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Abstract

Background: Impaired nutritional status is a major health problem affecting young children in developing countries that has a significant impact on child morbidity and mortality.

Aims: This study aimed to assess the prevalence of undernutrition among children aged < 5 years, using conventional indices and the Composite Index of Anthropometric Failure (CIAF), and then comparing their estimated results.

Methods: A community-based cross-sectional study was conducted and information was collected through house-to-house visits using precoded structured records. We analysed data from 1292 children aged 6–59 months, from Ahwar and Al-Mahfed rural districts in Abyan Governate, South Yemen, with reference to the 2006 World Health Organization growth standards.

Results: CIAF identified undernutrition in 70.1% of children, while conventional anthropometric indices revealed 38.5% stunting, 39.9% wasting, and 55.1% underweight. Compared with conventional indices, CIAF aggregate recognized 31.6%, 30.2% and 15% more undernourished children than stunting, wasting and underweight separately. According to CIAF, 21% had a single anthropometric failure and 49.2% exhibited multiple failures. Stunting Index, Wasting Index and Underweight Index were 0.55, 0.57 and 0.79, respectively.

Conclusions: CIAF gives a better estimate of undernutrition than currently used conventional

indices; identifies more children with multiple anthropometric failures; and reflects a wider view of the extent and pattern of undernutrition of children living in communities with limited resource settings.

Keywords: undernutrition, Composite Index of Anthropometric Failure, children, rural areas, Yemen

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Introduction

Impaired nutritional status is a major health problem affecting young children in developing countries that has a significant impact on child morbidity and mortality. Undernutrition is, arguably, the cause of nearly half of all deaths in children aged < 5 years, leading to the unnecessary loss of ~3 million lives per year (1). Globally, Yemen ranks among the worst countries for child malnutrition; first for severe underweight and second for stunting (2). In 2013, the Yemeni National Health and Demographic Survey (YNHDS) revealed stunting, wasting and underweight in children aged < 5 years to be 47%, 14% and 39%, respectively (3). Based on World Health Organization (WHO) criteria, the public health significance of undernutrition among children is considered critical when the prevalence of stunting exceeds 40% and wasting 15% (4). Conventional anthropometric indices of stunting (low height for age), wasting (low weight for height) and underweight (low weight for age) have been used widely when evaluating the nutritional status of children. According to WHO, these indices reflect distinct biological processes: stunting indicates chronic or long-term undernutrition; wasting acute undernutrition; and underweight is a composite of acute and chronic undernutrition, but without any distinction between them (5). The 3 indices denote different facets of undernutrition, but they are not mutually exclusive and usually coexist (6). Therefore, it has been argued that conventional

indices are not sufficient for measuring the overall prevalence of undernutrition among young children. To overcome this limitation, suggestions were made to construct a new aggregate of indicators (7,8).

In 2000, Svedberg proposed the Composite Index of Anthropometric Failure (CIAF) (9). The original model comprised 6 subgroups (A–F) of anthropometric failure to which Nandy et al. added subgroup Y in 2005 (10). CIAF provides a single figure for the overall estimate of undernourished children in a population, which none of the current indicators can estimate separately. Furthermore, subcategories of multiple anthropometric failures can predict risk of morbidity and mortality more precisely than single indices can (11,12). Although CIAF is a useful composite measure, it fails to highlight the individual contribution and importance of stunting, underweight and wasting relative to the overall prevalence of undernutrition. Therefore 3 new indices, proposed by Bose et al. in 2010 (7), were introduced, known as the Stunting Index (SI), Underweight Index (UI) and Wasting Index (WI). These new indices attempt to provide additional information on the relative significance and severity of these 3 measures with respect to the total burden of undernutrition. 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 (13). 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.

However, there is scarce information about the use of this new tool as no such study has been reported from Yemen. The present study assessed the prevalence of undernutrition among children aged < 5 years using conventional indices as well as CIAF and compared their results.

Methods

Study location

Abyan Governorate is located in Southern Yemen, bordering the Gulf of Aden in the south, with an area of 16 442 km2 and 2 main ecological zones – the coastal regions and the highlands. It is divided into 11 administrative districts, including Ahwar (coastal region) and Al-Mahfed (highlands); these 2 rural districts are adjacent and occupy the eastern part of the governorate. According to the 2004 census in Yemen, the population of Ahwar was 30 589 and Al-Mahfed 32 557, of which approximately 14.1% and 13.2% were children aged < 5 years, respectively. These 2 districts were chosen for this survey because they were considered to be indirectly affected by the armed conflict that emerged in Abyan in 2011, between the local branch of AQAP (Ansar al-Shari'a) and the government forces (14).

Study design and sampling

This was a community-based cross-sectional study using data generated from the nutritional assessment triage records of children aged 6–59 months residing in 2 rural districts of Abyan Governorate (Ahwar and Al-Mahfed). It was carried out during August to November 2013.

In response to a malnutrition crisis in Abyan, which is one of the areas that is hardest to reach and one of the most affected by political unrest, the United Nations Children's Fund (UNICEF) partnered Field Medical Foundation (FMF) to execute a 1-year nutrition project starting in May 2013. FMF conducted community-based management of acute malnutrition services in those areas through a network of specifically trained community health volunteers and mobile teams who screened children aged < 5 years using precoded structured records (15). Two-stage cluster sampling was adopted in this survey. Two of the 11 districts were selected, and then 20 villages/clusters (9 from Ahwar and 11 from Al-Mahfed) were randomly chosen. In each cluster, 30–32 households were randomly selected, giving a total sample size of 627 households. The field work was conducted through house-to-house visits and data were collected by direct interviews with mothers or the primary caregivers of the children after giving their verbal consent to participate. This was followed by an anthropometric assessment. The nutritional assessment triage records included in this analysis were obtained by the FMF mobile team under the supervision of one of the authors.

Data collection

Data on age, sex, weight and length/height were obtained for every participant. All children were physically normal, devoid of any gross deformities and had no chronic illnesses. The children were barefoot with light clothing and in the correct position during anthropometric measurements. Weight was measured using a Seca weighing machine, which was calibrated on a daily basis. Height was recorded using a stadiometer and was measured to the nearest 0.1 cm. Recumbent length was measured by an infantometer for children aged < 2 years or those not able to stand without support. Each measurement was done twice and by 2 independent observers and the mean of the readings was recorded. The 2006 WHO Multicenter Growth Reference Study (16) was used to assess every child's length/height-for-age, weight-for-length/height, and weight-for-age z scores. Children were categorized into 2 age groups (< and ≥ 2 years) to highlight the prevalence of stunting in those aged < 2 years. The prevalence of undernutrition was assessed by conventional anthropometric indices of stunting, wasting and underweight, as well as CIAF. The significance of each of the conventional indices, in proportion to CIAF, was also evaluated by calculating SI (stunting/CIAF), WI (wasting/CIAF), and UI (underweight/CIAF). These indices do not have any units (7).

Definitions

Wasting was defined as weight-for-height z score (WHZ) < –2; stunting was defined as height-for-age z score (HAZ) < –2; and underweight was defined as weight-for-age z score (WAZ) < –2; CIAF subgroups are presented in Table 1 . The sum of the children in groups B to

Y provided the CIAF. Group A was excluded from the final estimate as children in this category had no anthropometric failure (10).

Ethical considerations and data analysis

Approval to use the nutritional assessment triage records for the purpose of this study was obtained from the FMF Head Office in Aden. Data processing and statistical analysis were carried out using SPSS for Windows version 20.0 and categorical data were summarized as frequencies and percentages. A $\chi 2$ test was performed to compare sex and age differences in the overall prevalence of undernutrition and between proportions of conventional indices and CIAF. $P < 0.05$ was considered to be statistically significant.

Results

A total of 1292 children were evaluated: 786 children from Ahwar (56% male, 44% female) and 506 from Al-Mahfed (47.6% male, 52.4% female). The prevalence of undernutrition by conventional indices and CIAF in the 2 districts is depicted in Figure 1 . According to CIAF, the prevalence of undernutrition was 70.4% in Ahwar and 69.6% in Al-Mahfed, with no significant differences ($P = 0.76$), hence data of both districts were analysed altogether.

CIAF identified undernutrition in 70.1% of the children overall, while conventional anthropometric indices showed 38.5% stunting, 39.9% wasting and 55.1% underweight (Table 2). Compared with conventional indices, CIAF aggregate recognized 31.6%, 30.2% and 15% more undernourished children than single stunting, wasting and underweight indices, respectively. Stunting was found significantly more among boys aged 2–5 years compared to < 2 years, while wasting, underweight and CIAF were significantly higher among girls aged 2–5 years compared to < 2 years. The prevalence of stunting, wasting, underweight and CIAF among both sexes was similar, except for the higher proportion of wasting among boys aged 6–23 months compared to their female counterparts (40.6% vs 21.9%, $P = 0.001$).

In this study and according to CIAF subgroups, only 387 (29.9%) were anthropometrically normal (Group A), 270 (20.9%) had single anthropometric failure, 450 (34.8%) had dual failures and 185 (14.3%) triple failures, giving a total of 635 (49.2%) of the children with multiple failures (Table 3). Out of the 6 subgroups of anthropometric failure, Group E (stunting and underweight), had the highest proportion among both boys and girls (19.6%), and Group F (stunting only) had the lowest prevalence (4.6%). Group C (wasting and underweight) and Group D (wasting, stunting and underweight), accounted for the second and third most prevalent groups (15.3% and 14.3%, respectively).

Table 4 displays the values of the 3 new indices with respect to and relative to total undernutrition expressed by CIAF. Both boys and girls were affected to approximately the same degree. The sex-combined values of SI, WI and UI were 0.549, 0.570 and 0.787, respectively. Underweight was predominantly observed in 78.7% of all cases of undernutrition, which was higher than stunting and wasting rates.

Discussion

In this study CIAF was utilized for the first time to provide an overall estimate of undernourished children in a rural community in Yemen. The prevalence of 70% by CIAF was evidently higher than those estimates by conventional indices (stunting 38.5%, wasting 39.9% and underweight 55.1%). Although CIAF is a good marker of undernutrition, it should be emphasized that conventional indices provide useful information and must not be disregarded, as CIAF itself is constructed from the aggregation of these indices. The main merit of CIAF is that it reveals additional dimensions of the malnutrition “iceberg” and it could have potential implications for policy-makers, resource allocation and trend monitoring of undernutrition at the community level (10).

The stunting prevalence of 31.2% among children aged < 2 years in the current sample is lower than 41.9% reported from rural Haryana, India (17) but higher than 21.6% in a rural community in Southeast Kenya (18). Stunting in children aged < 2 years could lead to long-term deleterious effects on cognitive ability, with an adverse impact on school and, later in adult life, work performance (19). Stunting is multifactorial and its prevention requires a multisectoral approach to improve the living conditions and nutritional level of children, as well as their families (20,21). Children older than 2 years showed a higher prevalence of undernutrition than younger children showed, and both boys and girls were equally affected, which is similar to a previous report from Southern Yemen (22).

The nutritional situation in Abyan has been exacerbated since 2011 due to armed conflict and the prevalence of aggravating factors and worsening malnutrition determinants such as water and sanitation, health, and food security. Another possible explanation is that rural children are underprivileged and have poor health outcomes. A recent analysis of the rural–urban gap in 3 Arab countries showed substantial regional disparities, which was 17.7% in Yemen compared to 2.3% in Egypt and 1.5% in Jordan (23). This gap was significantly related to economic inequality. In addition, rural households have received little, if any education, and have lower access to health care, clean water and sanitation.

The 2013 YNHDS of children aged < 5 years showed stunting in 47%, wasting 14% and underweight in 39% (3). The higher prevalence of wasting (39.9%) and underweight (55.1%) in the current study was probably attributed to acute undernutrition that most likely resulted from recent food deprivation and/or illness (14).

In a global comparison of data from the demographic health surveys in 8 countries, the present CIAF (70%) was higher than that in India (61.8%), Bangladesh (56.1%), Nepal (57.9%), Nigeria (51.6%), Liberia (44%), Ghana (35.6%), Egypt (36%), and Dominican Republic (12.5%) (6). However, our findings were similar to those in regional studies in India: Tamil Nadu (68.6%) (24), West Bengal (73.1%) (25) and Kashmir (73.2%) (26). A higher proportion of CIAF (80.3%) was reported in a study of slum children in Bankura, West Bengal (27). Differences among countries may be related to several factors that include socioeconomic inequalities, quality of health care services, food insecurity and political stability.

CIAF identified that nearly half of the children (49.2%) in our study had double or multiple failures (Groups C–E), compared to 20.9% with single anthropometric failures (Groups B, F and Y). The E category of CIAF (stunting and underweight) contributed the most (19.6%) to the aggregate CIAF, which could be explained by recent nutritional deficiency or long-term compromised nutritional status in this community. Identification of children with multiple anthropometric failures may have prognostic importance. In a recent review of 10 prospective studies in developing countries, the risk of all-cause mortality was significantly associated with multiple failures in a dose-dependent manner, compared to those children who did not have any deficit (12).

The 3 new indices, SI, UI and WI, provided information about the implication of each problem with respect to the total prevalence of undernutrition expressed by CIAF, and therefore, the higher the value, the greater the severity of undernutrition. Our study showed that the underweight index was high (0.787) compared to that in 3 previous reports (Table 5) (7,10,24,28). UI is a measure that does not distinguish acute from chronic (recent or remote) undernutrition, therefore, our findings indicate the need for a rapid relief response to lessen the impact of acute nutritional crises, and to maintain long-term preventive measures and sustained nutritional support.

This study documented for the first time the utility of CIAF for the assessment of undernutrition in Yemen with a good sample size. However, a number of limitations should be mentioned. First, the study covered only a limited population in a particular area, thus it does not represent rural children throughout the country. Further research in other localities using CIAF will reveal a clearer overall picture about the burden of undernutrition among children in Yemen.

Furthermore, due to the cross-sectional design and its inherent drawbacks, this analysis did not allow us to determine the fate of children being evaluated or which type of anthropometric failure carried the greatest risk for morbidity and mortality.

Conclusion

This study demonstrated that CIAF gives an overall and more accurate estimate of undernutrition than currently used conventional indices. Additionally, CIAF identifies more children with multiple anthropometric failures and reflects a wider view of the extent and pattern of undernutrition among children living in limited-resource settings such as Yemen. Underestimating the size of this vulnerable group might deprive a substantial number of children from receiving the benefit of extra supplementation and the care they urgently require. CIAF can help prevent this by providing a single aggregated figure with a more comprehensive view of undernutrition, while addressing conventional indices in the process. Implementing this in policy, planning and monitoring of nutrition intervention programmes at this stage should be viewed as crucial.

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Évaluation de la dénutrition à l’aide de l’indice composite d’insuffisance anthropométrique chez les enfants de moins de cinq ans au Yémen rural

Résumé

Contexte : L’altération de l’état nutritionnel est un grave problème de santé qui touche les jeunes enfants dans les pays à faible revenu et qui a un impact significatif sur la morbidité et la mortalité infantiles.

Objectifs : La présente étude visait à évaluer la prévalence de la dénutrition chez les enfants

de moins de 5 ans en utilisant les indices classiques et l'indice composite d'insuffisance anthropométrique, puis en comparant leurs résultats estimés.

Méthodes : Une étude communautaire transversale a été réalisée et des informations ont été recueillies au moyen d'un document structuré précodé lors de visites porte-à-porte. Nous avons analysé les données relatives à 1292 enfants âgés entre 6 et 59 mois des districts ruraux d'Ahwar et d'Al-Mahfed, dans le gouvernorat d'Abyan (sud du Yémen), par rapport aux normes de croissance publiées en 2006 par l'OMS.

Résultats : D'après l'indice composite d'insuffisance anthropométrique, 70 % des enfants souffraient de dénutrition. Selon les indices anthropométriques classiques, les prévalences du retard de croissance, de l'émaciation et du déficit pondéral étaient de 38,5 %, 39,9 % et 55,1 % respectivement. L'indice composite susmentionné, qui fournit un chiffre agrégé, a ainsi identifié 31,5 %, 30,1 % et 14,9 % d'enfants dénutris en plus que les mesures du retard de croissance, de l'émaciation et du déficit pondéral prises séparément. D'après cet indice composite, 21 % des enfants présentaient une seule insuffisance anthropométrique et 49,2 % présentaient des insuffisances multiples. Les indices de retard de croissance, d'émaciation et de déficit pondéral obtenus étaient, respectivement, de 0,55, 0,57 et 0,79.

Conclusions : L'indice composite d'insuffisance anthropométrique donne un meilleur aperçu de la dénutrition que les indices classiques actuellement utilisés. Il identifie en outre plus d'enfants souffrant d'insuffisances anthropométriques multiples et brosse un tableau plus complet de l'ampleur et de la nature du problème de la dénutrition des enfants vivant dans des communautés où les ressources sont limitées.

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