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Original Research Article

Women's Empowerment in Agriculture and Household Food Insecurity in Nigeria

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Abstract: Lack of gender parity in access to agricultural resources and services adversely influences women's productivity and subsequently the food security status of their households. The study analysed the effects of women empowerment on food insecurity status of Nigerian households using secondary data from the 2018/2019 General Household Survey (GHS). Information from 448 households with consistent information were used to construct the Abbreviated Women's Empowerment in Agriculture Index (A-WEAI) and Household Hunger Scale (HHS) Data were analyzed using descriptive statistics, probit regression and IV-ordered probit regression models. Results showed that 93.4% of the women were disempowered, while 47.4 percent of men were disempowered. The overall Gender Parity Index was 0.606 with about 17.1 percent of the women having high gender parity, while more than half did not have gender parity with the primary male in their households. However, less than a quarter of the women were empowered in the five domains, about half (49.4%), 57.1%, 45.6% and 44.5% of households that experienced no hunger, mild hunger, moderate hunger and severe hunger, respectively, had disempowered women. About 50.6% had no hunger, 42.9% had mild hunger, 54.4% had moderate hunger and 55.5% had severe hunger among the empowered women's households. Increasing women empowerment in agriculture reduced the incidence of severe food insecurity by 4.0%. Female-headed households, along with the household head's age and high literacy level, significantly reduce the likelihood of severe food insecurity

Keywords: Women's empowerment; Food insecurity; Nigeria.

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1. Introduction

Food insecurity in all its forms continues to be a challenge in the developing world (FAO/ WFP/IFAD, 2020). Current food insecurity is driven by food shortages, supply disruptions and inflation affecting key agricultural inputs such as fertilizers and seeds (World

Bank, 2023). In Nigeria, malnutrition is widespread due to food shortages and economic crisis relating to food price increase and rise in the general price levels. Severe conditions of food insecurity are observed in the conflict-prone northern zone of the country (Owoo, 2021). Nigeria's policies to address its food insecurity has mainly been supply-driven and a number of local and national programmes and policies are aimed at increasing agricultural production (e.g., National Policy on Food and Nutrition in early 2001; Zero Hunger by 2030, 2016 National Plan of Action on Food and Nutrition, FAO emergency programmes, Global Food Security Strategy, etc.). However, extant study indicate that food insecurity is on the rise in Nigeria. This is aided by the high level of poverty, high level of unemployment and high level of inflation of food prices. This could effectively hinder the achievement of government policies and goals on attainment of food security for all its people. Also, very little has been done with respect to the empowerment of rural households and women in agriculture.

In many cases (Alkire *et al.*, 2013; Owoo, 2021; Ayevbuomwan, 2016), women and girls are over-represented among those who are food-insecure, partly because women often are denied basic human rights such as the right to own property, to find decent work, and to have an education and good health. Most African countries, including Nigeria, rank relatively low in terms of women's empowerment (Commonwealth gender equality report card 2011). For millions of African women, hunger, violence, exclusion and discrimination are their everyday realities. Women face the problem of access to credit facilities, ownership of land, and overwhelming domestic chores, discrimination and marginalization, among others (Obayelu, 2022).

Most women in agriculture are marginalised and disempowered in the agricultural sector (Mohsin *et al.*, 2021). They often lack access and control to productive assets. Women's land rights are fragile and transient, being dependent upon age and marital status (Tsiboe *et al.*, 2018). The low level of women empowerment in agriculture is therefore a major contributor to increasing food insecurity among farming households. Creating appropriate measure to empower women will help to improve the wellbeing among the households and contribute to their food security. Many empirical studies have been carried out on food security (Ashagidigbi *et al.*, 2022; Obayelu *et al.*, 2021; Ogunniyi *et al.*, 2021) and women's empowerment in Nigeria (Obayelu & Chime, 2020; Oyeboade *et al.*, 2021). Ogunnaike *et al.* (2019) undertook a microstudy to assess women's empowerment on food security of farming households in Ogun State and did not consider endogeneity of women's empowerment. However, there is limited information on the influence of women's empowerment in agriculture on food insecurity in Nigeria. The effect of women's empowerment on rural household food insecurity in Nigeria was therefore investigated in this study. This study contributes provides an empirical roadmap for policymakers to achieve the Sustainable Development Goals 2 (end hunger, achieve food security and improved nutrition) and 5 (achieve gender equality and empower all women and girls).

2. Review of Literature

The theory of household economics states that the household shares the same resources and alms to in order to increase its utility or welfare through production and consumption of "commodities" such as good health, and aesthetical and gastronomic utility from food (Becker, 1965). However, disparities in wage rates and in interest and rental rates adjust the nominal income and the money value of income of households that depend on wages and income from capital assets for their livelihood (Bjornlund *et al.,* 2022). Similarly, variations in market prices of goods and services change the households' real income or how much they can buy in the marketplace with a given nominal income. Relatively higher prices, for example, reduce the household's real income (Shittu *et al*., 2015). However, the utility concept does not directly relate to food insecurity but relates only indirectly through its impact on consumption levels induced by price changes (Kornher & Sakketa, 2021).

For farming households, access to productive assets is mostly viewed as a function of private property rights, the possession of which enhances agricultural productivity as it incentivizes farmers to invest in and make efficient use of their land, and consequently increase their income and food availability (Bugri & Yeboah, 2017; Po & Gordon, 2018). However, institutions, power, and diversity in natural resource governance largely determine access to and use of productive assets (Mutea *et al*., 2020). Consequently, access to productive assets must also integrate control over the assets in order to derive benefits from them (UN, 2009; Solotaroff *et al.*, 2019). However, women in agriculture in developing countries have inequitable access and control over productive assets like financial, land and water resources, labour and quality inputs due to institutional, labour, capital and market networks constraints (IOM, 2016; FAO, 2018; Obayelu, 2022).

The theory of access conceptualizes how configurations of bundles of private property rights and bundles of powers shape access to resources and how this access is gained, maintained, and controlled (Mutea *et al*., 2020). The theory of access to resources underpins this study because it offers a comprehensive framework for examining the role of access in understanding household food security—which is one of major livelihood outcomes—through interactions between the bundle of (private property) rights and bundle of powers. Sustainable livelihood outcomes are achievable through the ability to gain, maintain, control, and enhance resources on which livelihoods depend (Serrat, 2017). Guided by the Theory of Access (Ribot & Peluso, 2003) the study identifies the main factors in the respective bundles of rights and powers that improve women’s empowerment with consequent derived production benefits from their productive assets to achieve household food security (Aziz *et al*., 2021).

3. Methodology

General Household Survey data for Nigeria 2018/2019 (Wave 4) was used for the purpose of this research, the wave four exercises was conducted using Computer Assisted

Person Interview (CAPI) techniques. All the questioners, household, agriculture and community questioners were implemented in both post planting and post harvesting visits of wave-4 using CAPI software. The data was collected from 5000 households in Nigeria who were enumerated systematically across the six geographical zones of the country, this focused on details of agricultural data, inter-institutional collaboration, and comprehensive analysis of welfare indicators and socio-economic characteristics. For the purpose of this research data, 448 households with consistent responses were extracted. Information extracted from the survey includes socioeconomic characteristics of the households, women's empowerment in agriculture, and food insecurity of the households.

2.1 Analytical techniques

Data were analysed using descriptive statistics, Household hunger scale, Abbreviated Women's Empowerment in Agriculture Index (A-WEAI) and Instrumental Variable Ordered Probit Regression Model. Descriptive statistics such as mean, frequency distribution, percentages, standard deviation was used to describe the socio-economic characteristics selected rural households in the study area. Abbreviated Women's Empowerment in Agriculture Index (A-WEAI) was used to determine the level of women empowerment and profile women empowerment of rural farm households in the study area. The WEAI is an innovative tool composed of two sub-indices: one measures women's empowerment across five domains (5DE) in agriculture (Table 1) and the other measures gender parity (GPI) in empowerment within household (Alkire *et al.,* 2013).

Table 1. Description of domains and empowerment indicators in the abbreviated women's empowerment in Agriculture Index.

Domain	Indicator	Weight
Production	Sole or joint decision-making over input in productive decisions	1/5
Resources	Sole or joint ownership of assets (land)	2/15
	Access to and decisions on credit	1/15
Income	Sole or joint control over use of income	1/5
Leadership	Active member in at least one economic or social group	1/5
Time	Workload (more than 10.5 hours in day)	1/5

Source: Malapit *et al*., 2015.

To identify the disempowered,

$$C_i = w_1 I_{1i} + w_2 I_{2i} + \cdots + w_n I_{ni} \quad (1)$$

where I_{ni} = 1 if the i^{th} individual has an inadequate achievement in nth indicator and I_{ni} = 0 if otherwise; w_n is weight attached to n^{th} indicator.

The first component of the 5DE is called the disempowered headcount ratio (H_p) which is the proportion or incidence of individuals whose share of weighted inadequacies is more than k ($H_p = q/N$). q is the number of disempowered individuals, while N is the sample size.

The second component is called the intensity of disempowerment (A_p) or average inadequacy score of disempowered individuals expressed as:

$$A_p = \sum_{i=1}^{q} \frac{C_i(K)}{q} \quad (2)$$

where $C_i(K)$ is censored inadequacy score of i^{th} individuals; q denotes number of disempowered individuals.

M_0 is the product of Hp and Ap M_0 = Hp ×Ap.

$$5DE = 1 - M_0 \quad (3)$$

The first component of the gender parity index is the proportion of gender parity inadequate households (that is the percentage of women who lack gender parity relative to their male household counterparts) and it is expressed as:

$$H_{GPI} = h/m \quad (4)$$

where h is the number of households classified that lack gender parity; m is total of dual-adult households in the sample.

The second component is called the average empowerment gap (IGPI), given as:

$$I_{GPI} = \frac{1}{h} \sum_{j=1}^{h} \frac{C_{ij}(K^m) - C_{ij}(K^w)}{1 - C_{ij}(K^m)} \quad (5)$$

where $C_{ij}(K^m)\ is$ censored inadequacy scores of the adult male living in j^{th} household $C_{ij}(K^w)$ is censored inadequacy scores of the adult woman living in j^{th} household; and h is the number of households that are lacking gender parity.

Gender parity Index is expressed as:

$$GPI = 1 - H_{GPI} * I_{GPI} \quad (6)$$

$$AWEAI = 0.9(5DE) + 0.1(GPI) - H_{GPI} * I_{GPI} \quad (7)$$

Food insecurity in this study was measured using Household Hunger Scale (HHS) developed in by USAID-funded Food and Nutrition Technical Assistance II project (FANTA) in collaboration with Tufts and Cornell Universities, among other partners (Coates *et al*., 2007). The Food insecurity (FI) of the households was measured on an ordinal scale which ranked using a household on a hunger scale from '1 = zero hunger' to '2 = mild hunger', '3 = moderate hunger' and '4 = severe hunger'.

2.2 Instrumental Variable Ordered Probit Regression

This was used to assess the bi-causal effect of women empowerment in agriculture and food security status of households in Northwestern Nigeria. Due to the potential endogeneity of women's empowerment, instrumental variable in the ordered probit model (IV ordered probit) was used for this analysis. Religion was used as an instrumental variable for women empowerment to address the possible two-way causal relationship between women empowerment and food security. This is because religion of women determines their need for empowerment. This variable satisfied the requirements of relevance and exogeneity for an effective IV. The IV ordered probit model was generalised from Amemiya (1978) and Newey (1987). The model is given as:

- For the first stage

$$W_i^* = \gamma Z_i + X'_i + \varepsilon_i \tag{8}$$

$$W_i = \begin{cases} 0 \ \ if \ W_i^* < 0 \\ 1, \ \ W_i^* \geq 0 \end{cases} \tag{9}$$

- For the second stage

$$FI_i^* = \alpha^* \widehat{W_i} + X'_i \beta + \varepsilon_i, \ \ i = 1,2,3, \dots, J \tag{10}$$

where W_i^* is the latent variable for women empowerment in Equation (8); Zi represents the instrumental variable of religion; Xi is a vector of exogenous variables of demographic and socioeconomic variables, ε_i is a normally distributed error term in the equation and *i* denotes an individual respondent. FI_i^* denotes the latent variable of food insecurity in Equation (10). $\widehat{W_i}$ is the fitted value of women empowerment estimated in the first stage; α^* is the coefficient of interest, which is a consistent estimate after substituting W_i into Equation (10).

4. Results and Discussions

4.1 Women's Empowerment in Agriculture

The overall A-WEAI results includes the positive equivalents of these numbers, the empowered headcount (1-H), the average adequacy score (1-A) and the percentage of women with gender parity (H_{GPI}) (Table 2). These were used to construct the disempowered headcount (H), the average inadequacy score (A), and the percentage of women with no

gender parity. The Abbreviated Women's Empowerment in Agriculture (A-WEAI) was 0.447 (Table 2). It is a weighted average of the 5DE sub-index value of 0.429 and the GPI sub-index value of 0.606.

The 5DE for Nigeria shows that only 6.6 percent of women were empowered. In the study area, the 93.4 percent of unempowered women had inadequate achievements in 61.1 percent of the domains (Table 2). Thus, following Alkire *et al.* (2013) women's M_0 is 93.4 percent × 61.1 percent = 0.571 and 5DE is 1 – 0.571 = 0.429. In the study area, 47.4 percent of men are not yet empowered. The average inadequacy score among these men was 42.7 percent. So, men's M_0 is 47.4 percent × 42.7 percent = 0.203 and men's 5DE is 1 – 0.203 = 0.797. Furthermore, The Gender Parity Index (GPI) shows that 17.1 percent of women have gender parity with the primary male within their households (Table 1). Of the 82.9 percent of women without gender parity, the empowerment gap between them and the male in their household was 47.5 percent. Thus, the overall GPI in the sample area was 0.606. This finding is comparable to that of that Alkire *et al*. (2013). The configuration of men's deprivations in empowerment was strikingly different from women's in Nigeria. Less than a quarter of the women were empowered in the five domains, while more than half do not have gender parity with the primary male in their household. Achieving gender equality is therefore sine qua non to achieving the sustainable development goal of zero hunger in Nigeria.

Table 2: Women's Empowerment in Agriculture Index (WEAI) for Nigeria

Indexes	**Women**	**Men**
Disempowered Headcount (H)	93.4%	47.4%
Average Inadequacy Score (A)	61.1%	42.7%
Disempowerment Index (M_0)	0.571	0.203
5DE Index (1 – M_0)	0.429	0.797
No. of observations used	482	426
% of women without gender parity (H_{GPI})	82.9%	
Average Empowerment Gap (I_{GPI})	47.5%	
GPI (1 - H_{GPI} x I_{GPI})	0.606	
No. of women in dual households	404	
WEAI (0.9 x 5DE + 0.1 x GPI)	0.447	

Note: WEAI = Women's Empowerment in Agriculture Index; 5DE = five domains of empowerment

Furthermore, the censored headcount ratio showed that women were both disempowered and deprived in input in productive decisions (11.2%), access to and decisions on credit (40.3%), and group membership (33. 8%) (Table 3). The least censored headcount was in the ownership of assets indicator (3.6%) indicating that women were deprived of the opportunity to be empowered in key areas of living. However, they were less deprived in access to and decisions on credit indicator (0.1) than in others as the contribution of this indicator to disempowerment greatly exceeded its weight. Not being an active member of a

social group had the highest contribution to disempowerment of women (29.3%) and men (32.3%), while workload and control over use of income had the least contribution to deprivation for women (7.2%) and men (8.1%), respectively.

Table 3: Nigeria 5DE decomposed by dimension and indicators

Variables	Production	Resources		Income	Leadership	Time
	Input in productive decisions	Ownership of assets	Access to and decisions on credit	Control over use of income	Group member	Workload
Indicator weight	0.20	0.13	0.07	0.20	0.20	0.20
Women						
Censored headcount	11.21%	3.60%	40.34%	10.16%	33.78%	16.22%
% Contribution	24.39%	2.90%	16.33%	19.88%	29.34%	7.16%
Men						
Censored headcount	0.43%	0.49%	17.12%	10.07%	24.15%	12.14%
% Contribution	24.12%	1.51%	12.48%	8.07%	32.27%	21.55%

4.2 Food insecurity status of households in Nigeria

More than half of the households experienced severe hunger (Table 4) implying that The highest proportion (55.1%) of the households:- (i) had no food of any kind to eat in the last 4 weeks before the survey and happened often; (ii) had at least a member go to sleep at night hungry and happened often; and (iii) had at least a member go a whole day and night without food and happened often . Only 18.1% experienced zero hunger. The result is corroborated by the findings of Ogunniyi *et al*. (2021) and Ehebhamen *et al*. (2017) that there is high prevalence of food insecurity among farming households in Nigeria. This result further showed that food security in Nigeria is a major concern for its population and can be described as worrisome requiring efforts from various stakeholders to tackle the menace.

Table 4: Food insecurity status of households in Nigeria

Hunger scale	Frequency	Percentage
Zero hunger (Threshold = 0)	81	18.08
Mild hunger (Threshold = 0.1 - 2)	63	14.06
Moderate hunger (Threshold = 2.1 - 4)	57	12.72
Severe hunger (Threshold = 4.1 - 6)	247	55.13
Total	448	100

4.3 Food insecurity profile in rural Nigeria

Household heads in their economically active age (41–60 years) were more susceptible to food insecurity than other age groups (Table 5). The aged respondents had lower probability of being affected with hunger because food intake declines with age and the elderly frequently report a decrease in appetite. (Clegg *et al*., 2023; Shuremu *et al*., 2022).

The higher percentage (91.4%) of households without food insecurity were male-headed. Similarly, more male-headed households experienced mild (88.9%), moderate (86.0%) and severe hunger (83.8%) than their female counterparts. Hence, the food insecurity was more prevalent among female-headed households than their male counterparts. This conforms with the findings of Abdullah *et al*., (2019) that women as compared to men are more likely to play a positive role in household food security reduction.

The incidence of severe hunger was highest within the household hunger scale with rural households being more susceptible to food insecurity than their urban counterparts. This finding indicated that the probability of being food insecure was highest in the rural sector compared to the urban sector and that poverty was prevalent in rural area due to lack of credit to engage in commercial farming instead subsistence farming which is the predominant practice within the rural settings. However, the highest proportion of both households with literate and non-literate heads were prone to severe food insecurity. This implies that most being able to read and write is not sufficient to reduce the incidence of severe hunger largely because it cannot guarantee era better paid job with higher income (Gnedeka & Wonyra, 2022).

Households with married (88.9%) heads had a higher percentage of zero hunger, while unmarried (11.1%) had lower percentage of zero hunger. Married (90.5%) had a higher percentage of mild hunger, while unmarried (9.5%) had lower percentage of mild hunger. Likewise, married (80.7%) had a higher percentage of moderate hunger, while unmarried (19.3%) had lower percentage of moderate hunger. Also, households with married (83.4%) heads had a higher percentage of severe hunger, while unmarried (16.6%) had lower percentage of severe hunger. Likewise, findings show that households with married heads were more prone to food insecurity than their unmarried counterparts. It is evidence that marital status may not explain food insecurity. However, married households have a lot of family obligations to meet within their reach, it may result that most time the household head may go hungry in order for the family to survive (Chai, 2023; Dallmann *et al*., 2023).

Furthermore, severe hunger had the highest percentage within the household hunger scale. Moreover, the results showed that respondents within the household size range (1–5) were more likely to be food insecure compared to another household size. Those respondents with higher household size have a lower probability tendency of being affected with hunger. This implies that most of the respondents with higher household size were able to involve their household in labour invariably increasing the farm size cultivated as such reduce food insecurity. Non-agricultural households (no farm size) were also more susceptible to food insecurity than their farming counterparts. Thus, sole engagement in non-farm livelihood activities makes households susceptible to food insecurity, which is consistent with the findings of Balana *et al*., (2023). However, a larger proportion of agricultural households experienced severe hunger probably due to the fact that agricultural households are characterized with large family sizes, relying only on agricultural activities for their livelihood, lower education attainment of household heads (Nuvey *et al*., 2022; Ruslan &

Prasetyo, 2023). The highest proportion of all the per capita expenditure groups experienced severe hunger.

Table 5. Food insecurity profile by socio economic variables

	Zero hunger (N=81)	Mild hunger (N=63)	Moderate hunger (N=57)	Severe hunger (N=247)	Pooled (N=448)
Age					
20–40	29 (35.8)	12 (19.05)	22 (38.60)	81 (32.79)	144 (32.14)
41–60	40 (49.38)	37 (58.73)	27 (47.37)	101 (40.89)	205 (45.76)
61–80	12 (14.81)	14 (22.22)	8 (14.04)	58 (23.48)	92 (20.54)
81–130	0 (0.00)	0 (0.00)	0 (0.00)	7 (2.83)	7 (1.56)
Sex					
Male	74 (91.36)	56 (88.89)	49 (85.96)	207 (83.81)	386 (86.16)
Female	7 (8.64)	7 (11.11)	8 (14.04)	40 (16.19)	62 (13.84)
Sector					
Urban	18 (22.22)	13 (20.63)	11 (19.3)	34 (13.77)	76 (16.96)
Rural	63 (77.78)	50 (79.37)	46 (80.7)	213 (86.23)	372 (83.04)
Literacy					
Literate	69 (85.19)	43 (68.25)	43 (75.44)	183 (74.09)	338 (75.45)
Non-literate	12 (14.81)	20 (31.75)	14 (24.56)	64 (25.91)	110 (24.55)
Marital status					
Unmarried	9 (11.11)	6 (9.52)	11 (19.30)	41 (16.6)	67 (14.96)
Married	72 (88.89)	57 (90.48)	46 (80.70)	206 (83.4)	381 (85.04)
Household size					
1–5	35 (43.21)	29 (46.03)	31 (54.39)	122 (49.39)	217 (48.44)
6–10	39 (48.15)	22 (34.92)	22 (38.60)	107 (43.32)	190 (42.41)
11–15	7 (8.64)	10 (15.87)	4 (7.02)	17 (6.88)	38 (8.48)
16–20	0 (0.00)	2 (3.17)	0 (0.00)	1 (0.4)	3 (0.67)
Farm size					
0	62 (76.54)	49 (77.78)	49 (85.96)	194 (78.54)	354 (79.02)
0.0001–4	19 (23.46)	14 (22.22)	8 (14.04)	53 (21.46)	94 (20.98)
Per capita expenditure (₦)					
< 10000	1 (1.23)	0 (0.00)	4 (7.02)	11 (4.45)	16 (3.57)
10001–50000	15 (18.52)	13 (20.63)	10 (17.54)	71 (28.74)	109 (24.33)
50001–100000	24 (29.63)	25 (39.68)	19 (33.33)	73 (29.55)	141 (31.47)
100011–864860.3	41 (50.62)	25 (39.68)	24 (42.11)	92 (37.25)	182 (40.63)

Figures in parentheses are percentages ₦ = Nigerian currency (Naira)

4.4 Distribution of Food insecurity by WEAI

Analysis of food insecurity by 5DE reveals that 49.4% of respondents who were disempowered in the 5DE had zero hunger, 57.14% had mild hunger, 45.61% had moderate

hunger while 44.53% had severe hunger (Table 6). For empowered women, 50.6% had zero hunger, 42.9% had mild hunger, 54.4% had moderate hunger and 55.5% had severe hunger.

Table 6. Food security profile by disempowerment

_5de	**Zero hunger (N=81)**	**Mild hunger (N=63)**	**Moderate hunger (N=57))**	**Severe hunger (N=247)**	**Pooled (N=448)**
Disempowered	40 (49.38)	36 (57.14)	26 (45.61)	110 (44.53)	212 (47.32)
Empowered	41 (50.62)	27 (42.86)	31 (54.39)	137 (55.47)	236 (52.68)
Total	81 (100)	63 (100)	57 (100)	247 (100)	448 (100)

Figures in parentheses are percentages

4.5 Effect of women's empowerment on food insecurity.

The result of the IV ordered probit regression analysis showed a Wald chi^2 of 114.59 and the Prob >chi^2 was 0.000 implying that the explanatory variables jointly explain food insecurity status of the households (Table 7). Due to the potential endogeneity of women's empowerment, instrumental variables are included in the ordered probit model (IV ordered probit) for the major analysis. The test of endogeneity shows the evidence that the women's empowerment is, in fact, correlated with the structural error and is endogenous (see Appendix). Therefore, religion was used as instrument because the variable has a casual effect on women empowerment, defines the outcome variable food insecurity only through women empowerment, i.e., religion does not have direct influence on food insecurity which is referred to as the exclusion restriction, and there is no confounding for the effect of women empowerment on food security. The instrument was tested using RIV test which showed that Wald test (Prob>chi2=0.3919) was not robust to weak instrument (see Appendix). The residual for the first stage of the equation (xhat) had a positive and significant relationship with food insecurity. However, its significance and sign differ slightly across the different categories of hunger scale. For instance, it was positive and significant for severe hunger 4.1760 (5%), while it was negative and significant for zero hunger, mild hunger and moderate hunger, 2.7781(5%), 1.0032 (5%), and 0.3946 (10%) respectively. Inclusion of the residual for the first stage of the equation (xhat) in the model provides a more consistent and less bias estimate than using the two-stage least square model (Zhang & Lewsey, 2024). Thus, estimate from the effect of women' empowerment on food insecurity using the IV ordered probit (Two-stage residual inclusion) model provides consistent, unbiased and reliable. The Durbin-Wu-Hausman test of endogeneity using instrumental variable rejected the null hypothesis that women's empowerment was exogenous. Thus, women's empowerment was correlated with the structural error and consequently endogenous.

Women's empowerment had an inverse relationship with food insecurity status of the households. Women's empowerment in the five domains positively affected food security along the classes of zero hunger, mild hunger and moderate hunger and negatively affected food security in the class of severe hunger. A unit increase in 5DE increased the probability of zero hunger by 2.28 units (Table 6). Also, a unit increase in 5DE increased the probabilities of mild hunger, moderate hunger and severe hunger by 0.96 units, 0.38 units and 4.03 units, respectively. This result indicates that increasing 5DE by one unit will significantly reduce severe food insecurity of households in Nigeria. An increase in empowerment in the five domains leads to a decrease in severe hunger. This is because women's empowerment in 5DE in allows women in the household opportunity to engage in production without limitations in control of resources, leadership and income before making it likely for those households to be food secured (Ayevbuomwan *et al.,* 2016). Women empowerment had a deteriorating effect on food insecurity, and it is a viable policy tool to achieve household food security in Nigeria (Sharaunga *et al.,* 2016). Being a female-headed household also increased the probability of zero hunger by 0.38 unit compared to the male gender. However, it decreased the probability of severe hunger by 0.08 unit. This is because women in Nigeria are majorly involved in keeping their homes and raising children (Abubakar, 2024). This result is similar to those of Haque *et al.* (2024) and Essilfie *et al.* (2024) who found that empowering women is fundamental to achieving food security. Thus, food security policies targeting female-headed households is crucial to achieving zero hunger in Nigeria (Sharaunga *et al.,* 2016; Ayevbuomwan *et al*., 2016).

Furthermore, the estimated results of age variable were not, in general, unexpected. The age of household heads reduced the probability of zero hunger, mild hunger and moderate hunger among the households but increased that of severe hunger situation. This suggested that households with ageing household heads were more likely to be food insecure. This finding agrees with the findings of Waxman *et al*. (2022) that age has a positive relationship with severe hunger among households. This is because as household heads advance in age, they approach retirement and subsequently have a reduced income and therefore a higher food insecurity incidence (Fernandes *et al*., 2018; Selvamani, 2023). Similarly, being married or separated or widowed positively influenced the likelihood of experiencing zero hunger, mild hunger and moderate hunger among the households, while being unmarried reduced the probability of experiencing severe hunger. Being a married household head increased the probability of the household experiencing zero hunger (0.158%), mild hunger (0.107%) and moderate hunger (0.085%) compared to being single while an increase in married respondents decreased severe hunger by 0.351%. Similarly, being separated from spouse increased the probability of the household experiencing zero hunger (0.588%), mild hunger (0.125%) or moderate hunger (0.053%) decreased their probability of experiencing severe hunger by 0.766%. Being widowed increased the probability of zero hunger, mild hunger and moderate hunger by 0.36%, 0.144% and 0.086% respectively, while it reduced the probability of severe hunger by 0.59%. This implied that being in a married household reduced the likelihood of experiencing severe hunger. This

supports the findings of Adepoju and Oyegoke (2018), which suggest that households with married heads are more likely to be food secure, as they tend to have larger households that engage in income-generating activities and contribute to the household income. Thus, the joint attempts to provide for the food requirement of the household improves the chances of being food secure. Likewise, assets of household reduced the probability that a household would experience zero hunger, mild hunger and moderate hunger. However, assets had a positive effect on severe hunger. While the reason for this observation may not be certain, the purchase of assets may deplete income that would have otherwise been expended on purchase of food items for the household.

Dependency ratio had a positive relationship with food insecurity and was significant. The result showed that an additional individual in the household increased the probability of experiencing zero hunger, mild hunger, moderate hunger and severe hunger marginally by 0.0013 unit, 0.0004 unit, 0.0001 unit and 0.0020 unit. This result is consistent with apriori expectation and consistent with the findings of Samim *et al*. (2021) that households with large dependency level were more predisposed to hunger compared to household with small household size. Moreover, the probability of being food insecure in the rural sector was 0.475. This may be owing to lack of proper implementation of government policies and programmes at the rural level. Rural communities are disconnected from development due to the neglect bottom-up approach to development. Residing in the rural area reduced the probability of experiencing zero hunger, mild hunger and moderate hunger compared to the urban sector while it positively influenced the probability of experiencing severe hunger. Thus, the likelihood of being severe food insecure was higher in rural areas than in the urban areas. This may be as a result of poor infrastructure in the rural sector which impedes production and processing of food and food products.

Table 7: Effect of women's empowerment on food insecurity

		(1) Zero hunger	**(2) Mild Hunger**	**(3) Moderate Hunger**	**(4) Severe Hunger**
	Coefficient	dy/dx	dy/dx	dy/dx	dy/dx
5DE	-10.4777**	2.6850**	0.9696**	0.3814*	-4.0361**
	(5.3127)	(1.3603)	(0.4992)	(0.2086)	(2.0250)
Female head	-1.1979*	0.3829*	0.0225	-0.0240	-0.3815**
	(0.7921)	(0.2572)	(0.0493)	(0.0478)	(0.1617)
Age	0.0172***	-0.0044***	-0.0015***	-0.0006**	0.0066***
	(0.0065)	(0.0016)	(0.0006)	(0.0002)	(0.0024)
Married	-1.3703*	0.1589***	0.1075***	0.0852**	-0.3517***
	(0.7484)	(0.0271)	(0.0303)	(0.0356)	(0.0857)
Divorced	-0.6405	0.0386	0.0405	0.0410	-0.1201
	(0.5944)	(0.0616)	(0.0481)	(0.0400)	(0.1469)
Separated	-2.6663*	0.5880**	0.1256***	0.0531*	-0.7669***
	(1.4530)	(0.2801)	(0.0386)	(0.0314)	(0.2315)
Widowed	-2.0543*	0.3658**	0.1444***	0.0864***	-0.5968***
	(1.1177)	(0.1698)	(0.0335)	(0.0289)	(0.2052)

		(1) Zero hunger	(2) Mild Hunger	(3) Moderate Hunger	(4) Severe Hunger
	Coefficient	dy/dx	dy/dx	dy/dx	dy/dx
Not literate	-0.2249	0.0605	0.0191	0.0063	-0.0860
	(0.2084)	(0.0582)	(0.0162)	(0.0045)	(0.0785)
Dependency ratio	0.0052*	0.0013*	0.0004*	0.0001*	0.0020*
	(0.0624)	(0.0160)	(0.0057)	(0.0022)	(0.0240)
Farm size	0.1409	-0.0361	-0.0130	-0.0051	0.0542
	(0.1479)	(0.0378)	(0.0137)	(0.0055)	(0.0568)
Assets	0.0001*	-0.0000*	-0.0000*	-4.75e-06*	0.0000*
	(0.0000)	(0.000)	(7.57e-06)	(3.08e-06)	(0.0000)
Rural	0.4755***	-0.1382***	-0.0369***	-0.0084**	0.1836***
	(0.1704)	(0.0545)	(0.0112)	(0.0035)	(0.0636)
xhat	10.8409**	-2.7781**	-1.0032**	-0.3946*	4.1760**
	(5.3101)	(1.3594)	(0.4998)	(0.2094)	(2.0225)
/cut 1	-7.148974				
	(3.494926)				
/cut 2	-6.688941				
	(3.493128)				
/cut 3	-6.345848				
	(3.49244)				
Prob > chi2 = 0.0000		Wald chi2=114.59	Pseudo R2=0.0168		
Test of Endogeneity					
Robust score chi2(1)		4.34532 (p=0.0371)			
Robust regression F (1,434)		4.83954 (p=0.0283)			

*** $p<0.01$, ** $p<0.05$, * $p<0.1$ Robust Standard errors in parentheses

5. Conclusions

The findings in this study suggested that multidimensional economic empowerment of women is relatively low and should be a matter of importance that concerned of rural women and education increases the probability of rural women being economically empowered while on the other hand, age of household head, household size reduces the probability of women being multidimensional empowered in rural Nigeria. Efforts should be directed at enabling rural women to be active participants in decision making concerning production and earnings. The ability of women to have access and control over assets, to be able to earn a living will give them a voice and a vote in decisions taken in the household. This will increase women's self-confidence, harnessing their innate potential to contribute massively to the sustainable development of society. Furthermore, the findings suggested that directing investment to the formal educational of women in Nigeria will reinforce the possibility of households to come out of food insecurity. It was also ascertained that women's empowerment may be another avenue for improving household security status and vice-versa. Therefore, bundling women's empowerment interventions with agricultural

interventions may make the latter more effective in improving nutrition in households with low production diversity. This will in the long run have a multiplier effect on helping the country to meet the second and the fifth Sustainable Development Goals of achieving zero hunger as well as gender equality and women's empowerment.

Supplementary Materials: Appendix is available at the end of this paper.

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Appendix

Weak instrument Test

rivtest

Weak instrument robust tests for linear IV with robust VCE

H0: beta [hunger: 5de] = 0

Test	Statistic	p-value
AR	Chi2 (1) = 4.72	Prob > chi2 (1) =0.0298
Wald	Chi2 (1) = 0.73	Prob > chi2 = 0.3919

Note: Wald test not robust to weak instruments.

The Instrumental variable used was religion while 5DE is the endogenous variable.

The instrument was tested using RIV test.