International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182 Print ISSN: 2349-5979
www.allsubjectjournal.com
Volume 2; Issue 12; December 2015; Page No. 148-157

Estimating multidimensional poverty and identifying poor households in Kano state

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Abstract
This paper critically examines the multidimensional poverty in Kano State using Alkire and Foster (2007) family of measures which provides an alternative measurement of multidimensional poverty. The method allows the identification of households as poor or otherwise using two steps analysis (i.e. the identification step and aggregation step). The paper also investigates the robustness of Alkire and Foster family of measures to change in poverty line and its sensitivity to change in weight for different dimensions. The paper further investigates the probability of household to be poor using logistic regression model. The results of the analysis are decomposed by location of residence (rural and urban). Results of the research in Kano State revealed that there is high level of poverty among the households. Poverty in the area cut across both social and economic deprivations. The most contributing factors to multidimensional poverty are sanitation (14.96%) and fuel used for cooking (14.59%). Others are child health (12.92%), housing condition (11.68%) and education of the household head (11.02%). This contribution differ between rural and urban areas. Results in the rural and urban areas showed that the resulting models are dissimilar and confirm the known fact that there is wider inequality between the urban and rural areas. The model is significant at *0.5* level as *p-value* is *<0.000*. Location of the household have higher odd ratio (9.03) of household to be poor. Hence, households in rural area have higher possibilities of being poor than their urban counterparts. The findings will be valuable for planning.

Keywords: Multidimensional poverty, counting measurement, robustness analysis, sensitivity analysis, Kano State.

1. Introduction

Poverty is the oldest enemy of mankind (Iqbal, 2002, in Malumfashi, 2008) [10], that has been in existence for many years and continues to exist in a large number of countries (Bourguignon & Chakravarty, 2003) [7]. Poverty can said to be the most serious global problem which adversely affect sustainable development not only in developing world, but worldwide. As far back as 1944, the International Labour Organization (ILO) in its Philadelphian Declaration stated that "poverty constitutes danger to prosperity everywhere". The world summit on sustainable development in Rio de Janeiro (1992) identified poverty as the most important factor militating against sustainable development and therefore called for its eradication/reduction (Dandago, 2008) [9]. Although poverty is one of the most compelling challenges confronted by mankind, there remain numerous issues when considering scale, form, and evaluation of responses within its multiple contexts (Malumfashi, 2008) [10]. Poverty is multifaceted and multidimensional problem with origin in both developing, transition and developed countries depending upon how we see it and defined its nature and extent (Chandy & Gertz, 2011) [8]. Poverty being a multidimensional phenomenon, the poor suffer from various forms of deprivation e.g. lack of access to employment, adequate housing and services, social protection and lack of access to health, education and personal security (World Bank, 2001) [22].

In 2009, Nigeria became a dominant force in Sub-Saharan Africa and this coupled with strong economy (with growth rate of six percent point) and booming oil and agricultural sector. Yet, ethno-religious conflicts have become a social concern, poverty, gender discrimination and violence against children and women have been on the increase (Samuels, Gavrilovic, Harper, & Nino- Zarazua, 2011) [17]. Resource allocation is inequitable as 20 percent of the populace controls 65 percent of the national wealth (UNDP, 2009) [18]. In 2004, 64% of the country's population were suffering from multiple deprivations (UNDP, 2010) [19], food poverty is around 64% and child poverty is on increase. In Kano State, poverty remains highly gendered with women constituting the vast majority of the poor population as they are most vulnerable to unemployment and social disadvantages. Economic growth and pro-poor development remain disconnected as the country failed to translate relatively her stable growth into improvements in terms of employment and poverty, which

have remained at very high levels in relations to the country's income status (Samuels, *et al*., 2011) [17].

This paper briefly reviews the literature on multidimensional measures of poverty and their application. It adopts the Alkire and Foster family of measures – which is an alternative methodology – to estimate multidimensional poverty in the study area and to identify poor households and their aggregation. The measures are robust and specifically design for cardinal/ordinal data. It first begins by selecting dimensions, indicators for each dimension and their cut-offs and then, observation is made on whether household is deprived in each dimension. In the next step, it aggregates the number of dimensions a household is deprived. The final step is deciding the aggregate cut-off; that is the minimum number of dimensions that a household need to be declared as multidimensional poor. Household is identified as multidimensional poor if he/she falls below the threshold. This method is flexible and also sensitive to change in weight.

By applying Alkire and Foster family of measures on selected variables (that are common to both 2006 population and housing census) from 2006 CWIQ household survey, the incidence of multidimensional poverty in Kano State is analysed. An assumption is made that what holds for the sampled household survey also holds for the entire households. Household deprived in numerous dimensions are identified and poverty rates at different levels of aggregation, i.e. location of residence (rural or urban) are assessed by allocating equal weight to all dimensions. However, different weights are assigned to some selected dimensions in order to assess the flexibility of the method. Finally, the probabilities of household to be in poverty is investigated using logistic regression model and it is clear that household location have higher odd ratio of 9.7, as such, households living in rural areas have higher possibilities of being poor.

2. Review of related literature

2.1. Multidimensional poverty

According to UNDP (2014) [20], more than 2.2 billion people are vulnerable to multidimensional poverty, including almost 1.5 billion who are multidimensionally poor. Three-quarters of the world's poor live in rural areas, where agricultural workers suffer the highest incidence of poverty, caught in a cauldron of low productivity, seasonal unemployment and low wages.

Perhaps the broadest approach to wellbeing and multidimensional approach to poverty was the one articulated by Amartya Sen (1987), who argue that wellbeing come from capability to function in society. Thus, poverty arises when people lack key capabilities, and so have inadequate incomes or education, or poor health, or insecurity, or low self-confidence, or a sense of powerlessness, or the absence of rights such as freedom of speech. Viewed in this way, poverty is a multidimensional phenomenon and less amenable to simple solutions. For instance, while higher average incomes will certainly help reduce poverty, these may need to be accompanied by measures to empower the poor, or insure them against risks, or to address specific weaknesses such as inadequate availability of schools or a corrupt health service (World Bank, 2001) [22].

Bourguignon & Chakravarty, (2003) [7] argue that poverty is "a shortfall from a threshold on each dimension of an individual's wellbeing." For that, innumerable aspects of an individual may be aggregated into a single cardinal index of wellbeing and that poverty may be defined in relation to that index. As such, multiple concepts of poverty will continue to be used in order to provide its designers with information (Alkire, *et al*., 2015, chp.3) [2].

2.2. Measuring multidimensional poverty

Recognising poverty as multidimensional phenomenon is not new in different fields of scholarship. Because, since the mid-1970s – when analysts began to find alternatives to complement predominant monetary measures of poverty – many empirical analyses have considered various non-monetary deprivations that the poor experience, a number of methodologies have emerged to assess the multidimensional aspects of poverty. Most of these analyses were fully motivated by the basic needs approach, the capability approach, and the social inclusion approach to mention few (Alkire, *et al*., 2015, chp.3) [2]. For detail (see Alkire, *et al*., 2015, chp.3) [2].

The existing methodologies include among others the followings: dashboard approach, the composite indices approach, Venn diagrams, the dominance approach, statistical approaches, fuzzy sets, and the axiomatic approach (which includes Alkire and Foster {2007} family of measures). These methods can be grouped into two broad categories. The first category comprises the marginal measures. The methods that are implemented using data from different sources and ignoring the joint distribution of deprivation. The second category encompasses methods that reflect the joint distribution and thus implemented using data in which information on each dimension is available for each unit of analysis (Alkire, *et al*., 2015, chp.3) [2].

2.3. Application of Alkire and Foster (2007) [1] family of measures

Since its development, it has engendered some practical interest. In literature, it was found that this method have been used in many studies. These include a Global Multidimensional Poverty Index (GMPI) estimated in over 100 developing countries as well as official national multidimensional poverty measures in Mexico, Colombia, Bhutan, and the Philippines with many other regional, national and subnational measures in progress. Other individuals like Batana (2008) [6] applied this method with DHS in fourteen Sub-Saharan African countries, Naveed and Islam (2010) [14] in Pakistan, Mariara, Wambugu, & Musau, (2011) [11] in Ghana. Adaptations of the methodology include the Gross National Happiness Index of the Royal Government of Bhutan (Ura, Alkire, & Zangmo, 2013) [21] and the Women's Empowerment in Agriculture Index (Alkire, Meinzen-Dick *et al*. 2013) [4]. Several academic studies have implemented the AF approach for different poverty measurement purposes and in different parts of the world. For the list of studies that implement the Alkire and Foster Method (see Alkire, *et al*., 2015, chp.5) [3].

3. Materials and method

3.1. The study area and dataset

The study area (Kano State) lies within Latitudes 10°30′00″ to 12º45′00″ north of the equator and Longitudes 7°10′00″ to 9º20′00″ east of the Greenwich Meridian. The area borders with four states, namely: Jigawa to the north, northeast and east, Bauchi to the southeast, Kaduna to the southwest and Katsina to the west and northwest. It has an approximate land area of 21,276.87 km^2. Kano State is divided into three senatorial districts which further subdivided into 44 local

government areas with 484 wards (Figure 1). According to 2006 population and housing census, Kano State has a total population of 9,401,288. The dominant socio-economic activities are mainly primary activities such as farming, local crafts, trading and livestock rearing among others (Momale, 2010) [12].

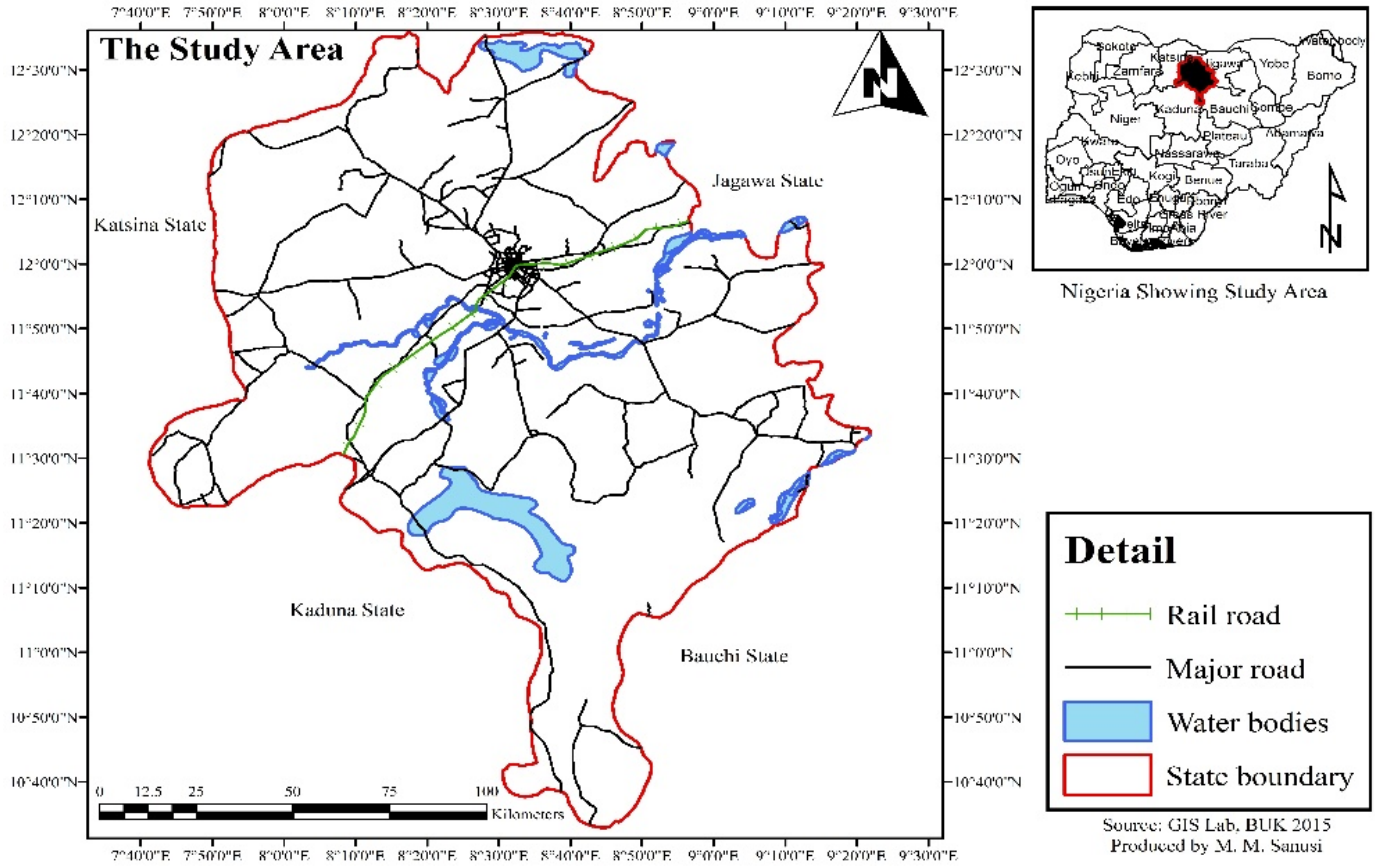

Fig 1: The study area

This paper will completely depends on secondary data from 2006 Nigerian Population and Housing Census (NPC) conducted by Nation Population Commission; and National Core Welfare Indicator Questionnaire Survey (NG-CWIQ) of 2006 conducted by the National Bureau of Statistics with the aim to collect minimum information not only for providing basic welfare indicators for monitoring poverty alleviation programs but, more generally, for providing indicators for monitoring welfare and other social trends for the different population groups across the country. The survey covers 77, 400 households in both rural and urban areas. From each local government, total number of 100 households made the sample. Alkire and Foster multidimensional poverty indices were estimated using Distributive Analysis Stata Package (DASP version 2.3), a Stata extension developed in 2013 by Abdelkrim Araar and Jean-Yves Duclos to assist researchers and policy analysts interested in conducting distributive analysis with Stata (Araar & Duclos, 2013) [5]. The results were presented in the form of tables, charts and graphs where appropriate. Figure 2 presents the methods used in the paper.

3.2 Alkire and Foster (2007) [1] multidimensional poverty indices

3.2.1 Dimensions and their cut-off

There is no unanimously agreed upon view regarding the dimensions and indicators to use for the analysis of multidimensional poverty. Yet, two views are the prominent ones. They are, the view of Nussbaum and that of Sen. Nussbaum (2000) [13] proposes a universal list of capabilities while Sen (2004) opposes such authoritative listing of valuable capabilities and argues for a strong role of public reasoning and a discussion in determining the valuable dimensions and the respective weights. Searching through varying literature on the selection of dimensions and indicators, it is found that researchers justifying their selection of indicators on the basis of five criteria (Alkire, 2007) [1]. They are as follows: (a) data availability and adequacy; (b) normative assumptions based upon theoretical frameworks; (c) public discussions; (d) deliberative participation; and (e) empirical analysis. The study adopted the first, second and fifth, and the selection is based on studies on capability approach to multidimensional poverty, MDGs, etc. total number of 20 indicators reflecting human wellbeing are selected for the analysis. These indicators were transformed to 10 dimensions before submitting to analysis using AF methods. The selected domains provides information on education, livelihood, sanitation, living standard, food security and ownership of assets among others.

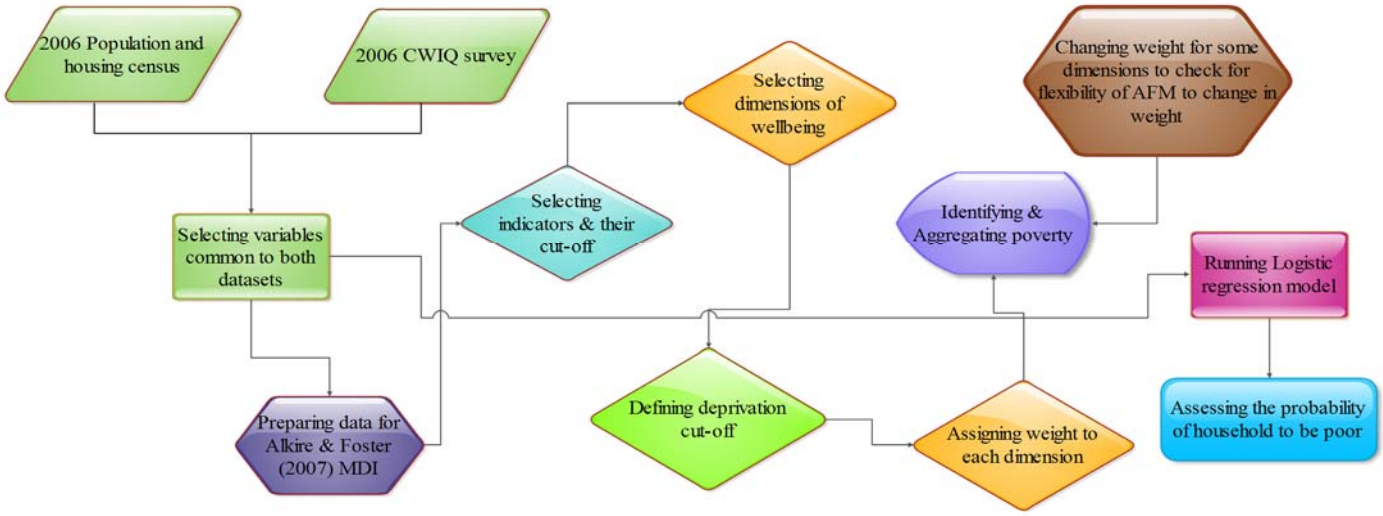

Fig 2: The flow diagram of methods

3.2.1.1. Deprivation cut-off

The base information in multidimensional poverty measurement is typically represented by $n \times d$ dimensional achievement matrix X, where x_{ij} is the achievement of person i in dimension j. It is assumed that achievements can be represented by non-negative real numbers (i.e. $x_{ij} \in \mathbb{R}_+$) and that higher achievements are preferred to lower ones. Based on the deprivation profile, each person is assigned a deprivation score that reflects the breadth of each person's deprivations across all dimensions. The deprivation score of each person is the sum of her weighted deprivations. Formally, the deprivation score is given by:

$$c_i = \sum_{j=1}^{d} w_j \, g_{ij}^0 = \sum_{j=1}^{d} \bar{g}_{ij}^0 \qquad (1)$$

Where c_i = censored deprivation score; $\sum_{j=1}^{d} w_j$ = deprivation values attached to dimension j; g_{ij}^0 = censored deprivation matrix of person i in dimension j (such that $g_{ij}^0 = 1$ whenever $x_{ij} < z_j$ and $g_{ij}^0 = 0$ otherwise); $\bar{g}_{ij}^0$ = weighted censored deprivation matrix of person i in dimension j (such that $\bar{g}_{ij}^0 = w_j$ if $g_{ij}^0 = 1$ and $\bar{g}_{ij}^0 = 0$ if $g_{ij}^0 = 0$)

The score increases as the number of deprivations a person experiences increases, and reaches its maximum when the person is deprived in all dimensions. A person who is not deprived in any dimension has a deprivation score equal to 0.

3.2.2.1 Poverty cut-off

In addition to the deprivation cut-offs z_j, the AF methodology uses a second cut-off or threshold to identify the multi dimensionally poor. This is called the poverty cut-off and is denoted by k. The poverty cut-off is the minimum deprivation score a person needs to exhibit in order to be identified as poor (Alkire, *et. al* 2015, chp.5) [3]. This poverty cut-off is implemented using an identification function ρ_k, which depends upon each person's achievement vector x_i; the deprivation cut-off vector $\boldsymbol{z}$, the weight vector w, and the poverty cut-off k. If person is poor, the identification function takes on a value of 1; if the person is not poor, the identification function has a value of 0. Notationally, the identification function is defined as $\rho_k\,(x_i; z) = 1$ if $c_i \geq k$ and $\rho_k\,(x_i; z) = 0$ otherwise.

3.2.2 Alkire and Foster (2007) [1] Family of measures

3.2.2.1 *Multidimensional Headcount Ration (H)*

Multidimensional Headcount Ratio shows the proportion of households that are poor. With *H* as headcount ratio; (*X;z,w,k)* as proportion of population that is poor (it is defined as $H = q/n$, where q is the number of persons identified as poor using the dual-cut-off approach); $\sum_{i=1}^{n} \mathbb{I}$ as identification function which takes the value of 1 if the indicated condition of $(c_i \geq k)$ is true for the i^{th} person, and 0 when otherwise, c_i denoting censored deprivation score (or more appropriately weighted deprivation score), k as dimension cut-off and n as population size, headcount ratio is estimated using the following notation as:

$$H(X; z, w, k) = \frac{\sum_{i=1}^{n} \mathbb{I}[c_i \geq k]}{n} \qquad (2)$$

As pointed by (Alkire, *et. al*., 2015: chp.5) [3], the term 'adjusted' in their multidimensional poverty measures refers to the fact that all measures incorporate the intensity of multiple deprivation

3.2.2.2 *Adjusted Headcount Ratio (M_0)*

The adjusted headcount ratio is the total number of deprivations experienced by the poor divided by maximum possible number of deprivations experienced by all the people (Alkire and Foster, 2008) [1]. It is the mean (μ) of an appropriate vector built from the original data and censored using the poverty line $\big(c(k)\big)$, the Adjusted Headcount Ratio is the mean of the censored deprivation score vector obtained using:

$$M_0 = \mu(c(k)) = \frac{1}{n} \times \sum_{i=1}^{n} c_i\,(k) \qquad (3)$$

Or more preferably:

$$M_0(X; w, z, k) = \frac{1}{nd} \sum_{i=1}^{n} \left[\mathbb{I}(c_i \geq k) \sum_{j=1}^{d} w_j g_{ij}^0 (x_{ij}) \right] \qquad (4)$$

Where: x_{ij} = achievement of person i in dimension j; nd = number of dimensions; All others same as above.

3.2.2.3 *Average deprivation score/Average poverty (A)*

This is also referred to as poverty intensity. It incorporates the information on the depth of poverty. With censored deprivation score $c_i(k)$ representing the share of possible deprivations experienced by a poor person i, the average deprivation score across the poor is given by: $A = \sum_{i=1}^{n} c_i(k)/q$. Like poverty gap information in income poverty, this partial index conveys relevant information about multidimensional poverty, in that persons who experience simultaneous deprivations in a higher fraction of dimensions have a higher intensity of poverty and are poorer than others having a lower intensity (Alkire, *et. al* 2015, chp.5) [3].

Thus, M_0 is given by

$$M_0(X;z) = \mu(c(k)) = H \times A = \frac{q}{n} \times \frac{1}{q}\sum_{i=1}^{q} c_i(k)$$
$$= \frac{1}{n}\sum_{i=1}^{n} c_i(k) = \frac{1}{n}\sum_{i=1}^{n}\sum_{j=1}^{d} w_j\, g_{ij}^0 \qquad (5)$$

3.2.3. Subgroup Decomposition

Overall poverty is a population-share weighted sum of subgroup poverty levels and this proved that poverty can be analysed by regions, by ethnic groups, and by other subgroups defined in a variety of ways (Alkire, *et. al,* 2015, chp.5) [3]. Using population subgroup decomposability property of Alkire and Foster measures, it is possible to monitor and understand the subgroup M_0 levels and compare them with the aggregate M_0. In addition, the subgroup decomposability provide us with information on the contribution of each subgroup to overall poverty, in that, the contribution of subgroup to overall poverty depends both on the level of poverty in subgroup and on the population share of the subgroup. (Alkire, *et. al,* 2015, chp.5) [3]. Having population share and the achievement matrix of subgroup ℓ denoted by $v^{\ell} = {n^{\ell}}/{n}$ and X^{ℓ}, respectively. The overall subgroup M_0 is expressed as

$$M_0(X) = \sum_{\ell=1}^{m} v^{\ell} M_0\left(X^{\ell}\right) \qquad (6)$$

The contribution of each subgroup to overall poverty is computed using the additive form of equation 6, to do so, the contribution of subgroup ℓ to overall population is denoted by $\mathbb{D}_{\ell}^0$ formulated as:

$$\mathbb{D}_{\ell}^0 = v^{\ell}\frac{M_0\left(X^{\ell}\right)}{M_0(X)} \qquad (7)$$

4. Result and discussion

4.1. Counting and identification

This section discusses poverty results using dual cut-off and counting approach developed by Alkire and Foster (2007) [1] for identification and measurement of multidimensional poverty. The assessments are based on 10 dimensions using different values of *k* (2, 3, 4, 5, 6, 7, 8, and 9). As proposed by Alkire and Foster, for a household to be declared as multi dimensionally poor, indicator cut-off need to be defined first, then dimension cut-off or threshold (*k)* need to be set and finally, household categorises as poor when below the threshold (which can be called as poverty line) or otherwise when above the cut-off.

4.2 Overall identification and aggregation of poverty

Households' percentage of deprivation related to each dimension are presented in Figure 3. More than 94 percent of the population are deprived in type of toilet facility. About 91.28 percent deprived in fuel used for cooking dimension and 80.94 percent of the households are deprived in child health. Almost 75 percent of households deprived in housing quality dimension.

Column 2 of Table 1 presents Headcount Ratio at different cut-off points (*k)*. It is observed from the table that using two dimensions as cut-off point (*k*=2), over 98.9 percent of the households fall below poverty line. However, using three dimensions (*k*=3), 97.4 are below the poverty threshold. The table also shows that the percentage of poor keep on shrinking with increasing value of *k*. Therefore, it is clear that the estimated index are robust to the change of *k* and the weight assigned to a given dimension (see Batana, 2008) [6].

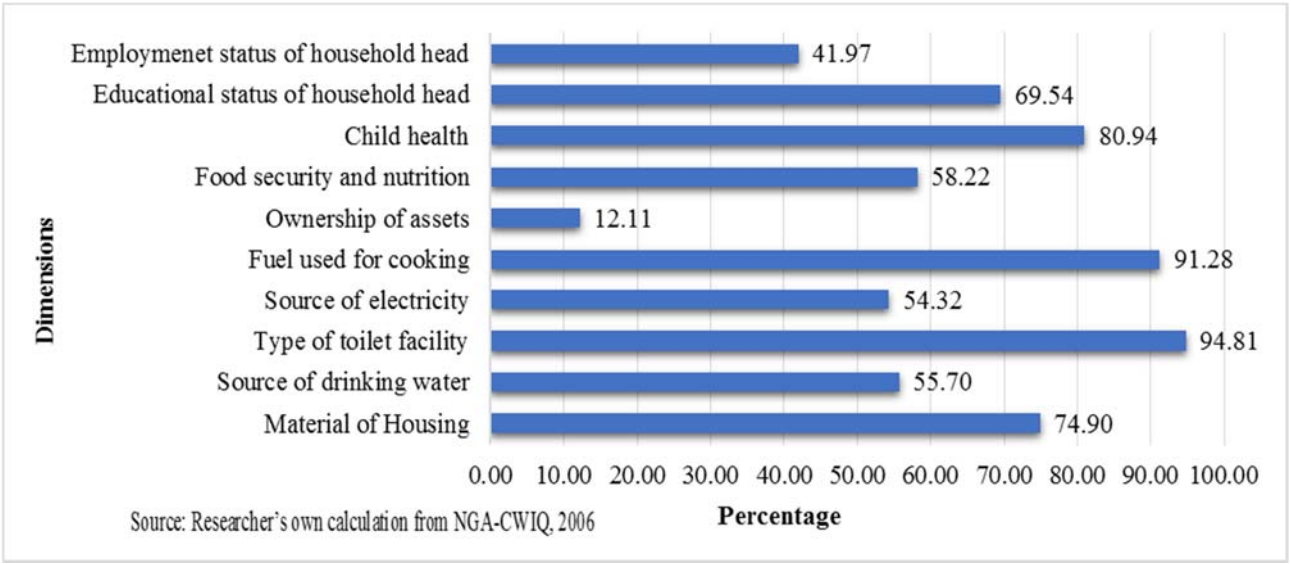

Fig 3: Percentage of households deprived in various dimensions

Breath or intensity of poverty faced by poor households however differ with different dimensional cut-off. In order to capture the intensity of poverty suffered by households, Adjusted Poverty Headcount ratio (M_0) is estimated. Column 3 of Table 1 revealed that using $k=2$, the Adjusted Poverty Ratio is 0.633 and shift to 0.630 at k=3. With k=4, the ratio is 0.621. Batana, (2009) [6]; Naveed & Islam, (2010) [14] found out that Adjusted Headcount Ratio behaves same way with Headcount ratio – it decreases with increasing cut-off and vice versa.

To capture the severity (i.e. the average percentage of deprivation a poor household suffers from the total dimensions), an average poverty gap is calculated using various cut-off points. At k=2, the Average Poverty gap is 0.640, in essence, this tells that from the total dimensions, poor households are averagely deprived in 64 percent when k set at two (2). At k=3, the Average Poverty Gap is 0.647 and this reveals that poor households, on average, are deprived in 64.7 percent of total dimensions. Moreover, the Average Poverty Gap keep increasing with increasing cut-off point. At k=8, the depth of poverty is 0.828 which means that, a household characterized as multi-dimensionally poor using this cut-off is on average suffering 82.8 percent level of all the dimensions.

Table 1: Incidence of deprivation at different level of k

Aggregate cut-off point *(k)*	Headcount Ratio *(H)*	Adjusted Headcount Ratio – Ratio of deprivations experienced by all poor households *(Mo)*	Average Poverty *(A = Mo/H)*
2	0.989	0.633	0.640
3	0.974	0.630	0.647
4	0.941	0.621	0.660
5	0.876	0.594	0.678
6	0.744	0.529	0.711
7	0.510	0.388	0.761
8	0.239	0.198	0.828
9	0.063	0.057	0.905

Nevertheless, we can silently say that, with larger number of dimensions as cut-off points, severity of poverty is on average more than at lower cut-off. That is to say, those falling below poverty line with higher cut-off are on average facing more deprivation than those falling at a lower cut-off. Hence, in this context, at higher cut-off, the number of dimensions one need to be deprived before classified as been poor are too many. For example, with $k=9$, the population of those below poverty line are on average experiencing deprivation on more than 90 percent of the total dimensions. In addition, with Average Poverty Gap, one can classify household as poor, moderately poor or extremely poor depending on the number of dimensions the household deprived on.

The relative contribution of dimension to multidimensional poverty is very important, as it will guide policy makers on the areas that need quick action. In our case for example, sanitation and fuel used for cooking will be the priority area as they have higher relative contribution. While dimension like assets will receive less. This is similar to findings of Naveed and Islam, (2010) [14] in Pakistan.

Each dimension contributes differently to multidimensional poverty. In order to find the relative contribution of each dimension, an estimate is made and the results of relative contribution of each dimension to multidimensional poverty based on $k=2$ are presented on figure 4. The figure shows that sanitation (with 14.96 percent) and main fuel used for cooking (14.59 percent) have higher relative contribution. This means that vast majority of the poor household are deprived in sanitation (which associate to type of toilet facility and type of waste collection) and type of fuel used for cooking.

4.3. Decomposing poverty by sector (location/place of residence), and other subgroups

This section presents the decomposed estimates of Alkire and Foster (2007) [1] multidimensional poverty indices based on type of place of residence (rural/urban) in order to capture the contribution of various population subgroup and sectors to global (in this case state) multidimensional deprivation.

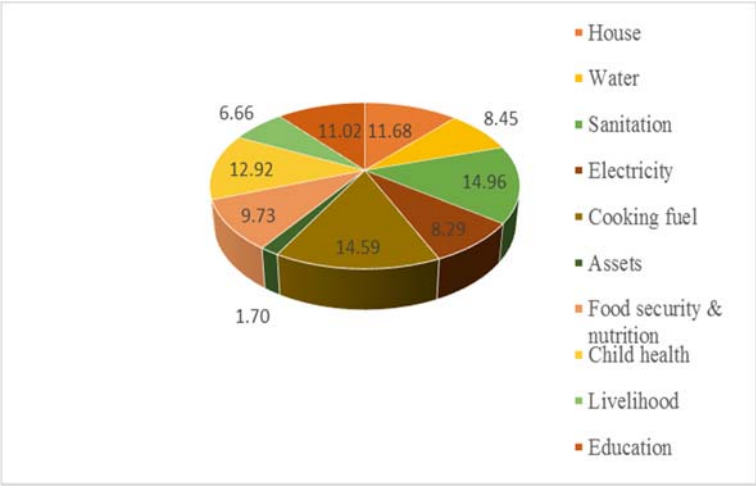

Fig 4: Relative contribution of each dimension to multidimensional poverty

4.4 Decomposition of Alkire and Foster (2007) [1] MDI by place of residence

Similar to all other measures of poverty (especially the traditional monetary measures), the incidence of poverty in the study area – using Alkire and Foster (2007) [1] multidimensional poverty indices of dual cut-off and counting – is higher in rural area than in urban area. The estimated percentages of poor and non-poor in both rural and urban areas are presented in Figure 5. While 60.79 percent of rural households are deprived in electricity, only 8.67 percent of the urbanites are deprived on the same very dimension. With regard to housing condition and materials, 80.67 percent of rural households are poor while 34.13 percent of urban household are poor in term of housing.

Table 2 presents the poverty estimates (Headcount, Adjusted Headcount Ratio, Average Poverty Gap and relative contribution of each sector to multidimensional poverty at different level of *k*). Column 3 of the table provides the Headcount Ratio, while column 4 gives the Adjusted Headcount Ratio, column 5 the Average Poverty Gap and column 6 the relative contribution. On the other side of the table, same measures are presented in columns 8, 9, 10, 11 and finally, the sum total contribution for both urban and rural areas is presented in the last column of the table.

Similar to headcount, the adjusted headcount ratio is higher in rural area than in urban area. Adjusted headcount ratio also exhibits same behaviour with poverty headcount (i.e. decreasing with increasing value of *k* and vice versa), but while poverty headcount presents an inflated estimates of poverty incidence, adjusted poverty headcount ratio presents a reasonable estimates. For example, at *k*=2, the adjusted poverty headcount ratio for rural area is 0.651 and 0.512 in urban area which is far lower than the poverty headcount estimates at the same value of *k* (0.993 for rural and 0.987 for urban). The ratio however, keep on dropping to about 0.065 in the rural area and 0.007 in the urban area with highest value of *k* (*k*=9).

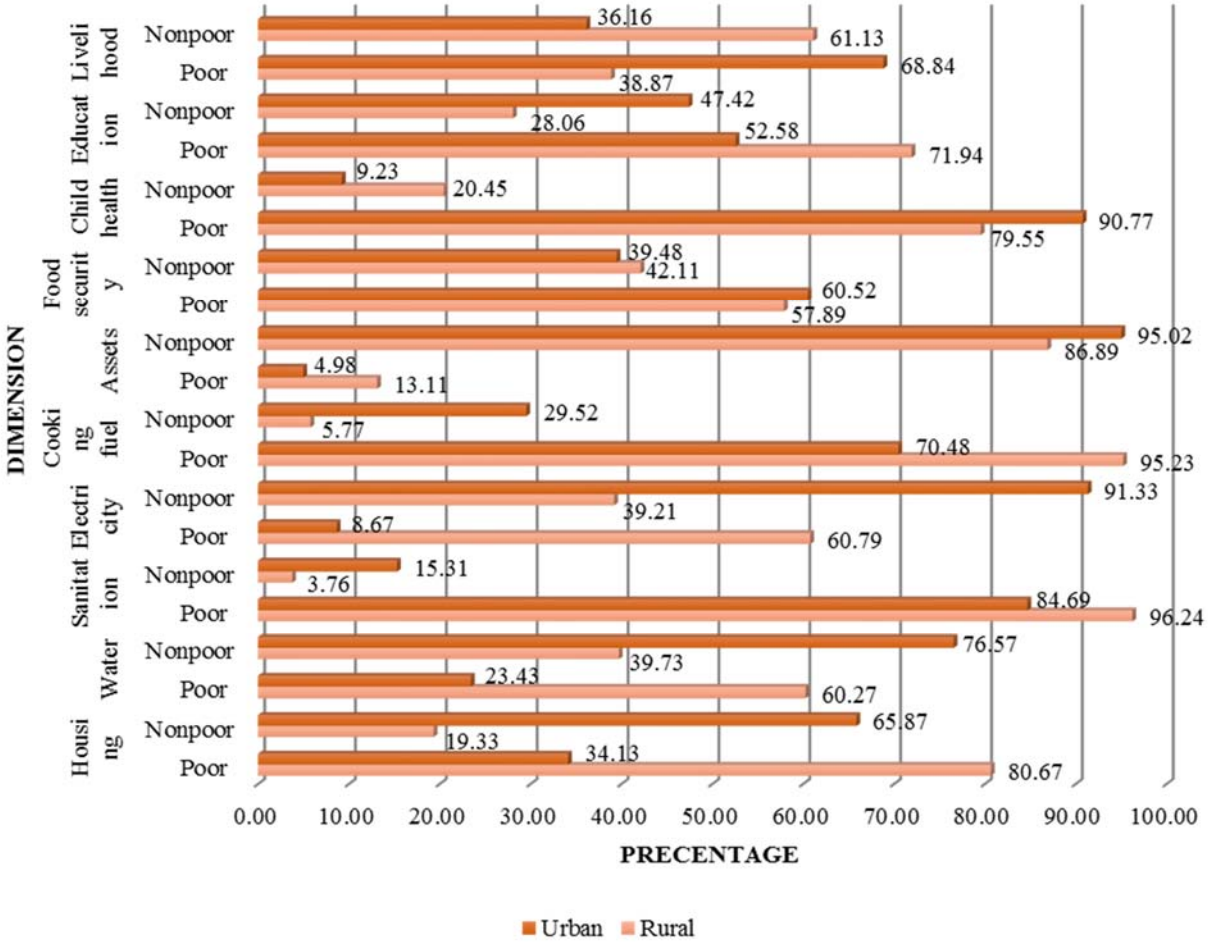

Fig 5: Percentage of poor and non-poor in rural and urban areas

The severity of poverty for rural and urban areas is not also the same. From the Average Poverty Gap estimates presented in Table 13, if deprivation threshold levelled at *k*=2, the Average Poverty Gap in rural area is 0.667 and 0.519 in urban area. This in essence means that the poor households in rural area are on average deprived in 66.7 percent of the total dimensions when households in the urban area are deprived on average in 51.9 percent of the total dimensions.

With regard to contribution of each sector to multidimensional poverty in the area, rural contribute higher. With *k*= 2, rural area contributes 87.6 percent to multidimensional deprivation while urban contributes just 12.4 percent of the total deprivation. The contribution of rural area to overall poverty is 88.2 percent, whereas, urban areas' contribution is 11. 8 percent when *k*=3. Urban area contributes 11.0 percent to the overall poverty when rural area contributing 89.0 percent as

threshold settled at k=4. However, if deprivation threshold is k=5, the relative contribution of rural area is 90.4 and 9.6 for the urban area. Comparing estimates in column 6 and column 11 of Table 2, we can say that the relative contribution of the two (2) sectors is symbiotic. That is, if one increases, the other one decreases.

Table 2: incidence of deprivation for rural and urban area at different level of k

	Sector										
	Rural					Urban					
Aggregate cut-off point (k)	**Population Share**	***H***	***Mo***	***A***	**% Contribution**	**Population Share**	***H***	***Mo***	***A***	**% Contribution**	**% Contributions for Urban &Rural**
k=2	3,828 (0.875)	0.993	0.651	0.667	0.876	542 (0.125)	0.987	0.512	0.519	0.124	1.000
k=3	3,828 (0.875)	0.981	0.649	0.662	0.882	542 (0.125)	0.921	0.499	0.542	0.118	1.000
k=4	3,828 (0.875)	0.957	0.642	0.671	0.890	542 (0.125)	0.830	0.472	0.569	0.110	1.000
k=5	3,828 (0.875)	0.905	0.621	0.686	0.904	542 (0.125)	0.671	0.408	0.608	0.096	1.000
k=6	3,828 (0.875)	0.789	0.563	0.714	0.928	542 (0.125)	0.429	0.287	0.669	0.072	1.000
k=7	3,828 (0.875)	0.551	0.420	0.762	0.944	542 (0.125)	0.228	0.166	0.728	0.056	1.000
k=8	3,828 (0.875)	0.264	0.220	0.833	0.969	542 (0.125)	0.059	0.048	0.814	0.031	1.000
k=9	3,828 (0.875)	0.071	0.065	0.915	0.985	542 (0.125)	0.007	0.007	1.000	0.015	1.000
total	3,828 (0.875)					542 (0.125)					4370 (100)

Table 3: Weight assign to each dimension

S/N	Dimension	Weight
1	Education	2
2	Access to safe drinking water	2
3	Housing	2
4	Child health	0.57
5	Food security	0.57
6	Consumer goods & durables	0.57
7	Sanitation	0.57
8	Electricity	0.57
9	Energy for cooking	0.57
10	Livelihood	0.57
Total		10

4.5. Sensitivity of Alkire and Foster (2007) [1] MDI to change in weight

Estimates in the erstwhile sections, generates by assigning equal weight to all the 10 dimensions, while in this section, three (3) dimensions (education, Health and source of drinking water) were assigned the largest weight (i.e. 2) considering their importance in human wellbeing, whereas, the weight of 0.57 assigns to the remaining seven (7) dimensions to sum the total weight to 10 (see Table 3). Unlike many other multidimensional poverty measures, the Alkire and Foster Multidimensional Poverty Index is flexible in allocating varying weights to different dimensions based on their relative importance. That is to say, we can give different weight to various dimensions of deprivation depending on the need for the measurement which determines the importance we attach to each dimension.

Table 4: Weighted estimates of multidimensional poverty index

Area	Cut-off			
	k=4	***k=5***	***k=6***	***k=7***
Aggregate				
Headcount (*H*)	0.868	0.739	0.668	0.406
Adjusted Headcount Ratio(*Mo)*	0.613	0.554	0.515	0.342
Average Poverty (*A*)	0.706	0.750	0.771	0.842
Rural				
Headcount (*H*)	0.900	0.790	0.719	0.451
Adjusted Headcount Ratio(*Mo)*	0.646	0.596	0.556	0.380
Average Poverty (*A*)	0.718	0.754	0.773	0.843
Urban				
Headcount (*H*)	0.641	0.384	0.312	0.089
Adjusted Headcount Ratio(*Mo)*	0.379	0.262	0.222	0.011
Average Poverty (*A*)	0.591	0.682	0.712	0.124

In order to assess the flexibility of this approach to multidimensional poverty, 4 different level of k (k=4 to 7) are selected for both the aggregate population and also for the decomposed units (location and senatorial districts. Table 4 presents the weighted estimates of multidimensional poverty index. Naveed & Islam (2010) [14] highlights that a cut-off point 4 (k=4) does not mean that a household deprived in four or more dimensions is called a multi dimensionally poor household. Instead, a household that is deprived in number of dimensions whose weighted sum equals four or more is called a multi dimensionally poor household.

At k=4, 86.8 percent of the household fall below poverty line. The number decreases to 73.9 percent with k=5. It is 66.8 and 40.6 percent when k=6 and 7 respectively. However, the Adjusted Poverty Gap and Average Poverty also change with changing value of k at different unit of analysis. Based on the estimates in Table 16 we can confidently say that, Alkire and Foster (2007) [1] MDI is robust to the change in poverty line

and also sensitive to change in weight. Because, comparing the results in this table with those in the previous sections at the same level of *k,* it is clear that changing weight of the three dimensions have greatly influences the outcomes of multidimensional poverty estimates in the state. In a nut shell, we can say that, like it is the case with unweighted estimates, at each cut-off point, poverty level is not the same. The incidence is high in rural area than in urban area.

4.6 Examining the possibilities of household to be poor

The probability of household to be poor is investigated using probit regression. Being poor or non-poor at k=5 is taken as dependent variable, whereas, consumption quintiles, age of household head, location, education level of household head, household head's employment status, senatorial district, household size, and gender of the household head serves as explanatory variables. The overall model is statistically significant, because p-value is <0.000 at 0.05 level of significance.

The result in table 5 shows that household in the bottom two (2) consumption quintile have 1.6 probability of being poor as compared to households in top consumption quintiles. The odds of being poor is roughly 1.3 when household head is illiterate (have not completed primary education) as compared to the household with at least primary education. Education contributes a lot in sharpening household's way of life. As it provides household with the ability to accept modern technological advancements (especially modern farm implements, innovations and inventions). It also open-up chances for the household to engage in different activities for better living. Educated households (being wise) have higher access to information that will help them improve their way of life. The probability of households with female heads to be poor is 1.9 when compared to male headed households. This can be attributed to the fact that females are not like males when it comes to work in that, going by African tradition, there are many jobs that are not suitable or that women do not normally engage in, maybe for their risk or for the societal norms and values, As such female headed household have higher possibilities of being poor than their male headed counterparts. Location of household (rural or urban) have higher odd ratio. A household living in rural area have higher possibilities of being poor when compared with households living in urban area.

Table 5: Result of Logistic regression

Explanatory variables	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Quintile	1.550567	0.0524259	12.97	0.000	1.451145	1.656801
Age of household head	1.005199	0.003089	1.69	0.092	0.999162	1.011271
Location	9.038924	1.060599	18.76	0.000	7.1819	11.37612
Household head education	1.250026	0.0329243	8.47	0.000	1.187133	1.316251
Employment status of head	0.934106	0.027474	-2.32	0.020	0.881781	0.989537
Senatorial district	0.840067	0.0409237	-3.58	0.000	0.763568	0.92423
household size	1.019061	0.0127826	1.51	0.132	0.994313	1.044425
Gender of household head	1.913852	0.5361012	2.32	0.020	1.105281	3.313934
Constant	0.00331	0.0013187	-14.33	0.000	0.001516	0.007227
Log likelihood	=	-1993.8102		Prob > chi2	=	0.0000
Number of obs	=	4370		Pseudo R2	=	0.1903
LR chi2(8)	=	937.05				

5. Conclusion

Quite a lot of results surface regarding multidimensional poverty measurement in Kano State. Results of the research in Kano State revealed that there is high level of poverty among the households. Poverty in the area cut across both social and economic deprivations. That includes the poor housing facilities, poor level of environmental sanitation, inadequate access to educational resources/facilities, medical and healthcare services, and unsecured means of livelihood, safe drinking water, standard cooking fuel, and modern electrification. Results in the rural and urban areas showed that the resulting models are dissimilar and confirm the known fact that there is wider inequality between the urban and rural areas. However, The multidimensional indicators that describe the two areas for both the poorest households and the least poor are often different, which is an important finding for policy purposes.

Furthermore, the estimated Alkire and Foster poverty indices are subject to the number of dimensions of deprivation well-thought-out and that measured poverty decreases with the number of dimensional cut-offs, that is, the weighted sum of deprivations (k), and the weight assign to individual dimensions. The most contributing factors to multidimensional poverty are sanitation (14.96%) and fuel used for cooking (14.59%). Others are child health (12.92%), housing condition (11.68%) and education of the household head (11.02%). This contribution differs between rural and urban areas. It is also observed that the odd ratio of household to be poor is higher if the household lives in rural area, and have not completed primary school, is in the two bottom welfare quintiles, unemployed or have an unsecured means of livelihood.

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