Economia agro-alimentare /
Food Economy

An International Journal on Agricultural and Food Systems

Vol. 23, Iss. 2, Art. 2, pp. 1-25 - ISSN 1126-1668 - ISSNe 1972-4802
DOI: 10.3280/ecag2-2021oa12344

Prevalence and correlates of food insecurity in rural Nigeria: A panel analysis

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Abstract

The study assessed dynamics of food insecurity among households in rural Nigeria using the Living Standard Measurement Survey-Integrated Survey on Agriculture (LSMS-ISA) collected in 2010/2011 and 2015/2016. Food insecurity status of the households was constructed using Household Food Insecurity Access Scale and analysed with descriptive statistics and random effect ordered probit model. Overall, 63.10%, 26.24%, 9.53% and 1.13% of households were food secure, mildly food insecure, moderately food insecure and severely food insecure, respectively in the first panel; while 46.53%, 31.63%, 19.39% and 2.45% were food secure, mildly food insecure, moderately food insecure and severely food insecure, respectively in the second panel. Food insecurity status increased with large household size, dependency ratio, being female-headed and aging household heads. Households in south-eastern Nigeria had a higher food insecurity incidence than elsewhere. Age, age squared, female to male adult ratio, primary and tertiary education, occupation, marital status, household size, access to credit and living in North East, North West, South West, South East and South zones were the correlates of food insecurity in rural Nigeria. Based on the findings, the study recommended an increased awareness on the use of family planning methods and improved access to family

Article info

Type:
Article
Submitted:
11/10/2019
Accepted:
06/10/2020
Available online:
06/09/2021

JEL codes:
Q18, R21, R23

Keywords:
Food insecurity access scale
Random effects
Socio-economic characteristics
Rural households

Managing Editor:
Simona Naspetti

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planning services. Also, severely food insecure households should be identified and specifically targeted by the government for appropriate safety net interventions.

Introduction

Despite a steady economic growth and development in many parts of the world, a significant proportion of the global population continues to suffer from food insecurity and malnutrition (ESAF, 2007). The Sustainable Development Goal of zero hunger recognizes that hunger and food insecurity are the core afflictions of poor people and specifically sets to end all forms of hunger and malnutrition, achieve food security, improved nutrition and promote sustainable agriculture by 2030 (UNDP, 2016). Thus, this makes food insecurity a very pertinent area of research. Food insecurity is a social and economic problem of lack of food due to resource or other constraints, not voluntary fasting or dieting, or because of illness or for other reasons (National Research Council, 2006). It is experienced when there is uncertainty about future food availability and access, insufficiency in the amount and kind of food required for a healthy lifestyle or the need to use socially unacceptable ways to acquire food (Wolfe *et al*., 2003; Quandt *et al*., 2001). Food insecurity is measured as a household level concept that refers to uncertain, insufficient, or unacceptable availability, access, or utilization of food. It is associated with inadequate intake of key nutrients, risk of overweight in women and some girls, depressive symptoms in adolescents and academic and social developmental delays in children (Stormer and Harrison, 2003). It is also associated with more behavioral problems and poorer school performance (Alaimo *et al*., 2001).

The prevalence of poverty and hunger is more pronounced in the rural areas of Nigeria where up to 80% of the population survive on less than a US dollar per day (Food Security Portal, 2014). Particularly, rural households have become even more vulnerable to malnutrition, erratic supply of food items, unaffordable food costs, low quality foods and sometimes complete lack of food (Akinyele, 2009). The International Fund for Agricultural Development (2012), rated Nigeria as the number one producer of yam, cassava and cowpea in the world. Nigeria is also the second highest producer of sweet potatoes in the world (Rolando, 2017; FAO, 2020). Despite these indices, Nigeria remains a food insecure nation and relies heavily on food importation. Majority of the rural populace engage in subsistent farming on small plots of land to feed their households and rely on seasonal rainfall

(Omorogiuwa *et al*., 2014). This suggests that rural households experience consistent food insecurity.

Although Nigeria prides itself as the giant of Africa with its economy becoming the largest in 2014, Not less than 70% of the Nigerian population survives on less than a dollar per day while food insecurity prevalence in rural areas stands at 71% (Akerele *et al*., 2013; Omorogiuwa *et al*., 2014)). According to FAO (2015) report, despite Nigeria having achieved a reduction of undernourishment of the population by more than half, from 19.3% in 1990 to 8.5% in 2010, the number of undernourished in Nigeria increased from about 10 million to almost 13 million from 2010 to 2012. Nigeria was also ranked 93^{rdt} out of a total of 117 countries on the 2019 Global Hunger Index and 15^{8th} out of a total of 189countries on the 2019 UNDP Human Development Index (Grebmer, 2019; UNDP, 2019).

Several studies had been carried out in different parts of Nigeria on household food insecurity using micro data (Akerele *et al.,* 2013; Agbola, 2014, Ahmed *et al*., 2015, Irohibe and Agwu, 2014, Ibrahim *et al.,* 2016). Further, previous studies had estimated food insecurity status using Foster, *et al*. (1984) food poverty index (Akerele *et al*., 2013), Cost of Calories (Agbola, 2014; Ahmed *et al*., 2015), Coping Strategies Index (Ibrahim *et al*., 2016), Household Dietary Diversity Scale (Ogundari, 2017), Food consumption score (Owoo, 2018), Food energy intake (Ayantoye *et al*., 2011) and USDA approach (Obayelu, 2012) to estimate food security. However, Ogundari (2017) used a nationally representative data to group households into different levels of food insecurity using food expenditure and dietary diversity score. This study however deviates from these studies by using a panel data to estimate correlates of food insecurity in rural Nigeria. Panel data suggest that households are heterogeneous and there is the risk of obtaining biased results if heterogeneity is not controlled (Baltagi, 2005). Therefore, panel data analyses are able to control for time invariant variables as well as identify and measure effects that are simply not detectable in pure cross-sections or pure time-series data. Panel data thus provide more informative result with more variability, less colinearity among the variables, more degrees of freedom and more efficiency (Blundell & Matyas, 1992). The panel models allow us to construct and test more complicated behavioural models than purely cross-sectional or time-series data. The study therefore contributes to the growing body of literature on panel data analyses of household food insecurity in developing countries, especially Nigeria. The prevalence and determinants of rural household food insecurity were therefore assessed overtime.

1. Methodology

The General Household Survey-Panel data was collected by the National Bureau of Statistics (NBS) in conjunction with the World Bank. Data from two waves, 2010/2011 (wave 1) and 2015/2016 (wave 3) were employed for the study and each wave consists of two seasons, post-planting and post-harvest. This study employed primarily the post-harvest data that was collected between July and August, however, missing information including educational status, remittances and other socioeconomic information was updated using the post-planting round that was collected between January and February. Data for the GHS panel survey was collected from 3,347 rural households and 1,569 urban households for wave 1 and from 3,114 rural households and 1,468 urban households for wave 3. The difference between the sample sizes of the two waves is because of non-response from households and also a change of location of some households. Therefore, due to incomplete information from some households and the panel nature of the study, data from 3,022 rural households constituted the sample size and were used for this study.

The Household Food Insecurity Access Scale (HFIAS) is a household food security survey instrument developed by the Food and Nutrition Technical Assistance program at the United States Agency for International Development (USAID, 2007). The choice of Household Food Insecurity Access Scale is based on the fact that the experience of food insecurity causes predictable reactions and responses that can be captured, quantified and summarized in a scale (Coates *et al*., 2007). The questionnaire consists nine Likert scale questions on various household responses to food access within the previous four weeks. The ranked responses to the nine HFIAS questions can be summed and presented as a scaled score to represent household food access insecurity (called the Household Food Insecure Access Scale Score or the HFIASS). In the HFIASS, higher values represent worse household food access. The HFIAS can be used as a continuous measure of the degree of food insecurity (access) in the household. A HFIAS score variable is calculated for each household by summing the codes (between 0 and 3) for each frequency-of-occurrence question. The maximum score for a household is 27 (the response of the household was 'often' to all 9 questions, coded with 3) and the minimum score is 0 (the household responded 'no' to all occurrence questions, and therefore the frequency-of-occurrence questions could be skipped). Food insecurity increases with the scores. According to this classification method, food secure households ≤ 1; Mildly food insecure households scored 2 to 8; Moderately food insecure households scored 9 to 16; and severely food insecure households scored 17 to 27.

The basis for random effects model is that the individual-specific difference across entities is expected to be a stochastic variable that is uncorrelated with the explanatory variables. The structural model of the random effects ordered probit model is presented as a latent variable model where the observed ordinal responses Y_{it} are generated from the latent continuous responses (Greene, 2012). Our model is given by:

$$Y_{it} = X_{it}\beta + vi + \varepsilon \quad (1)$$

Where, Y_{it} is a latent variable (food Insecurity statuses) ranging from 1 to 4; i is the observation; X is a vector of explanatory variables; β is a vector of unknown parameters to be estimated; v is the time-invariant random variable assumed to be unrelated to any independent variable; and ε is the error term assumed to be independent and distributed as standard normal with mean zero and variance one.

The individual's error term is not correlated with the predictors which allows for time invariant variables to play a role as explanatory variables by specifying the intercept parameters α_i to consist of a fixed part that represents the population average ($\bar{\alpha}$) and a random individual difference from the population average, e_{it}, this is broken down as: $\alpha_i = \bar{\alpha} + e_{it}$. The random individual differences e_{it} called the random effects, are analogous to random error terms, and it is assumed that they have zero mean, are uncorrelated across individuals and they also are assumed to have constant variance, σ^2 e, so that; E(e*i*) = 0, cov(e*i* *ej*) = 0 and var(e*i*)= $\sigma^2 e$, then

$$Y_{it} = \bar{\alpha} + e_{it} + \beta X_{it} + u_{it} \quad (2)$$

Rearranging,

$$Yit = \bar{\alpha} + \beta xit + vit \quad (3)$$

vit is the combined error term and this model is often referred to as error component model.

The measurement model for ordered outcomes was obtained by expanding the measurement model for binary outcomes by dividing the latent variable into four ordinal categories:

$$Y_{\text{it}} = m_i \; if \; m_{i-1} < y_{\text{it}} < \tau_m$$

Therefore, the latent variable could be measured as

$$Y_{it}\begin{cases} 1 - \text{Food secure} & \text{if } \tau_0 = {}_1 \le y_{it} \le \tau_1 \\ 2 - \text{Mildly food insecure} & \text{if } \tau_1 = \tau_1 \le y_{it} \le \tau_2 \\ 3 - \text{Moderately food insecure} & \text{if } \tau_2 = \tau_2 \le y_{it} \le \tau_3 \\ 4 - \text{Severely food insecure} & \text{if } \tau_3 = \tau_3 \le y_{it} \le \tau_{4=4} \end{cases}$$

X_i = ith explanatory variable (i = 1, 2, 3, … n)
β_i = coefficients ith explanatory variable (i = 1, 2, 3, … n)
ε = error term

This model was run using Stata/SE version14.1.

The Wald test is one of three classical approaches to hypothesis testing, together with the Lagrange multiplier and the likelihood-ratio test. It is based on the asymptotic normality of the estimator, specifically in that it tests whether the difference between the unrestricted parameter estimate and the hypothesized value is statistically significant. An advantage of the Wald test is that it only requires the estimation of the unrestricted model, which lowers the computational burden when compared to the likelihood-ratio test. Under the Wald statistical test, the maximum likelihood estimate of the parameter of interest is compared with the proposed value, with the assumption that the difference between the two will be approximately normally distributed. Typically, the square of the difference is compared to the chi-square distribution. In the standard form, the Wald test is used to test linear hypotheses that can be represented by a single matrix. The hypothesis for the test a non-linearity is:

$H_0 : c(\theta) = 0$
$H_1 : c(\theta) \neq 0$

The model was then subjected to the Hausman test (Wooldridge, 2003) to choose between the fixed or the random effect. The null hypothesis states that if the individual effects are random, there would be no significant difference between the estimators because they are consistent. However, the estimators differ in the alternative hypothesis.

2. Results and Discussion

2.1. *Food insecurity profile by households' demographic characteristics*

The study defined a household head as the leader of a group of people living together under the same roof, sharing meals and taking decisions together. About 26.2% of the rural households were mildly food insecure,

9.5% were moderately food insecure and 1.1% were severely food insecure in the first panel, while food insecurity status worsened in the second panel to 31.6%, 19.4% and 2.5% mildly, moderately and severely food insecure households respectively (Table 1). Overall, the incidence of food insecurity increased from 36.9% in the first panel to 53.5% in the second panel suggesting a movement of rural households into food insecurity in the second panel. This movement into food insecurity may be as a result of limited economic and physical capacities as well as environmental and economic shocks (Edeh & Brempong, 2015) and agrees with the findings of Ribar and Hamrick (2003) that rural households move into and out of a state of food insecurity and malnutrition. In addition, there was a persistent increase in the prices of food items between 2014 and 2017 across Nigeria, which reduced the economic access of the Nigerian households to food items (FAO, 2019). The prevalence of rising food insecurity therefore has different consequences for the individual, society, and government (Daneshi-Maskooni *et al*., 2017). Moreover, the incidences of food insecurity increased among female-headed households but decreased among their male counterparts in the second panel (Table 1). Overall, the incidence of food security reduced from 66.3% to 49.7% and 41.6% to 32.7% of all the male-headed and female-headed households, respectively. Notably, there was a 46.2% increase in female-headed households in the second panel probably owing to death of spouse or divorce. Male-headed households were thus more food secure than their female counterparts. This conforms to the findings of Ahmed *et al*. (2015) that female-headed households usually have limited access to productive assets and are usually saddled with the responsibility of home keeping and raising children which usually limit their involvement in income generating activities.

Households with younger household (≤ 30 years old) heads were the least food secure, while those in 31-40 and 41-50 year cohorts constituted 49.3% of the food secure group in almost equal proportion in the first panel. Food insecurity for this age group also decreased from 20.59% in the first wave to 17.57% in the second wave. This may be because they are in the productive age group and would be able to make a meaningful impact in agricultural production and as well participate in non-farm activities for improved food security (Agada & Igbokwe, 2014). Incidence of severe food insecurity also increased by 15.4% among the aged (> 60 years), while food security incidence increased by 37.7% among them. This suggests that that older household heads are more likely to move into food insecurity because they may not have adequate resources to curb food insecurity owing to reduced income from fragile health and morbidity (Quddus & Bauer, 2014).

Moreover, households with married heads experienced the highest level of food security in the both panels, while food insecurity indices of the widowed households increased in the second panel. Thus, joint efforts by

couples to provide for the food requirement of the household improves the chances of being food secure. Married households are likely to be more food secure owing to the fact that they are likely to have larger households with members engage in income generating activities and contribute to household income (Yusuf *et al*., 2015).

Table 1 - Food insecurity profile by household demographic characteristics

Demographic characteristics	2010/2011				2015/2016			
	Food Secure (n=1,907)	Mildly Food Insecure (n=793)	Moderately Food Insecure (n=288)	Severely Food Insecure (n=34)	Food Secure (n=1,406)	Mildly Food Insecure (n=956)	Moderately Food Insecure (n=586)	Severely Food Insecure (n=74)
Gender								
Male	1,746 (91.56)	645 (81.34)	220 (76.39)	24 (70.59)	1,221 (86.84)	761 (79.60)	429 (73.21)	45 (60.81)
Female	161 (8.44)	148 (18.66)	68 (23.61)	10 (29.41)	185 (13.16)	195 (20.40)	157 (26.79)	29 (39.19)
Age of household head								
≤ 20	13 (0.68)	3 (0.38)	0 (0.00)	0 (0.00)	7 (0.50)	5 (0.52)	2 (0.34)	0 (0.00)
21-30	213 (11.17)	67 (8.45)	19 (6.60)	3 (8.82)	64 (4.55)	36 (3.77)	25 (4.27)	3 (4.05)
31-40	472 (24.75)	148 (18.66)	55 (19.10)	7 (20.59)	253 (17.99)	177 (18.51)	73 (12.46)	13 (17.57)
41-50	468 (24.54)	188 (23.71)	64 (22.22)	6 (17.65)	376 (26.74)	245 (25.63)	121 (20.65)	14 (18.92)
51-60	361 (18.93)	164 (20.68)	60 (20.83)	9 (26.47)	320 (22.76)	197 (20.61)	169 (28.84)	13 (17.57)
> 60	380 (19.93)	223 (28.12)	90 (31.25)	9 (26.47)	386 (27.45)	296 (30.96)	196 (33.45)	31 (41.89)
Marital status								
Single	38 (1.99)	21 (2.65)	5 (1.74)	1 (2.94)	34 (2.42)	17 (1.78)	24 (4.10)	2 (2.70)
Married	1,686 (88.41)	610 (76.92)	208 (72.22)	23 (67.65)	1,159 (82.43)	725 (75.84)	390 (66.55)	35 (47.30)
Divorced	9 (0.47)	6 (0.76)	4 (1.39)	1 (2.94)	8 (0.57)	7 (0.73)	9 (1.54)	2 (2.70)
Separated	22 (1.15)	21 (2.65)	9 (3.13)	1 (2.94)	27 (1.92)	21 (2.20)	8 (1.37)	4 (5.41)
Widowed	152 (7.97)	135 (17.02)	62 (21.53)	8 (23.53)	178 (12.66)	186 (19.46)	155 (26.45)	31 (41.89)

** Figures in parentheses represent percentages of the distribution

2.2. *Food insecurity profile by household composition*

Households with three to six members were the most food secure group (44.4%) in the first panel but decreases to 32.9 in the second panel (Table 2). Households with more than 10 members were the least food secure in both panels. Incidences of food insecurity increased among households with more than six members in the second panel but decreased among those with less than seven members. Food insecurity thus increased with household size because large household size tends to exert more pressure on consumption, especially where there are many dependants, particularly children and elderly people (Omonona & Agoi, 2007; Agada & Igbokwe, 2014). Moreover,

Table 2 - Food insecurity profile by households' composition

Variables	2010/2011				2015/2016			
	Food Secure (n=1,907)	**Mildly Food Insecure (n=793)**	**Moderately Food Insecure (n=288)**	**Severely Food Insecure (n=34)**	**Food Secure (n=1,406)**	**Mildly Food Insecure (n=956)**	**Moderately Food Insecure (n=586)**	**Severely Food Insecure (n=74)**
Household Size								
< 3	219 (11.48)	102 (12.86)	36 (12.50)	6 (17.65)	84 (5.97)	74 (7.74)	47 (8.02)	12 (16.22)
3-6	846 (44.36)	405 (51.07)	146 (50.69)	18 (52.94)	463 (32.93)	338 (35.36)	221 (37.71)	23 (31.08)
7-10	622 (32.62)	226 (28.50)	91 (31.60)	9 (26.47)	536 (38.12)	369 (38.60)	235 (40.10)	29 (39.19)
Above 10	220 (11.54)	60 (7.57)	15 (5.21)	1 (2.94)	323 (22.97)	175 (18.31)	83 (14.16)	10 (13.51)
Dependency ratio								
< 1	1,249 (65.50)	469 (59.14)	170 (59.03)	24 (70.59)	1,051 (74.75)	713 (74.58)	424 (72.35)	54 (72.97)
1	311 (16.31)	129 (16.27)	51 (17.71)	5 (14.71)	161 (11.45)	111 (11.61)	70 (11.95)	12 (16.22)
> 1	347 (18.20)	195 (24.59)	67 (23.26)	5 (14.71)	194 (13.80)	132 (13.81)	92 (15.70)	8 (10.81)
Female to male adult ratio								
≤ 2	1,803 (94.55)	742 (93.57)	267 (92.71)	32 (94.12)	1,237 (87.98)	829 (86.72)	513 (87.54)	65 (87.84)
2.1-5.0	103 (5.40)	50 (6.31)	20 (6.94)	2 (5.88)	163 (11.59)	121 (12.66)	65 (11.09)	9 (12.16)
> 5	1 (0.05)	1 (0.13)	1 (0.35)	0 (0.00)	6 (0.43)	6 (0.63)	8 (1.37)	0 (0.00)

** Figures in parentheses represent percentages of the distribution

dependency ratio was measured as the ratio of number of dependents in the household to the number of working household members. Households with lower dependency ratio were more food secure as 65.5% and 74.8% of households with dependency ratio of less than one were food secure in the first and second panels respectively (Table 2). Food insecurity increased in the second panel for households with dependency ratio of less than one but decreased for households with a dependency ratio of one and above. Furthermore, food insecurity increased as the female to male adult ratio increased. Female to male adult ratio gives the ratio of adult female members of a household to the adult male members. About 94.6% and 87.9% of households with female to male adult ratio of less than or equal to 2 were food secure in the first and second panels respectively while households with female to male adult ratio of above five were the least food secure as only 0.05% and 0.4% of these households were food secure. Food insecurity status increased across the panel for households with female to male ratio of above two and decreased across the panel for households with female to male adult ratio of below two. This suggested that households with a higher number of adult females were more food insecure than households having less adult female members.

2.3. *Food insecurity profile by households' economic characteristics*

Most household heads in rural Nigeria had no formal education and (Table 3). About 51.6% and 58.9% of households whose heads had no formal education were food secure in the first and second panels respectively while 10.0% and 11.7% of households whose heads had tertiary education were food secure in the respective panels. Food insecurity was least among households whose heads had tertiary education as 2.9% and 4.1% were severely food insecure in both waves while households with no formal education were the most food insecure as 50% and 67.6% were food insecure in both waves. This is because the level of formal education attained could impact positively on household production and nutrition decisions thereby incidence of food insecurity (Kumba, 2015; Ayantoye & Amao, 2017).

Households whose heads were primarily engaged in farming were more food secure than their non-farming counterparts in the both panels. However, the incidences of food insecurity decreased among non-farming households in the second panel. Farming households however experienced an increase in food insecurity incidence in the second panel. The higher food insecurity status of primarily farming households could be attributed to fact that agriculture is characterized by seasonal variations in production as well as long production cycles. This agrees with the findings of Agbola (2014) being

Table 3 - Food insecurity profile by economic characteristics

Economic characteristics	2010/2011				2015/2016			
	Food Secure (n=1,907)	Mildly Food Insecure (n=793)	Moderately Food Insecure (n=288)	Severely Food Insecure (n=34)	Food Secure (n=1,406)	Mildly Food Insecure (n=956)	Moderately Food Insecure (n=586)	Severely Food Insecure (n=74)
Educational status of household head								
No formal Education	983 (51.55)	305 (38.46)	87 (30.21)	17 (50.00)	828 (58.89)	609 (63.70)	306 (52.22)	50 (67.57)
Primary Education	434 (22.76)	261 (32.91)	128 (44.44)	14 (41.18)	210 (14.94)	163 (17.05)	148 (25.26)	14 (18.92)
Secondary Education	299 (15.68)	157 (19.80)	57 (19.79)	2 (5.88)	204 (14.51)	125 (13.08)	85 (14.51)	7 (9.46)
Tertiary Education	191 (10.02)	70 (8.83)	16 (5.56)	1 (2.94)	164 (11.66)	59 (6.17)	47 (8.02)	3 (4.05)
Primary Occupation								
Farming	1,160 (60.83)	451 (56.87)	162 (56.25)	24 (70.59)	1,256 (89.33)	871 (91.11)	535 (91.30)	70 (94.59)
Non Farming	747 (39.17)	342 (43.13)	126 (43.75)	10 (29.41)	150 (10.67)	85 (8.89)	51 (8.70)	4 (5.41)
Farm size (Hectares)								
< 1	980 (51.39)	546 (68.85)	225 (78.13)	25 (73.53)	702 (49.93)	562 (58.79)	473 (80.72)	63 (85.14)
1-2	369 (19.35)	93 (11.73)	28 (9.72)	3 (8.82)	305 (21.69)	190 (19.87)	56 (9.56)	7 (9.46)
> 2	558 (29.26)	154 (19.42)	35 (12.15)	6 (17.65)	399 (28.38)	204 (21.34)	57 (9.73)	4 (5.41)
Land Ownership								
Owned land	562 (29.47)	166 (20.93)	62 (21.53)	11 (32.35)	263 (18.71)	239 (25.00)	117 (19.97)	22 (29.73)
Did not own land	1,345 (70.53)	627 (79.07)	226 (78.47)	23 (67.65)	1,143 (81.29)	717 (75.00)	469 (80.03)	52 (70.27)
Access to credit								
Yes	532 (27.90)	270 (34.05)	85 (29.51)	12 (35.29)	464 (33.00)	374 (39.12)	247 (42.15)	34 (45.95)
No	1,375 (72.10)	523 (65.95)	203 (70.49)	22 (64.71)	942 (67.00)	582 (60.88)	339 (57.85)	40 (54.05)
Access to remittances								
Yes	13 (0.68)	9 (1.13)	4 (1.39)	0 (0.00)	45 (3.20)	16 (1.67)	14 (2.39)	0 (0.00)
No	1,894 (99.32)	784 (98.87)	284 (98.61)	34 (100.00)	1,361 (96.80)	940 (98.33)	572 (97.61)	74 (100.00)

** Figures in parentheses represent percentages of the distribution

engaged primarily in farming increases the probability of the household being food insecure in Nigeria. This is expected, as agriculture in the rural areas of Nigeria is largely characterized by low capital involvement, use of crude implements, poor infrastructural facilities and drudgery which would lead to low earnings and subsequently inability to meet household food requirements (Adepoju & Adejare, 2013).

Furthermore, 51.4% and 49.9% of smallholder farming households, with less than a hectare of farmland, were food secure in the first and second panels, respectively. Lower proportions of households with one to two hectares (19.4% and 21.7%) and those with more than two hectares (29.3% and 28.4%) were food secure in the first and second panels, respectively. However, the incidences of food insecurity increased in the second panel for all categories. However, Severe food insecurity was highest among smallholder farming households (73.5%) with less than a hectare of farmland and increased to 85.14% in the second panel. Farm size is a reflection of own food production ability and it is believed that increase in farm size would result in increased food production and ultimately, increased likelihood of household food security (Ahmed *et al*., 2015).

About 72.1% and 67% of households that had no access to credit were food secure in the first and second panels respectively while 27.9% and 33% of households that had access to credit were food secure in the respective panels. Also, food insecurity is seen to decrease across the panel for households that had no access to credit as 64.71% were severely food insecure in the first panel and decreased to 54.1% in the second panel while it increased in households that had access to credit as 35.3% were severely food insecure in the first panel and increased to 46.0% in the second panel. This could be because a majority of household heads in rural Nigeria have low level of education and may not be able to properly manage credit. Thus, having access to credit may not improve food insecurity status of rural households.

Moreover, 29.5% and 18.7% of households that owned lands were food secure in the first and second panels respectively while 70.53% and 81.29% of households that did not own lands were food secure in the respective panels. Conversely, the incidence of severe food insecurity was however highest (67.65%) in households that did not own lands in the first panel and increased to 70.27% in the second panel. Although access to land rights is low in rural Nigeria and it may not have a significant effect on enhancing household food security in rural Nigeria. This is because an efficient use of land resources, rather than its ownership, would translate to more income and improved food security. Similarly, the majority (99.3% and 96.8%) of households that had no access to remittance were food secure, while 0.7%% and 3.2% of those with access to remittance were food secure in the first and second panels respectively. Although households with no access to remittance had

a higher proportion of food secure members, they also represented a higher percentage of food insecure households. This could be attributed to the fact that remittance contributes to household income which would lead to increase in per capita consumption and consequently improved food security (Adepoju & Adejare, 2013).

2.4. *Food Insecurity Profile by Share of Non-food Expenditure and zones of residence*

Share of non-food expenditure is obtained by dividing the expenditure on non-food items by the total expenditure of the household. A larger percentage of the households spent less than ten percent of their income on non-food expenditure, while less than one percent of the households with

Table 4 - Food insecurity profile by share of non-food expenditure and zones of residence

Variables	2010/2011				2015/2016			
	Food Secure (n=1,907)	**Mildly Food Insecure (n=793)**	**Moderately Food Insecure (n=288)**	**Severely Food Insecure (n=34)**	**Food Secure (n=1,406)**	**Mildly Food Insecure (n=956)**	**Moderately Food Insecure (n=586)**	**Severely Food Insecure (n=74)**
Share of Non-food Expenditure								
0	312 (16.36)	96 (12.11)	48 (16.67)	5 (14.71)	239 (17.00)	150 (15.69)	62 (10.58)	13 (17.57)
0.1-0.9	1,594 (83.59)	696 (87.77)	240 (83.33)	29 (85.29)	1,163 (82.72)	804 (84.10)	523 (89.25)	60 (81.08)
1	1 (0.05)	1 (0.13)	0 (0.00)	0 (0.00)	4 (0.28)	2 (0.21)	1 (0.17)	1 (1.35)
Geo-political zones								
North Central	389 (20.40)	120 (15.13)	40 (13.89)	6 (17.65)	373 (26.53)	135 (14.12)	41 (7.00)	6 (8.11)
North East	404 (21.19)	111 (14.00)	5 (1.74)	0 (0.00)	248 (17.64)	210 (21.97)	57 (9.73)	5 (6.76)
North West	658 (34.50)	41 (5.17)	6 (2.08)	9 (26.47)	428 (30.44)	232 (24.27)	52 (8.87)	2 (2.70)
South East	162 (8.50)	253 (31.90)	119 (41.32)	10 (29.41)	65 (4.62)	143 (14.96)	296 (50.51)	40 (54.05)
South South	180 (9.44)	204 (25.73)	92 (31.94)	9 (26.47)	166 (11.81)	176 (18.41)	123 (20.99)	20 (27.03)
South West	114 (5.98)	64 (8.07)	26 (9.03)	0 (0.00)	126 (8.96)	60 (6.28)	17 (2.90)	1 (1.35)

** Figures in parentheses represent percentages of the distribution

50% non-food expenditure. This suggested that most of the households had low welfare and were food insecure. However, food secure households with less than ten percent share of non-food expenditure were more than those that spent all their income on food were food secure in both waves. This is consistent with Engel's law that a poorer households spend the greater proportion of its total expenditure on the provision of food. Furthermore, about a fifth (20.40%) and a quarter (26.53%) of rural households in the North-Central; 21.19% and 17.64% in the North East; 34.5% and 30.4% in the North-West; 8.5% and 4.62% in the South-East; 9.44% and 11.81% in the South-South and 5.98% and 8.96% in the South-West were food secure. Across the six geopolitical zones, rural households in the South-East recorded the highest level of food insecurity.

2.5. *Determinants of Food Insecurity in Rural Nigeria*

The fixed effect and random effect models were conducted to ascertain the most suitable model for the analysis. The Hausman test was carried out to determine the most suitable model and it had a chi square value of 229.33 and was insignificant (Appendices II and III) suggesting that the random effects model was a more suitable model than the fixed effect model. The model had an overall chi-square value of 1076.97 with a log likelihood of –5568.8335, which was significantly different from zero, indicating goodness of fit of the model (Table 5). Further, the global Wald test of simple and composite linear hypothesis was applied to find out if the explanatory variables in the model are a significant improvement to the model. The P-value was less than 0.05 so the null hypothesis was rejected that the explanatory variables were simultaneously equal to zero (Appendix IV) implying that the explanatory variables were not zero and should be included in the model. The estimated cut-off points (μ) satisfied the conditions that $\mu 1 < \mu 2 < \mu 3$. This implies that these categories were ranked in an ordered way (Knight *et al*., 2005). Age, age squared, female to male adult ratio, marital status, primary education, occupation, household size and access to credit had positive coefficient, while marital status, tertiary education and being resident in North west were negative.

An additional year in the age of the household head would the probability of the household being mildly food insecure, moderately and severely food insecure marginally by 0.0008, 0.0001 and 0.0002 units, respectively. A similar increase would reduce the probability of the household being food secure by 0.20 unit. Following the life-cycle hypothesis, being aged would reduce the probability of being food secure than reducing the probability of being mildly food insecure, moderately and severely food insecure in the

Table 5 - Determinants of Food Insecurity (Random Effects)

		Food secure	Mildly food insecure	Moderately food insecure	Severely food insecure
Variables	**Coefficient**	**dy/dx**	**dy/dx**	**dy/dx**	**dy/dx**
Age	0.0609***	–0.0020*	0.0008*	0.0001*	0.0002*
	(0.0036)	(0.0012)	(0.0002)	(0.0006)	(0.0001)
Age squared	–1.05e-06**	3.47e-07**	-1.37e-07**	–1.70e-07**	–4.02e-08**
	(6.93e-07)	(2.13e-07)	(1.12e-07)	(1.08e-07)	(7.06e-08)
Gender	–0.2611	0.0863	–0.0341	–0.0422	–0.0099
	(0.0792)	(0.0263)	(0.0235)	(0.0029)	(0.0069)
Female to Male adult ratio	0.3151*	–0.0104*	0.0041*	0.0051*	0.0012*
	(0.0170)	(0.0056)	(0.0024)	(0.0028)	(0.0007)
Marital Status	–0.2771***	0.0916***	–0.0362***	–0.0448***	–0.0106***
	(0.0755)	(0.0249)	(0.0099)	(0.0122)	(0.0030)
Primary Education	0.0717*	–0.0237*	0.0094*	–0.0116*	0.0127***
	(0.0429)	(0.0141)	(0.0056)	(0.0075)	(0.0019)
Secondary Education	–0.0741	0.0245	–0.0097	–0.0119	0.0028
	(0.0503)	(0.0178)	(0.0066)	(0.0081)	(0.0019)
Tertiary Education	–0.3140***	0.1037***	–0.0410***	–0.0507***	0.0120***
	(0.6548)	(0.0216)	(0.0086)	(0.0106)	(0.0027)
Occupation	0.1184***	–0.0391***	0.0410***	0.0507***	0.00120***
	(0.6510)	(0.0216)	(0.0086)	(0.0106)	(0.0027)
Household size	0.0021***	–0.0069***	0.0027***	0.0034***	0.0008***
	(0.0054)	(0.0018)	(0.0007)	(0.0009)	(0.0002)
Dependency Ratio	0.2423	–0.0043	0.0017	0.0022	0.0005
	(0.1735)	(0.0062)	(0.0024)	(0.0031)	(0.0007)
Share of non-food Exp.	0.2092	–0.0691	0.0273	0.0338	0.080
	(0.1859)	(0.0661)	(0.0243)	(0.0301)	(0.0072)
Farm size	–0.0004	0.0001	–5.0e-05	–0.0001	–1.40e-05
	(0.0002)	(0.0001)	(3.0e-05)	(0.00004)	(8.32e-06)
Access to Credit	0.1323***	–0.0437***	0.0170***	0.0214***	0.0073***
	(0.0339)	(0.0111)	(0.0044)	(0.0055)	(0.0015)
Access to Remittance	0.1058	–0.0350	0.0138	0.1709	0.040
	(0.4614)	(0.1524)	(0.0603)	(0.0745)	(0.0017)
Land Ownership	0.5569	–0.0184	–0.0073	0.0899	–0.0213
	(0.5275)	(0.1741)	(0.0069)	(0.0085)	(0.2023)
North East	0.0955*	–0.3362*	0.0203*	0.0124*	0.0010*
	(0.0559)	(0.0197)	(0.0119)	(0.0073)	(0.0006)
North West	–0.2512***	0.0814***	–0.0537***	–0.0258***	–0.0016***
	(0.5487)	(0.0178)	(0.0117)	(0.0058)	(0.0004)
South East	1.2964***	–0.4609***	0.1190***	0.2765***	0.0646***
	(0.0586)	(0.0174)	(0.0096)	(0.1245)	(0.0063)

Table 5 - continued

		Food secure	Mildly food insecure	Moderately food insecure	Severely food insecure
Variables	**Coefficient**	**dy/dx**	**dy/dx**	**dy/dx**	**dy/dx**
South South	0.8799***	–0.3268***	0.1309***	0.1698***	0.2608***
	(0.0057)	(0.0194)	(0.0092)	(0.1141)	(0.0033)
South West	0.2317***	–0.0835***	0.0479***	0.0327***	0.0028***
	(0.0739)	(0.0270)	(0.0149)	(0.0011)	(0.0011)
Age-gender	–0.0051*	0.0017*	–0.0007*	–0.0008*	–0.0002*
	(0.0029)	(0.0010)	(0.0004)	(0.0005)	(0.0001)
Marital Status-occupation	–0.0246	0.0081	–0.0032	–0.0039	–0.0009
	(0.0209)	(0.0069)	(0.0027)	(0.0034)	(0.0008)
Farm size-household size	2.62e-05	–8.65e-06	3.42e-06	4.23e-06	1.00e-06
	(1.94e-05)	(6.43e-06)	(2.53e-06)	(3.15e-06)	(7.51e-07)
Remittance-land ownership	0.2971	–0.0982	0.0388	0.0480	.01136
	(0.2658)	(0.0877)	(0.0347)	(0.0429)	(0.0102)
Cut 1	1.3778	(1.08313)			
Cut 2	2.4318	(1.0844)			
Cut 3	3.7574	(1.0867)			
Number of observations	6044				
Log likelihood	–5568.8355				
Wald chi^2 (25)	1076.98				
Prob > chi^2	0.0000				
$Sigma^2$_u	0.0449				

Note: ***, ** & * indicate significant levels at 1%, 5% and 10% respectively
Figures in parentheses represent the standard errors

long-run. This suggested that rural household heads were more vulnerable to food insecurity in old age. This is because as household heads advance in age, they approach retirement and subsequently have a reduced income and are susceptible to being food insecure (Omonona & Agoi, 2007).

Being a male-headed household reduced the probability of being mildly, moderately or severely food insecure but increased probability of being food secure than their female counterparts. This may be owing to lower dependency ratios observed in male-headed households where both the head and their spouse were engaged in income generating activities. This is consistent with findings of Smith *et al.* (2017) that women had a higher probability of experiencing severe food insecurity than their male counterparts in Latin America and the Caribbean. Male-headed households have a higher probability of being food secure than the female-headed households probably because the

latter are usually saddled with the responsibilities of home keeping and raising children, which limit their involvement in income generating activities (Ahmed *et al*., 2015). Similarly, a unit increase in adult female to male ratio would increase the probability of being mildly food insecure, moderately food insecure and severely food insecure by 0.0041, 0.0051 and 0.0012 units, respectively but decrease the probability of being food secure by 0.0104 unit. Being a married head reduced the probability of a household being mildly, moderately and severely food insecure but increased the probability of being food secure. This is similar to the findings of Yusuf *et al*. (2015) that households in Ibadan, Nigeria, with married heads were more likely to be food secured owing to the fact that they were likely to have spouses with income generating activities and contribute to household income. Thus, the joint efforts to provide for the food requirement of the household improves the chances of being food secure.

Furthermore, an increase in household heads with primary education would reduce the probability of the household being food secure and moderately food insecure but increased that mild and severe food insecurity incidence. However, a similar increase in household heads with tertiary education would increase the probability of being food secure but decrease the probability of the household being mildly and moderately food insecure. This implies that low levels of education promote food insecurity, while a higher level of formal education could impact positively on the household production and nutrition decision, thereby reducing food insecurity (Ahmed *et al*., 2015; Smith *et al*., 2017). The probabilities of a household being mildly, moderately and severely food insecure were exacerbated with its head being primarily engaged in farming. This could be attributed to the fact that agriculture is characterized by seasonal variations in production and which consequently results in irregular income and a high probability of being food insecure (Adepoju & Adejare, 2013). This buttressed the findings of Ayantoye *et al*., (2011) that household heads engaging in farming activities were more food insecure in southwestern Nigeria.

Contrary to a priori expectation, food insecurity status of rural households increased with access to credit. This may be because the households were not able to efficiently manage credit made available to them. The study controlled for interaction effects and regional differences by creating dummies for geopolitical zones and interaction between variables as carried out by Mahmood *et al*. (2019). In terms of interaction effect, a combination of age and male gender had a positive relationship with a household being food secure and a negative relationship with the household being mildly, moderately or severely food insecure. This can be linked to the gender considerations in allocating productive resources to people in Nigeria. The regional effect revealed that living in North East, South East, South South and South west, Nigeria increases the chances of a household being food secure and decrease the chances of a household being mildly, moderately

or severely food insecure. Conversely, a negative relationship exists between living in North West, Nigeria and the probability of a household being food secure and increases the chances of a household being mildly, moderately and severely food insecure.

3. Conclusion and recommendations

The study examined food insecurity status of rural households in Nigeria. However, the secondary panel data used for the study has small sample size and thus policy makers should take caution in generalizing the results of this study to a wider context of rural households in developing countries. Food insecurity was prominent among households which had older household heads and also among female headed households. Households with heads having tertiary education were less food insecure compared to other households showing that a higher level of formal education could impact positively on household nutrition decisions, thereby reducing food insecurity. An increase in household size and consequently dependency ratio was seen to increase food insecurity levels of households. Also, households that engaged in farming as their occupation was seen to be more food insecure than other households and this was attributed to seasonal variations in production, long production cycles and consequently irregular income. Food security among rural farming households will improve as smallholder farmers move to efficient subsistence farming, and consequently develop the rural economies (Auerbach, 2018). Based on the foregoing, increased awareness on the use of birth control practices and improved access to family planning services, led by government and development partners, would enhance household food insecurity in rural Nigeria. Furthermore, households with elderly, widowed and female-headed households should be specifically targeted for safety net such as subsidized food prices, distribution of food crops relief materials, special nutrition programme, provision of free meals for malnourished households as well as improved access to credit facilities.

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Appendix 1 – *A priori Expectation for Determinants of Food Insecurity in Rural Nigeria*

Variable	Description	Expected sign	Reference
X1	Age of Household Head	+/–	Ibrahim *et al*., 2016
X2	Gender of Household head	+/–	Ahmed *et al*., 2015, Adepoju & Adejare 2013
X3	Marital status of Household head	+/–	Adepoju & Adejare 2013
X4	Primary Education of Household head	+/–	Ahmed *et al*., 2015, Amao and Ayantoye 2015
X5	Secondary Education of Household head	+/–	Adepoju & Adejare 2013, Ahmed *et al*., 2015
X6	Tertiary Education of Household head	+/–	Adepoju & Adejare 2013, Ahmed *et al*., 2015
X7	Occupation	+/–	Amao and Ayantoye 2017
X8	Household size	+/–	Agbola 2014
X9	Dependency ratio	+/–	Adepoju & Adejare 2013, Ibrahim *et al*., 2016,
X10	Farm size	+/–	Ahmed *et al*., 2015, Ibrahim *et al*., 2016
X11	Share of nonfood expenditure	+/–	Adepoju and Adejare 2013
X12	Access to credit	+/–	Adepoju & Adejare 2013, Ibrahim *et al*., 2016
X13	Land ownership	+/–	Amao and Ayantoye 2017
X14	Access to remittance	+/–	Agbola 2014, Adepoju & Adejare 2013

Appendix 2 – *Fixed effects Model and Random effects Model*

Variable	Fixed effects Model	Random effects Model
	Coef. (SE)	Coef. (SE)
Age	0.0051*** (0.0016)	0.0052* (0.0007)
Age squared	6.81e-07 (5.61e-07)	1.12e-06*** (4.41e-07)
Gender	0.0885 (0.0847)	–0.13244*** (0.0475)
Female to Male adult ratio	0.0175 (0.0188)	0.0321** (0.0113)
Marital Status	–0.1531** (0.0672)	0.2496*** (0.0434)
Primary Education	–0.0355 (0.0419)	0.2028*** (0.0257)
Secondary Education	0.0555 (0.0557)	0.1541 (0.0311)
Tertiary Education	–0.0245 (0.0805)	0.0212 (0.0399)
Occupation	0.1179 (0.0319)	0.1111*** (0.0243)
Household size	0.0821*** (0.0093)	0.0033 (0.0034)
Dependency Ratio	–0.00304 (0.0149)	0.0076 (0.0108)
Share of non-food Exp.	–0.2699* (0.1491)	0.2406** (0.1176)
Farm size	0.0000 (0.0001)	–0.0002 (0.000)
Access to Credit	0.1481*** (0.0277)	0.1149*** (0.0210)
Access to Remittance	–0.0862** (0.1045)	–0.0925 (0.0770)
Land Ownership	0.0453*** (0.0314)	0.0350 (0.0231)
_Cons	0.6697 (0.1106)	1.4125***(0.0579)
Sigma_u	0.6957	0.3332
Sigma_e	0.6768	0.6768
Rho	0.51374	0.1951

Appendix 3 – *Hausman Test*

Variable	Fixed	Random	Difference	S.E
Age	0.0110	0.0052	0.0057	0.0023
Age squared	1.11e-06	1.12e-06	–4.31e-09	
Gender	–0.4451	–0.1324	0.3126	0.1111
Female to Male adult ratio	0.03239	0.0321	–0.0002	
Marital Status	–0.3073	–0.2496	0.0577	0.0594
Primary Education	0.2025	0.0203	–0.0004	0.0227
Secondary Education	0.1534	0.1541	–0.0008	
Tertiary Education	0.0147	0.0212	–0.0065	0.0013
Occupation	0.0271	0.1111	–0.0840- 0.0355	0.0325
Household size	0.0027	0.0033	–0.0576	0.0227
Dependency Ratio	0.0063	0.0076	–0.0014	0.0007
Share of non-food Exp.	0.2442	0.2406	0.0035	
Farm size	–0.0002	–0.0000	–0.0002	0.0001
Access to Credit	0.1128	00.1150	–0.0022	
Access to Remittance	0.5226	0.0925	0.6151	0.2285
Land Ownership	0.6733	–0.0350	0.7084	0.3307

Chi^2 = (b–B)'[(V_b–V_B)^(–1)](b–B) = 19.39
Prob > chi2 = 0.1505

Appendix 4 – *Specification Test*

Wald Test of Simple and Composite Linear Hypothesis
[Food Security]Age of Household head = 0
[Food Security]Household size = 0
[Food Security]Dependency ratio = 0
[Food Security]Farm size = 0
[Food Security]Age square = 0
[Food Security]Female to Male Adult ratio = 0
[Food Security]Share of non-food Expenditure = 0
[Food Security]Gender of Household head= 0
[Food Security]Marital status of Household head = 0
[Food Security]Primary Education = 0
[Food Security]Secondary Education = 0
[Food Security]Tertiary Education = 0
[Food Security]Occupation of Household head = 0
[Food Security]Access to Remittance = 0
[Food Security]Land Ownership = 0
[Food Security]Access to Credit = 0
[Food Security]North East = 0
[Food Security]North West = 0
[Food Security]South East = 0
[Food Security]South West = 0
[Food Security]South South= 0
[Food Security]Age-gender= 0
[Food Security]Remitance-landownership= 0
[Food Security]Farmsize-householdsize= 0
[Food Security]Maritalstatus-occupation= 0
chi2(25) = 1719.15
Prob > chi2 = 0.0000

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