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Assessment of Undernutrition Using Composite Index of Anthropometric Failure Among Under-Five Children in Ibadan South West Local Government Area, Oyo State, Nigeria

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Abstract
Background: *Undernutrition is a major health problem affecting young children in developing countries that has a significant impact on child morbidity and mortality. This study aimed to assess the prevalence of undernutrition among under five children, using conventional indices and the Composite Index of Anthropometric Failure (CIAF).*
Materials and Methods: *This cross-sectional study employed three-stage sampling procedures to select three communities (high, medium and low densities), 393 households and 393 children. The children anthropometry was also measured and classified as stunting (height for age), wasting (weight for height) and (weight for age) using WHO Anthro. Data were analysed using descriptive statistics and Chi-square test.*
Results: *The mean age of the children was 20.0±15.9 months. There were 190 females (48.3%) and 203 males (51.7%). The data showed that prevalence of stunting, wasting and underweight among the children were 32.1%, 3.8% and 10.9% respectively. The CIAF distinguished seven sub-groups of anthropometric status, namely, group A 'normal'-(52)52.5%, group B 'wasted only' (1)0.8%, group C 'wasted and underweight' - 19(19.2%) and group D 'stunted, wasted and underweight' - 2(1.7%). Others are group E 'stunted and underweight' – 7(5.8%), group F 'stunted only'- 37(7.1%) and lastly, group Y 'underweight only'- 5(4.2%). The CIAF counted a total of (47) 47.5% of children in groups B to Y who were in a state of 'Anthropometric Failure', thus revealing a higher prevalence of undernutrition than the conventional indicators.*
Conclusion*: CIAF is useful tool in preventing undernutrition among under five children; it identified children with multiple failures and provided a single aggregated figure of the number of affected children, thereby showing the overall magnitude of undernutrition in the study population. The CIAF could be a complement to the conventional indicators for reporting prevalence of undernutrition*
Keywords: *Undernutrition, Composite Index of Anthropometric Failure, Anthropometry, Children*

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I. Introduction

Adequate nutrition is essential in early childhood to ensure healthy growth, organ formation and cognitive development[1], Inadequate nutrition in the first two years of a child's life can lead to irreversible consequences.[2,3] Globally in 2022, 149 million children under the age of five are stunted, 45 million are wasted and 37 million were overweight. Globally, Nigeria ranks among the worst countries for child malnutrition[4]. The most recent Nigeria Demographic and Health Survey also reported a national prevalence figure of 7 percent wasting, 37 percent stunting and 23 percent underweight for Nigerian children under the age of five years[5]. These numbers have not significantly changed since 2013 when 37% of children under-five were moderately or severely stunted[6] (NPC& ICF Macro 2013). This figures contributes to a high level of mortality and morbidity which implies the persistence of poverty and malnutrition[7] (Gorstein *et al.* 1994).

Anthropometry is defined as the measurement of physical dimensions and gross composition of the body. It is a useful tool for determining the nutritional status of both individuals and populations.[8] It is easy to administer, involves less costly equipment and is suitable for making research outcomes. This tool is used for estimating the prevalence of undernutrition prevalence in children, with the three most commonly used measures of child undernutrition being stunting, wasting and underweight. Each of these indicators reflects anthropometric failure, though they symbolise diverse aspects of undernutrition. Based on WHO classification, these indices reflect distinct biological processes; stunting shows chronic or long-term undernutrition; wasting ac*ute undernutrition and underweight is a combination of acute and chronic undernutrition, but without any

difference between them.[10] These three indices indicate diverse aspects of undernutrition, but are not mutually exclusive and usually coexist. Conversely, none of these indicators can truly reveal total prevalence of undernutrition in populace as it is not possible to add the three indicators to get a single prevalence figure. Therefore, conventional indices may not be sufficient for measuring the overall prevalence of child undernutrition. A newly constructed aggregate of indicators were suggested to overcome this drawback

The Composite index of Anthropometric Failure (CIAF); which is an alternative indicator was proposed by Svedberg[11]. The original model comprised 6 subgroups (A–F) of anthropometric failure to which Nandy added subgroup Y in 2005[12] as shown in table 1. CIAF provides a single figure for the overall estimate of undernourished children in a population, which none of the current indicators can estimate separately. Additionally, subcategories of multiple anthropometric failures can predict risk of morbidity and mortality more precisely than single indices can[13,14]. Accurate reporting of prevalence data on undernutrition and targeting the highest-risk populations may help to improve the quality and outcome of nutritional support and therefore direct more attention to the health of survivors. A limited number of studies have been conducted, using both CIAF and the WHO Z-score system for estimation of the magnitude of undernutrition among children.

Several studies have reported on the prevalence of child stunting, wasting and underweight at national levels in India.[15,16] Indonesia,[17] Asia[18] and Bangladesh[19] and Nigeria.[20] In Nigeria, information on occurrence of anthropometric failures across different population densities are few. Reducing anthropometric failures among under five children is one of the means of combating malnutrition since it is associated with survival, health outcomes, quality of life and productivity. Therefore, it is important to explore how anthropometric failure is distributed amongst children across different population densities in urban areas in Ibadan South West Local Government Area (IBSWLGA) using the CIAF tool. This study describes the prevalence and pattern of anthropometric failures, thereby providing a comprehensive measure of the burden of malnutrition among IBSWLG children in Oyo State, Nigeria. The findings can provide useful data to policy makers to effectively target nutrition policies in Nigeria.

Table 1: The groups of the Composite Index of Anthropometric Failure(CIAF)

Group	Interpretation
A. No Failure	Adequate height and weight (>-2Z score)
B. Wasting only	Low Weight for Height Z-score only
C. Wasting and underweight	Low Weight for Height Z-score, low Weight for Age Z- score
D. Wasting, Stunting and Underweight	Low weight for height Z-score, weight for age Z-score and Height for age Z-score
E Stunting and Underweight	Low Height for Age Z-score, low weight for age Z-score
F Stunting only	Low height for age Z-score only
Y Underweight only	Low Weight for Age Z-score only

II. Material and Methods

Scope of the Study: The study was carried out in Ibadan South West Local Government Area in Ibadan. Ibadan is the capital city of Oyo State, one of the 36 States in Nigeria, with population of 3.8 million in the South Western part of Nigeria. Ibadan South West Local Government Area has 12 wards and is located between latitudes 7° 25' and 7° 45' N and longitudes 3° 40' and 3° 70' E. It has a land mass of about 244,55km square.

Study Design: Descriptive cross sectional study.

***Data* source and collection:** Ibadan South West Local Government Area was purposively selected out of the 33 local Government Areas of Oyo state due to its unique characteristics of having different density groupings of high, medium and low density location according to the National Population Commission groupings. A list of the 12 wards in the Ibadan South West Local Government Area was drawn and stratified into high, medium and low density areas. Simple random sampling technique was used to select three wards (one from high, medium and low density areas) and then one community from each of the three wards selected. The list of under-five children in the selected study communities was obtained from the National Population Commission (NPC) of the three different communities. Using systematic sampling, every fifth household with under-five child in each of the three selected communities were chosen for the study. In the case of non-availability of under-five child in a selected household, the next household was selected to replace it.

Three hundred and ninety-three children were randomly selected from the three communities. Anthropometric assessments (weight and height/length) were conducted using standard procedures. Age in months was calculated from the date of birth to the date of the survey.

Statistical analysis

For the data analysis, z-scores of height-for-age, weight-for-height and weight-for-age were derived and prevalence of child undernutrition was estimated according to the World Health Organization growth

standards, using WHO Anthro 2005 software. The Composite Index of Anthropometric failure (CIAF) was calculated using SPSS version 20.

III. Results and Discussion

A total of 393 children were evaluated; there were 190 females (48.3%) and 203 males (51.7%). Children between the ages of 3-12 months constituted the largest proportion (50.6%), while those of ages 49-60 months (7.6%) were the least. The mean age of the children was 20.0 months.

The prevalence of undernutrition was calculated using the WHO Anthro software© to obtain the conventional anthropometric indicators as 55.9% were stunted, 4.0% were wasted and 16.5% were underweight. The highest prevalence of stunting and wasting was reported in the high density community 36.9%, 4.2% respectively while the prevalence of underweight was highest in the medium density areas (11.9%) as shown in table 2

According to CIAF groupings, only 192 (48.9%) were anthropometrically normal (Group A), while 144(36.6%) had single anthropometric failure, 47(12.0%) had dual failures and 10 (2.5%) triple failures. Out of the six sub-groups with anthropometric failures, group F (containing children who are stunted only) was the highest occurrence (44.0%). About 3(0.8%) were wasted only (group B), 8(2.0%) were wasted and underweight (group C) and 9(2.3%) were stunted, wasted and underweight (group D). Others in group E (stunted and underweight) 47(14.2%), while 7(1.8%) were underweight only. This is shown pictorially in a Venn diagram (Figure 1). The *'x' in* figure 1 is a theoretical combination of wasting and stunting. Though, this incidence does not occur in real terms. This is because a child to cannot concurrently experience stunting and wasting and not be underweight.

Considering the different population densities, for the high density area, out of the six groups with anthropometric failures, group F (stunted only) had the highest 42(30.2%), while the children in group B (wasted only) had the least 3(0.8%) as shown in table 3. Only 4(2.8%) experienced triple anthropometric failures (group D) while dual failures were found among group C (2.2%) and group E (7.2%). For the medium density area, the CIAF groupings revealed group F had the highest 40(29.9%), while the children in group B had the least 2(1.5%). Groups D, C, E and Y had 3(2.2%), 4(3.0%), 18(13.4%) and 5(3.7%) children respectively. In the low density areas, group F had the highest prevalence 37(30.8%) while groups D, C, E and Y had 3(2.5%), 2(1.7%), 7(5.8%)5(4.2%) children respectively.

Table 2: Prevalence of undernutrition in the selected communities

Prevalence of Undernutrition	High density	Medium density	Low density	Total
Stunting	50(36.9)	41(30.6)	35(29.2)	126(32.1)
Wasting	6(4.2)	4(2.9)	2(2.2)	12(3.1)
Underweight	14(10.1)	16(11.9)	13(10.8)	43(10.9)

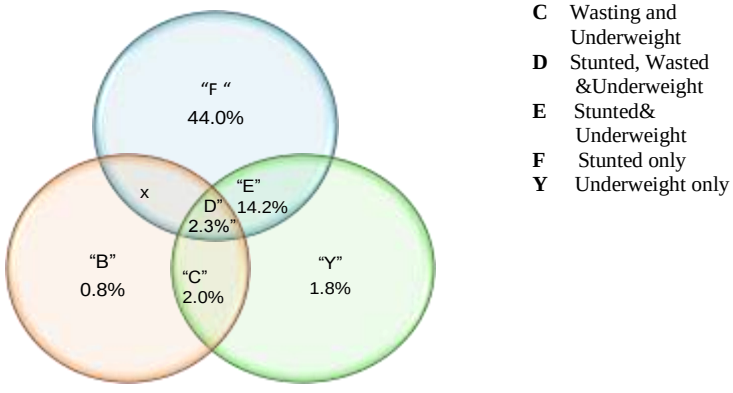

Figure 1: Prevalence of Undernutrition using Composite Index of Anthropometric Failure

Table 3: Prevalence of Undernutrition using Composite Index of Anthropometric Failure (CIAF) based on location

Sub groups	Anthropometric Failure	High density area	Medium density area	Low density area	Total
A	No Failure	65(46.8)	62(46.3)	65(54.2)	192
B	Wasting only	3(0.8)	2(1.5)	1(0.8)	6
C	Wasting and Underweight	6(2.2)	4(3.0)	2(1.7)	12
D	Wasting, Stunting &Underweight	4(2.8)	3(2.2)	3(2.5)	10
E	Stunting and Underweight	10(7.2)	18(13.4)	7(5.8)	35
F	Stunting only	42(30.2)	40(29.9)	37(30.8)	119
Y	Underweight only	9(6.5)	5(3.7)	5(4.2)	19
	Total	74	72	55	
Total CIAF (B+C+D+E+F+Y)				201	
Single Failure (B+F+Y)				144	
Multiple Failure (C+E+D)				57	

IV. Discussion

This study revealed a high level of undernutrition existed among the under-five children using the conventional anthropometric measures and the CIAF. This could result in numerous adverse consequences. Undernutrition could lead to death in children resulting from diseases such as malaria, diarrhoea, pneumonia and measles[22]. Other consequences of undernutrition include poor educational achievement and negative cognitive development,[23] obesity and risk of chronic diseases later in life[24].

The CIAF showed the magnitude of undernutrition by reflecting the single aggregated figure of the number of children affected in the study population. This study showed that 201 children (out of 393) were identified with anthropometric failure (51.1%). CIAF was higher in (18.8%) high and medium density areas (18.3%) than in low density areas (13.9%). Based on the three different locations, there was a little disparity in the prevalence of multiple anthropometric failure as seen in Table 3.

Based on location, the occurrence of multiple anthropometric failure was highest in the high density community which could possibly be due to their low standard of living/ poverty and the inconducive environment they live and low level of food security. All these factors have effect on the nutritional status of the children residence in such environment or location. Zulu et al.[25] reported that one of the features of urban poverty in Sub-Sahara Africa is the proliferation of overcrowded slums and shantytowns characterized by unhygienic environmental conditions (e.g. uncollected garbage, unsafe water and poor drainage) which worsen the susceptibility of residents to various health problems. As a result of such unhealthy conditions, rates of child malnutrition, morbidity and mortality are several times higher in slums and peri-urban areas than in more privileged urban neighbourhoods, and even than in rural areas[26]. The medium density community showed a reduction in the prevalence of CIAF, this could be as a result of a little improvement in the living conditions and access to health than those residing in high density areas. This area has better access to good housing, improved medical care and access to food and clean water. The low density community has the lowest prevalence of CIAF and the best nutritional status. This could partly be due to their improved living condition, better health care and having adequate purchasing power to eat healthy and nutritional foods. These findings further support report of Fosto[27] in 2006 that assembled evidence from developing countries which showed that the locus of poverty and malnourishment is gradually shifting from rural to urban areas, as the number of urban poor and undernourished is increasing more quickly than the rural number.

Similar study has been reported among young children in rural community in Oyo state, Nigeria with an overall prevalence of 47.5%[10]. In another study conducted in West and Central Africa[28] the prevalence of CIAF was 52%. Apart from Nigeria, similar studies have been conducted in other countries like India where higher prevalence was reported in Lakhimpur,[29] Assam (48.6%)[30], Kottayam Kerala (45.7%)[31], West Bengal[32] (61.3%), Pune Maharastra[33] (75.3%), Nagpur, Maharastra[34] (48.5%), Tiruchirappalli, Tamil Nadu, India[35] (85.0%). Other countries where CIAF has been reported include Malawi (59%)[36], Kenya[37] (38.2%), China[38] (27.9%) (Endris, 2017), Thailand[39] (27.41), Indonesia[40] (51.4%)**.** However, fewer studies that have reported lower prevalence among the children; these include Kashmir, India[41] (30.35%) and Singur, West Bengal[42] (36.1%).

Apart from assessing the overall burden of undernutrition, CIAF also showed the various forms of overlapping of anthropometric failures which will help to accurately identify -children with single and multiple anthropometric failures. Therefore, the use of CIAF will further complement the conventional anthropometric measures assist in more accurate identification of decision making and adopting the most appropriate programmes for intervention by government and policy makers. In addition to the overall burden of

undernutrition which the CIAF succinctly provides, the index provides additional information on the overlapping, interconnected relationships as well as the multiple anthropometric deficits that exist in individuals.

V. Conclusion

This study revealed children who experienced not only single but dual and multiple anthropometric failures in different population densities. The identified children are at a greater risk of morbidity and are more likely to experiencing different dimensions of poverty[43] which may intensify risk of mortality as shown in a study[44]. The CIAF can be used at both local government and state levels in Nigeria to fully understand the factors associated with multiple anthropometric failures, and proffer the effective measures that could be appropriate for the different population densities. This will further assist in prioritizing intervention activities, in decision making and in proper allocation of resources.

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