



Dietary diversity, environment and health-related factors of under-five children: evidence from cassava commercialization households in rural South-West Nigeria

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Abstract

Diverse and quality diets are crucial to sustainable growth and development of under-five children, especially those of rural farming households. This study investigated the dietary diversity, environment, and health-related factors of young children. The study employed the use of cross-sectional survey data from 140 under-five children of cassava farming households in Ogun and Oyo states, South-West Nigeria. The study estimated factors influencing dietary diversity of under-five children and assessed children dietary diversity, and the availability of some environment and health-related factors of the farming households. The findings indicated that 98.7% and 97.5% of children consumed grains, with roots and tubers while 36.7% and 36.3% consumed legumes in Ogun and Oyo states respectively. The results also found that 48.6% of children sampled met the minimum cut-off point of 4 food groups with dietary diversity mean score of 3.28. The logit regression analysis indicated that child's age, mothers' age, distance to farm, and food expenditure were among the significant determinants of children dietary diversity. Therefore, this study seeks the collaborative efforts of stakeholders in providing nutrition-sensitive intervention programs for household members, especially mothers and young children in order to promote consumption of diversified diets and enhance healthy living of rural farming households.

Keywords Under-five children · Children dietary diversity score (CDDS) · Malnutrition · Diverse diets · Farm households · Sustainable development goals

Introduction

Diversity of infants and young children's diet is of utmost importance in ensuring sustainable growth and development from infancy to adulthood. When diets are not diversified,

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young children are exposed to diverse forms of malnutrition (undernutrition or overnutrition), mostly stunting and micronutrient deficiency, and leading to heightened morbidity and mortality (NPC and ICF 2019). Young children and women of child-bearing age are mostly regarded as the major groups of people at risk of burdens of malnutrition and therefore, high-quality diets are recommended for them to meet their daily dietary requirement (Global Panel 2016; Garnett 2016; Otegunrin et al. 2019a, b; Otegunrin and Otegunrin 2021a). Diverse and quality diets are equally pivotal to the nutrition and healthy living of all members of the household. Issues of diet and diet quality are crucial to the attainment of almost all the United Nations Sustainable Goals. The most prominent SDGs are SDGs 2, 3, and 12; “end hunger,” “ensure healthy and promote wellbeing for all at all ages” and “ensure sustainable consumption and production patterns” respectively (UNGA 2015; EUPHA 2017; Otegunrin and Otegunrin 2021b). Dietary pattern is regarded as a health barometer and as an indicator of the value of the diets consumed. It is equally valuable for measuring food security status of a particular population (Mirmiran et al. 2006; Azadbakht and Esmailzader 2012; Obayelu and Osho 2020). Dietary diversity is usually linked to the value and amount of food, usually in terms of its accessibility, availability, affordability, and utilization to meet members of the household’s nutrition recommendations (Hilbruner and Egan 2008; Kennedy et al. 2010; Obayelu and Osho 2020). High-quality and diverse diet is sufficient with regards to value and amount, inexpensive, harmless, and culturally acceptable, while contributing to human nutrition and health status (Drewnowski 2014; Donati et al. 2016; Fanzo 2019; FAO et al. 2020; Otegunrin and Otegunrin 2021b). Dietary diversity complements the consumption of all-important dietary fibers and antioxidants that help to ward off diseases (Johns and Eyzaguirre 2007; WHO 2013; Akerele et al. 2017).

The reports from Nigeria Demographic and Health Survey (NDHS) 2018 showed that 37% of under-five children are stunted, 7% are wasted, and 22% are underweight. The report also showed that a little above 10% of under 24-month children were fed minimum acceptable diets in the 24-h period before the commencement of the survey. It is worthy of note that 38.9%, 58.4%, and 39.1% of the rural households in Nigeria had access to electricity, good source of drinking water, and improved toilet facilities respectively (NPC and ICF 2019). However, empirical reports also revealed that the proportion of undernourished population in Nigeria moved up from about 10% in 2000 to 14% in 2018 (von Grebmer et al. 2019; Otegunrin et al. 2020a; Ayinde et al. 2020; Otegunrin 2021). Studies by International Food Policy Research Institute (IFPRI) reported that most of the undernourished population in developing countries are members of smallholder farming households especially in developing low- and middle-income countries who depend mainly on

agriculture as significant means of livelihood with almost no social support interventions (IFPRI 2016). Quality diets are pivotal to the achievement of United Nations Sustainable Development Goal (SDG) because inadequately nourished citizens will be less innovative and productive (Garnett 2016, 2017; Willett et al. 2019; Otegunrin and Otegunrin 2021b).

High-quality dietary patterns that enhance healthy living of members of farming households are one of the factors that lead to increased agricultural production, sales of produce (crop commercialization), and by extension, to the country’s food sufficiency approach.

However, the emergence of ravaging COVID-19 pandemic has huge negative effect on the diet quality of many people around the world leading to a sharp rise in the cost of food items, making it less affordable especially in the developing countries (FAO et al. 2020, 2021; Otegunrin et al. 2020a, b; Otegunrin et al. 2021; Otegunrin and Otegunrin 2020).

Agricultural commercialization (sometimes referred to as market participation) arises when agricultural operations depend mostly on the market for the sale of produce and for the purchase of production inputs (APRA 2018). Also, agricultural commercialization implies increased market transactions (that is, market participation) for capturing the gains from specialization (Carletto et al. 2017; Opondo et al. 2017; Otegunrin et al. 2019c). Commercialization comes in different ways. It may be on the output side of production regarding the sales of agricultural produce or on the input side of production pertaining to the use of purchased inputs. The measurement of the degree of commercialization of subsistence agriculture from the output side of production provides avenue to capture the marketing behavior (from pure subsistence to completely commercialize) of individual households (Carletto et al. 2017; Otegunrin et al. 2019c).

In Nigeria, cassava (*Manihot esculenta* Crantz) ranked first among the most important crops by production and second by consumption (SAHEL 2016; Otegunrin and Sawicka 2019). It is widely believed to be one of the most commonly cultivated root crop and likewise a food security crop in the tropical region. According to FAO statistical database, Nigeria remained the top producer of cassava in six decades (1961–2019) in Africa and globally with total production estimate of 780,000 tonnes in 1961 and now increased to 59,193,708 tonnes in 2019, having 19.5% share of the global production (FAOSTAT 2021). About 90% of the cassava roots are consumed as food while 10% is used for industrial purposes but it is quite unfortunate that export opportunity for cassava in Nigeria is less than 1% (Otegunrin and Sawicka, 2019; Otegunrin and Otegunrin 2021a).

Previous empirical studies have reported the influence of agricultural commercialization on poverty status of rural household members (Hussayn et al. 2020), and influence

of agricultural commercialization on nutrition outcomes of young children in Nigeria and three other developing countries (Okezie and Nwosu 2007; Carletto et al. 2017). Some studies found that about 50% of under-five children from rural households in Madagascar had poorly diversified diets (Rakotonirainy et al. 2018). Recent empirical studies that analyzed the dietary diversity of under-five children of commercializing households in Nigeria are limited. This study is therefore, contributing to existing literature by analyzing the dietary diversity, environment, and health-related factors of under-five children of cassava commercializing households in South-West Nigeria.

Research methodology

The study area

South-West is one of the six geopolitical zones of Nigeria and is located in Western region of Africa with total land mass of 923,768 km² (Maps of World 2021). Nigeria is a multi-ethnic country having Igbo, Hausa, and Yoruba as the three major ethnic groups. The six states in South-West are; Lagos, Ekiti, Ogun, Ondo, Osun, and Oyo. The region lies between latitude 9° 4.9199¹ N and longitude 8° 4.9199¹ E (Find Latitude and Longitude 2021). Ogun state has its capital in Abeokuta which is the most populous city in the state. Ogun state lies between latitude N 6° 54.59¹ and longitude E 3° 15.5018¹, and covers an area of 16,980.55 km². The state is predominantly covered by rainforest with wooden savanna in the northwest. Oyo state lies between latitude N 8° 7.174¹ and longitude E 3° 25.1732¹ and is the fifth most populous state in Nigeria with its capital in Ibadan and covers an area of 24,454 km² (Find Latitude and Longitude 2021). The two states are largely Yoruba speaking states, though not without diversity in dialects within and across the two states. There are two distinct seasons in Ogun and Oyo, i.e., rainy and the dry seasons. Agriculture remained the most common means of livelihood of about 70% of the rural population in Ogun and Oyo states (Lawal and Samuel, 2010; Otekunrin and Otekunrin 2021a). The main cash crops mostly grown in the Ogun and Oyo states include cocoa, citrus, and timber, while the food crops are cassava, yam, maize, cowpea, melon, and millet. Livestock production include pigs, rabbits, sheep, goats, poultry, and snails (Lawal and Samuel, 2010; Otekunrin and Otekunrin 2021a) (Fig. 1).

Study design, samples, data source, and sampling procedure

Cross-sectional data was collected and were used for this study. Multi-stage sampling procedure was employed, random sampling of two from six cassava producing states

in the South-West region was done in the first stage while second stage involved random selection of five Local Government area (LGAs) from Oyo state and three LGAs from Ogun state. In third stage, 24 villages were selected from the eight LGAs. Fourth stage involved a random selection of 16 cassava farming households resulting in a total of 384 farming households. The data were gathered through structured, interviewer-administered questionnaire which include the household socioeconomic characteristics, children dietary diversity score (CDDS), environment and health-related factors, food consumption and expenditure pattern, and other salient household information. After data cleaning, 32 of the questionnaires were discarded due to incomplete information. In the 352 sampled cassava farming households, there were 140 under-five children.

Modeling agricultural commercialization levels

The cassava commercialization levels of the cassava farming households (living with the 140 under-five children) in the study areas were analyzed using crop commercialization Index (CCI) by Strasberg et al. 1999; Carletto et al. 2017; Otekunrin et al. 2019c defined as follows:

$$CCI_i = \frac{\text{Gross value of crop sale}_{\text{hhi, yearj}}}{\text{Gross value of all crop production}_{\text{hhi, yearj}}} \times 100 \quad (1)$$

We have hh_i is the i^{th} household in year j .

With this method of estimation, agricultural commercialization can be represented by a scale from absolute subsistence household (CCI = 0) to perfectly commercialized (CCI = 100). This method allows for more than just the usual dichotomy of sellers and non-sellers, or between staple and cash crop producers (Carletto et al. 2017; Otekunrin et al. 2019c; Otekunrin and Otekunrin 2021b). It also gives information about how much of the harvested households decide to offer for sale in the market. The crop sold ratio represents the ratio of gross value of crop sold and gross value of all crop production (Shively and Sununtnasuk 2015).

Cassava farming households were categorized based on their cassava commercialization levels. Farming households that did not participate (non-sellers) in the sale of the cassava roots were categorized as follows:

- (i) Zero commercialization level (CCI I = 0%) while those that participated actively (sellers) are grouped into;
- (ii) Low commercialization level (CCI II = 1–49%)
- (iii) Medium–High commercialization level (CCI III = 50–75%) and
- (iv) Very high commercialization level (CCI IV = > 75%) levels (Otekunrin and Otekunrin 2021a)

Measuring under-five children dietary diversity score

The under-five CDDS is an important child-centered dietary diversity questionnaire used in measuring children dietary pattern in a period of time such as 30-day, 7-day, and 24-h recall period. Seven (7) food groups and a cut-off of 4 food groups out of the seven, based on WHO guideline was adapted in this study. The food groups are as follows:

- (i) Grains, white roots and tubers
- (ii) Legumes, nuts and seeds
- (iii) Dairy products (milk, yogurt, cheese)
- (iv) Flesh foods (meat, fish, poultry and liver/organ meats, sea foods),
- (v) Eggs
- (vi) Vitamin A-rich fruits and vegetables
- (vii) Other fruits and vegetables (WHO 2007)

The CDDS is the number of food groups consumed by the child in 24-h period. The CDDS was summed up and a score of 1 was given to each food group consumed making a maximum value of 7 points. The proportion of children achieving the minimum of 4 food groups out of 7 was calculated. Other studies that have used similar food groups include; Steyn et al. 2006; Kennedy et al. 2010; Steyn et al. 2014; Ochieng et al. 2017. A CDDS of 4 is referred to as the minimum DDS. This shows that a child having less than 4 CDDS is categorized as having low dietary diversity (WHO 2007; Rakotonirainy et al. 2018; Custodio et al. 2019).

Modeling the determinants of under-five children dietary diversity

The factors influencing dietary diversity among under-five children of cassava commercializing households were analyzed using the logistic regression model. The application of the regression modeling is appropriate given that the dependent variable which is the under-five children dietary diversity score (dichotomous in nature) grouped as one (1) if a child attains 4 or more food groups out of 7, and zero (0) otherwise expressed as a function of a vector of independent variables hypothesized to influence the dietary diversity of under-five children of cassava commercialization households. The independent variables included in the model include child age, child gender, mothers' age, mothers' year of schooling, household size, farm size, farm income, non-farm income, distance to market, food expenditure, mothers' nutrition knowledge, access to healthcare, access to electricity, and access to improved toilet and crop sold ratio (proxy for commercialization levels). The model specification of the logit regression is given below (Gujarati and Porter 2009):

$$\text{Logit}(p) = \ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_i X_i + U_i \quad (2)$$

where p denotes the probability of attaining the dietary diversity of 4 or more food groups out of 7, the β_i 's are the parameter estimates of the independent variables, the X_i 's represent the independent variables and U_i 's are the stochastic error terms.

Results and discussion

The socioeconomic description of under-five children of cassava farming households and CDDS are presented in Tables 1 and 2. The results indicated that the mean age of the children was estimated to be 32.8 months and about 46% were male. About 73% of the household heads were men while the mean age of household head was 49 years, showing that household heads are advanced in age.

The mean household size was 6 persons while household head had about 7 years of education. The mothers had about 5 years of education. Table 1 also revealed that mean household farm income and non-farm income was N139, 250 (431 US \$, February 2020) and N66, 250 (205 US \$, February 2020) per year respectively. The mean household monthly food expenditure was N21, 892. The under-five children mean DDS (standard deviation in parenthesis) was 3.28 (± 1.28) indicating that that on the average, the children fail to meet up with the WHO recommended 4 food groups out of 7 among smallholder cassava farming households in the study areas.

In Table 2, the result revealed that 96.7% and 97.5% of the under-five children consumed grains, with roots and tubers while only 36.7% and 36.3% consumed legumes in Ogun and Oyo respectively (Fig. 2). The results further indicated that only 5.0% and 13.8% of under-fives consumed dairy products in Ogun and Oyo states respectively. On the average (pooled), only 5.0% of the group consumed eggs, only 48.6% met the cut-off point of 4 food groups in 24-h recall period. Studies by Ekesa et al. (2011), Kennedy et al. (2017) and Custodio et al. (2019) found low consumption of food items such as egg, meat, and milk products among young children in some African countries.

In general, the mean number of food groups for this category was 3.28 (± 1.28) indicating that the children in the study areas did not meet the recommended DDS of 4 out of 7 food groups in 24-h recall period. Other study in Nigeria recorded a mean DDS of 6.04 out of 12 food groups for under-five children in Imo state (Ukegbu and Ogu 2017). Studies from other developing economies like the Philippines and Trinidad and Tobago where a mean DDS of 4.91 from 9 food groups for young children in the Philippines while 4.6 from 6 food groups was recorded for under-five

Table 1 Description of household and child-related factors

Variables	Description	Mean	Standard deviation
Child's age	Under-five child's age (months)	32.82	17.49
Household size	Number of persons belonging to the household	5.84	2.28
Household head's age	Head of household's age (years)	49.57	10.94
Mother's age	Age of child's mother (years)	39.49	9.62
Household head education	Number of years of schooling of household head	6.99	3.97
Mother's education	Number of years of schooling of child's mother	4.89	3.78
DDS	Dietary diversity score of under-five (0–7)	3.28	1.28
Farm size	Size of the household cassava farmland (hectare)	1.41	0.99
Farm income	Total household farm income annually (naira)	139,250	120,669
Non-farm income	Annual household non-farm income (naira)	66,250	64,641
Food expenditure	Household food expenditure (monthly)	21,892	8,824
Distance to market	Distance from farm to closest market (Km)	9.15	4.39
Crop share ratio	Crop commercialization index (CCI) level	0.6262	0.2808

Source: underlying survey data 2020. Exchange rate in February 2020: 1 US \$ = N323 Number of under-five children = 140.

Table 2 CDDS (under-five) of cassava farming household members' food groups

S/N	Food groups	Ogun (<i>n</i> = 60) Frequency (%)	Oyo (<i>n</i> = 80) Frequency (%)	Pooled (<i>n</i> = 140) Frequency (%)
1	Grains, white roots and tubers	58 (96.7)	78 (97.5)	136 (97.1)
2	Legumes, nuts and seeds	22 (36.7)	29 (36.3)	51 (36.4)
3	Dairy products (milk, yoghurt, cheese)	3 (5.0)	11 (13.8)	14 (10.0)
4	Flesh foods	38 (63.3)	53 (66.3)	91 (65.0)
5	Eggs	1 (1.7)	6 (7.5)	7 (5.0)
6	Vitamins A-rich fruits and vegetables	11 (18.3)	40 (50.0)	51 (36.4)
7	Others fruits and vegetables	42 (70.0)	68 (85.0)	110 (78.6)
Food groups cut-off				
	< 4 Food groups	40 (66.7)	32 (40.0)	72 (51.4)
	≥ 4 Food groups	20 (33.3)	48 (60.0)	68 (48.6)
	Mean score (±SD)	2.90 (± 1.20)	3.56 (± 1.27)	3.28 (± 1.28)

Field Survey Data, 2020. *SD*, standard deviation.

children in Trinidad and Tobago (Sealey-Potts and Potts 2014) These results are consistent with findings from Savy et al. (2005); Keding et al. (2012); Herrador et al. (2015); Ochieng et al. (2017) who found that diets of children and women comprised mostly starchy staples, roots and tubers, legumes, and vegetables.

The levels of agricultural commercialization of cassava farming households

This section presents the levels of agricultural commercialization of cassava farming households in Oyo and Ogun states, South-West Nigeria. The results were computed using the CCI of each cassava farmers in the cassava farming households as specified above. The results revealed that that 9.2% and 16.1% of smallholder cassava farming households were at zero level of commercialization

(non-seller) in Ogun and Oyo states respectively. About half (49.7%) of the cassava farmers had CCI above 75% in Ogun state while 33.7% were in Oyo state. Less than 50% (40.1%) of the total respondents fall in the category of very high CCI. The mean household CCI of the respondents was 59.1% belonging to the category of medium–high level of commercialization (CCI III) with maximum CCI of 95.5%.

This indicated that cassava farming households that did not participate in marketing of their cassava roots were low (13.4%) while about 87% of cassava farmers participated actively in the study areas. This indicates that cassava farmers do not consume all their produce (cassava roots) but offer larger proportion for sale in open market. This is similar to the study by Hussayn et al. (2020) and Kolapo et al. (2020) who reported higher level of market participation by cassava farmers and processors in Nigeria.

Fig. 1 Map of South-West Nigeria showing the study areas; Ogun and Oyo states. Source: maps of South-West Nigeria (Legit.ng)

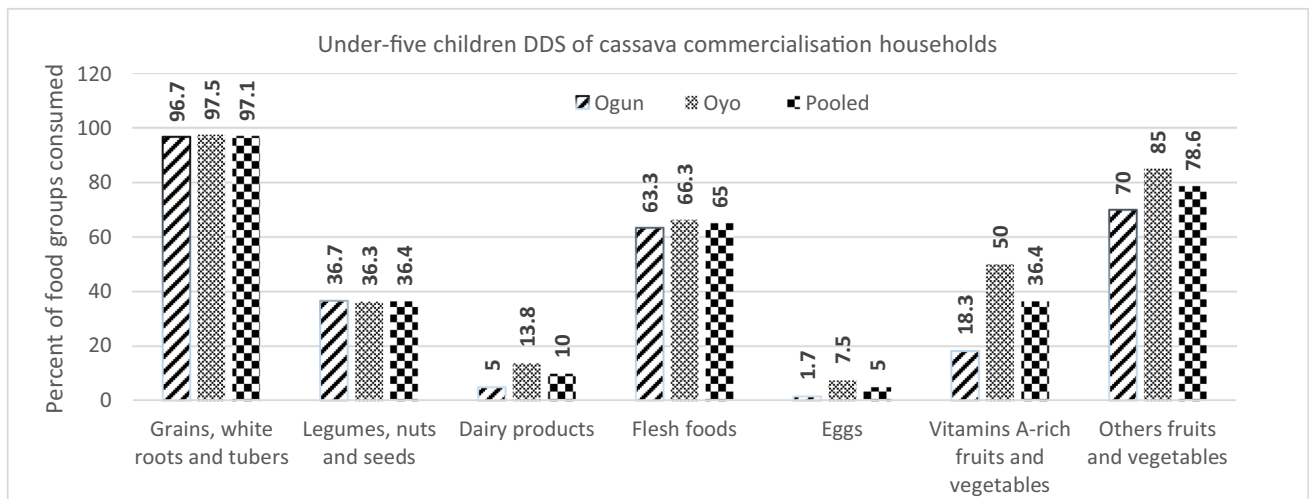


Fig. 2 Under-five children DDS of cassava commercialization households in South-West Nigeria. Source: authors’ graph from field survey 2020. DDS, dietary diversity score

Exploring children dietary diversity among cassava commercialization households levels

This section brings to bear the under-five children dietary patterns belonging to the four cassava commercialization households levels (CCI I–I V) in the Ogun and Oyo states. The results from Table 3 revealed that according to individual cassava household’s CCI levels, all the under-five children in Ogun state that belong to zero commercialization households (zero level) did not meet the 4 food group benchmark while about 73% of the children in Oyo state met the

4 food groups out of 7 in 24-h recall period. Medium–high commercialization households (CCI III) in Ogun had higher percent (68.2%) of under-five children that failed to meet up with the WHO recommended 4 food groups out of 7 while only about 30% of children in the same commercialization household (CCI III) in Oyo state did not meet the recommended 4 food groups. No under-five children were found in Ogun state low commercialization households (CCI II). The results further revealed that the highest percent (60.7%) of children that did not meet the recommended 4 food groups in the two states belonging to the very high commercialization

Table 3 Comparing CDDS (under-five) thresholds and CCI household levels

CCI levels	CDDS (under-five)	State		
		Ogun (n = 60) Frequency (%)	Oyo (n = 80) Frequency (%)	Pooled (n = 140) Frequency (%)
Zero level (non-seller)	Food groups < 4	6 (100)	3 (27.3)	9 (52.9)
	Food groups ≥ 4	-	8 (72.7)	8 (47.1)
	Total	6 (100)	11 (100)	17 (100)
Low level	Food groups > 4	-	3 (30)	3 (30.0)
	Food groups ≥ 4	-	7 (70)	7 (70.0)
	Total	-	10 (100)	10 (100)
Medium–high level	Food groups > 4	15 (68.2)	8 (26.7)	23 (44.2)
	Food groups ≥ 4	7 (31.8)	22 (73.3)	29 (55.8)
	Total	22 (100)	30 (100)	52 (100)
Very high level	Food groups > 4	19 (59.4)	18 (62.1)	37 (60.7)
	Food groups ≥ 4	13 (40.6)	11 (37.9)	24 (39.3)
	Total	32 (100)	29 (100)	61 (100)
Total	Food groups > 4	40 (66.7)	32 (40.0)	72 (51.4)
	Food groups ≥ 4	20 (33.3)	48 (60.0)	68 (48.6)
	Total	60 (100)	80 (100)	140 (100)

Field Survey Data, 2020.

households (CCI IV)—with 59.4% under-five children in Ogun and 62.1% in Oyo states respectively.

However, results from the scatter plot (Fig. 3) between crop commercialization index (CCI) and children dietary diversity score (CDDS) revealed the existence of very weak negative association between CCI and CDDS with correlation coefficient $r = -0.1225$. This relationship shows that as CDDS increases, CCI may go down corroborating the findings (cross tabulation) in Table 3 that under-five children that belong to higher commercialization households (“Very-High Level) recorded the highest percentage of children that failed to meet the recommended 4 food groups out of 7 among the cassava commercializing households in the study areas. It indicated that belonging to highly commercialized

households does not translate to having healthy and quality diets for the young children of cassava farming households.

Under-five children’s environment and health-related factors across cassava commercialization household levels

Tables 4, 5, 6, 7, and 8 present the distribution of under-five children across cassava commercialization households according to environment and health-related factors. Among the factors considered are (i) mothers’ nutrition-related knowledge, (ii) access to piped water, (iii) access to electricity, (iv) access to healthcare service, and (v) access to improved toilet in the Ogun and Oyo states.

Fig. 3 The relationship between CDDS and CCI. Source: authors’ graph from field survey data 2020

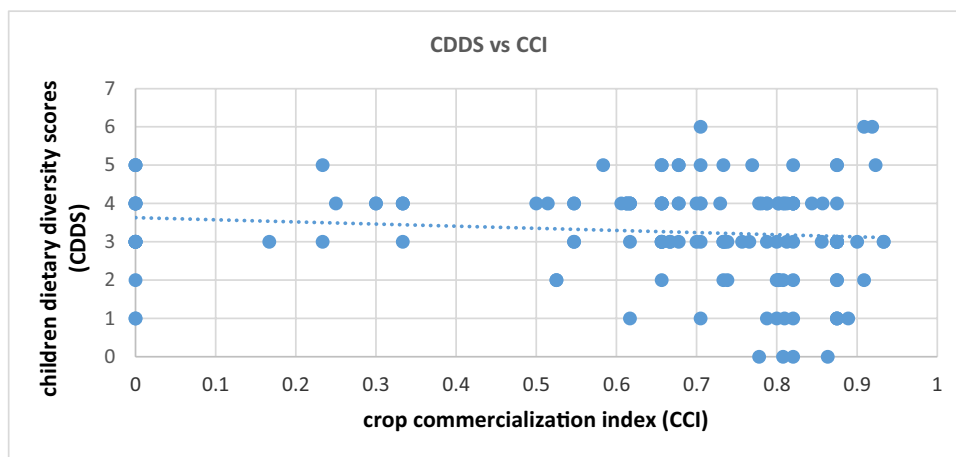


Table 4 Percent distribution of mothers’ nutrition-related knowledge among cassava commercialization household levels

CCI household levels	Mothers’ nutrition-related knowledge	State		Pooled (n = 140)
		Ogun (n = 60)	Oyo (n = 80)	
		Frequency (%)	Frequency (%)	
Zero level (non-seller)	Have nutrition knowledge	1 (16.7)	2 (18.2)	3 (17.6)
	No nutrition training	5 (83.3)	9 (81.8)	14 (82.4)
	Total	6 (100)	11 (100)	17 (100)
Low level	Have nutrition training	-	5 (50)	5 (50.0)
	No nutrition training	-	5 (50)	5 (50.0)
	Total	-	10 (100)	10 (100)
Medium–high level	Have nutrition training	2 (9.1)	7 (23.3)	9 (17.3)
	No nutrition training	20 (90.9)	23 (76.7)	43 (82.7)
	Total	22 (100)	30 (100)	52 (100)
Very high level	Have nutrition training	6 (18.8)	4 (13.8)	10 (16.4)
	No nutrition training	26 (81.3)	25 (86.2)	51 (83.6)
	Total	32 (100)	29 (100)	61 (100)
Total	Have nutrition training	9 (15.0)	18 (22.5)	27 (19.3)
	No nutrition training	51 (85.0)	62 (77.5)	113 (80.7)
	Total	60 (100)	80 (100)	140 (100)

Field Survey, 2020.

Table 5 Percent distribution of access to piped water among cassava commercialization household levels

CCI household levels	Access to piped water	State		Pooled (n = 140)
		Ogun (n = 60)	Oyo (n = 80)	
		Frequency (%)	Frequency (%)	
Zero level (non-seller)	Have access to piped water	2 (33.3)	0 (0.0)	2 (11.8)
	No access to piped water	4 (66.7)	11 (100)	15 (88.2)
	Total	6 (100)	11 (100)	17 (100)
Low level	Have access to piped water	-	0 (0.0)	0 (0.0)
	No access to piped water	-	10 (100)	10 (100.0)
	Total	-	10 (100)	10 (100)
Medium–high level	Have access to piped water	8 (36.4)	0 (0.0)	8 (15.4)
	No access to piped water	14 (63.6)	30 (100)	44 (84.6)
	Total	22 (100)	30 (100)	52 (100)
Very high level	Have access to piped water	5 (15.6)	0 (0.0)	5 (8.2)
	No access to piped water	27 (84.4)	29 (100)	56 (91.8)
	Total	32 (100)	29 (100)	61 (100)
Total	Have access to piped water	15 (25.0)	0 (0.0)	15 (10.7)
	No access to piped water	45 (75.0)	80 (100)	125 (89.3)
	Total	60 (100)	80 (100)	140 (100)

Field Survey, 2020.

Table 4 revealed the level of nutrition-related knowledge among mothers of under-five children in the study areas. The mothers of different cassava commercialization household levels were asked if they were exposed to any nutrition knowledge such as nutrition-related subjects in schools, nutrition training programs by extension officers, or other

government and non-governmental organizations, listening to nutrition-related programs on radio and television before the survey was conducted. The results (Table 4) indicated that about 82% of the mothers in zero commercialization level (CCI I) did not have any form of nutrition knowledge in the two states while it was the same in medium–high

Table 6 Percent distribution of access to electricity among cassava commercialization household levels

CCI household levels	Access to electricity	State		Pooled (<i>n</i> = 140)
		Ogun (<i>n</i> = 60)	Oyo (<i>n</i> = 80)	
		Frequency (%)	Frequency (%)	
Zero level (non-seller)	Have access to electricity	5 (83.3)	0 (0.0)	5 (29.4)
	No access to electricity	1 (16.7)	11 (100)	12 (70.6)
	Total	6 (100)	11 (100)	17 (100)
Low level	Have access to electricity	-	2 (20.0)	2 (20.0)
	No access to electricity	-	8 (80)	8 (80.0)
	Total	-	10 (100)	10 (100)
Medium–high level	Have access to electricity	16 (72.7)	4 (13.3)	20 (38.5)
	No access to electricity	6 (27.3)	26 (86.7)	32 (61.5)
	Total	22 (100)	30 (100)	52 (100)
Very high level	Have access to electricity	16 (50.0)	3 (10.3)	19 (31.1)
	No access to electricity	16 (50.0)	26 (89.7)	42 (68.9)
	Total	32 (100)	29 (100)	61 (100)
Total	Have access to electricity	37 (61.7)	9 (11.3)	46 (32.9)
	No access to electricity	23 (38.3)	71 (88.8)	94 (67.1)
	Total	60 (100)	80 (100)	140 (100)

Field Survey, 2020.

Table 7 Percent distribution of access to healthcare services among cassava commercialization household levels

CCI household levels	Access to healthcare services	State		Pooled (<i>n</i> = 140)
		Ogun (<i>n</i> = 60)	Oyo (<i>n</i> = 80)	
		Frequency (%)	Frequency (%)	
Zero level (non-seller)	Have access to healthcare	5 (83.3)	3 (27.3)	8 (47.1)
	No access to healthcare	1 (16.7)	8 (72.7)	9 (52.9)
	Total	6 (100)	11 (100)	17 (100)
Low level	Have access to healthcare	-	7 (70.0)	7 (70.0)
	No access to healthcare	-	3 (30)	3 (30.0)
	Total	-	10 (100)	10 (100)
Medium–high level	Have access to healthcare	20 (90.9)	17 (56.7)	37 (71.2)
	No access to healthcare	2 (9.1)	13 (43.3)	15 (28.8)
	Total	22 (100)	30 (100)	52 (100)
Very high level	Have access to healthcare	18 (56.3)	10 (34.5)	28 (45.9)
	No access to healthcare	14 (43.8)	19 (65.5)	33 (54.1)
	Total	32 (100)	29 (100)	61 (100)
Total	Have access to healthcare	43 (71.7)	37 (46.3)	80 (57.1)
	No access to healthcare	17 (28.3)	43 (53.8)	60 (42.9)
	Total	60 (100)	80 (100)	140 (100)

Field Survey, 2020.

commercialization households (CCI III) where just 17% of the mothers had nutrition-related knowledge that can help in improving the nutrition and households dietary patterns. Generally, the results revealed that about 81% of the mothers in the four cassava commercialization household levels in rural settings of the two states (Ogun, 85.0%; Oyo, 77.5%) did not have any form of nutrition knowledge that can help

in improving the nutrition and healthy living of the children and other members of the households. This similar to the studies by Fadare et al. (2019) who found low level of mothers' nutrition-related knowledge among rural households in Nigeria. Moreover, other studies found positive association between mothers' educational background (in order to assess healthcare services and comprehend health-related

Table 8 Percent distribution of access to improved toilet among cassava commercialization household levels

CCI household levels	Access to improved toilet	State		Pooled (<i>n</i> = 140)
		Ogun (<i>n</i> = 60)	Oyo (<i>n</i> = 80)	
		Frequency (%)	Frequency (%)	Frequency (%)
Zero level (non-seller)	Have access to improved toilet	3 (50.0)	0 (0.0)	3 (17.6)
	No access to improved toilet	3 (50.0)	11 (100)	14 (82.4)
	Total	6 (100)	11 (100)	17 (100)
Low level	Have access to improved toilet	-	1 (10.0)	1 (10.0)
	No access to improved toilet	-	9 (90)	9 (90.0)
	Total	-	10 (100)	10 (100)
Medium–high level	Have access to improved toilet	8 (36.4)	4 (13.3)	12 (23.1)
	No access to improved toilet	14 (63.6)	26 (86.7)	40 (76.9)
	Total	22 (100)	30 (100)	52 (100)
Very high level	Have access to improved toilet	13 (40.6)	3 (10.3)	16 (26.2)
	No access to improved toilet	19 (59.4)	26 (89.7)	45 (73.8)
	Total	32 (100)	29 (100)	61 (100)
Total	Have access to improved toilet	24 (40.0)	8 (10.0)	32 (22.9)
	No access to improved toilet	36 (60.0)	72 (90.0)	108 (77.1)
	Total	60 (100)	80 (100)	140 (100)

Field Survey, 2020.

messages) and children nutrition (including higher dietary diversity) in other developing economies (Abuya et al. 2011; Frempong and Annim 2017; Rakotonirainy et al. 2018; Custodio et al. 2019).

Table 5 showed the level of access to piped water among cassava commercializing households in Ogun and Oyo states. The result indicated that about 88% of the cassava commercialization household belonging to zero level (CCI I) did not have access to piped water in the two states (Ogun, 66.7% and Oyo, 100%), while only 15.4% had access to piped water in medium–high commercialization households (CCI III) in the two states. The result further revealed that very high commercialization households (CCI IV) had the highest percentage (91.8%) of households with no access to piped water among the four cassava commercialization household levels in the two states (Ogun, 84.4% and Oyo, 100%). Generally, only about 11% of the cassava commercialization households had access to potable source of drinking water in the two states (Ogun, 25.0% and Oyo 0%). This is abysmally lower than the national average (58.4%) recorded in the 2018 for rural households in the country (NPC & ICF 2019). This result is similar to the findings from South Africa (but with higher access to piped water), where it indicated that about 45% of households in South Africa were able to access piped water in 2019 (Omotayo et al. 2021).

Table 6 revealed the level of access to electricity across the four categories of cassava commercializing households in the study areas. The result showed that only about 29% of the cassava commercialization household belonging to zero

level (CCI I) had access to electricity in the two states while about 69% do not have access to electricity in very-high commercialization households (CCI IV) in the two states (Ogun, 50.0% and Oyo, 89.7%). Table 6 further indicated that about 67% of all the four categories of cassava commercialization households in the two states were with no access to electricity (Ogun, 38.3% and Oyo, 88.8%). The percentage of cassava commercialization households in Oyo state (having under-five children) with no access to electricity was more than twice the percentage of those in Ogun state. This result is still lower (32.9%) than the national average (38.9%) of rural households with access to electricity revealed in the 2018 NDHS (NPC and ICF 2019). This may not be unconnected to the fact that more rural farming households in Ogun were connected to the national grid which gave them more access to electricity than those in Oyo state. Moreover, considering Africa's electricity index which revealed that Nigeria's electricity index score (score/100) fluctuate between 1.95 in 2003 and 2.72 in 2020 (AfDB 2013; 2020). Access to electricity tends to improve the living condition of the rural households. It also provides access to nutrition-related information from mass media such as television and radio that can help improve the dietary patterns and diet quality of the young children and that of the entire cassava commercialization households.

Table 7 indicated the level of access to healthcare service across the four categories of cassava commercializing households in Ogun and Oyo state, South-West Nigeria. The result revealed that about 47% of the cassava commercialization household belonging to zero level (CCI I) had access

to healthcare services in the two states while about 71% of the medium–high commercialization households had access to healthcare services in the two states (Ogun, 90.9% and Oyo, 56.7%) and also recorded the highest percentage of households with access to healthcare among the four cassava commercializing households in the study areas. Table 7 further indicated that about 57% of all the four categories of cassava commercialization households in the two states had access to healthcare (Ogun, 71.7% and Oyo, 46.3%). Considering access to healthcare in the two states, higher percent (71.7%) of cassava farming households in Ogun state had access to healthcare that those in Oyo state (46.3%). This result revealed better availability of rural healthcare services in Ogun state than that of Oyo state.

Table 8 indicated the level of access to improve toilet among cassava commercialization household levels in the study areas (Ogun and Oyo states). The result showed that only about 18% of the cassava commercialization household belonging to zero level (CCI I) had access to improved toilet while less than 25% (23.1%) of the households in medium–high commercialization level had access to improved toilet in the two states. Table 8 further indicated that 77.1% of all the four cassava commercialization household levels did not have access to improved toilet in the study areas (Ogun, 60.0% and Oyo, 90.0%). This result is lower

(22.9%) than the national average of about 39%. The Nigeria DHS 2018 revealed that only 39.1% of rural households had access to improved toilet and about 33% of rural households use open defecation (NPC and ICF 2019). According to United Nations Children’s Fund (UNICEF), Nigeria is ranked second globally with 38 million people practicing open defecation while West and Central Africa accounted for about 24% of global open defecation (UNICEF 2021). Open defecation is believed to aggravate the prevalence of malnutrition and diarrheal disease incidence mostly in young children and it is a leading cause of child deaths in Africa (UNICEF 2021; Omotayo et al. 2021).

Determinants of under-five children dietary diversity

Logit regression results of the factors influencing under-five dietary diversity among cassava farming households are presented in Table 9. As indicated above, logit regression was used to regress children dietary diversity against some sets of explanatory variables such as household and child-related, environment, and health-related variables. The dependent variable is a dummy, 1 if child failed to meet the WHO recommended 4 food groups out of 7 and zero otherwise. The results indicated that the log-likelihood ratio is -77.86 with

Table 9 Results of the logistic regression of children dietary diversity

Variables	Estimated values	Robust standard error	$P > z $	Marginal effects
Child age (months)	0.0356***	0.0119	0.003	0.0088
+ Child gender	0.8307*	0.4695	0.077	0.2041
Mothers’ age	0.0505**	0.0243	0.038	0.0126
Mothers’ year of schooling	0.1001*	0.0564	0.076	0.0250
Household Size	-0.0107	0.0935	0.909	-0.0027
Farm Size	0.2226	0.3791	0.557	0.0556
Farm Income	-1.39e-06	2.69e-06	0.606	-3.46e-07
Nonfarm Income	3.96e-06	3.76e-06	0.291	9.87e-07
Distance (farm to market)	-0.1483**	0.0573	0.010	-0.0370
Food expenditure	-0.00006**	0.00003	0.030	-0.00002
+ Mothers’ nutrition knowledge	-0.0353	0.5469	0.948	-0.0088
+ Access to healthcare	-1.0501*	0.5415	0.052	-0.2566
+ Access to electricity	0.1670	0.6151	0.786	-0.0417
+ Access to toilet	-0.4911	0.5731	0.391	-0.1207
Crop sold ratio	0.0844	0.8321	0.919	0.0211
Constant	-1.1798	1.2531	0.346	

(+) Represent dummy variable (0 or 1). ***Significance at 1% level, **significance at 5% level, *significance at 10% level.

Number of observation = 140.

Wald $\chi^2(15) = 34.25$.

Prob > $\chi^2 = 0.0031$.

Log pseudo likelihood = -77.862423 .

Pseudo $R^2 = 0.1972$.

Chi-square probability ($\text{Prob} > \chi^2 = 0.0031$) significant at 1% level, suggesting that the model of good fit. The results in Table 9 revealed that age (months) and mothers' age of cassava farming households in the study areas of Ogun and Oyo states are both significant and positively influence the dietary diversity of the under-five children. The marginal effect coefficient shows that a unit increase in age of child is expected to lead to 0.0088 (0.85%) increases in the probability of under-five children meeting up the WHO recommended DDS of 4 food groups out of 7 per day. This implies that as the child grows older, the probability of meeting the recommended DDS of 4 food groups per day becomes higher. This is similar to Rakotonirainy et al. (2018) who found that young children mostly consume relatively non-varying diets than older children in Madagascar. Also, Custodio et al. (2019) opined that age increase in young children is significantly associated to minimum CDDS. The results marginal effect coefficient of mother's age showed that a unit increase in mother's age will increase the likelihood of a child consuming diverse diets (meeting the recommended CDDS) by 0.0126 (1.26%) when all other factors are held constant. This suggests that the likelihood of not meeting the recommended 4 food groups per day among under-five children reduces as the mother advances in age. This may be connected to the fact that older mothers have more knowledge and experience (informal education) on traditional food preparation that can improve nutrition and wellbeing of the household especially young children.

Distance to market and food expenditure are both significant ($p < 0.05$) but have negative relationship with the children dietary diversity. The marginal effect coefficient of 0.0370 (distance to market) suggests that a unit increase in distance from farm to market (Km) will make the probability of under-five children consuming the recommended 4 food groups go down by 3.9%. The implication of this is that, the farther the distance to the market, the more difficult it is for the children to meet the recommended CDDS. Also, if food expenditure increases by one percent point, the probability of children meeting the recommended 4 food groups per day reduces by 0.002%. This may be possible if the choice of food consumed in the households were not diverse but monotonous in nature especially energy-dense food (mostly carbohydrates), will make it difficult to meet the recommended 4 food groups out of 7 per day.

Moreover, mother's education is significant at 10% level. A unit increase in educational level of a mother of an under-five child will increase the likelihood of a child consuming diverse diets and meeting the recommended DDS by 0.0250 (2.5%) when other factors are held constant. This is consistent with Aemro et al. (2011); Senarath et al. (2012); Rakotonirainy et al. (2018) who posited that low educational level of mothers in households increased the likelihood of the children having a low dietary diversity score. The education

of the parents, especially mothers is very vital in determining how diverse the diets of their household would be especially the young children (Custodio et al. 2019).

Furthermore, access to healthcare services is significant but has a negative influence on under-five children DDS. A unit increase in access to healthcare reduces the probability of under-five children meeting the recommended DDS by 25.6%. This result is contrary to a priori expectation that the more access households have to healthcare services the better their health status. This may be due to the fact that most of the healthcare centers in the study areas are non-existent and those available are ill-equipped with no healthcare personnel to attend them when healthcare services are needed urgently. This is contrary to the findings by Na et al. (2017); (2018) who posited that access to health and nutrition services are associated with children dietary diversity.

The result also revealed that household commercialization levels (crop sold ratio) did not significantly influence children dietary diversity in the study areas. This indicated that levels (CCI I–VI) of commercialization among cassava farming households may not influence the dietary diversity or diet quality of young children and also the entire farm households. Other studies that found similar results (but with women) that CCI household levels did not significantly influence minimum dietary diversity for women (MDD-W) in Ogun and Oyo state, Nigeria (Otegunrin and Otegunrin 2021a).

The study limitations

The study adopted only 24-h recall period for assessing of the dietary diversity of the rural cassava farming households in the study areas. The study relied solely on the ability of the members of the farming households to remember and the correctness of the type of food consumed in that recall period. Also, this study employed only under-five children of rural crop farmers (only cassava farmers) with no consideration for under-five children from rural livestock farming households in the study areas. The study was carried out among rural smallholder cassava farming households having less than 5 ha of farmland while farmers/farming households with more than 5 ha of farmlands were excluded which may give different results.

The results from Ogun and Oyo states (South-West) in this study may not be generalized for all rural farming households from other geo-political zones in Nigeria.

Future research areas

Future studies aimed at assessing the dietary diversity of under-five children of farming households may be carried out in other geo-political zones (South-South, North-Central, South-East, North-West, and North-East) of Nigeria.

Moreover, other studies on dietary diversity of other members of the farming households such as young children (aged 5–9 years), adolescents (10–19 years), women of childbearing age, and men are also needed to assess the dietary patterns of the farming households.

Conclusion and recommendations

Based on the findings of this study, majority of under-five children consumed grains, with roots and tubers while less than 40% consumed legumes in both Ogun and Oyo states. In the two states, about 49% met the recommended minimum cut-off point of 4 food groups with dietary diversity mean score of 3.28. The distribution of under-five children across cassava commercialized households according to environment and health-related factors revealed that about 81% of the mothers did not have any form of nutrition-related knowledge while 77% of the four cassava commercialization household levels did not have access to improved toilet in the two states. The logit regression analysis indicated that child's age, mothers' age, distance to farm, and food expenditure were among the significant determinants of under-five children dietary diversity. The study revealed the existence of very weak negative association between CCI and CDDS which corroborated the findings that under-five children that belong to higher commercialization households ("Very-High Level) recorded the highest percentage of children that failed to meet the recommended 4 food groups out of 7 among the cassava commercializing households in the study areas. Therefore, based on the findings, the study recommends that stakeholders should facilitate adequate nutrition training/orientation for members of farming households especially those saddled with the responsibility of households' food preparation in order to improve their diet quality. Also, there is need for government and non-governmental organizations (NGOs) intervention in the provision of rural infrastructure development such as access road network, functional healthcare centers, public conveniences (improved toilet facilities), and functional piped water facilities to improve the living condition of the rural farming households.

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Data availability The data that support the findings of this study are available upon reasonable request from the authors.

Declarations

Ethical approval and consent to participate The study was approved by the Department of Agricultural Economics and Farm Management Review Board of Federal University of Agriculture, Abeokuta (FUNAAB), Nigeria. Also, the Oyo State Ethics Review Committee of the Ministry of Health, Department of Planning, Research & Statistics approved this study with Reference Number: AD13/479/4420^A. Informed consent was obtained from the respondents before the survey was carried out and respondent data are fully anonymized.

Competing interests The authors declare no competing interests.

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