Estimated burden of aggregate anthropometric failure among Malawian children

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Background: The prevalence and trends of undernutrition among children below the age of five in Malawi are well known from a conventional (stunting, wasting and underweight) but not aggregate indicator perspective.

Objective: A study was undertaken to estimate the burden of undernutrition among Malawian children below the age of five, using the Composite Indicator of Anthropometric Failure (CIAF), which enables determination of an aggregate burden of malnutrition.

Setting: The study used secondary data from the Malawi Demographic and Health Surveys (MDHS) of 1992, 2000, 2004 and 2010.

Subjects: The subjects were caregivers and under-five children as sampled in the respective MDHS years considered for this study.

Method: The study employed CIAF as an alternative approach to describe undernutrition in four cohorts of Malawian children, in contrast to the more common evaluation of stunting, wasting and underweight. CIAF identifies seven mutually exclusive groups of possible anthropometric status in a population of children, with six of them representing potential anthropometric failure and the seventh group encompassing children not affected by any form of undernutrition. CIAF was calculated by difference, taking into account those children who did not reflect any form of undernutrition. CIAF was applied on four data sets from the Malawi Demographic and Health Surveys (MDHS) of 1992 (n = 3 174), 2000 (n = 10 102), 2004 (n = 8 934) and 2010 (n = 4 586) to generate anthropometric failure values.

Results: Until the 2010 MDHS, which registered a 51% value, the prevalence of CIAF approximated 59% in 1992, and 57% in both 2000 and 2004. These values are much higher than the prevalence of underweight (< 24%, in all years), a conventional indicator of malnutrition. CIAF not only provides the burden of undernutrition of a population as a single measure but also helps in detecting children with multiple anthropometric failures for targeted interventions.

Conclusions: Compared with CIAF, conventional anthropometric indicators seriously underestimated the prevalence of anthropometric failure among Malawian children. This is due to the fact that CIAF gives an aggregate estimate of anthropometric failure, hence it is a better indicator of the magnitude of undernutrition. There is need for CIAF to be integrated in routine nutrition assessments, and it is suggested that cut-off values to assess the degree of its severity be developed to make it more relevant.

Keywords: anthropometric failure, composite, underestimation

Introduction
Changes in body dimensions reflect the aggregate health and welfare of individuals and populations, hence anthropometry is used to assess and predict their performance, health and survival.1 Although the most common anthropometric indicators of stunting (height-for-age), underweight (weight-for-age) and wasting (weight-for-height) reflect distinct biological processes, none of them is able to give an aggregate estimate of undernutrition in a population, because they overlap.2 This has important implications for policy-makers and organisations seeking to meet international targets in nutrition, because they miss out on a platform on which to base and evaluate nutrition interventions as well as to decide on the extent of their coverage.3 More importantly, using underweight as an aggregate indicator underestimates the seriousness of undernutrition because it is a product of stunting and wasting, and not their sum.3

Against the above background, in 2000, Peter Svedberg developed a model that classifies undernutrition into mutually exclusive groups, enabling the determination of aggregate prevalence of child undernutrition.2 The model, known as the Composite Indicator of Anthropometric Failure (CIAF), identifies six groups used to classify undernutrition as follows: A (no anthropometric failure), B (wasting only), C (wasting and underweight), D (wasting, stunting and underweight), E (stunting and underweight) and F (stunting only). The seventh group (underweight only, Y) was added by Nandy in 2005. CIAF is calculated by aggregating CIAF subcategories from B through Y or subtracting group A from the summation of all the other groups. CIAF not only provides the burden of under-nutrition of a population as a single measure but also helps in detecting children with multiple anthropometric failures for targeted interventions.4

Opponents of CIAF have argued that its usefulness has to be carefully considered vis-à-vis the widely used conventional classifications before being adopted, claiming that it does not necessary address the limitations of the conventional classification such as being able to satisfy the long-felt need for a combined clinical and anthropometric classification that would be useful for clinical as well as community health work.5 However, they observe that CIAF is welcome in view of the paucity of recent attempts to classify undernourished children satisfactorily.

Countries such as India, China and Bangladesh have adopted the CIAF model to redefine nutrition situations in their countries to better inform nutrition programming. In Malawi, where child undernutrition remains a significant public health problem, CIAF presents an opportunity to reinvestigate the prevalence and trends of child undernutrition from an aggregate perspective, in order to inform decisions of the national nutrition response. It is in light of the above that this study was conducted to assess the prevalence and trends of aggregate anthropometric failure in Malawi, using the CIAF model.
Method
The study used the Malawi Demographic and Health Survey (DHS) data sets of 1992 (n = 3 174), 2000 (n = 10 102), 2004 (n = 8 934) and 2010 (n = 4 586) employing the CIAF model\(^6\) to determine the aggregate burden of anthropometric undernutrition. The DHS is a national socio-demographic survey that collects information based on a stratified two-stage cluster sampling design. Some of the information collected includes anthropometry, feeding practices, vaccination status, birth interval, childhood morbidity and mortality, use of maternal and child health services, and mother’s background information on under-five children.

For all the Malawi demographic and health surveys (MDHS), districts from the northern region and urban areas were oversampled to take into account the smaller population size in these areas, and sample weights were applied to correct for oversampling.\(^6\)\(^–\)\(^9\) In all four instances, the DHS data sets used were hierarchical in nature, and a list of households from selected clusters represented the sampling frame for the selection of households to participate in the survey. The clusters (groupings of households) at the top were the primary sampling units also known as communities or enumeration areas from which households were selected. Below the clusters were the households with children under the age of five. Below the households were the number of under-five children from each survey. At the lowest level were the number of children with weight for age, weight for height, and height for age z-scores. In 1992, 5 000 households were selected for interviews, while 13 220 were selected in 2000, and 15 091 and 27 307 were included in the 2004 and 2010 MDH surveys, respectively.

To standardise field work, NSO recruited and trained several people to serve as supervisors, field editors, female and male interviewers, reserve interviewers, and quality control interviewers.\(^6\)\(^–\)\(^9\) The training course consisted of instructions regarding interviewing techniques and field procedures, a detailed review of items on the questionnaires, instruction and practice in weighing and measuring children, mock interviews between participants in the classroom, and practice interviews with real respondents. Senior staff members from NSO, ICF Macro resident advisers and consultants coordinated and supervised field-work activities.

In terms of anthropometry, DHS measured children’s heights and weights in all sampled households regardless of whether their caregiver was interviewed or not. Data were collected to enable construction of conventional indices—height-for-age, weight-for-age, and height-for-weight—to enable construction of three conventional indicators of undernutrition (stunting, wasting and underweight), CIAF and its seven subcategories. CIAF was calculated by difference taking into account those children who did not reflect any form of undernutrition. Data were weighted due to probability proportion to size used during the respective surveys to come up with representative means and percentages.\(^10\) After excluding outliers and children with incomplete and missing values (pooled total of 4 033), a pooled sample of anthropometric values for 26 796 under-fives was analysed.

Results
Table 1 summarises the demographic characteristics of the children. Across the surveys, there were notable differences in sample size and residence, while other variables were comparable.

In terms of specific anthropometric failure types, the percentage of children without any form of undernutrition increased slightly between 1992 and 2004 and sharply in 2010 (Table 2). Further, most of the children were in anthropometric failure due to stunting only (> 34% across all years), followed by those suffering from a combination of stunting and underweight (> 9% in all years). A few children (< 4%) were in anthropometric failure due to being concurrently stunted, wasted and underweight, while less than 1% were underweight only.

The CIAF analysis produced worryingly higher (> 50% in all years) estimated values of undernutrition (Figure 1), which were

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**Table 1: Demographic characteristics of under-five children in the 1992, 2000, 2004 and 2010 Malawi Demographic and Health Surveys**

| Characteristic | 1992 MDHS (n = 3 174) | 2000 MDHS (n = 10 102) | 2004 MDHS (n = 8 934) | 2010 MDHS (n = 4 586) |
|---------------|-----------------------|------------------------|-----------------------|-----------------------|
| Region (%)    |                       |                        |                       |                       |
| North         | 30.37                 | 17.80                  | 12.78                 | 17.18                 |
| Central       | 34.69                 | 38.30                  | 37.46                 | 37.13                 |
| South         | 34.94                 | 43.90                  | 49.75                 | 45.68                 |
| Residence (%) |                       |                        |                       |                       |
| Urban         | 24.95                 | 18.40                  | 10.43                 | 9.94                  |
| Rural         | 75.05                 | 81.60                  | 89.57                 | 90.06                 |
| Household head sex (%) |           |                        |                       |                       |
| Male          | 83.30                 | 79.20                  | 81.05                 | 91.89                 |
| Female        | 16.70                 | 20.80                  | 18.95                 | 8.11                  |
| Child sex (%) |                       |                        |                       |                       |
| Male          | 49.97                 | 49.90                  | 50.82                 | 49.56                 |
| Female        | 50.03                 | 50.10                  | 49.18                 | 50.44                 |
| Age groups in months (%) |           |                        |                       |                       |
| 0–6           | 15.15                 | 14.90                  | 13.86                 | 9.81                  |
| 7–12          | 13.07                 | 12.20                  | 12.54                 | 10.31                 |
| 13–23         | 19.41                 | 19.30                  | 21.34                 | 20.98                 |
| 24–35         | 18.37                 | 19.70                  | 17.36                 | 20.21                 |
| 36–59         | 33.99                 | 33.80                  | 34.90                 | 38.68                 |

Data sources: NSO (Malawi) and ORC Macro.\(^*\)\(^*\)
Table 2: Categories of the Composite Indicator of Anthropometric Failure

| CIAF category | 1992 (n = 3 174) | 2000 (n = 10 102) | 2004 (n = 8 934) | 2010 (n = 4 586) |
|---------------|------------------|------------------|-----------------|-----------------|
| No failure (%) | 41.0             | 42.8             | 42.6            | 49.4            |
| Wasting only (%) | 1.1              | 1.8              | 2.4             | 1.7             |
| Wasting and underweight (%) | 2.0              | 1.9              | 2.1             | 1.1             |
| Wasting, stunting and underweight (%) | 3.3              | 2.1              | 1.6             | 1.3             |
| Stunting and underweight (%) | 17.6             | 13.9             | 12.6            | 9.6             |
| Stunting only (%) | 34.0             | 36.6             | 38.2            | 36.2            |
| Underweight only (%) | 0.7              | 0.7              | 0.7             | 0.7             |
| CIAF, n (%) | 1 873 (59.0) | 5 758 (57.2) | 5 092 (57.3) | 2 293 (50.6) |
| Total (%) | 100.0           | 100.0           | 100.0           | 100.0           |

Data sources: NSO (Malawi) and ORC Macro.

Figure 1: Trends of anthropometric failure in Malawi, 1992–2010.

The observed CIAF values are marginally lower compared with other nationally representative surveys. An Indian study used CIAF on a nationally representative sample of 24 396 children and found 60% of them to be in anthropometric failure. A study in Bangladesh constructed and applied CIAF to 5 258 children (1 831 from urban and 3 427 from rural areas) in the 2007 BDHS (Bangladesh Demographic and Health Survey). The study established that 47% and 58% of children from urban and rural areas, respectively, were in anthropometric failure.

Conclusions
It is evident from this study that Malawi has had a serious problem of anthropometric failure as evidenced by CIAF. The study corroborates earlier studies, in which the authors argued that using underweight as the main criterion for assessing the magnitude of undernutrition underestimates the magnitude of the problem of undernutrition. Given the growing evidence on assessing anthropometric failure using CIAF as a more comprehensive indicator, there is a need to develop cut-offs to determine its public health significance, especially with regard to informing policy-makers about the actual magnitude of undernutrition. It is being recommended that the inclusion of
CIAF as a nutrition indicator be seriously considered in nutrition programming at national as well as other levels of implementation, as it truly addresses the long-felt need for an aggregate anthropometric indicator.

Conflict of interest – The authors have no conflict of interest to declare.

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References
1. Bruce C. Anthropometric indicators measurement guide. Washington: Food and Nutrition Technical Assistance; 2001.
2. Pei L, Ren L, Yan H. A survey of undernutrition in children under three years of age in rural Western China. BMC Public Health. 2014;14:243. https://doi.org/10.1186/1471-2458-14-121
3. Nandy S, Irving M, Gordon D, et al. Poverty, child undernutrition and morbidity: New evidence from India. Bristol, Eng: World Health Org. 2005;83:210–16. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2624218/pdf/15798845.pdf
4. Dasgupta A, et al. Assessment of undernutrition with the Composite Index of Anthropometric Failure (CIAF) among under-five children in a rural area of West Bengal. Indian J Commun Health. 2014;26:132–8.
5. Bhattacharyya KM. Composite index of anthropometric failure, is it more useful? Public health review World Health Organization. 2006;84:4.
6. NSO (Malawi) and ORC Macro. Malawi Demographic and Health Survey 1992. Zomba, Malawi, Calverton, Maryland, USA: National Statistical Office and ORC Macro; 1994.
7. NSO (Malawi) and ORC Macro. Malawi Demographic and Health Survey 2000. Zomba, Malawi and Calverton, Maryland, USA: National Statistical Office and ORC Macro; 2001.
8. NSO and ORC Macro. Malawi Demographic and Health Survey, 2004. Zomba, Malawi and Calverton, Maryland, USA: NSO (National Statistical Office) and ORC Macro; 2005.
9. NSO (Malawi) and ICF Macro. Malawi Demographic and Health Survey report 2010. Malawi and Calverton, Maryland, USA: National Statistical Office and ICF Macro; 2011.
10. Johnson DR, Elliott LA. Sampling Design Effects: Do They Affect the Analyses of Data from the National Survey of Families and Households? J Marr Family. 1998;60:993–1001. https://doi.org/10.2307/353640
11. Government of Malawi. Monitoring the situation of mothers and children, multiple indicator cluster survey 2012. Lilongwe, Malawi: Government of Malawi; 2014.
12. NSO and ICF International. Malawi Demographic and Health Survey 2015/2016. Zomba Malawi and Maryland USA: National Statistical Office (NSO) and ICF International (USA); 2016.
13. Khan REA, Raza MA. Nutritional status of children in Bangladesh: Measuring Composite Index of Anthropometric Failure (CIAF) and its determinants. Pak J Comm Soc Sci. 2014;8:11–23.
14. Shit S, Taraphdar P, Mukhopadhyay DK, et al. Assessment of nutritional status by Composite Index for Anthropometric Failure (CIAF): A study among slum children in Bankura, west Bengal. Indian J Public Health. 2012;54:4.
15. Gaiha R, Jha R, Kulkarni VS. Child undernutrition in India. Canberra: Australian National University; 2010.
16. Bose K. Mandal. Proposed new anthropometric indices of childhood undernutrition. Malaysian J Nutr. 2010;131–6.

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