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**Original Research Article**

# Identification of undernutrition in under five children: Z score or a composite index of anthropometric failure?

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## ABSTRACT

**Background:** Undernutrition continues to be the primary cause of ill health and premature mortality. The sustainable development goal 2 aims to end all forms of hunger by 2030 and lead towards an improvement in child health. The national data categorize the level of undernutrition as underweight, wasting and stunting. The weight for age estimates used under ICDS misses out the other forms of malnutrition. This study was conducted to assess the prevalence of undernutrition using a composite index of anthropometric failure (CIAF) and compare it with conventional indices.
**Methods:** A community based setting and cross-sectional study design. By **s**imple random sampling 265 under-five children residing in a marginalized community of North West district of Delhi. Interviewer administered questionnaire was used to collect information and anthropometric measurements were taken using standard operative procedures. Z scores were calculated by WHO-ANTHRO software version 3.2.2. Descriptive analysis was conducted using statistical package for social sciences version 22.
**Results:** The prevalence of anthropometric failure by CIAF was 60.5% and based on other indices undernutrition was found as 44.5% stunting, 35.4% underweight and 26.4% wasting. MUAC detected 23.7% of undernourished. CIAF provides a better picture of undernutrition compared to other indices.
**Conclusions:** Since CIAF is more than that estimated by any of the conventional indicators, it proves to be a better indicator in assessing the overall burden of under-nutrition in a population. Development of policies based on CIAF to reduce the burden of undernutrition may prove to be more effective.

**Keywords:** Composite index of anthropometric failure, Stunting, Under-five children, Underweight, Wasting, Z score

## INTRODUCTION

The burden of undernutrition is hanging high globally and continues to be a primary cause of ill-health and premature mortality among children in developing countries. It is commonly assessed using anthropometric measures in combination with sex and age. Using these anthropometric measures indices like weight-for-age Z score (WAZ), height-for-age Z score (HAZ), weight-for-height Z score (WHZ) and mid-upper arm circumference (MUAC) have been developed.[1] Low weight for height reflects acute undernutrition with loss of mass suggestive of wasting and low height for age, also known as stunting represents chronic undernutrition due to poor skeletal growth. MUAC less than 11.5 cm is suggestive of severe wasting and severe acute malnutrition.[2] On the other hand, a low weight for age, i.e. underweight, represents both acute and chronic malnutrition.

These conventional indices reflect distinct biological processes, but they are not mutually exclusive. A child who is found to be stunted can also be underweight and

wasted at the same time. Hence, a sum of the children who are underweight, stunted and wasted in a population does not reveal the overall number of undernourished children. Instead may depict an over or under estimation due to the overlap between these conventional indices. Determining the magnitude of undernutrition using a single parameter will help the health administrators and policy makers to work on all the modifiable factors for effective prevention and control of undernutrition in under five children.

In this regard, an aggregated indicator for measurement of overall prevalence of undernutrition was proposed by Peter Svedberg, known as, Composite Index of Anthropometric Failure (CIAF).[3] It consisted of six groups and to these another group Y was added by Nandy et al.[4] This composite index identifies six mutually exclusive categories of children with different forms of anthropometric failure (Group B, C, D, E, F and Y). Those children with age appropriate height and weight are categorized with no anthropometric failure (Group A). Therefore, individual category depicts undernutrition without overlap and by counting all the children in six categories it provides the burden of undernutrition as single measure with anthropometric failure (Table 1). With this back ground, this study was conducted to assess the nutritional status in under-5 children living in a slum of Kirari Suleman Nagar, North West Delhi district, it helps to strategize for the upcoming program intervention. The nutrition status was assessed using WHO Z-score system and CIAF.

**Table 1: Classification of children with anthropometric failure.**

| Group | Description |
|---|---|
| **A** | No anthropometric failure |
| **B** | Wasting only |
| **C** | Wasting and underweight |
| **D** | Wasting, stunting and underweight |
| **E** | Stunting and underweight |
| **F** | Stunting only |
| **Y** | Underweight only |

## METHODS

This descriptive community based cross-sectional study was conducted on 265 under- five children selected from 5 wards of Kirari Suleman Nagar, North-West District of Delhi. The data was collected by trained outreach workers. They were rigorously trained for data collection by team at MAMTA-HIMC, Delhi. Informed consent was obtained from each participant before the survey. Every day filled data was checked for completeness and consistency by supervisor. This study was conducted from August to October, 2018.

### *Sample size and sampling technique*

Sample size for the cross sectional study was calculated using the formula $n = 4pq/d^2$. According to NFHS 4, prevalence of stunting in under 5 children in North West Delhi was reported to be 38.5%.[5] Using Epi Info software, the sample size for finite population was estimated to be 254 with p=38.5% and d=5%, at confidence level of 90%. The data was collected for a sample of 265 children.

It is rare that nutritional deficiencies are evenly distributed between the different age and sex groups. Hence, children were selected by simple random sampling. Each ward, Primary Sampling Unit (PSU), was segmented into four parts. Right hand rule was followed for conducting 12-13 interviews in each segment and a total of 53 interviews in each PSU. Interviewers knocked every household without skipping till first eligible respondent was found. It was ensured that only one eligible child from each household is interviewed. In case of more than one eligible participant in the household, KISH table (Kish, 1949) was used to select an eligible participant for the interview. Children of families who had moved into slum with in the past one month, children who were not a resident of the slum, but visiting and children whose mothers were not available at the time of survey were excluded.

### *Study tools*

Semi structured pretested questionnaire, portable weighing machine and non-stretchable measuring tape were used to collect data. The WHO Z score system and CIAF was used to estimate the magnitude of undernutrition. The study used Computer-Assisted Personal Interviewing (CAPI) for collection of data. Therefore, a hand held device-based survey where all interviews were aided by the android based mobile phones were used for the study. MAMTA-HIMC was responsible for the development and quality assurance of the final CAPI software platform integration and throughout data collection until the closeout of the study, with oversight from the team.

The data included weight, recumbent length (less than 2 years or child not able to stand without support), standing height and for children above 6 months' MUAC. MUAC is currently not recommended for use among infants aged below 6 months because of a lack of data on its reliability, measurement in practice and predictive value for death.[6] Children aged less than 24 months were weighed while being held by their mother, after which the mother's weight was subtracted to derive the weight of the child. Weight was measured using portable analogue weighing machine with accuracy of 50 grams. Height was measured using a non-stretchable tape with the participant standing on a flat and firm surface to the nearest 0.1 cm.

### *Definitions*

Wasting denotes acute malnutrition and defined as a weight for height Z-score (WHZ) of <-2. Severe wasting is considered if WHZ is <-3 of the WHO (2006) reference standards. Whereas, stunting represents chronic malnutrition with height for age Z-score (HAZ) of <-2 and severe stunting is considered if HAZ is <-3 of the WHO (2006) reference standards. Underweight for age is defined as weight for age Z-score (WAZ) <–2 of the WHO (2006) reference standards.[7] The cut-off points for MUAC of 12.5 cm was used for identifying children with undernutrition, an MUAC between 12.5 and 11.5 cm denotes moderate undernutrition (borderline), and less than 11.5 cm denotes severe undernutrition. Severe acute malnutrition (SAM) is defined by a low mid-upper-arm-circumference (MUAC), and/or a weight-for-height below − 3 Z-scores of the median WHO growth standards and/or presence of bilateral pitting oedema.[2]

### *Data analysis*

WAZ, HAZ and WHZ scores were computed using WHO ANTHRO software version 3.2.2. Descriptive analysis was conducted, including frequencies and percentages, using Statistical Package for Social Sciences (SPSS) version 22.

## RESULTS

The total number of under-five children in the surveyed household was 265 and all were included into the study. The mean age of mother and father of the under-five children in the surveyed district was found to be 26.8 years and 30.7 years respectively and almost all practiced Hinduism. Among the surveyed respondents' majority belonged to general category followed by scheduled castes (SC) and other backward class (OBC) (Table 2). The average monthly household income was observed to be Rs. 10537±5800.725 with a range of Rs. 1000-80000.

Breastfeeding after birth was initiated within an hour in 42.6% (n=113) children. In the first three days, 29.9% of the children were given feeds other than breast milk. These prelacteal feeds consisted of honey, infant formula, janam ghutti, sugar syrup and gripe water in the decreasing order of prevalence. Breastfeeding was done in all except 7.4% of children and exclusively breastfeeding was given to 55.4% of the children till the age of 6 months. In the past twelve months, services from anaganwadi center were availed by 54.9% (n=145) of the study participants. The services availed were immunization (59.2%), growth monitoring of under-five (11.3%), supplementary food (21.3%) and health education (8.2%).

**Table 2: Background information of the study subjects (n=265).**

| | N (%) |
|---|---|
| **Caste** | |
| Scheduled caste/ schedule tribe | 70 (26.4) |
| Other backward class | 27 (10.2) |
| General | 168 (63.4) |
| **Number of under-five children in family** | |
| One under five | 174 (65.7) |
| Two under five | 91 (34.3) |
| **Sex distribution of the under five children** | |
| Male | 149 (56.2) |
| Female | 116 (43.8) |
| **Age distribution of under five children (months)** | |
| 0-11 | 48 (18.1) |
| 12-23 | 73 (27.5) |
| 24-35 | 49 (18.5) |
| 36-47 | 67 (25.3) |
| 48-59 | 28 (10.6) |
| **Feeding practice in first 6 months** | |
| Exclusively breastfed | 147 (55.4) |
| Mixed feeding | 118 (44.5) |

**Table 3: Distribution of under-five children according to age (n=265)**

| Age (months) | N | Males N (%) | Females N (%) | Weight | Height |
|---|---|---|---|---|---|
| **0-11** | 48 | 24 (50) | 24 (50) | 6.502±3.006 | 62.40±14.139 |
| **12-23** | 73 | 46 (63) | 27 (37) | 9.189±2.993 | 76.91±14.051 |
| **24-35** | 49 | 23 (46.9) | 26 (53.1) | 10.355±2.988 | 83.43±14.440 |
| **36-47** | 67 | 40 (60.6) | 26 (39.4) | 12.41±2.996 | 89.91±14.068 |
| **48-59** | 28 | 16 (57.1) | 12 (42.9) | 13.5±2.999 | 96.29±14.079 |

**Table 4: Prevalence of undernutrition according to the conventional indices (n=265)**

| Anthropometric index | N (%) |
|---|---|
| **Stunting/ height for age Z Score (HAZ)** | |
| Normal | 147 (55.5) |
| Moderate (<-2 SD) | 51 (19.2) |
| Severe (<-3 SD) | 67 (25.3) |
| **Underweight/ weight for age z score (WAZ)** | |
| Normal | 171 (64.5) |
| Moderate (<-2 SD) | 56 (21.1) |
| Severe (<-3 SD) | 38 (14.3) |
| **Wasting/ weight for height z score (WHZ)** | |
| Normal | 194 (73.6) |
| Moderate (<-2 SD) | 40 (15.1) |
| Severe (<-3 SD) | 30 (11.3) |
| **Mid-upper arm circumference (MUAC)*** | |
| Normal | 202 (76.2) |
| Borderline | 47 (17.7) |
| Severe | 16 (6) |

* n=242 (MUAC is considered for children 6 months and above).

**Table 5: Prevalence of undernutrition among under five children based on composite index of anthropometric failure.**

| Parameter | Number of children (%) |
|---|---|
| **Group A (No failure)** | 105 (39.6) |
| **Group B (Wasting only)** | 14 (5.3) |
| **Group C (Wasting and underweight)** | 26 (9.8) |
| **Group D (Wasting, stunting and underweight)** | 30 (11.3) |
| **Group E (Stunting and underweight)** | 36 (13.6) |
| **Group F (Stunting only)** | 49 (18.5) |
| **Group Y (Underweight only)** | 5 (1.9) |

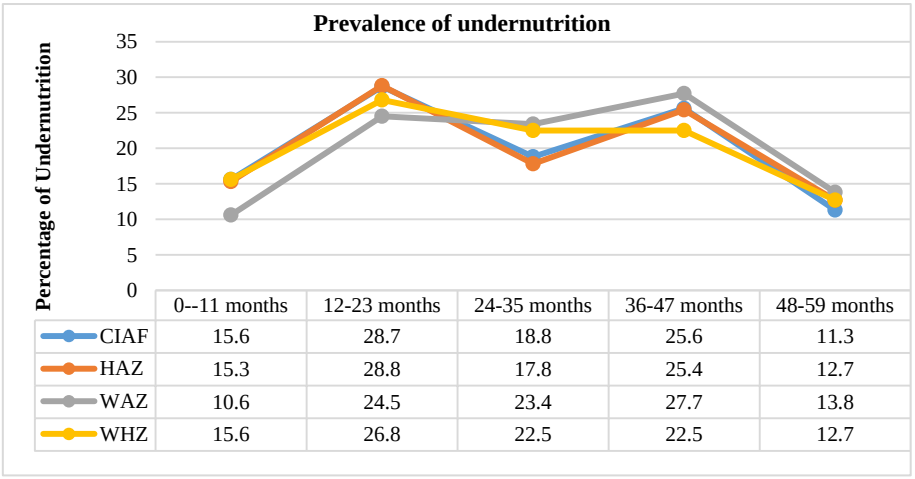
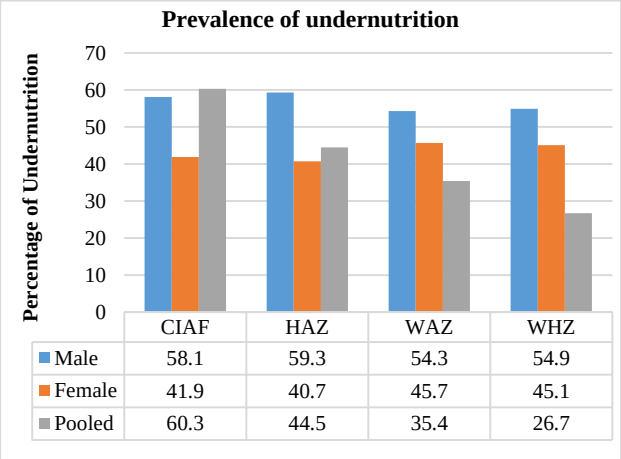



**Figure 1: Age wise distribution of undernutrition as measured by different indices.**

It was observed that with increasing age the mean weight and height increased (Table 3). The assessment of nutritional status of children according to different anthropometric indices is depicted in Table 4. The prevalence of stunting and wasting was maximum in children aged 12-23 months (HAZ= 28.8% and WHZ= 26.8%) and higher in male under five. Underweight was also observed to be more in male under five children and the overall prevalence was highest in the age group of 36-47 months (27.7%) followed by 12-23 months (26.8%).

Among studied under-fives, 60.4% (n=160) children had some form of anthropometric failure (Table 5). Nearly one-fifth of the children i.e. 49 (18.5%) belonged to

group F with stunting only and 30 (11.3%) children were wasted, stunted and underweight (Group D). A total of 68 (25.7%) children in the study had single anthropometric failure (Group B, F, and Y), whereas 92 (34.7%) children had multiple anthropometric failures (Group C, D, and E). Figure 1 and 2 illustrate the distribution of undernutrition measured by different indices in different age groups and sex respectively.




| | CIAF | HAZ | WAZ | WHZ |
|---|---|---|---|---|
| Male | 58.1 | 59.3 | 54.3 | 54.9 |
| Female | 41.9 | 40.7 | 45.7 | 45.1 |
| Pooled | 60.3 | 44.5 | 35.4 | 26.7 |

**Figure 2: Distribution of undernutrtion as measured by different indices.**

## DISCUSSION

The present study was conducted in Kirari Suleman Nagar, census town in Northwest district of Delhi. The principal focus of the study was to assess the magnitude of undernutrition in under-five children using z-score and CIAF. As per WHO Z-score, stunting (44.5%) was the most prevalent form of undernutrition followed by underweight (35.4%) and wasting (26.4%) in the study area. Similarly, NHFS-4 report for Northwest District of Delhi represents a higher prevalence of stunting (38.5%) compared to underweight (32.6%) and wasting (19.9%).[5] The rates were consistent with other studies.[8-10]

Nutrition in the first 1000 days of life is known to have influence on future growth and development of children. During the period of complementary feeding, children are at high risk of undernutrition.[11] This study found although the prevalence of breastfeeding was high (92.6%), but exclusive breast feeding was done by half of the mothers only, which suggest a lack of knowledge regarding the benefits and importance of exclusive breastfeeding. The maximum proportion of undernourished children were in the age group of 13-24 months. This is suggestive of the fact that premature cessation or low frequency of breastfeeding contributes to insufficient nutrient and energy intake in infants beyond 6 months of age. Also, complementary feed of inadequate nutritional quality, or given too early or too late, in too small amounts, or not frequently enough leads to undernutrition.

Children were also assessed for anthropometric failure using CIAF, which permits us disaggregation of the undernourished children in to different subgroups for further analyses. According to CIAF, it was observed that around two third of the children were suffering from one or more anthropometric failure. The result was in coherence with studies conducted in similar settings.[12,13] Currently, under Integrated Child Development Services (ICDS) at anganwadi centres classification of undernutrition is based on weight-for-age (underweight). In such scenario, using underweight as sole criteria we will be able to identify only half of the undernourished children (Group C, D, E and Y) and miss out the other half (Group B and F). Similarly, stunting will not be able to record the undernourished children in group B, C and Y (16.9%) and wasting miss out those in group E, F and Y (33.9%). Therefore, not using a composite index of anthropometric failure leads to under representation of undernutrition.

## CONCLUSION

Nearly two thirds of the children were in the zone of malnutrition by anthropometric failure. Findings from the current study suggest that the conventional measures of undernutrition may be missing out a considerable proportion of undernourished children present in the population. Underestimating this proportion might prevent undernourished children from receiving the benefit of the extra supplementation they deserve. It has shown that an alternative indicator can be constructed to provide a single aggregated figure of the number of undernourished children in a population. It must be emphasized, however, that conventional indices reflect distinct biological processes and cannot be disregarded, but this issue has been addressed with the CIAF indicators and merits further consideration as a policy and monitoring tool for planning purposes. CIAF can be used in place of the weight for age measure currently being used under ICDS scheme to assess the true level of undernutrition among under five children.

The study also clearly emphasizes to optimize efforts in prevention and management of undernutrition on domiciliary basis. It calls for encouraging, strengthening and raising awareness amongst the care giver regarding importance of nutrition of the under five children. There is an urgent need for mobilization of the community to avail the services offered by AWC under Integrated Child Development Scheme (ICDS) to meet the basic nutritional needs of the under-five children and the mother. In this regard, MAMTA has initiated a holistic assessment and optimum community education intervention in view of the public health importance of nutrition in the community. Applying these measures sincerely and continuously will improve the health of children and fight malnutrition in the community.

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