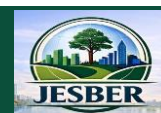


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Research article

SPATIAL ACCESSIBILITY TO RURAL MARKET CENTRES AND HOUSEHOLD FOOD SECURITY IN SOUTHERN CROSS RIVER STATE, NIGERIA

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ABSTRACT

Spatial accessibility to food markets significantly impacts rural food systems, influencing households' access to sufficient and diverse foods. This study investigates the relationship between spatial accessibility to rural market centers and household food security in Southern Cross River State, Nigeria, comparing food-security outcomes across accessibility levels and assessing implications for food-access planning in Southern Cross River State. A cross-sectional survey was conducted from June to August 2024 involving 420 households from 25 rural communities. Data on proximity to market centers, Months of Adequate Household Food Provisioning (MAHFP), dietary diversity, and food expenditure were collected. Households were categorized by distance to the nearest market (10 km or more). Descriptive and comparative analyses assessed food-security outcomes across these categories. Pearson's chi-square test was used to assess the relationship between household proximity to market centers and three food-security indicators. The findings indicated spatial differences in access to rural market centers. Households within 10 km exhibited better outcomes in food provisioning, dietary diversity, and food expenditure compared to those beyond 10 km. Additionally, there was an association between spatial accessibility and food-security outcomes, though the cross-sectional design limits causal inferences. The study emphasizes the need to integrate spatial accessibility into rural food-security planning. Enhancing connectivity, strengthening market infrastructure, and supporting agricultural livelihoods can reduce geographical barriers to food access in Southern Cross River State.

KEYWORDS

spatial accessibility; rural market centres; household food security; dietary diversity; food access; Southern Cross River State.

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1. INTRODUCTION

Food security remains a major development challenge in sub-Saharan Africa, where many rural households continue to experience difficulties in obtaining sufficient, affordable and nutritionally diverse foods. Although food security is influenced by agricultural production, income and other socioeconomic conditions, access to food is also shaped by the spatial organisation of food systems. The geographical location of households relative to markets, transport infrastructure and other food-distribution facilities can influence the time, cost and effort required to obtain food. Consequently, spatial accessibility to food markets represents an important dimension of household food security, particularly in rural areas where geographical inequalities in access can be substantial (Benassai-Dalmau et al., 2026; Usman & Haile, 2022).

Rural market centres perform important functions within local food systems by connecting agricultural producers, traders and consumers. They provide locations through which food commodities are exchanged and distributed and can increase households' access to food items that are not produced locally. Beyond their economic functions, markets also constitute important spaces within wider social and environmental systems, where changing environmental conditions can influence market activities and the resilience of food-distribution networks (Ochiche et al., 2026). Improved access to markets may also reduce transaction and transportation costs, expand opportunities for food purchases and increase access to a greater diversity of food products. Evidence from Eastern Africa demonstrates that households located closer to market centres tend to have higher consumption expenditure, more diverse diets and lower levels of food insecurity than households located farther away (Usman & Haile, 2022). Similarly, a systematic review of studies from low- and middle-income countries found that market access was generally positively associated with farm household dietary diversity, although the magnitude and nature of this relationship varied across geographical and socioeconomic contexts (Nandi et al., 2021). The spatial organisation and distribution of markets have also been recognised as important geographical

issues within Cross River State, where periodic markets serve as important centres of exchange and interaction for surrounding rural communities (Ochiche et al., 2021).

The spatial dimension of market accessibility is particularly important in rural areas where dispersed settlements, inadequate road infrastructure and high transportation costs may constrain physical access to food markets. Recent spatial assessments across Africa show pronounced geographical inequalities in food-market accessibility, with rural and economically disadvantaged populations often experiencing longer travel times and lower market availability (Benassai-Dalmau et al., 2026). Distance to market centres can therefore represent an important geographical barrier, particularly where households depend on walking, irregular public transportation or costly private transport. Longer distances may increase the monetary and time costs of obtaining food, reduce the frequency of market visits and limit access to diverse or perishable food products. Conversely, households located closer to functioning market centres may have greater opportunities for regular food purchases and dietary diversification. However, recent spatial research also demonstrates that geographical distance alone does not fully represent market accessibility, as the relationship between market access and dietary outcomes may vary across local geographical contexts and according to how accessibility is measured (Milner et al., 2022). Evidence from Calabar also suggests that market patronage is shaped by multiple factors, reinforcing the need to consider accessibility within the broader geographical and socioeconomic context in which households interact with markets (Ochiche et al., 2023).

Recent research increasingly demonstrates the importance of markets and accessibility in shaping household dietary outcomes in Africa. Using representative panel data from six African countries, including Nigeria, Nguyen and Qaim (2025) found that market purchases and market access were more important for household dietary diversity than own-farm production. Their findings further showed that the role of food production diversity varied across spatial contexts, reinforcing the importance of considering the geographical organisation of food systems when examining rural diets. Similarly, Usman and Haile (2022) reported that improved market access was associated with higher household consumption expenditure, greater dietary diversity and improved food security among rural households in Ethiopia and Tanzania.

The importance of market access is also evident within Nigeria's evolving food system. Evidence from Nigeria indicates that both rural and urban households obtain a substantial proportion of their food from markets and that market access and non-farm income can reduce households' dependence on producing the foods they consume themselves (Mekonnen et al. 2021). More recent evidence from cross-country African research, including Nigeria, further indicates that markets constitute important sources of diverse foods for rural households (Nguyen & Qaim, 2025). These findings highlight the growing importance of markets within rural food systems. Nevertheless, despite the increasing recognition of market-based food acquisition, relatively limited empirical attention has been given to the geographical relationship between household proximity to rural market centres and multiple indicators of household food security within specific rural areas of Nigeria. Evidence from Cross River State further demonstrates the broader socioeconomic importance of rural markets in supporting livelihoods and facilitating interactions between rural communities and economic activities (Bassey et al., 2023).

This gap is particularly relevant in Southern Cross River State, where agriculture constitutes an important component of rural livelihoods but geographical accessibility varies across communities. Rural settlements differ in their proximity and connectivity to market centres, while road and transportation conditions may influence the movement of both agricultural products and consumers. Such geographical differences can create uneven opportunities for households to access food markets and may consequently correspond with variations in household food-security outcomes. However, there remains limited spatially focused evidence examining how household proximity to rural market centres is associated with food provisioning, dietary diversity and household food expenditure within the study area.

The present study therefore approaches rural market accessibility as a spatial dimension of household food security. Using GPS-based information, it examines the geographical relationship between surveyed households and their nearest rural market centres. Household proximity is subsequently used to assess spatial accessibility, compare food-security outcomes across different levels of market accessibility and examine the relationship between proximity to market centres and selected indicators of household food security. These indicators include months of adequate household food provisioning, dietary diversity and household food expenditure. By

incorporating a spatial perspective, the study contributes to discussions of rural food systems and household food security in Nigeria.

The study is guided by the proposition that spatial accessibility to market centres may influence household food access through its effects on the physical and economic costs of obtaining food. Greater geographical proximity may reduce travel burdens and facilitate more frequent interaction with food-distribution networks, whereas greater distance may increase barriers to obtaining sufficient and diverse foods. At the same time, market accessibility is only one component of household food security and interacts with transportation conditions, household income, agricultural production, food prices and other socioeconomic factors. Accordingly, given the cross-sectional design of the study, the analysis focuses on observed spatial differences and relationships rather than making definitive causal claims.

Against this background, the study examines spatial accessibility to rural market centres and household food security in Southern Cross River State, Nigeria. Specifically, the study is guided by the following research questions:

1. What is the spatial accessibility of surveyed households to rural market centres in Southern Cross River State?
2. How do household food-security outcomes differ across different levels of market accessibility?
3. What relationship exists between proximity to rural market centres and selected indicators of household food security, including months of adequate household food provisioning, dietary diversity and household food expenditure?
4. What are the implications of spatial differences in market accessibility for household food security and rural food-access planning in Southern Cross River State?

2. AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to examine the relationship between spatial accessibility to rural market centres and household food security in Southern Cross River State, Nigeria. Specifically, the study seeks to:

1. examine the spatial accessibility of surveyed households to rural market centres in Southern Cross River State.
2. compare household food-security outcomes across different levels of market accessibility.
3. examine the relationship between proximity to rural market centres and selected indicators of household food security, including months of adequate household food provisioning, dietary diversity and household food expenditure.
4. assess the implications of spatial differences in market accessibility for household food security and rural food-access planning in Southern Cross River State.

3. MATERIALS AND METHODS

3.1 Study Area

The study was conducted in Southern Cross River State, Nigeria, covering the southern part of Cross River State. The study area includes Calabar South, Calabar Municipality, Bakassi, Akpabuyo, Akamkpa, Odukpani and Biase Local Government Areas. The area lies approximately between latitudes 4°25'03" and 5°48'01" N and longitudes 7°58'00" and 8°59'01" E (See Figure 1).

Southern Cross River State is bounded to the north by the Central Senatorial District of Cross River State, to the south by the Atlantic Ocean, to the east by the Republic of Cameroon and to the west by neighbouring states, including Ebonyi, Abia and Akwa Ibom. The area is characterised by diverse physical environments, including inland and coastal plains, river valleys, wetlands and mangrove ecosystems. The wider Cross River Basin and coastal environment are particularly associated with extensive wetland systems and environmental conditions that shape settlement, agriculture and livelihood activities (Akpabio & Umoh, 2021).

Agriculture constitutes an important component of rural livelihoods in the study area. Major food and tree crops cultivated across Cross River South include cassava (*Manihot esculenta*), yam (*Dioscorea* spp.), plantain (*Musa*

spp.), banana (*Musa* spp.), cocoyam (*Colocasia esculenta*), oil palm (*Elaeis guineensis*) and other food crops. Recent agricultural evidence identifies Cross River State as an important producing area for several staple crops, including cassava, yam, cocoyam, plantain and banana (Kalio et al., 2020; NAERLS & FMARD, 2022). Despite the area's agricultural importance, physical accessibility varies across communities. Wetland and swamp environments, seasonal flooding and limitations in rural infrastructure can constrain agricultural activities and movement in parts of the Cross River region (Akpabio & Umoh, 2021). Studies of rural transportation and accessibility in Cross River State also highlight the importance of transport infrastructure and road conditions for rural mobility and development (Bassey et al., 2022; Ilori & Anusa, 2020).

The geographical characteristics of the study area make it appropriate for examining the relationship between spatial accessibility to rural market centres and household food security. Rural communities differ in their proximity and connectivity to market centres and in the geographical conditions that influence physical movement and access to food-distribution networks. These differences provide an appropriate spatial context for examining variations in household market accessibility and associated food-security outcomes.

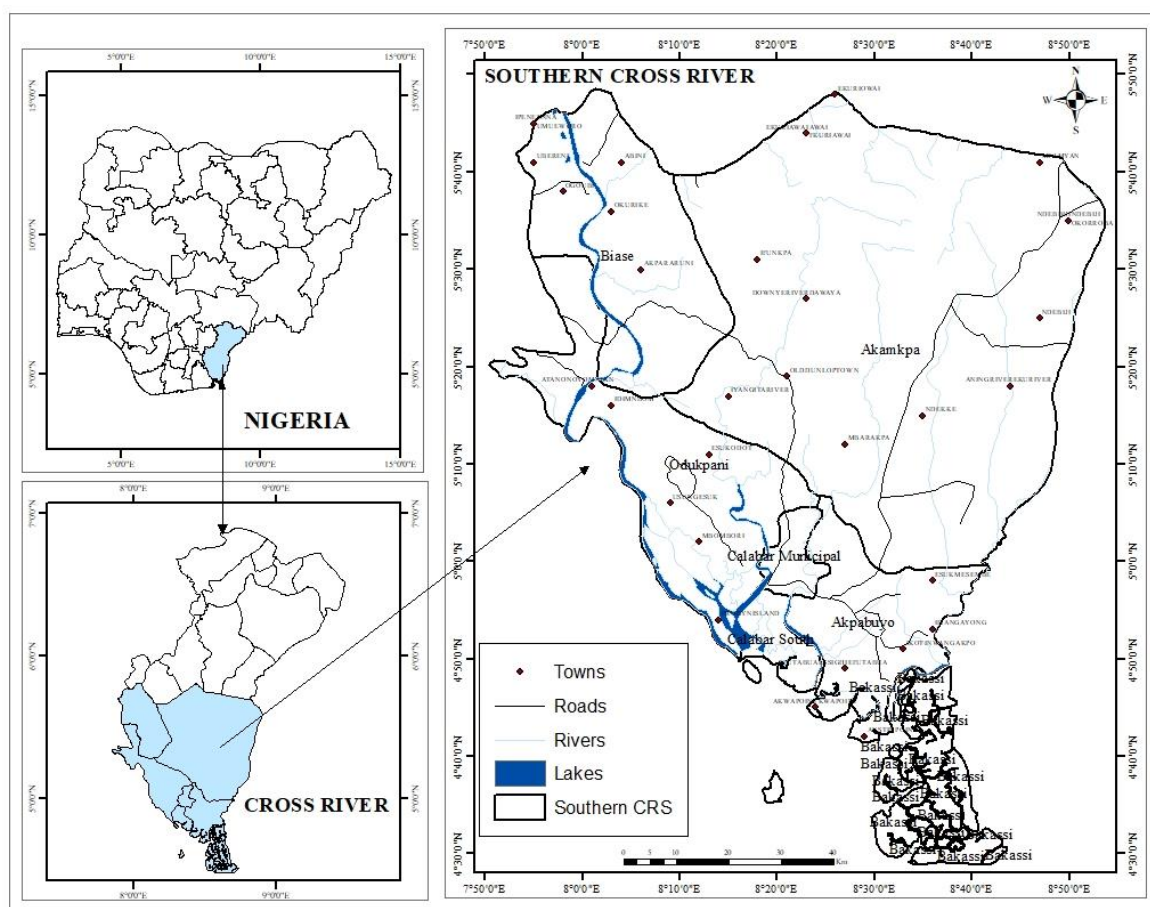


Figure 1. Study Area Location in Southern Cross River State, Nigeria.

Source: Authors' Analysis

3.2 Research Design

The study adopted a cross-sectional household survey design. Data were collected between June and August 2024 from selected rural communities in Southern Cross River State.

3.3 Sampling Procedure and Sample Size

A multistage sampling procedure was used to select households from 25 rural communities across the selected Local Government Areas of Southern Cross River State. The communities were purposively selected along major transportation corridors to capture differences in spatial accessibility to rural market centres. Within the selected communities, housing units were selected using systematic random sampling, and the household heads or representatives were given questionnaire to fill or respond to questionnaire interview.

A total of 420 completed household questionnaires were obtained and used for the analysis. Although the original field records did not document a formal sample-size calculation, the final sample exceeds the conventional Cochran minimum of approximately 384 households for a large or unspecified population at a 95% confidence level, 5% margin of error and 50% assumed population proportion. The sample was therefore considered adequate for the descriptive and comparative analyses undertaken in the study. However, because community selection was restricted to major transportation corridors, the findings should be interpreted within the geographical and sampling scope of the study rather than assumed to represent all rural households in Southern Cross River State.

The selection of communities along major transportation corridors was adopted to capture variation in household accessibility to rural market centres within the study area. However, this approach may introduce selection bias because communities located away from major transportation corridors, particularly more geographically isolated settlements, were not equally represented in the sample. Consequently, households in more remote communities may experience different levels of market accessibility and food-security conditions from those observed among the surveyed households. The findings should therefore be interpreted within the spatial and sampling scope of the study and should not be assumed to be fully representative of all rural households in Southern Cross River State.

3.4 Data Collection

Primary data were collected using a structured questionnaire administered to household heads or their representatives. The survey obtained information on household characteristics, proximity to the nearest rural market centre, monthly household food expenditure, dietary diversity and months of adequate household food provisioning.

GPS-based information and spatial analysis were used to determine household proximity to the nearest rural market centres. The resulting information provided the spatial basis for assessing differences in household food-security outcomes according to market accessibility.

3.5 Ethical Considerations

Prior to data collection, permission to conduct the household survey was obtained from the respective village heads in the selected communities. Participation in the study was voluntary, and respondents were informed about the purpose of the study and the nature of the information being requested. Informed consent was obtained from each respondent before the questionnaire was administered. Respondents were also informed that the information provided would be used solely for academic research purposes and that their participation was voluntary.

3.6 Measurement of Spatial Accessibility to Rural Market Centres

Spatial accessibility to rural market centres was operationalised using the Euclidean distance between each surveyed household and its nearest rural market centre. Geographic coordinates of surveyed households and identified rural market centres were obtained using a Global Positioning System (GPS). The coordinate data were imported into ArcGIS 10.8 for spatial processing and analysis.

The household and market locations were represented as point features in the GIS environment, and the distance between each household and its nearest rural market centre was calculated as straight-line (Euclidean or as the crow flies) distance. The resulting household-to-market distances were subsequently used to classify households according to their spatial accessibility to rural market centres.

3.7 Classification of Market Accessibility

The 10 km threshold used to classify household accessibility was determined from the observed spatial distribution of household-to-market distances and field conditions in the study area. It was therefore adopted as a study-specific analytical threshold rather than as a universally applicable definition of market accessibility.

Households located within 10 km of their nearest rural market centre were classified as having relatively closer market access (≤ 10 km), while households located beyond 10 km were classified as having relatively lower spatial accessibility (> 10 km). This classification provided a consistent basis for comparing food-security outcomes across different levels of market proximity.

3.8 Measurement of Household Food-Security Indicators

Household food security was assessed using three complementary indicators: maximum months of adequate household food provisioning (MAHFP), dietary diversity and monthly household food expenditure. MAHFP captured the number of months during the preceding 12-month period in which households experienced adequate food provisioning. Dietary diversity captured the number of distinct food groups consumed by the household during the specified recall period, while monthly food expenditure was used as a supplementary indicator of household food-purchasing capacity.

The selection of MAHFP and dietary diversity was informed by established approaches to household food-security measurement. However, the indicators were operationalised according to the questionnaire and field conditions of the present study rather than presented as exact replications of standard instruments. MAHFP was categorised into 1–8 and 9–12 months, while dietary diversity was categorised into 1–5 and 6–9 food groups. These categories were defined using mutually exclusive boundaries for the comparative analysis.

Monthly household food expenditure was treated as a supplementary socioeconomic indicator rather than a standalone measure of food security. The three indicators were therefore interpreted jointly to provide a broader assessment of household food-security conditions in relation to spatial accessibility to rural market centres.

3.8.1 Measurement of Maximum Months of Adequate Household Food Provisioning

Maximum Months of Adequate Household Food Provisioning (MAHFP) was used to capture the number of months during the preceding 12-month period in which the household considered its food provisioning adequate. The measure was operationalised as the number of months during which the household did not experience inadequate food provisioning. For comparative analysis, the resulting MAHFP values were grouped into two mutually exclusive categories: 1–8 months and 9–12 months.

The MAHFP approach was selected because it provides a simple measure of seasonal and annual household food-provisioning adequacy and is particularly applicable to rural households whose food access may vary across the agricultural calendar. The study's categorisation and application of MAHFP were adapted to the objectives and field context of the present research.

For the purpose of comparative analysis, MAHFP was categorised into 1–8 months and 9–12 months of adequate food provisioning. Dietary diversity was classified into 1–5 food groups and 6–9 food groups, while monthly household food expenditure was categorised into ₦20,000–₦29,999 and ₦30,000–₦40,000. The categories were defined using mutually exclusive bounds to ensure that each household was assigned to only one category for each indicator.

3.8.2 Measurement of Household Dietary Diversity

Household dietary diversity was assessed based on the number of distinct food groups consumed by the household during the specified dietary-recall period. The food groups represented the range of foods consumed by participating households and were used to provide an indication of the variety of the household diet. For comparative analysis, households were classified into two mutually exclusive categories: 1–5 food groups and 6–9 food groups.

The dietary-diversity measure was used as one of the complementary indicators of household food-security conditions. It was interpreted alongside MAHFP rather than as a standalone measure of overall household food security.

3.8.3 Monthly Household Food Expenditure

Monthly household food expenditure was used as an additional indicator of household food access. Respondents reported their average monthly expenditure on food.

The available results grouped households into the following expenditure categories:

- ~~₦20,000–₦29,999~~, and
- ~~₦30,000–₦40,000~~.

Food expenditure was interpreted cautiously because higher expenditure does not necessarily indicate better household food security. Expenditure may also vary according to household size, income, food prices and purchasing behaviour. It was therefore considered alongside MAHFP and dietary diversity rather than as an independent measure of household food security.

3.9 Data Analysis

The analysis was aligned with the study objectives.

First, descriptive statistics, including frequencies and percentages, were used to examine the spatial accessibility of surveyed households to rural market centres.

Second, the food-security outcomes of households located within 10 km of market centres were compared with those located more than 10 km away. The comparison focused on MAHFP, household dietary diversity and monthly food expenditure.

Finally, the available statistical results were used to examine the reported association between household proximity to market centres and food-security outcomes. Statistical significance was assessed at the 5% level. Pearson's chi-square test of independence was used to examine the relationship between household proximity to rural market centres and the three selected food-security indicators

4. RESULTS AND DISCUSSION

4.1 Spatial Accessibility of Surveyed Households to Rural Market Centres

The first objective of the study was to examine the spatial accessibility of surveyed households to rural market centres in Southern Cross River State.

A total of 420 households were surveyed across the selected communities. Household accessibility to rural market centres was assessed based on the distance between surveyed households and their nearest market centres. The households were classified into two spatial accessibility categories: those located within 10 km of the nearest market centre and those located more than 10 km away.

The results presented in Table 1 show that 302 households, representing 72.0% of the surveyed population, were located within 10 km of the nearest rural market centre. In contrast, 118 households, representing 28.0%, were located more than 10 km from the nearest market centre.

This distribution indicates that the majority of surveyed households had relatively greater geographical proximity to rural market centres. Nevertheless, more than one-quarter of the households were located at distances exceeding 10 km, indicating relatively lower spatial accessibility.

Table 1. Distribution of surveyed households according to distance from the nearest rural market centre

Distance to nearest market centre	Frequency	Percentage
≤10 km	302	72.0
>10 km	118	28.0
Total	420	100.0

Source: Author's Household Survey, 2024.

Discussion

The spatial distribution of households relative to rural market centres demonstrates that market accessibility is geographically differentiated within Southern Cross River State. Although most surveyed households were located within 10 km of a market centre, the finding that 28.0% were located beyond this distance suggests that a substantial proportion of households may experience relatively greater geographical barriers to accessing markets.

This finding is consistent with recent studies that conceptualise food access as a spatially differentiated phenomenon. Campomanes et al. (2024) demonstrated that both physical and economic food access vary considerably across geographical space and that spatial approaches are useful for identifying populations that experience unequal access to food resources. Their findings reinforce the relevance of incorporating geographical location into food-security research rather than treating food access as a purely household-level economic condition.

Comparable evidence from Ghana also highlights the importance of physical access to community markets for rural household welfare. Nkegbe and Mumin (2022), using nationally representative household data from Ghana, found that access to community markets was associated with improved household food security and nutrition. This provides broader sub-Saharan African support for the importance of spatially accessible market infrastructure in shaping household food-access conditions.

The findings of the present study therefore support the argument that distance represents an important, although incomplete, indicator of rural market accessibility. Households located farther from market centres may face greater travel requirements, transportation costs and time constraints. However, geographical distance alone does not fully capture actual accessibility. Road quality, transportation availability, travel time and seasonal conditions may either reduce or intensify the effects of physical distance.

This observation is particularly relevant to the study area because the use of GPS-based location information provides a geographical basis for identifying differences in household proximity to food-distribution facilities. The results therefore establish the spatial context within which differences in household food-security outcomes can subsequently be examined.

4.2 Household Food-Security Outcomes across Different Levels of Market Accessibility

The second objective of the study was to compare household food-security outcomes across different levels of market accessibility.

The comparison was based on three indicators: Months of Adequate Household Food Provisioning (MAHFP), monthly household food expenditure and household dietary diversity.

The results presented in Table 2 reveal noticeable differences in the distribution of household food-security outcomes between households located within 10 km of a rural market centre and those located more than 10 km away.

With respect to MAHFP, households located within 10 km of the nearest market centre had a greater representation in the 9–12-month category, while households located more than 10 km away were more concentrated in the 1–8-month category. Specifically, 230 households located within the relatively accessible category were reported in the 9–12-month category, compared with 42 households among those located farther from market centres.

A similar pattern was observed for dietary diversity. Among households located within 10 km of the nearest market centre, 195 households were reported within the higher dietary-diversity category of 6–9 food groups, while 107 households were within the lower category of 1–5 food groups. Among households located more than 10 km away, 43 households were within the higher dietary-diversity category, while 75 households were within the lower category.

Monthly household food expenditure also differed across the two accessibility groups. Among households located within 10 km of a market centre, 205 households were reported in the ₦30,000–₦40,000 expenditure category, compared with 97 households in the ₦20,000–₦29,999 category. Conversely, among households

located more than 10 km away, 68 households were reported in the lower expenditure category and 50 households in the higher expenditure category.

Overall, the findings indicate that households with relatively greater spatial accessibility to rural market centres showed a more favourable distribution across the three selected food-security indicators.

Table 2. Household food-security outcomes according to distance from the nearest market centre

Food-security indicator	≤10 km n (%)	>10 km n (%)	Pearson χ^2	df	p-value
MAHFP			61.182	1	<0.001
1–8 months	72 (23.8)	76 (64.4)			
9–12 months	230 (76.2)	42 (35.6)			
Dietary diversity			27.340	1	<0.001
1–5 food groups	107 (35.4)	75 (63.6)			
6–9 food groups	195 (64.6)	43 (36.4)			
Monthly food expenditure			23.145	1	<0.001
₦20,000–₦29,999	97 (32.1)	68 (57.6)			
₦30,000–₦40,000	205 (67.9)	50 (42.4)			

Source: Author's Household Survey, 2024.

Discussion

The comparative findings reveal a consistent pattern in which households located closer to rural market centres recorded more favourable outcomes across MAHFP, dietary diversity and food expenditure. This pattern is broadly consistent with evidence from other developing-country settings showing that market accessibility can influence household food consumption and food-security outcomes.

Most notably, the findings closely correspond with those of Usman and Haile (2022), who examined the relationship between market access, dietary diversity and food security using nationally representative household data from Ethiopia and Tanzania. Their findings showed that households located closer to market centres generally had higher household consumption expenditure, more diverse diets and lower levels of food insecurity than households located farther away. The similarity between their findings and those of the present study strengthens the argument that geographical accessibility to markets may represent an important component of household food access in sub-Saharan Africa.

Evidence from Ghana provides a comparable finding. Nkegbe and Mumin (2022) reported that access to community markets was associated with improved household food security and nutrition, although the magnitude of these relationships depended on the broader community-development context. Their findings reinforce the relevance of market accessibility as one component of the wider food-access environment within which rural households obtain food.

The present findings also correspond with broader evidence from a systematic review by Nandi et al. (2021), which found that most empirical studies in low- and middle-income countries reported a positive association between market access and household dietary diversity. However, the review also emphasised that these relationships are context-specific and should not be assumed to operate uniformly across different geographical environments.

The findings should therefore be interpreted as evidence of association rather than causation. Household food-security outcomes may also be influenced by income, household size, agricultural production, food prices and livelihood opportunities. Nevertheless, the consistency of the observed pattern across the three indicators

suggests that spatial accessibility to market centres constitutes an important element of the broader household food environment.

4.3 Relationship between Proximity to Rural Market Centres and Household Food-Security Indicators

Pearson's chi-square test of independence was used to examine the relationship between household proximity to rural market centres and the three selected food-security indicators: maximum months of adequate household food provisioning (MAHFP), dietary diversity and monthly household food expenditure. The analysis showed statistically significant associations between market accessibility and all three indicators. The results indicate that households located within 10 km of a rural market centre generally recorded more favourable food-security outcomes than households located beyond 10 km. However, because the study employed a cross-sectional design, these associations should not be interpreted as evidence of a causal effect of market proximity on household food security.

4.3.1 Proximity to Rural Market Centres and Months of Adequate Household Food

The analysis of the household survey data revealed a statistically significant association between proximity to rural market centres and maximum months of adequate household food provisioning (MAHFP) ($\chi^2 = 61.182$, $df = 1$, $p < 0.001$). Households located within 10 km of a rural market centre recorded a higher proportion of households experiencing 9–12 months of adequate food provisioning, while households located more than 10 km from a market centre were more strongly represented among those experiencing only 1–8 months of adequate food provisioning.

The observed pattern suggests that households with closer spatial access to rural market centres tend to experience more favourable food-provisioning conditions. Greater proximity to markets may provide households with easier access to food supplies and opportunities to purchase food when household production is insufficient. However, the cross-sectional design of the study permits the identification of associations rather than causal relationships. The observed relationship should therefore be interpreted as evidence of a spatial association between market proximity and MAHFP rather than as evidence that greater proximity directly causes improved household food security.

Discussion

The observed relationship between market proximity and MAHFP suggests that geographical accessibility may influence households' ability to maintain adequate food supplies throughout the year. Markets provide households with opportunities to supplement food obtained through their own production, particularly during periods when household food stocks are depleted.

This interpretation is consistent with Usman and Haile (2022), who found that greater market access was associated with lower food insecurity among rural households in Ethiopia and Tanzania. Their study suggests that markets can influence food security through multiple pathways, including reduced transaction costs, improved access to food commodities and improved economic opportunities.

The present finding is also broadly consistent with evidence from Ghana. Nkegbe and Mumin (2022) found that access to community markets was associated with improved household food-security and nutrition outcomes. Although their study examined community-market access using a different methodological approach from the present household-level spatial analysis, both studies point to the importance of market accessibility in shaping rural households' food-access conditions.

The present findings therefore provide additional evidence from Southern Nigeria that the geographical relationship between households and market centres may be relevant to food provisioning. However, unlike studies based on longitudinal or advanced econometric models, the present study is cross-sectional and cannot establish whether proximity to markets independently causes improved food provisioning.

The findings should consequently be interpreted as indicating a statistically significant association between market proximity and MAHFP rather than a causal effect.

4.3.2 Proximity to Rural Market Centres and Household Dietary Diversity

A statistically significant association was also observed between household proximity to rural market centres and dietary diversity ($\chi^2 = 27.340$, $df = 1$, $p < 0.001$). Households located within 10 km of a rural market centre had a higher proportion of households consuming foods from 6–9 food groups, whereas households located more than 10 km from a market centre were more strongly represented in the lower dietary-diversity category of 1–5 food groups.

The result indicates that households with greater spatial access to rural markets tended to report more diverse diets. This finding is consistent with evidence from studies showing that market access can expand household opportunities to obtain a wider range of foods beyond those produced directly by the household. However, other factors, including household income, own-production diversity and food prices, may also influence dietary diversity and were not independently controlled for in the present analysis.

The relationship between market accessibility and dietary diversity is consistent with a substantial body of recent research suggesting that markets provide an important pathway through which households obtain foods that are not produced on their own farms. The systematic review by Nandi et al. (2021) found that the majority of empirical studies examined reported a positive association between market access and farm household dietary diversity. The review nevertheless noted considerable geographical and methodological variation across studies, indicating that the effect of market access depends on local socioeconomic and food-system conditions.

The findings also closely correspond with Usman and Haile (2022), who found that households with greater market access consumed more diverse diets in Ethiopia and Tanzania. The authors argued that improved market access can expand the variety of food available to rural households and provide opportunities for consumption diversification. Evidence from Nigeria also highlights the importance of markets in household food acquisition. Research on rural and urban households in Nigeria found that markets represent an important source of food for households and that market access and non-farm income can reduce the extent to which households depend exclusively on producing their own food. This demonstrates the importance of markets within Nigeria's evolving food system.

However, the relationship between market accessibility and dietary diversity is not always straightforward. A spatially explicit study by Milner et al. (2022) in Kenya found that the relationship between market access and dietary diversity varied depending on how accessibility was measured and the local characteristics of households and farms. In some locations, proximity to roads was more strongly associated with dietary diversity than direct proximity to a physical market.

This contrasting evidence is important for interpreting the present findings. It suggests that the positive association observed in Southern Cross River State should not be interpreted as universal. Instead, the effect of market proximity may depend on transportation infrastructure, market characteristics and local household livelihoods.

Nevertheless, the present findings support the broader argument that spatial accessibility to markets may contribute to household dietary diversification by improving opportunities to obtain foods that are unavailable or only seasonally available through household production.

4.3.3 Proximity to Rural Market Centres and Household Food Expenditure

The relationship between household proximity to rural market centres and monthly household food expenditure was also statistically significant ($\chi^2 = 23.145$, $df = 1$, $p < 0.001$). Households located within 10 km of a rural market centre had a higher proportion of households reporting monthly food expenditure in the ₦30,000–₦40,000 category, whereas households located more than 10 km from a market centre were more strongly represented in the ₦20,000–₦29,999 category.

Although food expenditure is not a standalone measure of household food security, the observed difference indicates that spatial accessibility to markets is associated with differences in household food-purchasing capacity or expenditure patterns. This finding should therefore be interpreted alongside MAHFP and dietary diversity rather than as an independent measure of food security.

The observed difference in food expenditure may reflect the relationship between geographical accessibility and household participation in food markets. Households located closer to market centres may have more frequent opportunities to purchase food and may face relatively lower transportation and transaction costs.

This finding closely corresponds with Usman and Haile (2022), who found that greater market access was associated with higher household consumption expenditure in Ethiopia and Tanzania. The authors argued that improved market accessibility may influence household welfare by reducing transaction costs, improving market participation and creating opportunities for households to diversify their consumption.

However, food expenditure must be interpreted cautiously as an indicator of household food security. Higher expenditure does not automatically indicate greater food security because it may also result from larger household size, higher local food prices or differences in consumption requirements.

For this reason, the present finding is most meaningful when interpreted alongside the results for MAHFP and dietary diversity. The fact that households located closer to markets showed more favourable patterns across all three indicators provides stronger evidence of an association between market accessibility and the household food environment than food expenditure alone would provide.

The Nigerian food-system literature further supports the importance of market participation in household food acquisition. Evidence from Nigeria shows that households increasingly obtain substantial proportions of their food through markets, including households engaged in agricultural production. This means that geographical barriers to markets may influence not only purchasing behaviour but also the broader food consumption opportunities available to households.

4.4 Implications of Spatial Differences in Market Accessibility for Household Food Security and Rural Food-Access Planning

The fourth objective of the study was to assess the implications of spatial differences in market accessibility for household food security and rural food-access planning in Southern Cross River State.

The results demonstrate that differences in geographical proximity to rural market centres correspond with variations in selected household food-security indicators. Households located closer to market centres showed more favourable patterns in adequate food provisioning, dietary diversity and reported food expenditure than households located farther away.

The findings suggest that spatial accessibility should be considered in the planning of rural food systems. Communities located farther from market centres may experience greater travel requirements and potentially higher transportation costs when obtaining food.

Recent spatial research supports the integration of geographical approaches into food-access planning. Campomanes et al. (2024) demonstrated the value of spatially explicit approaches for mapping differences in physical and economic food access across geographical areas. Their work highlights the potential for geospatial methods to identify areas experiencing relative disadvantages in food access.

Similarly, Milner et al. (2022) demonstrated that spatially explicit analysis can reveal important geographical differences in the relationship between accessibility and household dietary outcomes. Their findings indicate that accessibility interventions should account for local geographical contexts rather than assuming that a single measure of market distance will apply equally across all communities.

The present findings therefore support the use of GPS and Geographic Information Systems in rural food-access planning. Spatial information can assist policymakers in identifying communities that are geographically disadvantaged in relation to market facilities.

The findings also have implications for rural infrastructure development. The results of Usman and Haile (2022) suggest that investments in accessible market development and rural infrastructure can strengthen household dietary diversity and food security. Similarly, evidence from Ghana indicates that access to community markets can contribute to improved household food-security and nutritional outcomes (Nkegbe & Mumin, 2022). This suggests that strengthening the spatial and functional accessibility of rural markets can form part of broader interventions aimed at improving household food access and nutrition.

For Southern Cross River State, this suggests the need to consider improved rural roads, transportation connectivity and the strategic distribution of market facilities as part of broader food-security planning.

Nevertheless, spatial accessibility interventions should not be viewed as a complete solution to household food insecurity. Market accessibility interacts with income, agricultural productivity, food prices and household livelihood opportunities. Therefore, improving geographical access should be integrated with broader

interventions aimed at improving household purchasing power, agricultural livelihoods and the affordability and availability of diverse foods.

4.5 Study Limitation

An important limitation of the study relates to the sampling of communities along major transportation corridors. Although this approach facilitated the examination of spatial differences in access to rural market centres, it may have resulted in the underrepresentation of communities located away from these corridors. Such communities may experience greater geographical isolation and different food-access conditions from those observed in the sampled settlements. The findings should therefore be interpreted primarily within the sampled communities and the broader study area rather than generalised without qualification to all rural households in Southern Cross River State. Future studies could address this limitation by incorporating communities at varying degrees of accessibility, including settlements located beyond major transportation corridors.

5. CONCLUSION, POLICY IMPLICATIONS AND RECOMMENDATIONS

5.1 Conclusion

This study examined the spatial accessibility of surveyed households to rural market centres and its relationship with selected indicators of household food security in Southern Cross River State, Nigeria. Using GPS-based information on household proximity to the nearest market centre, the study compared food-security outcomes between households located within 10 km of market centres and those located farther away.

The findings revealed spatial differences in household access to rural markets and corresponding differences in food-security outcomes. Households located closer to market centres showed more favourable patterns in months of adequate household food provisioning, dietary diversity and household food expenditure than those located farther away. The findings therefore suggest that geographical proximity to rural market centres represents an important dimension of household food access and should be considered alongside agricultural production, income and other socioeconomic factors.

The study further demonstrates the value of incorporating spatial accessibility into rural food-security research and planning. However, the findings indicate associations rather than causal relationships, as the cross-sectional design and available data do not permit causal inference. Moreover, distance alone does not fully capture market accessibility, which may also be influenced by road conditions, transportation availability and costs, food prices and household socioeconomic characteristics.

Overall, the study provides evidence that the geographical organisation of rural food systems may contribute to differences in household food-security outcomes in Southern Cross River State. It therefore highlights the need to incorporate spatial considerations into efforts aimed at improving rural food access and household food security.

5.2 Policy Implications and Recommendations

The findings suggest that rural food-security planning should incorporate spatial accessibility assessments. Government and development agencies should use GPS and Geographic Information Systems to identify communities with relatively poor access to rural market centres and prioritise such areas for intervention.

Improving rural road infrastructure and transportation connectivity may help reduce the time, cost and physical barriers associated with accessing markets, particularly for geographically disadvantaged communities. The spatial distribution of market facilities should also be considered in rural and regional development planning, with attention given to strengthening existing markets or providing strategically located facilities where accessibility gaps are substantial.

However, improved physical accessibility alone is unlikely to guarantee household food security. Spatial interventions should therefore be integrated with measures that strengthen agricultural livelihoods, household purchasing power, smallholder market participation and the availability and affordability of diverse foods.

Future research should build on this study by using complete household-level datasets and more comprehensive measures of accessibility, including road-network distance, travel time, transportation costs and seasonal variations in access. Where adequate data are available, multivariable and spatial analytical techniques could

further examine the relationship between market accessibility and household food-security outcomes while accounting for relevant socioeconomic and agricultural factors.

DECLARATIONS

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Data availability: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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