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EFFECT OF DIETARY DIVERSITY ON STUNTING OF CHILDREN IN NIGERIA

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ABSTRACT
Stunting in developing economies like Nigeria is strongly linked to diets consumed by children of less than five (5) years. This linkage matters as food dietary diversity is linked to food and security. The paper addressed a gap in the literature on how dietary diversity is linked to stunting children of less than five (5) years in Nigeria. The study used panel data from the three waves of the Living Standard Measurement survey of households in Nigeria, a representative of Africa's most populous nation. Our empirical approach includes instrumental variable regressions with household random effects to account for time-invariant unobserved and observed characteristics that could jointly determine stunting. Dietary diversity was found to reduce the probability of wasting in children by an average of 1.33 at the 0.01 level of significance while food prices was found to reduce dietary diversity by an average of 0.03 at the 0.01 level of significance. These findings are relevant to future policies on stabilizing food prices and nutrition education for mothers to improve the nutrition of their children.

Keywords: Dietary Diversity, Food Prices, Instrumental Variable, Probit, Stunting.

INTRODUCTION
The challenge of malnutrition is huge, posing serious health issues which also translate into economic problems for about one third of the world's population consuming poor diets (International Food Policy Research Institute [IFPRI], 2016). Promoting a healthy diet has become a global priority because of the scientific linkage between food intake and human health (Gao *et al.,* 2013). Malnutrition is a condition that occurs when people consistently do not consume or absorb the right amounts and types of food and essential nutrients. Globally, malnutrition contributes to more than three million deaths of children each year (Black *et al.,* 2013).

Malnutrition is a lingering problem in Africa. African children make up one-quarter of the estimated 148 million underweight children globally. While sub-Saharan Africa is still struggling with high rates of underweight and stunting in children under five, with the proportion of stunted children being 41% (World Health Organization [WHO], 2017). The diet of an organism is what it eats, which is largely determined by the availability and palatability of foods. For humans, a healthy diet includes preparation of food and storage methods that preserve nutrients from oxidation, heat or leaching, and that reduce risk of foodborne illness (Whitney and Rolfes, 2013). Wiesmann *et al.* (2009) defined dietary diversity as the number of different foods or food groups eaten over a reference period regarding the frequency of consumption. Eating a wide variety of foods is likely to increase nutrient adequacy (Delia and Ernest, 2017).

Nigeria's Demographic and Health Survey [DHS], (2013) reports small improvements in rates of stunting: from 42% of children in 2003 to 37% of children in 2013 (DHS, 2013). Anthropometric indices like weight for age, height for age, especially of fewer than 5 children are used to assess the nutritional status of children from birth to 59 months of age (Food and

Nutrition Technical Assistance [FANTA], 2013). These disturbing results call for a deeper look into factors that drive malnutrition in Nigeria.

Lack of diet diversity is a particularly severe problem among poor populations in the developing world (Hooshmand and Udipi, 2013). Malnutrition is intergenerational in nature, with women and children mostly affected because malnourished women give birth to malnourished children and the cycles continues if there are no interventions to break it. Because of the perceived importance of dietary diversity for health and nutrition, indicators of dietary diversity have become increasingly popular in recent years (Martin-Prevel *et al.,* 2012). There have been different studies in Nigeria on the effect of dietary diversity on malnutrition; however, little or no studies have been done using a panel approach to examine the effect of dietary diversity on malnutrition.

MATERIALS AND METHODS

The Study Area

The study area is Nigeria. Nigeria has about 923, 763km^2 of landmass which runs from about longitude 2^o 40^1 to 15^0 45^1 East of the Greenwich meridian and from latitude 4^0 15^1 to 13^0 55^1 north of the equator (Maps of World, 2014). Nigeria shares land borders with the Republic of Benin in the west, Chad and Cameroon in the east and Niger in the north (Wikipedia, 2018), the Atlantic Ocean forms the southern boundary. Nigeria is indeed a unique tropical country that cuts across all tropical ecological zones. These include, the southern zone of mangrove swamp located between latitude 4^o and 6^o 30^{1}N, the tropical rainforest found around latitude 6^o 30^1 to 7^o 45^1 stretching from the southeast, the guinea savannah belt around latitude 7^{0}N to 45^{0}10^{1}N, the Sudan Savannah belt around 10^0 12^{1}N and the Sahel Saharan in areas above 12^{0}N (Maps of World, 2014). Noted geographical features in Nigeria include the Adamawa highlands, Mambilla Plateau, Jos Plateau, Obudu Plateau, the Niger River, Benue River and Niger Delta.

Nigeria is found in the Tropics, where the climate is seasonally damp and very humid. Nigeria is affected by four climatic types; these climate types are distinguishable, as one move from the southern part of Nigeria to the northern part of Nigeria through Nigeria's middle belt. Nigeria is made up of 36 states including the Federal Capital Territory. Its capital is located in Abuja. Nigeria is covered by three types of vegetation: forests (where there is significant tree cover), savannahs (insignificant tree cover, with grasses and flowers located between trees), and *montane* land. (The *montane* is the least common and is mainly found in the mountains near the Cameroon border.) Both the forest zone and the savannah zone are divided into three parts. The unique characteristics of Nigeria make it vulnerable to climatic and environmental externalities resulting from both nature and anthropogenic driving factors. The country has a population of over 190 million people (USAID, 2018). An estimated proportion of 18% of under five children are stunted while 37% are wasting, a percentage greater than the world's average of 25%, these statistics makes Nigeria suitable for this study.

Sampling Techniques

The population for the study consisted of children under the age of five years in Nigeria. The GHS-Panel survey is modeled after the Living Standard Measurement Study-Integrated Survey on Africa (LSMS-ISA) surveys and is representative at the national, zonal, state and local government area levels. The LSMS which was sponsored by the World Bank consists of an unbalance panel from three waves collected in 2010, 2012 and 2015. Data collection was done at the household and individual level, the components used for this analysis includes the asset component, health component, roaster component and housing component. Only households with children under the age of 5 were selected for the study. Age and weight of the children were converted to z-scores and outliers following WHO recommendation for the range of stunting were dropped, bringing the number of children used for this analysis to 24,813.

Analytical Techniques

The study used binary probit and random effects probit regressions. The random effects estimation approach leverages the fact that about 24,813 children under five were surveyed in multiple waves. Observed and unobserved household characteristics that do not change between successive waves of the survey become useful in estimating the effect of dietary diversity on stunting of children. The dependent variable stunting was measured as a dummy variable, 1 was given to children whose standardized z-score is less than 2 indicating they are wasted and 0 was given to children whose z-score is greater than 2 indicating they are not stunted.

The treatment variable dietary diversity was measured using a seven (7) count dietary diversity over the past seven days as its primary nutritional measure. The food groups were classified as follows:

1. Grain, roots, tubers and plantain
2. Vitamin A rich plant foods
3. Other fruits and vegetables
4. Flesh foods (meat, poultry, fish and sea foods)
5. Eggs
6. Pulse, legumes or nuts
7. Milk and milk products.

The foods consumed from the sugary food group (sweets, pastries and drinks), were also recorded. However, it was excluded from the analysis because they are known to have poor bioavailability of micronutrients (Acham *et al.,* 2013). Total food production and food prices were measured in naira. Income which was proxied with asset was measured in naira, age of household head was measured in years, own food production, farm employment, non-farm employment, own food production, education of household head, education of mothers, sex of household head, sex of child, were measured as dummy variables. Household size was measure per person.

Model Specification

Probit random effect showing the effect of water sources on wasting is modeled below following (Train, 2009). The model for effect of dietary diversity on the nutritional status of children is shown as:

$$P_{nit} = \int_{\varepsilon_{it} \in B_{it}} \emptyset \varepsilon_{it} \partial \varepsilon_{it} \qquad \ldots (1)$$

where;

P_{nit} = Probability of nutritional status n (stunting) that varies for individual *i* in time *t*
β_{it} = treatment and covariates that varies for individual *i* in time t listed below
D_{it} = Dietary diversity score that varies for individual *i* in time *t*
X_{it} = Covariates (age of household head, gender of household head, household wealth, education of household head, number of household size, total food consumed, involvement in farm enterprise, dummy for non-farm enterprise, dummy for household's engagement in own food production, dummy for geo-political zones, dummy for seasons,) that varies for individual *i* in time *t*
$\emptyset \varepsilon_{nit}$ = joint normal density with covariance Ω.

ε_{ht} = Random error term that varies for individual i in time t.

The dietary diversity is suspected to be endogenous and, therefore, a probit instrumental variable estimation will be employed.

At the first stage, the probit instrumental variable estimation was given as:

$$D_{it} = \rho_i + T + \pi P_{it} + \phi X_{it} + \mu_{it} \qquad \ldots(2)$$

where;
D_{it} = Dietary diversity score that varies for individual i in time t.
ρ_i = Time invariant unobservable individual characteristics (e.g., ethnicity)
T = Time effect
P_{it} = Food Prices that varies for individual i in time t
X_{it} = Covariates (Age of household head, household wealth, education of household head, number of household size, age of child, total food consumed, health status, own food production, involvement in farm enterprise dummy, dummy for non-farm enterprise, dummy for seasons, for geo-political zones) that varies for individual i in time t
μ_{ht}= Random error term that varies for individual i in time t.

At the second stage, the probit instrumental variable estimation was given as:

$$Y_{ht} = \alpha_h + T + \tau \widehat{D}_{it} + \theta W_{it} + \beta X_{it} + \eta_{it} \qquad \ldots(3)$$

where;
Y_{it} = Nutritional status that varies for individual i in time t
α_h = Time invariant Unobservable individual characteristics, e.g., ability.
T = Time effect
$\widehat{D}_{it}$ = predicted value of dietary diversity score from first stage regression
W_{it} = Water source that varies for individual i in time t
X_{it} = Covariates (age of household head, household wealth, education of household head, number of household size, age of child, total food consumed, health status, own food production, involvement in farm enterprise dummy, dummy for non-farm enterprise, dummy for seasons, for geo-political zones) that varies for individual i in time t.
η_{ht} = Random error term that varies for individual i in time t.

Effect of Dietary Diversity on Nutritional Status

The result on the effect of dietary diversity on nutritional status (stunting) of children is reported in Table 1. An instrumental variable regression was done as the treatment variable dietary diversity is suspected to be endogenous. The test for endogeneity shows that at a significant value of 1% (1.41***) the null hypothesis of no endogeneity was rejected therefor the probit instrumental variable regression is appropriate to find the effect of dietary diversity on stunting. The result of the probit instrumental variable estimation shows that on average an increase in dietary diversity reduces the probability of stunting by 1.33 at the 0.01 level of significance. Surprisingly, income reduces the probability of stunting at the 0.01 level of significance by 0.12, this could be that an increase in income increases economic power which helps in the consumption of foods that add nutritional value to children, this result agrees with that of Black (2013) who found a positive relationship between income and stunting. An increase in education of the head of household leads to a decrease in the probability of stunting by 0.15 at the 0.01 level of significance this result is in line with Pradeep *et al.* (2013) who found that illiterate parents increased the odds of stunting. An increase in the age of head of household head reduces the probability of stunting in children marginally by 0.003 at the 0.1 level of significance, this might be that as parents age, they might have more time to take care of their young children. This result agrees with Ayenew *et al*. (2018) who found that age of household head significantly affected their nutritional status positively.

Table 1: Effect of Dietary Diversity on Stunting of Children

Variables	Probit	Probit Random Effect Regression	Probit Instrumental Variable (MFX)
Dietary diversity	0.19(0.02)***	0.18(0.02)***	-1.33(0.21)***
Total Consumption	-0.12(0.01)***	-0.12(0.01)***	-0.04(0.03)
Income	-0.06(0.01)***	-0.05(0.01)***	-0.12(0.03)***
Head of household education	-0.34(0.04)***	-0.34(0.04)***	-0.15(0.06)***
Age of household head	0.002(0.001)**	0.003(0.001)**	-0.003(0.001)***
Sex of child	0.24(0.03)***	0.24(0.03)***	0.12(0.07)*
Farm employment	0.24(0.05)***	0.23(0.05)***	0.29(0.06)***
Non-farm employment	-0.11(0.03)***	-0.13(0.03)***	-0.07(0.04)*
Own production of food	-1.22(0.13)***	-1.22(0.13)***	1.36(0.30)***
Sex of head of household	0.08(0.03)***	0.07(0.03)***	0.05(0.03)*
Mother's education	-1.72(0.09)***	-1.67(0.09)***	-0.99(0.36)***
Household size	-0.03(0.01)***	-0.03(0.01)***	-0.03(0.01)***
Post-planting1	-0.32(0.01)***	-0.32(0.05)***	-0.32(0.04)***
Post-harvest1	0.26(0.04)***	0.26(0.04)***	-0.003(0.09)
Post-planting2	0.08(0.04)*	0.09(0.04)**	0.01(0.05)
Post-harvest2	-0.17(0.05)***	-0.16(0.05)***	-0.15(0.03)***
Post-planting3	-0.15(0.04)***	-0.14(0.04)***	-0.20(0.04)***
North Central	0.24(0.04)***	0.23(0.04)***	-0.23(0.09)**
North East	1.04(0.05)***	1.03(0.05)***	-0.03(0.28)
North west	0.89(0.04)***	0.88(0.04)***	-0.31(0.26)
South East	-0.03(0.05)	-0.04(0.05)	-0.11(0.03)***
South South	0.02(0.04)	0.02(0.04)	-0.08(0.03)**
Constant	0.57(0.19)***	0.51(0.02)**	8.50(0.85)***
Number of Obs.	17,421	17,421	16,489
Log likelihood	-6513.86	-6508.53	-22066.32
athrho2_1			1.41(0.49)***

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: Data Analysis, 2019

The result also shows that boys are more likely to be stunted compared to girls by 0.12 at the 0.1 level of significance, this result agrees with Pradeep *et al.* (2013) who found that male children are more likely to get stunted compared to their female counterparts. Farm employment led to an increase in the probability of stunting by 0.29 at the 0.01 level of significance, this might be as a result of low monetary proceeds gotten from this venture which might lead to the consumption of food with less nutritional value. Non-farm employment reduces the probability of stunting marginally by 0.07 at the 0.1 level of significance; this could be that proceeds gotten from non-farm employment will help in purchasing foods that can help in improving their nutritional level.

The study also found that the own production of food leads to an increase in the probability of stunting by 1.36 at the 0.01 level of significance. This might be as a result of the small-scale level of farming characterized by farming in Nigeria therefore produce from farming households are rarely sufficient to meet the dietary needs of the family which might lead to an increase in probability of stunting their children. A household headed by a male increases the probability of stunting marginally by 0.05 at the 0.1 level of significance compared to a household headed by a female, this could be that women spend more of their resources on their families which results in better nutritional outcome, this result disagrees with that of FAO (2012) who found that female headed household are susceptible to malnutrition because they are usually less empowered to ensure food security and good nutrition.

Furthermore, the study disclosed that children whose mothers have a formal education were less likely to be stunted by 0.99 at the 0.01 level of significance compared to children whose mothers have no formal education, this result agrees with (Black, 2013) who found that mother's education reduces the probability of stunting in children. An increase in household size reduces the probability of stunting marginally by 0.03 at the 0.01 level of significance, this might be that larger household have more income from members of the households who work to earn a living which might lead to an increase in their economic status and also improved nutritional status. All the planting seasons were controlled for and post-planting seasons in waves 1 and 3, post-harvest season in wave 2 all lead to a decrease in the probability of stunting at the 0.01 level of significance. Living in the North-Central, South-East and South-South regions all led to a decrease in the probability of stunted children at the 0.05, 0.01 and 0.05 level of significance.

CONCLUSION AND RECOMMENDATIONS

The study analyzed the effect of dietary diversity on stunting in less than five years old children in Nigeria. The study used a panel data from the living standard measurement survey, a representative of Africa's most populous nation. The outcome of the instrumental variable regression shows that dietary diversity reduces the likelihood of stunting in children. Food prices were found to reduce dietary diversity. Other factors that are associated with stunting in children from the study includes total food consumed, low income, male head of household, male child (boys), younger parents, low education of mothers. Farm employment and own production of food was found to increase the likelihood of stunting because of the small-scale nature of farming by most farm households. The study recommends policies that will lead to reduction in food prices in other to enhance the dietary diversity of children. Also, an improvement in the economic status of parents will also help reduce the incidence of stunting in their young children.

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