogalle *et al*. (2021), following systematic review procedures, consistently link family structure, living conditions, educational attainment, and income to dietary patterns and choices.

The results revealed that the age of the household head influences the dietary diversity scores. Among households surveyed, only 8% of those with a head who was over 40 years old scored between 0 and 2 on dietary diversity, suggesting that older heads possess accumulated dietary knowledge that enhances family diet quality over time.

5. Conclusion

The results of this study show that the factors determining household dietary diversity in south-west Benin include: the household's place of residence, the religion of the head of household and their spouse, the household's rate of coverage of basic needs, the number of years spent in the locality, and the occupation of the head of the household.

Conflict of interest

The author states that there is no conflict of interest. All statements or arguments made in this paper are the sole responsibility of the authors.

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