ORIGINAL RESEARCH ARTICLE

Prevalence and patterns of anthropometric failure among under-five children in Nigeria: Evidence from the National nutrition and health survey, 2018

K Alarape[1], OB Yusuf[2], JO Akinyemi[2], FO Samuel[2], IO Morhason-Bello[2], KK Salami[2], O Obisesan[2], T Ilori[2], AA Aderinto[2], A Alada[2], AS Jegede[2], O Fawole[2], I Kana[3], O Solanke[3], J Suleiman[3], D Okara[3], A Adebiyi[3], AM Abdullahi[3], OO Ejiade[2], IF Adewole[2]*

Ministry of Health, Oyo State[1]; University of Ibadan, Ibadan[2]; Federal Ministry of Health[3]

*For Correspondence: Email: *ifadewole@gmail.com*

Abstract

Globally, malnutrition among under-five children remains a public health concern. There is increasing concern at research and policy levels about anthropometric failure and the double burden of child malnutrition across different groups of children. The objective of this study was to describe the magnitude and distribution of various forms of anthropometric failure (AF) among children under age five in Nigeria. We used the 2018 National Nutrition and Health Survey data collected among 19,471 under-five children in Nigeria. The most prevalent AF was stunting only (17.7%) followed by stunting and underweight (13.9%). Wasting, stunting and underweight was found among 3.5% of the sample. Wasting, stunting and underweight was most common in age 6-11 months (7.0%) and 12-23 months (6.9%). Overall, about 1 out of 5 under-five children has multiple anthropometric failure. The peak age group for multiple AFs was between six months and 35 months. Multiple AF was less likely among females compared to males (RR=0.74, CI: 0.69, 0.80). The risk of multiple AF was higher in both North East (RR=2.15, CI: 1.78, 2.59) and North West (RR=2.98, CI: 2.51, 3.55) relative to the North Central. In contrast, the risk was lesser in the South East (RR=0.75, CI: 0.59, 0.95) and other southern regions. The study showed that multiple anthropometric failure is a common problem among children in Nigeria. Programmes that will support prevention and early identification of different types of malnutrition among under-five children across States in Nigeria are recommended. *(Afr J Reprod Health 2022; 26[11s]: 54-61).*

Keywords: Undernutrition, stunting, malnutrition, children, Nigeria

Résumé

À l'échelle mondiale, la malnutrition chez les enfants de moins de cinq ans demeure un problème de santé publique. Au niveau de la recherche et des politiques, on s'inquiète de plus en plus de l'échec anthropométrique et du double fardeau de la malnutrition infantile dans différents groupes d'enfants. L'objectif de cette étude était de décrire l'ampleur et la distribution des diverses formes d'échec anthropométrique (AF) chez les enfants de moins de cinq ans au Nigeria. Nous avons utilisé les données de l'Enquête nationale sur la nutrition et la santé de 2018 recueillies auprès de 19 471 enfants de moins de cinq ans au Nigeria. La FA la plus répandue était le retard de croissance uniquement (17,7 %) suivi du retard de croissance et de l'insuffisance pondérale (13,9 %). L'émaciation, le retard de croissance et l'insuffisance pondérale ont été constatés chez 3,5 % de l'échantillon. L'émaciation, le retard de croissance et l'insuffisance pondérale étaient les plus fréquents chez les 6-11 mois (7,0 %) et les 12-23 mois (6,9 %). Dans l'ensemble, environ 1 enfant de moins de 5 ans sur 5 présente une défaillance anthropométrique multiple. Le groupe d'âge maximal pour les FA multiples se situait entre six mois et 35 mois. La FA multiple était moins probable chez les femmes que chez les hommes (RR = 0,74, IC : 0,69, 0,80). Le risque de FA multiple était plus élevé à la fois dans le Nord-Est (RR = 2,15, IC : 1,78, 2,59) et dans le Nord-Ouest (RR = 2,98, IC : 2,51, 3,55) par rapport au Centre-Nord. En revanche, le risque était moindre dans le Sud-Est (RR=0,75, IC : 0,59, 0,95) et les autres régions du sud. L'étude a montré que l'échec anthropométrique multiple est un problème courant chez les enfants au Nigeria. Des programmes qui soutiendront la prévention et l'identification précoce des différents types de malnutrition chez les enfants de moins de cinq ans dans les États du Nigeria sont recommandés. *(Afr J Reprod Health 2022; 26[11s]: 54-61).*

Mots-clés: Dénutrition, retard de croissance, malnutrition, enfants, Nigéria

Introduction

Malnutrition remains a global concern, with its momentous anti-human and, sometimes, irreversible consequences which hamper physical, social and economic development[1-3]. Malnutrition covers all forms of poor or abnormal nutrition and manifestation of overweight, obesity, as well as undernutrition[4]. For child undernutrition, the three most common indicators are stunting (population-level indicator of chronic undernutrition), wasting (a population-level indicator of acute undernutrition) and underweight (a combined measure to reflect both acute and chronic undernutrition, although it cannot distinguish between them). Singly, each of these three conventional indicators reflect different types of anthropometric failure, and therefore, different facets of undernutrition, yet none of these indicators, on their own can truly reflect total prevalence or total burden of undernutrition in population. Svedberg argued that the conventional indicators may each be underestimating the scale of the problem of child undernutrition and proposed a single aggregate indicator - the Composite Index of Anthropometric Failure (CIAF)[5], and subsequently modified by Nandy *et al*[6] - which incorporates all combinations of, and multiple anthropometric deficits which may exist simultaneously in the same child.

Several studies have employed the CIAF as a useful complement to the conventional indicators for reporting prevalence of undernutrition and for targeting of nutrition interventions. In addition, the CIAF has been used to show associated raised morbidity and mortality risks among children with dual and triple combinations of anthropometric deficits[7,8,9]. Recently, a more expanded CIAF that includes overweight, has been reported; this advances the efforts to comprehensively profile the burden of malnutrition among children by recognising the coexistence of stunting and overweight which indicates a double burden in children[10] and a major risk factor for chronic diseases. This form of malnutrition has received increasing recent attention in public health literature[11,12] being a contrasting form of malnutrition, which demands two-pronged interventions that can simultaneously address both undernutrition as well as overnutrition[13]. Children in many African countries including Nigeria are experiencing increasing incidence of stunting, especially among children aged 0-59 months, despite the reported global decrease in stunting[14]. Nigeria reportedly recorded the highest number of chronically malnourished children in Africa, especially in low height-for-age or stunting[2]. More specifically, the National Population Commission and ICF International reported that more than 11.7 million stunted children in sub-Saharan Africa were from Nigeria. Although underweight among children under five (19.9%) in Nigeria is lower than that of Africa (22%) since 2014, the two statistical figures surpassed the global benchmark, which is 15%[3]. According to the report, the highest prevalence of malnutrition was in the Northwest with 55% of children followed by the Northeast (42%) and Northcentral (29%)[2]. At the state level, Kebbi state (61%) has the highest rate while Enugu state (12%) has the lowest rate of stunting[2]. In addition, stunting is more common in the rural areas (42%) relative to the urban areas (26%) in Nigeria. The prevalence of severe stunting in Nigeria is two times higher in rural areas compared to urban settings (26% vs 13%).

Different studies have reported on the prevalence and determinants of child stunting, wasting and underweight at national level in Nigeria, however, the literature on dual or multiple anthropometric failures are either scarce or not known. Reducing anthropometric failures in children under the age of five is one of the most urgent nutrition goals a country can address because of its direct association with survival, present and future health outcomes, quality of life and productivity. Thus, it is important to explore how anthropometric failure is distributed amongst children across geographies and sociodemographic groups in Nigeria. Our study describes the prevalence and pattern of co-occurring anthropometric failures as well as overweight, thereby providing a comprehensive measure of the burden of malnutrition in Nigerian children. The findings can provide policy makers with useful data to effectively target nutrition policies in Nigeria.

Methods

The data analysed were collected in the 2018 round of National Nutrition and Health Survey (NNHS) conducted by the Nigeria Federal Ministry of Health, in partnership with the National Bureau of

Statistics and various development partners, including UNICEF and World Bank[3]. The survey used cross-sectional design and Standardized Monitoring and Assessment of Relief Transitions (SMART) methodology to collect representative data from women aged 15-49 years and children 0-59 months in the 36 states and Federal Capital Territory[3].

A two-stage cluster sampling technique was employed. The first stage was selection of 36 clusters, which were census enumeration areas (EAs), using probability proportional to size in each state of the Federation. Subsequently, 20 households were selected from the EAs using the systematic random sampling technique. All consenting women aged 15-49 years were interviewed about their nutrition and general reproductive health issues, such as antenatal care utilisation, contraceptive use and HIV testing. Data were also collected on under-five children on anthropometric characteristics, immunization, vitamin A supplementation, deworming as well as infants and young children feeding.

Data were collected between February and May 2018 by trained interviewers using Open Data Kit installed on Galaxy tablets. This electronic data collection facilitated real-time data quality check and preliminary analysis as fieldwork progressed. A total of 24,985 women were successfully interviewed, while data were collected on 19,471 under five children.

In the NNHS, anthropometric data were pre-processed and analysed in Emergency Nutritional Assessment (ENA) software to derive indices to assess nutritional status. The ENA software used WHO 2006 child growth reference as standard for derivation of standardised scores of Height-for-Age (HA), Weight-for-Age (WA) and Weight-for-Height (WH). Children with HA standard scores less than -2 standard deviation (-2SD) of the reference population were classified as stunted. Similarly, those with WA scores less than -2SD were underweight and those above +2SD were classified as overweight. Lastly, wasting was defined as WH scores less than -2SD.

The outcome variable addressed in this paper was anthropometric failure which was classified into the following categories: no failure, wasting only, wasting and underweight, wasting, stunting and underweight; stunting and underweight; stunting only; stunting and underweight; stunting only; stunting and overweight; overweight only; and underweight only[10]. Wasting and stunting is not a biologically plausible combination, as a child cannot simultaneously experience stunting and wasting and not be underweight. Further, we derived type of anthropometric failure as no failure; single failure and multiple failure. Single failure are those with any one of the four (wasting, stunting, underweight, overweight) while multiple failure are those with any two or more.

Descriptive statistics, such as means, standard deviations (SD), and percentages/proportions were used to summarize the variables. Anthropometric failure (AF) was cross-tabulated against the available background variables (age of child, sex, and geo-political zone). A similar cross-tabulation was done for type of AF. Thereafter, we employed multinomial logit model with robust standard errors to estimate relative risk ratios for the independent association between type of AF and the three background variables. Robust standard errors were estimated to adjust for the cluster sampling technique used for data collection. Stata MP Version 14 was used for analysis.

Results

The age distribution of the children showed that about one-tenth were below six months and 6-11 months, while other age groups constituted about 20% each. Males accounted for 50.3% of all children. Regarding regional distribution, 30.0% and 22.0% were domiciled in Northwest and Northeast, respectively. Southeast and Southwest accounted for 8.4% and 9.8% respectively of all children surveyed while North Central and South South constituted 8.4% and 18.7% respectively.

Distribution of anthropometric failure

Table 1 shows the distribution of anthropometric failure (AF) among under-five children in Nigeria according to age group, sex, and geo-political region. A little more than half (58.1%) had no AF while the most prevalent AF was stunting only (17.7%) followed by stunting and underweight (13.9%). Wasting, stunting and underweight was found among 3.5% of the sample.

Children less than 6 months were the most affected by wasting only (4.3%) while age 6-11 months had the highest prevalence of wasting and

Table 1: Prevalence of anthropometric failure among under-five children in Nigeria, NNHS 2018

	n	Categories of AF (%)								
		No AF	Wasting only	Wasting+ Underweight	Wasting+ Stunting+ Underweight	Stunting+ underweight	Stunting only	Stunting+ Overweight	Overweight only	Underweight only
Overall	19471	58.1	1.4	2.4	3.5	13.9	17.7	0.5	0.7	1.8
Age group										
< 6 Months	2033	69	4.3	3.5	1.3	7.5	7	1.5	2.6	3.3
6-11 Months	2115	59.6	2.3	5.3	7	11.9	9.3	0.5	0.7	3.4
12-23 Months	3976	52.5	1.2	2.7	6.9	16.7	18.1	0.2	0.5	1.3
24-35 Months	3951	54.3	0.8	1.4	3	16.7	21.3	0.4	0.7	1.6
36-47 Months	3859	58.1	0.5	1.2	1.5	13.7	22.8	0.5	0.3	1.4
48-59 Months	3537	61.5	1.1	1.8	1.6	12.9	18.9	0.4	0.1	1.7
Sex										
Male	9790	55.1	1.3	2.5	4.1	14.9	18.9	0.5	0.9	1.8
Female	9681	61.1	1.6	2.2	2.8	12.9	16.4	0.5	0.5	2.0
Zone										
North Central	3636	65.5	1.4	1.4	2.3	10.3	16.4	0.5	0.9	1.5
North East	4274	51.4	1.4	3	4.3	16	20.5	0.8	0.7	2.0
North West	5815	43.6	1.1	2.4	5.1	20.6	24.2	0.5	0.5	2.1
South East	1643	75.3	2.1	2.5	1.5	7.9	7.9	0.6	0.7	1.5
South South	2187	72.6	1.7	2.8	1.7	8.3	10.3	0.1	0.9	1.6
South West	1916	71.7	1.7	2.2	2.8	7.7	11	0.2	0.6	2.2

AF: Anthropometric Failure

Table 2: Prevalence of single and multiple anthropometric failures among under-five children in Nigeria, NNHS 2018

	n	Type of Anthropometric Failure (%)		
		No failure	Single	Multiple
Overall	19471	58.1	21.6	20.3
Age group				
< 6 Months	2033	69.0	17.1	13.9
6-11 Months	2115	59.6	15.7	24.7
12-23 Months	3976	52.5	21.0	26.4
24-35 Months	3951	54.3	24.3	21.5
36-47 Months	3859	58.1	25.1	16.9
48-59 Months	3537	61.5	21.8	16.7
Sex				
Male	9790	55.1	22.8	22.1
Female	9681	61.1	20.4	18.5
Zone				
North Central	3636	65.5	20.1	14.4
North East	4274	51.4	24.6	24.0
North West	5815	43.6	27.8	28.6
South East	1643	75.3	12.3	12.4
South South	2187	72.6	14.5	12.9
South West	1916	71.7	15.4	12.9

Table 3: Risk Ratio for Association between background characteristics and anthropometric failure among under-five children in Nigeria, NNHS 2018

|	Relative Risk Ratio (95% CI)	
	Single AF vs No Failure	Multiple AF vs No Failure
Background characteristics		
Age group		
< 6 Months	1.00	1.00
6-11 Months	1.07 (0.89, 1.27)	2.08 (1.74, 2.49)*
12-23 Months	1.68 (1.44, 1.96)*	2.61 (2.22, 3.07)*
24-35 Months	1.89 (1.63, 2.21)*	2.08 (1.75, 2.46)*
36-47 Months	1.85 (1.58, 2.16)*	1.55 (1.31, 1.84)*
48-59 Months	1.49 (1.27, 1.75)*	1.41 (1.19, 1.660*
Sex		
Male	1.00	1.00
Female	0.80 (0.74, 0.86)*	0.74 (0.69, 0.80)*
Zone		
North Central	1.00	1.00
North East	1.57 (1.35, 1.82)*	2.15 (1.78, 2.59)*
North West	2.10 (1.82, 2.42)*	2.98 (2.51, 3.55)*
South East	0.53 (0.44, 0.64)*	0.75 (0.59, 0.95)*
South South	0.64 (0.54, 0.77)*	0.81 (0.65, 0.99)
South West	0.69 (0.57, 0.84)*	0.81 (0.65, 1.00)

AF: Anthropometric Failure; * p<0.05

underweight (5.3%). Wasting, stunting and underweight was most common in age 6-11 months (7.0%) and 12-23 months (6.9%). Stunting and underweight was highest in age 12-23 months and 24-35 months (16.7%). Age 36-47 months had the highest prevalence of stunting only (22.8%). Underweight only, and Overweight + stunting were rare.

The following forms of AFs were more common among male children than females: wasting + underweight (male-2.5%, female-2.2%); wasting + stunting + underweight (male-4.1%, female-2.8%); stunting + underweight (male-14.9%, female-12.9%); stunting only (male-18.9%, female-16.4%); and overweight only (male-0.9%, female-0.5%). The North West and North

East have the highest prevalence of most forms of AF.

Multiple anthropometric failure

Overall, about 1 out of 5 under-five children had multiple anthropometric failure (Table 2). The peak age group for multiple AFs was between 6 and 35 months. Further, the prevalence of multiple AF was higher among males (22.1%) than females (18.5%). Regional disaggregation showed that the North West (28.6%) and North East (24.0%) ranked top in terms of multiple AF. The South East (12.4%) had the lowest (Table 2). Figure 1 showed the prevalence of wasting + underweight across the 36 States and the Federal Capital Territory (FCT). The highest was Delta State (4.4%) in the South South while the lowest was Kogi (0.5%) in the North Central. Eighteen States had levels of wasting + underweight above the national prevalence (2.4%). The prevalence of wasting + stunting + underweight (Figure 2) was highest in Jigawa (6.8%), Sokoto (6.1%) both in North West. Stunting + Underweight (Figure 3) was most common in Yobe State (25.9%) while the lowest prevalence was observed in Anambra State (4.0%). Stunting + Overweight was not as common as the other forms of multiple AF. Only Taraba (2.1%) and Benue State (1.1%) had prevalence above 1% (Figure 4).
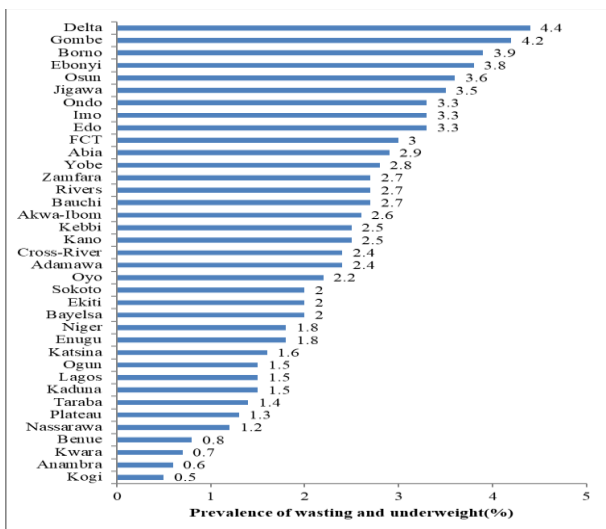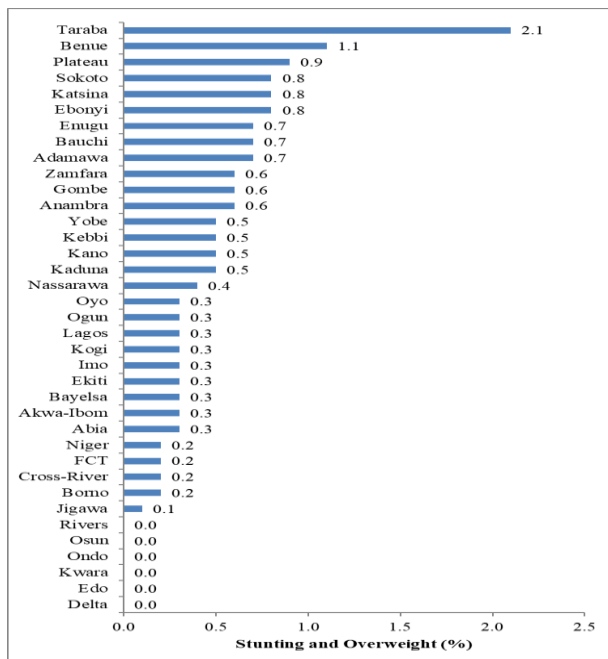

Figure 1: Prevalence of wasting and underweight among under-five children in the 36 States and FCT in Nigeria, NNHS, 2018
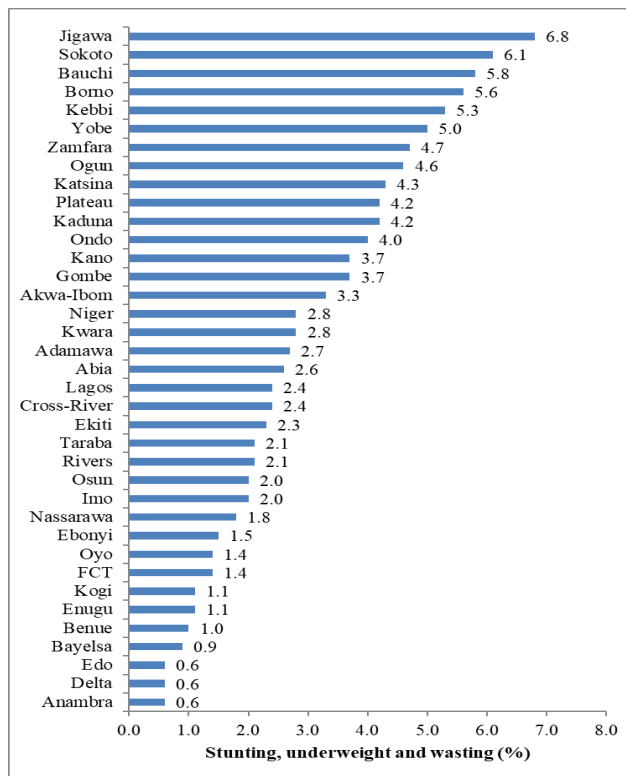
Figure 2: Prevalence of stunting, wasting and underweight among under-five children in the 36 States and FCT in Nigeria, NNHS, 2018
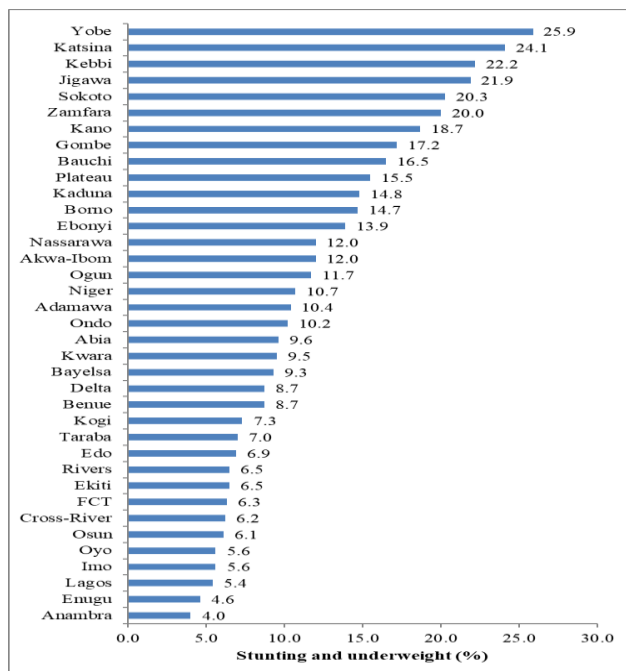
Figure 3: Prevalence of stunting and underweight among under-five children in the 36 States and FCT in Nigeria, NNHS, 2018

Figure 4: Prevalence of stunting and overweight among under-five children in the 36 States and FCT in Nigeria, NNHS, 2018

Risk Ratios for the effect of background variables on single and multiple AF are presented in Table 3. For single AF, the risk increased with age of children from 6-11 months (RR=1.07, CI 0.89, 1.27) till 36-47 months (RR=1.85, CI: 1.58, 2.16). Female children were less likely of single AF compared to their male counterparts (RR=0.80, CI: 0.74-0.86). There was significant differentials between North Central and other regions. Under-five children in the North East (RR=1.57, CI: 1.35, 1.82) and North West (RR=2.10, CI: 1.82, 2.42) were more likely to have single AF compared to those in the North Central. The reverse was the case in the Southern regions compared to the North Central. For multiple AF, the age pattern was similar to that of single AF but the magnitude of effect was higher. Sex difference was also wider with the likelihood of multiple AF being 26% lesser among females (RR=0.74, CI: 0.69, 0.80). The risk of multiple AF was higher in both North East (RR=2.15, CI: 1.78, 2.59) and North West (RR=2.98, CI: 2.51, 3.55) relative to the North Central. In contrast, the risk was lesser in the South East (RR=0.75, CI: 0.59, 0.95) and other southern regions, with only the former attaining statistical significance (Table 3).

Discussion

This study described the prevalence and patterns of various forms of anthropometric failure among under-five children in Nigeria. We found that every four out of 10 of children experienced some form of undernutrition, with the greatest burden for a single failure of stunting only for nearly one in 5 children, followed by concurrent stunting and underweight for one in 7 children. The combination of stunting and overweight which is representative of the double burden of malnutrition was not as common as the other forms of multiple anthropometric failure but is just emerging in the population. Our analysis provides a holistic picture which, otherwise would not be revealed by the usual prevalence of stunting, underweight, and wasting without disaggregation as these obscure the proportion of children in a population most at risk for poor health outcomes owing to multiple, concurrent anthropometric failures[15]. This may produce a deeper understanding of the forms of anthropometric failure as well as inform policies and programs to accelerate progress towards reducing child malnutrition in Nigeria. Without examining the co-occurrence of different types of anthropometric failure, policy and intervention may be somewhat misaligned with the burden of disease[16]. We found that sex, age and region were associated with the odds of single and multiple anthropometric failures. Although this was not explored in this study, the reasons for these nutritional outcomes may not be far from what have already been reported about Nigerian children in the literature[17,18]. Sex-specific biological vulnerability[19], sub-optimal breastfeeding and complementary feeding practices[20] as well as poverty and conflicts in the northern region compared to the rest of the country[21] may be key explanations for the observed prevalence and distribution of anthropometric failures in this study.

Male children had a higher proportion of multiple forms of anthropometric failures, and the prevalence of most forms of anthropometric failure in all children peaked at the age of 12-23 months. We also found a significantly higher odds of coexisting forms of undernutrition in children after their first birthday. However, this

was the reverse for the coexistence of stunting with overweight suggesting that this form of double burden of malnutrition may not (yet) be an issue of public health emergency in this population. The regional distribution of the multiple anthropometric failures also confirmed the geographical vulnerability of the North West and North East regions of Nigeria, while providing early warning on the situation in other regions otherwise considered less alarming.

Our study utilised secondary data collected before the COVID-19 pandemic, an era which affected food systems including food supply, food prices and food consumption; this aggravated food and nutrition insecurity worldwide including Nigeria[22,23]. Children are the most vulnerable segment of the population to nutrition shocks, hence it is possible that the current situation of child malnutrition in Nigeria, particularly stunting which is a cumulative outcome of nutritional deprivation has worsened, as an aftermath of the pandemic. The next set of anthropometric data collected nationally post-COVID-19 will indicate the direction of the prevalence of the various combinations of anthropometric failure in Nigerian children.

A significant burden of multiple anthropometric deficits in a population suggests an early environment of sub-optimal nutrition and recurrent infections, all underlined by multidimensional poverty. A multisectoral approach to the delivery of both nutrition specific and nutrition sensitive programmes can help to reduce the prevalence of the different forms of malnutrition.

Strength and weaknesses

This study provides both national and sub-national outlook on the burden of anthropometric failure among under-five children in Nigeria. Beyond the common information about stunting, wasting and underweight that has been presented in previous reports and studies, the study followed recent discourse about childhood malnutrition to show that nearly half of Nigerian under-fives are at risk. While the findings are from a nationally representative survey, the cross-sectional nature of the dataset implies that, we cannot account for children who move between categories of anthropometric failures

over time. Furthermore, a major weakness is the very few numbers of background and other explanatory variables available for analyses. This is the peculiar nature of the SMART methodology used for data collection. It was meant to have very few questions that can be deployed for rapid assessment on a large scale. This limitation notwithstanding, the study has been able to show that no geo-political region in Nigeria is free of multiple anthropometric failures though the magnitude varied.

Ethical consideration

This was a secondary data analysis. The original protocol of NNHS was reviewed and approved by the National Health Research Ethics Committee of Nigeria (NHREC).

Conclusion and policy implications

In conclusion, anthropometric failure is common in Nigeria with a higher burden in Northern regions compared to the Southern regions. We advocate innovative strategies and intervention that could help to reduce the burden in Nigeria and the possible associated public health risks. Further studies are recommended, especially those that will investigate drivers of each of the common dual malnutrition problems in children especially in high burden states for better understanding of the root causes of this public health problem in Nigeria.

In view of the morbidity and mortality risks associated with anthropometric failure, pregnant women and under-five caregivers need to be continuously educated about children nutrition so that preventive efforts can be initiated early enough. Secondly, nutritional interventions may be more effective if they are tailored to the peculiarities of each States and geo-political region. In fact, the States would need to take leadership since there is no administrative structure at the level of regions. State ownership is essential so that programmes and partnerships can be targeted at specific vulnerable groups in each state.

References

1. WHO. The double burden of malnutrition: policy brief. Available   from

https://www.who.int/publications/i/item/WHO-NMH-NHD-17.3 (Accessed 24/01/2022). 2017.

2. USAID. Nigeria: Nutrition Profile. Available from https://www.usaid.gov/global-health/health areas/nutrition/countries/nigeria-nutrition-profile (Accessed 24/01/2022). 2018.

3. National Nutrition and Health Survey (NNHS). The nutrition and health situation of Nigeria. USAID, UKAID, UNICEF, National Bureau of Statistics Abuja, Nigeria. Available from: https://www.nigerianstat.gov.ng/pdfuploads/Report%20of%20NNHS-2014-final.pdf (Accessed 24/01/2022). 2018.

4. Webb P, Stordalen GA, Singh S, Wijesinha-Bettoni R, Shetty P and Lartey A. Hunger and malnutrition in the 21st century. *Bmj* 2018; 361: k2238.

5. Svedberg P. (2000). Anthropometric status; an incomplete indicator of undernutrition. In: Poverty and undernutrition; theory, measurement and policy. New Delhi: Oxford India Paperbacks

6. Nandy S, Irving M, Gordon D, Subramanian SV and Davey Smith G. Poverty, child undernutrition and morbidity: new evidence from India. *Bull World Health Organ*, 2005, 83(3):210–6.

7. Nandy S and Svedberg P. The Composite Index of Anthropometric Failure (CIAF): An alternative indicator for malnutrition in young children. In: *Handbook of Anthropometry.* Springer; 2012:127-137.

8. Myatt M, Khara T, Schoenbuchner S, Pietzsch S, Dolan C, Lelijveld N and Briend A. Children who are both wasted and stunted are also underweight and have a high risk of death: a descriptive epidemiology of multiple anthropometric deficits using data from 51 countries. *Arch Public Health*. 2018;76(1):28.

9. Gausman J, Kim R and Subramanian SV. Associations of single versus multiple anthropometric failure with mortality in children under 5 years: A prospective cohort study. SSM Popul Health. 2021;16:100965

10. Kuiti BK and Bose K. The concept of composite index of anthropometric failure (CIAF): revisited and revised. Anthropol Open J, 2018, 3(1), 32-5.

11. Bejarano IF, Oyhenart EE, Torres MF, Cesani MF, Garraza M, Navazo B, Zonta ML, Luis MA., Quintero FA, Dipierri JE and Alfaro E. Extended composite index of anthropometric failure in Argentinean preschool and school children. *Public health nutrition*, 2019, *22*(18), pp.3327-3335.

12. Khaliq A, Wraith D, Miller Y and Nambiar-Mann S. Prevalence, trends, and socioeconomic determinants of coexisting forms of malnutrition amongst children under five years of age in Pakistan. Nutrients, 2021, 13(12), 4566.

13. Popkin BM, Corvalan C and Grummer-Strawn LM. Dynamics of the double burden of malnutrition and the changing nutrition reality. *Lancet.* 2020;395:65–74. doi: 10.1016/S0140-6736(19)32497-3

14. Global Nutrition Report. Shining a light to spur action on nutrition. Available from https://globalnutritionreport.org/reports/global-nutrition-report-2018/ (Accessed 25/01/2022). 2018.

15. Khara T, Mwangome M, Ngari M and Dolan C. Children concurrently wasted and stunted: a meta-analysis of prevalence data of children 6-59 months from 84 countries. Matern Child Nutr. 2018;14(2)

16. Gausman J, Kim R, Li Z, Tu L, Rajpal S, Joe W and Subramanian. Comparison of child undernutrition anthropometric indicators across 56 low- and middle-income countries. *JAMA Netw Open*. 2022;5(3):e221223.

17. Adeyemi O, Toure M, Covic N, van den Bold M, Nisbett N and Headey D. Understanding drivers of stunting reduction in Nigeria from 2003 to 2018: a regression analysis. *Food Security*, 2022, pp.1-17.

18. Tesfaw LM and Fenta HM. Multivariate logistic regression analysis on the association between anthropometric indicators of under-five children in Nigeria: NDHS 2018. *BMC pediatrics*, 2021, *21*(1), pp.1-13.

19. Thurstans S, Opondo C, Seal A, Wells J, Khara T, Dolan C, Briend A, Myatt M, Garenne M, Sear R and Kerac M. Boys are more likely to be undernourished than girls: a systematic review and meta-analysis of sex differences in undernutrition. *BMJ Global Health*, 2020, 5(12).

20. National Population Commission (NPC) [Nigeria] and ICF. Nigeria Demographic and Health Survey 2018 Key Indicators Report. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF; 2019.

21. Olarewaju OA. "Insecurity in northern Nigeria: Implications for maternal and child health." *Clinical Epidemiology and Global Health.* 2021,12: 100869.

22. Samuel FO, Eyinla TE, Oluwaseun A, Leshi OO, Brai BI and Afolabi WA. Food Access and Experience of Food Insecurity in Nigerian Households during the COVID-19 Lockdown. *Food and Nutrition Sciences*, 2021, *12*(11), pp.1062-1072.

23. Iheme GO, Jagun AO, Egechizuorom IM, Ogbonna OC, Edafioghor LO, Adeleke FA, Asouzu NC, Mebude AS, Enuka HC, Kupoluyi OE, Onyekwere CC, Okwu UP and Olah LE. Food consumption and coping strategies of urban households in Nigeria during the COVID-19 pandemic lockdown. World Nutrition, 2020, 11(3), pp.35-50.