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# Dietary diversity of households in Akwa Ibom State, Nigeria

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**Abstract**

This study analysed the dietary diversity of households in Akwa Ibom State. Cross-sectional data was collected using a multistage sampling procedure resulting in 457 respondents. Specifically, the study determined the prevalence, margin and intensity of dietary diversity of households based on three critical indices. Additionally, a fractional probit regression was estimated to determine the factors affecting the dietary diversity of households. Based on three critical indices (0.67, 0.87 and 0.59), 90%, 62% and 95% of the population respectively have sufficiently diverse diets. The disaggregated mean prevalence (given the three critical indices) indicates that the difference, in number of food groups consumed, between households with less than diverse and sufficiently diverse diets are five (5), four (4) and eight (8) respectively. The mean margin indicates that, at the minimum, policy may seek to increase the number of food groups consumed by households with less than diverse diets by two food groups. The intensity of the margin at critical index 0.59 is 0.17, showing that the margin of dietary diversity is most critical in this context. Results from the fractional probit regression unveil that education, household income, access to home garden, access to other farmland and ownership of livestock are significant in explaining the probability of households being dietary diverse.

***Keywords:*** Dietary Diversity; Prevalence; Margin; Intensity; Fractional Probit Regression



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## 1. Introduction

The term, Food and Nutrition Security is used to combine the aspects of food security and nutrition security, as well as to point to the idea that they are related. The use of the term 'Food and Nutrition Security' has become common practice in a number of international agencies such as IFPRI, UNICEF and FAO. (Pangaribowo, E.N, Gerber, N.T, Orero, M, 2013). The UN system of high level Task Force on Global Food Security (HLTF) in their Comprehensive Framework for Action (CFA) defined Food and Nutrition Security as a condition when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Food and Nutrition Security has also been defined by (Weingartner, 2010) as a condition under which adequate food (quantity, quality, safety, socio-cultural acceptability) is available and accessible for and satisfactorily utilized by all individuals at all times to live a healthy and happy life.

The four pillars of Food and Nutrition Security are availability, access, Use and Utilization and Stability. Use describes the socio-economic aspects of household food and nutrition security, determined by knowledge and habits. Dietary diversity refers to an increase in the variety of foods across and within food groups capable of ensuring adequate intake of essential nutrients that can promote good health (Ruel, 2002). Since no single food can contain all nutrients (Labadarios, Steyn and Nel, J, 2011) noted that the more food groups included in daily diet the greater the likelihood of meeting nutrient requirements. With that background, Kennedy, Fanou, Seghieri and Brouwer, (2009) similarly suggested that, a diet which is sufficiently diverse may reflect nutrient adequacy.

The diets of many households in Africa are predominantly plant-based, consisting largely of starchy staples (which contain low number of micro-nutrients that are often not easily absorbed) with little or no proteins of animal origin and few fresh fruits and vegetables (Arimond and Ruel, 2004). Understanding diversity in food consumption is crucial in various areas. A varied diet is generally conceived by nutritionists as an essential component of high-quality diet; having high correlation with adequate of intake of protein and micro-nutrients as well as prevention of excessive intake of other nutrients such as fat and chronic diseases (Ruel, 2002; Johns and Sthapit, 2004). Inadequate intake of micro-nutrients is well pronounced in many developing countries leading, among others, to impaired cognitive development, blindness especially among children, heightened morbidity, and in severe cases, mortality.

In poorer regions of the world, Micronutrient Malnutrition is certain to exist wherever there is under nutrition due to food shortages and is likely to be common where diets lack diversity. Generally speaking, whereas wealthier population groups are able to augments dietary staples with micronutrient-rich foods such as meat, fish, poultry, eggs, milks and dairy products and have greater access to a variety of foods and vegetables, poorer people tends to consume only small amounts of such foods, relying instead on more monotonous diets based on cereals, roots and tubers. The micronutrient content of cereals, particularly after milling is low, so these typically provide only a small proportion of the daily requirements for most vitamins and minerals. Fat intake among such groups is also often very low and given the role of fat in facilitating the absorption of a range of micro nutrients across the gut walls, the low level of dietary fats puts such populations at further risk of MNM. Consequently, proportions that consumes few animals' source foods may suffer from a high presence of several micronutrients' deficiencies simultaneously (Allen, L, Benoist, Dary, O, Hurrell, R, 2006). This results in deficiencies in micronutrients such as vitamin A, iron, and zinc which in turn negatively affects the survival, health, development, and wellbeing of billions of people. However, it has been observed that the more food groups included in a daily diet the greater the likelihood of meeting nutrient requirements while monotonous diets, based mainly on starches such as maize and bread, have been closely associated with food insecurity (Styen, Nel,Nantel, Kennedy and Labadarios, 2006). Studies have mostly reported the occurrence of malnutrition in mothers and children cum their inadequate dietary intakes and not the diversity of their diets (Ajani, 2010). Furthermore, empirical literature reveals that socioeconomic status of households is a core determinant of dietary diversity in both developed and developing countries (Mayen et al., 2014). Additionally, most studies restrict their analysis to reporting a mean dietary diversity score. It is against this background that this study is carried out to estimate the prevalence, margin and intensity of dietary diversity of households and also to determine the factors affecting this dietary diversity in Akwa Ibom State, Nigeria.

## 2. Materials and methods

### 2.1. Study area

The study was conducted in Akwa Ibom State. The State is located in the South-South geopolitical and South East ecological zones of Nigeria. It is one of the Niger Delta States. The State lies between 4º33" and 5º33" North latitudes, and 7º35" and 8º25 East longitudes. The estimated total area is put at 7,245,935km$^2$, and has a shoreline of 129km on the Atlantic Ocean to the South. It shares borders with Cross River State to the East, Abia State to the North, and Rivers State to the West (Ajana 1996 and Uwatt 2000).

The population of the State according to the 1991 census was 2,359,736, out of which 1,162,430 are males while 1,197,306 are females (National Population Commission, NPC 1991). The 2006 provisional census puts the population at 3,920,208, out of which 2,044,510 are males while 1,875,698 are females.

The major ethnic groupings in the state are Ibibio, Anang and Oron. Ibibio is the main language, but there are variations in dialects within the State: Annang, Eket, Ibeno, Itu Mbon Uso, Mbo, Okobo and Oron, while Andoni language is spoken by a minute population of the State. The above population lives within the tropical rainforest zone with two major seasons: rainy season (May to October) and a dry season (November to April). Annual rainfall ranges between 2400mm along the coast and 2000mm. The physical features directly influence the choice of crop cultivation and fishing as a means of sustainable livelihood. In 1997, the State was divided into six (6) agricultural zones namely- Abak, Etinan, Eket, Uyo, Oron and Ikot Ekpene.

### 2.2. Data collection

Data for the study was cross-sectional. This primary data was obtained using a structured questionnaire that was administered to households. Furthermore, a multistage sampling procedure was applied in this study. In the first stage, three agricultural zones were randomly selected out of the six agricultural zones, namely: Uyo, Eket and Ikot Ekpene. Next, three local governments each were purposively to give urban, semi-urban and rural representation to the study. Thirdly, six communities were randomly selected from each of the selected Local governments. In the last stage 10 households were randomly selected, giving a total of 540 households (180 from each selected zone). However, 457 questionnaires were duly and properly completed and hence the analysis was based on this number. Data was collected in 2018.

## 2.3. Estimation procedure

### *2.3.1. Estimating prevalence, margin and intensity*

Using a scale with twelve (items), a household dietary diversity index, *ddi*, was obtained. This index is the number of food categories selected by the household preparer expressed as a proportion of the total number of categories (= 12). The index was categorised into 0 – 4 (low), 5 – 8 (medium), 9 – 12 (high), as a proportion of 12. A critical index was obtained by selecting the score in the upper medium range viz: 8/12 = 0.67. Additionally, two other critical indices were obtained namely the mean dietary diversity index (*ddi*) and 2/3 of the mean dietary diversity index. Households with *ddi* values below the critical indices are termed as less than diverse and those with values above and equal to are named sufficiently diverse. Based on this critical indices: 0.67, 0.87 and 0.59, the prevalence, margin and intensity of households with less than diverse and sufficiently diverse diets were obtained.

2.3.1.1. Prevalence: Three measures akin to frequencies and means are explained in this section.

*Percentage Prevalence:* The first measure of prevalence was simply a percentage of households with less than diverse diets (who fall below) and sufficiently diverse diets (above/equal to) the critical indices. This measure used an indicator function that takes on a value of 1 for households with less than diverse (and sufficiently diverse) diets in alternate veins. This is given as:

$$ddi_{pp} = \sum_{i=1}^{N} 1(ddi < 0.67)\ {}^{1}/_{N}$$

And

$$ddi_{pp} = \sum_{i=1}^{N} 1(ddi \geq 0.67)\ {}^{1}/_{N}$$

N = total number of households (= 457)

N/B: 0.67 was successively substituted for 0.87 and 0.59-the other two critical scores earlier defined.

*Disaggregated mean Prevalence:* A second measure of prevalence was also obtained. This was essentially a mean computed based on actual values of *ddi* (as opposed to the use of an indicator function that assigns 1 to households that have less than diverse and sufficiently diverse diets, alternately). This measure was obtained asfollows:

$$ddi_{pa} = \sum_{i=1}^{N} (ddi < 0.67)\ {}^{1}/_{n}$$

n = number of households with *ddi* < 0.67

$$ddi_{pa} = \sum_{i=1}^{N} (ddi \geq 0.67)\ ^{1}/_{n}$$

n = number of households with *ddi* ≥ 0.67.

N/B: 0.67 was successively substituted for the other two critical indices 0.87 and 0.59. The values of n are similarly substituted to reflect what was obtainable when considering the other two critical scores.

*Weighted Mean Prevalence:* A third measure of prevalence of households with less than diverse and sufficiently diverse diets was essentially a weighted mean for households in both categories. The weights used are the sum of the *ddi* of households that have less than diverse (and sufficiently diverse) diets expressed as a proportion of the total *ddi* for all households in the study area.

$$ddi_{wpa} < 0.67 = mean\ ddi\ \times \frac{\sum ddi < 0.67}{\sum ddi}$$

$$ddi_{wpa} \geq 0.67 = mean\ ddi\ \times \frac{\sum ddi \geq 0.67}{\sum ddi}$$

N/B: 0.67 was successively substituted for 0.87 and 0.59.

2.3.1.2. Margin

The mean margin and mean proportionate margin were the measures of the margin, which is basically a deviation from the threshold score by households with less than diverse diets in the study area, reported in this section. These two measures are computed based on the number of households with less than diverse diets and all households in the study area -the rationale for this being that the number of households with less than diverse diets and all the households provide the basis for conclusion in terms of targeted interventions (ones geared towards uninformed households) and untargeted ones (ones spread across all households).

2.3.1.2.1 Mean Margin: This measure of the margin was obtained as follows:

$$ddi_{mm} = \sum_{i=1}^{N} (0.67 - < 0.67) \frac{1}{N}$$

N = total number of households (= 457)

And

$$ddi_{mm} = \sum_{i=1}^{N} (0.67 - < 0.67) \frac{1}{n}$$

n = number of households with *ddi* < 0.67

N/B: 0.67 was successively substituted for the other two critical scores 0.87 and 0.59. Similarly corresponding values of n for 0.87 and 0.59 were accordingly substituted.

2.3.1.2.2 Mean Proportionate Margin: This measure of the margin was given as follows:

$$ddi_{mpm} = \sum_{i=1}^{N} \left( \frac{0.67 - < 0.67}{0.67} \right) \frac{1}{n}$$

n = number of households with *ddi* < 0.67

$$ddi_{mpm} = \sum_{i=1}^{N} \left(\frac{0.67 - < 0.67}{0.67}\right) \frac{1}{N}$$

N = total number of households (= 457)

N/B: 0.67 was successively substituted for the other two critical scores 0.87 and 0.59. Similarly corresponding values of n for 0.87 and 0.59 were accordingly substituted.

2.3.1.3 Intensity**:** This measure was obtained as follows:

$$ddi_{in} = \sum_{i=1}^{N} \left(\frac{0.67 - < 0.67}{0.67}\right)^2 \frac{1}{n}$$

n = number of households with *ddi* < 0.67

$$ddi_{in} = \sum_{i=1}^{N} \left(\frac{0.67 - < 0.67}{0.67}\right)^2 \frac{1}{N}$$

N = total number of households (= 457)

N/B: 0.67 was successively substituted for the other two critical scores 0.87 and 0.59. Similarly corresponding values of n for 0.87 and 0.59 were accordingly substituted.

### *2.3.2. Estimating factors affecting dietary diversity*

The probability of a household being dietary diverse was determined essentially by socio-economic characteristics and other factors revealed in empirical literature. Dietary Diversity is usually measured as a score but in the context of this study it is measured as a proportion of a given maximum possible score. Probit models, as contrasted with linear probability models, have conditional probabilities that are nonlinearly related to the independent variable(s). Furthermore, probit functions have the characteristic of approaching 0 and 1 asymptotically, hence the predicted probabilities are always sensible. In addition, the probit model is based on the standard normal cumulative density function (CDF). This is defined basically as follows:

$$F(Z) = \int_{-\infty}^{z} 2\pi^{1/2}\, e^{-z^2/2} dz \qquad (1)$$

where $Z$ is a standard normal variable and $e$ is the base of the natural log. In a probit model since the standard normal CDF replaces the linear function, what is estimated is as given below:

$$E(Y|x_i) = \Pr\,(Y = 1|x_i) = F(\beta_0 + \beta_i X_i) = \int_{-\alpha}^{\beta_0 \beta_i x_i} (2\pi)^{1/2}\, e^{\frac{\beta_0 + \beta_i x_i}{2}} d(\beta_0 + \beta_i X_i). \qquad (2)$$

The β terms are not estimated using Ordinary Least Squares regression but a technique known as maximum likelihood estimation. This estimation finds values for the parameters (βs) that maximize the probability of observing the Y values in the sample with the given X values.

Sometimes it is more convenient for a researcher to express the dependent variable as a fraction, percentage or proportion. In such an instance, as is the case in this study, fractional probit regressions, a variant of the traditional probit regression is used. In simple terms, the main difference is that in this context the dependent variable is 0≤Y≤1.

The coefficients produced by estimating a probit model provide the change in the Z (standard normal) value for a unit change in the dependent variables. In order, therefore, to obtain the impact of the independent variables on the probability of observing the outcome, marginal effects are further estimated. The dietary diversity of households is expressed as a proportion of a maximum possible value and is hence a value that lies between 0 and 1. The factors affecting the probability of a household being dietary diverse are the explanatory variables for the fractional probit model. These variables are: [$X_1$] = Age, [$X_2$] =Education, [$X_3$] =Household size, [$X_4$] = Monthly income of household, [$X_5$] =Access to Home Garden, [$X_6$] = Access to other farmland, [$X_7$] = Ownership of livestock, [$X_8$] = Main materials of house.

**Table 1.** Lists, Codes and Description of Variables used in Regression

| Variables | Codes | Description |
|---|---|---|
| Age[$X_1$] | Years | Continuous |
| Education[$X_2$] | Years | Continuous |
| Household Size[$X_3$] | Figures | Continuous |
| Monthly income of household head[$X_4$] | Amount [Naira] | Continuous |
| Access to Home Garden[$X_5$] | Yes=1, No=0 | Dummy |
| Access to Other farmland[$X_6$] | Yes=1, No=0 | Dummy |
| Ownership of livestock[$X_7$] | Yes=1, No=0 | Dummy |
| Main Materials of house[$X_8$] | Mud=0, Mud & Cement=1 Cement Only=2 | Dummy |

*source: field survey, 2018*

## 3. Results and discussion

### 3.1. Summary statistics of continuous variables

Table 2 reveals that the household food preparers have spent a mean of 13 years acquiring, secondary school education suggesting a fair level of literacy. It further shows the presence of a mean of 1 child below 5 years and 1 adult above 65 years implying that analysing the dietary diversity of households in the study area is crucial because of the presence of these more vulnerable members of the household.

**Table 2.** Summary Statistics of the continuous variables

| Variables | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Age(years) | 41 | 11 | 18 | 78 |
| Monthly income(figures in Naira) | 94793.03 | 71297.76 | 10000 | 850000 |
| Education(years) | 13 | 4 | 0 | 23 |
| Household Size(figures) | 5 | 1 | 1 | 9 |
| Children below five (5) years(figures) | 1 | 1 | 0 | 6 |
| Adults above 65 years(figures) | 1 | 1 | 0 | 5 |

*source: field survey, 2018*

## 3.2. Descriptive statistics of dummy variables

Table 3 shows that over 90% of the population are married, employed females. This formed the basis for which marital status, gender and employment status as socioeconomic characteristics of the population were excluded from the fractional probit regression as these factors were almost completely determined.

**Table 3.** Descriptive Statistics of the Dummy Variables

| Marital Status | Frequencies | Percentages |
|---|---|---|
| Single | 40 | 8.75 |
| Married | 417 | 91.25 |
| Total | 457 | 100 |
| Employment Status | | |
| Unemployed | 12 | 2.63 |
| Employed | 445 | 97.37 |
| Total | 457 | 100 |
| Gender | | |
| Male | 1 | 0.22 |
| Female | 456 | 99.78 |
| Total | 457 | 100 |
| Access to Home Garden | | |
| Yes | 315 | 68.93 |
| No | 142 | 31.07 |
| Total | 457 | 100 |
| Access to Other Farmland | | |
| Yes | 273 | 59.74 |
| No | 184 | 40.26 |
| Total | 457 | 100 |
| Ownership of Livestock | | |
| Yes | 156 | 34.14 |
| No | 301 | 65.86 |
| Total | 457 | 100 |
| Main Materials of House | | |
| Mud | 14 | 3.06 |
| Mud and Cement | 69 | 15.10 |
| Cement Only | 374 | 81.84 |
| Total | 457 | 100 |

*source: field survey, 2018*

## 3.3. Food group consumption of households

In Table 4, the escalated consumption of foods high in carbohydrates (97.16% and 95.19%) may be a picture of the rural area, adding that the intake of starchy staples is not restricted to the rural areas but to the Nigerian context (Ajani.2010). An intake of vegetable and fruits by over 80% of may not be unconnected to the over 65% access to home garden (Table 3) and the everyday tastes of the people of Akwa Ibom State. The high distribution of households that consume fish, as seen in Table 4 is likely because the state under study is coastal.

**Table 4.** Percentage of Households by Food Group Consumption

| S/No. | Food Groups | Percentage |
|---|---|---|
| 1 | Bread, rice, noodles, biscuits, or any other foods made from millet, sorghum, maize, wheat or any other locally available grain | 97.16 |
| 2 | Potatoes, yams, cassava or any other foods made from roots or tubers | 95.19 |
| 3 | Any vegetables | 95.62 |
| 4 | Any fruits | 86.21 |
| 5 | Beef, pork, lamb, goat, rabbit, wild game, chicken, duck, other birds, liver, kidney, heart or other organ meats. | 86.65 |
| 6 | Any eggs | 74.84 |
| 7 | Any fresh, dried fish or shellfish. | 93.22 |
| 8 | Any foods made from beans, peas, lentils or nuts | 82.71 |
| 9 | Any cheese, yoghurt, milk or other milk products | 82.93 |
| 10 | Any foods made with oil, fat or butter | 90.15 |
| 11 | Any sugar or honey | 82.71 |
| 12 | Any other foods such as condiments, coffee or tea | 80.74 |

*Source: Field Survey, 2018*

## 3.4. Prevalence

### *3.4.1. Percentage prevalence*

As shown in Table 5, based on the critical index (= 0.67), 10.50% and 89.50% of households are found to have less than diverse and sufficiently diverse diets. 38% and 62% of households in the study area have less than diverse and sufficiently diverse diets respectively when the mean *ddi* (=0.87) is taken as critical index 5.2% and 94.75% of households in Akwa Ibom State have less than diverse and sufficiently diverse diets, using the mean *ddi* (0.585) as critical index. Simply put at critical indices 0.67, 0.87 and 0.59, the critical dietary diversity scores are 8, 10 and 7 respectively. In contrast to these scores, McDonald et al. 2015 reported a mean dietary diversity score of 4.7 for households in rural Cambodia. In further contrast, in rural Burkina Faso, Savy et al. (2006) reveal dietary diversity scores of 3.4 and 3.8 during cereal shortage and cereal harvest period respectively. Agada and Igbokwe (2015) similarly report a mean dietary diversity of 4.6, in contrast to scores obtained at three critical indices. These contrasts could possibly be explained by the fact that this study was carried out in both rural and urban areas of Akwa Ibom State whereas the contrasted studies were done in strictly rural areas. Vakili et al. (2013), in a similar vein, report a mean dietary diversity score of 6.81akin to the score of 7 obtained at critical index 0.59. Ayenew et al. (2018) report a mean dietary diversity score 6.6 in Nigeria, in tandem with the dietary score of 7 obtained at critical index 0.59.

### *3.4.2. Disaggregated mean prevalence*

Multiplying the value of the disaggregated mean prevalence, consistently, given all three critical indices, gives the precise number of food groups being consumed by less than diverse and sufficiently diverse diet households. Results show that, 0.48 and 0.92 are the mean dietary diversity indices, at critical index 0.67, assuming the population is dichotomized with households having less than diverse diets in one category and sufficiently diverse diets in another category respectively. These values, therefore, mean that less than diverse and sufficiently diverse households consume six (6) and eleven (11) food groups respectively. At critical index 0.87, 0.68 and 0.99 are the mean dietary diversity indices, taken given that the population is split into households having less than diverse diets and sufficiently diverse diets respectively. Similarly these values suggest that less than diverse and sufficiently diverse households consume eight (8) and twelve (12) food groups respectively. The values 0.39 and 0.90 are equal to the mean of households having less than diverse diets and sufficiently diverse diets in the area at critical index 0.59. In this vein these values imply that less than diverse and sufficiently diverse households consume three (3) and eleven (11) food groups respectively.

The results of the percentage prevalence and disaggregated mean prevalence, taken together, reveal in the first vein, given 0.67 as critical index that 10.50% and 89.50% of households consume six (6) and eleven (11) food groups respectively. Similarly, taking the mean 0.87 as threshold index, 38% and 62% respectively of households consume eight (8) and twelve (12) food groups respectively. Lastly, in this regard, given two thirds of the mean, 0.59, as critical index, 5.25% and 94.75% of households consume three (3) and eleven (11) food groups respectively.

### *3.4.3. Weighted mean prevalence*

In percentages as seen in Table 5, at critical index 0.67, households with less than diverse diets and sufficiently diverse diets contribute 5.82% and 94.18% to the total value of the total *ddi*. In actual figures, alternatively, the contribution of households with less than diverse and sufficiently diverse diets to the value of the mean is 0.05 and 0.82 respectively. Households having less than diverse and sufficiently diverse diets, when critical index is mean *ddi* (=0.87), comprise 29.83% and 70.17% of the total value of dietary practices index. Additionally at critical index (=0.59), 0.26 and 0.61 are the actual values contributed by households having less than diverse and sufficiently diverse diets to the value of the mean *ddi*. 2.32% and 97.68% is contributed to the value of the total *ddi* at critical index 0.59, by the households that have less than diverse and sufficiently diverse diets. In the same vein, households having less than diverse and sufficiently diverse diets contribute 0.02 and 0.85 to the value of the mean, in actual figures.

**Table 5.** Dietary Diversity of Households: Prevalence

| | Prevalence | | | | | |
|---|---|---|---|---|---|---|
| | **Percentage prevalence** | | **Disaggregated Mean prevalence** | | **Weighted mean prevalence/percentage contribution** | |
| **Critical indices** | **Less than diverse** | **Sufficiently diverse** | **Less than diverse** | **Sufficiently diverse** | **Less than diverse** | **Sufficiently diverse** |
| 0.67 | 10.50 | 89.50 | 0.48 | 0.92 | 0.05(5.82) | 0.82(94.18) |
| 0.87 | 38 | 62 | 0.68 | 0.99 | 0.26(29.83) | 0.61(70.17) |
| 0.59 | 5.25 | 94.75 | 0.39 | 0.90 | 0.02(2.32) | 0.85(97.68) |

*Source: Field Survey, 2018 *less than diverse (<critical index), sufficiently diverse (≥ critical index)*

## 3.5. Margin

### *3.5.1. Mean margin*

Based on the three critical indices (0.67, 0.87, 0.59), the figures 0.19, 0.19 and 0.2 depict the mean deviation from the critical indices strictly of households found to have less than diverse diets. It should be noted that the value of the critical indices, respectively, assume that sufficiently diverse diets households consume at most eight (8), ten (10) and seven (7) food groups. This fact is obtained by simply multiplying the value of the critical indices by twelve (12), which is the total number of food groups presented. This values are the minimum values by which any intervention should aim to raise the value of the *ddi* (increase the dietary diversity of households) of households in the study area, provided that the measures are targeted only at households where *ddi* is below the respective indices being considered. Simply, the results of the mean margin imply that for households to be sufficiently diverse in their diets, it is required that they consume an extra two food groups, given the three critical indices.

Similarly, based on the critical indices 0.67, 0.87 and 0.59, the figures 0.02, 0.07 and 0.01 are the minimum values by which an intervention or policy set should aim to increase the *ddi* of all households in the study area, regardless of whether the household has less than diverse or sufficiently diverse diets.

### *3.5.2. Mean proportionate margin*

Given the three critical indices (0.67, 0.87 and 0.59) the values 0.28, 0.22 and 0.34 are the mean proportionate margin of the population (where households with *ddi* < 0.67, < 0.87, <0.59 have zero margin). This measure can be seen as the minimum value (expressed as a proportion of the critical index) by which *ddi* of households have to be raised to increase them to the critical values under consideration. Multiplying these values by the respective critical indices, the precise minimum value by which an intervention should seek to raise *ddi* is obtained. This is provided that the intervention are targeted only at households with less than diverse diets.

In a related vein, based on the three critical indices 0.67, 0.87 and 0.59, the figures 0.03, 0.08 and 0.02 are the ratio of minimum value by which *ddi* must be raised with perfect targeting (intervention aimed at households with less than diverse diets) to the maximum value with no targeting (where intervention is applicable to all households) which would entail aiming to raise the value of every household's *ddi* enough to ensure they are not below the critical value.

**Table 6.** Dietary Diversity of Households: Margin

| Critical Index | Mean Margin | | Mean Proportionate Margin | |
|---|---|---|---|---|
| | Targeted(n) | Untargeted(N) | Targeted(n) | Untargeted(N) |
| 0.67 | 0.19 | 0.02 | 0.28 | 0.03 |
| 0.87 | 0.19 | 0.07 | 0.22 | 0.08 |
| 0.59 | 0.20 | 0.01 | 0.34 | 0.02 |

*Source: Field Survey, 2018.*

## 3.6. Intensity

The figures 0.12, 0.08, 0.17 and 0.01, 0.03 and 0.01, in Table 6, reveal the intensity (severity) of the deviation of households with less than diverse diets from the critical indices: 0.67, 0.87 and 0.59 (respectively) when the mean margin and mean proportionate margin are obtained based on the number of households that have less than diverse diets and all the households respectively. The lower the value of the intensity the less crucial a problem the lack of dietary diversity is.

**Table 7.** Dietary Diversity of Households: Intensity

| Critical Index | Intensity | |
|---|---|---|
| | Targeted(n) | Untargeted(N) |
| 0.67 | 0.12 | 0.01 |
| 0.87 | 0.08 | 0.03 |
| 0.59 | 0.17 | 0.01 |

*Source: Field Survey, 2018.*

## 3.7. Factors influencing dietary diversity of households

Education of household food preparer and household income are statistically significant at 1%, positively and negatively related respectively, in explaining the probability of households being dietary diverse. This shows that a more educated household food preparer is more likely to run a dietary diverse household than a less educated one. It further reveals that a household with lower income is more likely to be dietary diverse. This is plausible because a lower income is likely to engender a more keen interest in the food preparers concern for the quality of the meals because of the attendant possible restriction in the food budget and hence result in more diverse diets than if income increased or remained unchanged. The marginal effects suggest that a 1 unit increase in education of household food preparer increases the probability of being dietary diverse by 1.6%. Additionally, the marginal effects imply that a 1 unit increase in household income decrease the probability of households being dietary diverse by $4.2e^{05}$%.

**Table 8.** Results from Fractional Probit Regression Analysis

| Independent Variables | P > \|z\| Value | Marginal effect |
|---|---|---|
| Age | 0.782 | .0001797 |
| Education | 0.000*** | .0164913 |
| Household Size | 0.318 | .0053624 |
| Household Income | 0.000*** | $-4.28e^{-0.7}$ |
| Access to other farm land | 0.055* | -.037212(*) |
| Access to home garden | 0.091* | .0337038(*) |
| Ownership of livestock | 0.068* | .0332473(*) |
| Main material of house | 0.471 | 0.0081159 |

*Statistics: prob>chi2= 0.0000;*
*number of observations=457;***p≤0.01,**p≤0.05;*p≤0.1*
*(*) marginal effect is the discreet change of dummy variable from 0 to 1. Source: Field Survey, 2018*

Household food preparers access to home garden and ownership of livestock are statistically significant at 10% and positively related to the probability of being dietary diverse. Access to other farmland is, on the other hand, statistically significant and negatively related to the probability of a household having a diverse diet. This means that households who have access to home gardens and own livestock are more likely to be dietary diverse that their counterparts who do not have access to home gardens and do not own livestock. This is intuitive because the products and proceeds from the harvest or sale of the attendant products of this access and ownership make having diverse diets more probable. The marginal effects show that household food preparers who have access to home gardens are 3.4% more likely to run dietary diverse households than households who do not. It additionally reveals that households that have access to other farmland are 3.7% less likely to have households that are dietary diverse than households who do not have this access, this is plausible because proceeds from other farmland may be sold to contribute to meet other needs of the households apart from further diversifying their diets. In the same vein, households that own livestock are 3.3% more likely to be dietary diverse than those who do not.

Taruvinga, Muchenje and Mushunje (2013) found, in corrorboration, that educational level, access to home garden, ownership of small livestock are significant in explaining the probability of households in South Africa having high dietary diversity. Among adult Saharawi refugees in Algeria, Morseth et al. (2017), similarly find that the more educated refugees are more likely to have high dietary diversity.

McDonald et al. (2015) in a similar vein found that ownership of livestock, number of types of fruit produced, quantity of vegetables produced, amount of homestead land owned by the household, amount of agricultural land owned by the household were significant in explaining dietary diversity of households in rural Cambodia. Similar findings were obtained by Harris-Fry et al. (2015) who found that households with vegetable gardens, rich households and literate women were more likely to have higher dietary scores. Mbwana et al. (2016), in further corroboration, that literary status of the mother, prior nutrition knowledge, cultivated land size, distance to a water source determine household dietary diversity. Bezerra and Sichieri (2011) similarly found that household income and education of household head were significant in explaining the probability of households being dietary diverse.

## 4. Conclusion

Dietary Diversity represents the number of food groups that a household consumes within a given recall period which is usually in turn a pointer to the nutrient adequacy of the household. The outcome of this study enables the conclusion that, given the three critical indices, 0.67, 0.87 and 0.59, only 10.5%, 38% and 5.25% of households in the study area have less than diverse diets. The mean margin (a measure that computes the difference in number of food groups consumed by less than diverse and sufficiently diverse households assuming that sufficiently diverse households have *ddi* values exactly equal to the critical index) shows that this difference is two food groups irrespective of the critical index being considered. Interestingly, however, the disaggregated mean prevalence obtains the difference in number of food groups consumed by less than diverse and sufficiently diverse households, without the restricting assumption that sufficiently diverse households all have values equal to the corresponding critical index. These differences for critical indices, 0.67, 0.87 and 0.59, are five (5), four (4) and eight (8) respectively. Factors affecting this outcome in the stated study area were determined. Education of household food preparer, access to home garden and ownership of livestock are statistically significant and positively related to the probability of a household being dietary diverse. Additionally, access to other farmland and household income are statistically significant in explaining the probability of a household being dietary diverse but negatively related to this probability. This suggests that an educated household food preparer who has access to home garden and owns livestock is likely to run a home where diets are diverse irrespective of the fact that this household may not have access to other farmland. These results are presented with the expectation that this would be a further addition to the understanding of the dynamics of dietary diversity in the study area.

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