

Original Article

MEASURING UNDERNUTRITION THROUGH Z-SCORES AND COMPOSITE INDEX OF ANTHROPOMETRIC FAILURE (CIAF): A STUDY AMONG SLUM CHILDREN IN AHMEDABAD CITY, GUJARAT

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ABSTRACT

Background: Undernutrition continues to be underlying cause of morbidity and premature mortality among children in India. The primary goal of our study was to investigate the prevalence of child undernutrition and applying Svedberg theory to construct Composite Index of Anthropometric Failure (CIAF)

Methods: We used cross-sectional anthropometric data for 372 child-mother pairs which were selected using two stage sampling. Anthropometric measurements was used to determine if children were low weight for age (underweight), low height for age (stunting) and low weight for height (wasting) based on WHO child growth standards and later used for construction of CIAF. Epi Info 7 and Anthro software used to calculate Z-scores and statistical analysis.

Results: Based on CIAF, the prevalence of undernutrition was 60.5%. Of the children included in the study, 42.7% found to be underweight, 15% being found to have wasting and 50% showing sign of stunting. Using underweight as the only criterion for identifying undernourished children may underestimate the true prevalence by as much as 17.5%.

Conclusion: Undernutrition still an important public health problem in this region. Use of WHO Z-score system recommended for identifying all aspects of undernutrition

Keywords: Malnutrition, Yong children, CIAF, Anthropometry

INTRODUCTION

Undernutrition contributed to more than thirty three percent of all child deaths, in spite of this it is rarely listed as the direct cause. Many factors contributing to undernutrition ranges from access to highly nutritious foods especially present context of rising food prices to poor feeding practices such as inadequate and not exclusive breastfeeding, offering the wrong foods, poor weaning practices and not ensuring that the child gets enough nutritious food¹. Moreover, child undernutrition is an important indicator of

the Millennium Development Goals (MDG) set between 1990 and 2015, which aim to halve the proportion of people who suffer from hunger². One in every three malnourished children in the world lives in India. At present in India 43% under five years children underweight, 20% have wasting and 48% have stunting³. Reported by Government of Gujarat prevalence of underweight in Gujarat is 38.7 per cent with 4.6% severely malnourished children⁴

Undernutrition in young children is conventionally determined through height and weight. The

most commonly used indices are derived from these measurements are low weight for age (underweight), low height for age (stunting) and low weight for height (wasting). These indices reflect distinct biological processes, and their use is necessary for determining appropriate interventions⁵. However, because they overlap none is able to provide comprehensive estimate of the number of undernourished children in a community. It might be possible, some children who are underweight will also have wasting and/or be stunted; some children who are stunted will also have wasting and/or be underweight; some children who have wasting will also be stunted and/or underweight

Economist Peter Svedberg argues that conventional indices are not sufficient for measuring the overall prevalence of undernutrition among children⁶. Being underweight is the interaction of stunting and wasting and not the sum, it misses some children who are considered undernourished by the other indices, thus producing an underestimate. Svedberg suggests that if children with stunting, wasting or underweight are all considered undernourished or to be in state of 'anthropometric failure'. A new indicator needed that incorporates all three indices -be they wasted and/or stunted and/or underweight therefore introduce a Composite Index of Anthropometric Failure (CIAF).

Svedberg's model identifies six groups of children. These groups include children whose height and weight above the age specific norm (above -2 z-scores) and also children whose height and weight for their age below the norm and thus experiencing one or more forms of anthropometric failure. The anthropometric subgroups are as follows: A- no failure, B-wasting only, C-wasting and underweight, D- wasting, stunting and underweight, E- stunting and underweight, F-stunting only and Y- underweight only. It therefore provides a single measure with which to estimate the overall prevalence of undernutrition.

The primary goal of our study was to investigate the prevalence of child undernutrition, applying Svedberg theory to construct CIAF and identifying distinct subgroups and comparing with conventional indices

METHODS

This study was a cross-sectional descriptive survey that was conducted using structured ques-

tionnaire and measurements of weight and length/height to determine the nutritional status of under five years children.

Prior to conducting sampling, the required sample size was calculated using the formula $[(1.96)^2 p (1-p)]/L^2$ where p represents estimated proportion which was taken as 40% with absolute precision of 5%. The results of this calculation indicated that the minimum sample size required was approximately 369. Therefore this study enrolled a total of 372 children under the age of five along with their mothers. Considering non-response additional list of participates was kept ready and utilized in case of unwillingness or absence of the participants

This study was conducted in slum areas of Ahmedabad city and mother-child pairs were selected using two stage sampling design. Details about slum areas, households and maps are available with Ahmedabad Municipal Corporation. This information utilized in selecting households and later mother-child pair. The city is comprised in five zones namely east, west, north, south and central for administrative purposes so in first stage of sampling two slum areas were selected from each zone (stratum) at random. This resulted in a total of 10 slum areas being selected. During the second stage, a total of 35-40 children were systemically sampled from each slum selected during the first stage. Before the survey, informed consent was first obtained from the mother or caregiver of children. Then, a face-to-face interview was conducted with a family questionnaire to collect the child's information and socio-demographic characteristics. The study protocol was approved by the institutional ethics committee of the Pramukhswami Medical College.

Measurements were performed according to standard procedure of the WHO⁷. Weight was measured with accuracy of 100 gm using a Salter weighing machine. The length of children under 2 years was obtained by a portable infantometer with accuracy of 0.1 cm placed on flat surface. The height of children over 2 years was measured by using a non-stretchable tape fixed to a vertical wall, with the participant standing on a firm/level surface with accuracy of 0.1 cm. Each measurement was done twice, and the mean of the two readings was recorded

Anthropometric indicators were constructed using data on children's age, weight and height. Three key anthropometric measures calculated from these measurements, were weight for age,

height for age and weight for height. These indices compared against 'WHO child growth standards 2006' by using WHO Anthro software (version 3.2.2). Children whose measurements fall below -2 z-scores of the reference population median are considered undernourished. Those children with measurements below -3 z-scores are considered to be severely malnourished. Data were analyzed using Epi Info 7 for Windows (CDC, Atlanta, USA) software. Chi-square test or Fisher's exact test was utilized to compare frequencies or proportions with $\alpha = 0.05$ as the critical level

RESULTS

All the study populations were Hindus by religion residing in urban areas. Of the 372 children included in the study 196 (52.7%) were boys and 176 (47.3%) were girls. The mean (\pm SD) age of the children was 30.7 months (\pm 16.2). About

35.2% study population living in nuclear families. 27.7 % of children's mother had no education, while 35.8% had a primary education and about 7% studied upto higher-secondary and above. The number of family members ranged from 2 to 13 (mean 6.3 ± 2.4) and average number of children in family was 1.8 ± 1.3 . The mothers' age at the time the child was born ranged from 19 to 40 years (mean 26.7 ± 4.54).

Table 1 shows the nutritional status of children under five years. The prevalence of underweight, wasting and stunting were high with 42.7% found to be underweight, 15% being found to have wasting and 50% showing sign of stunting. The highest proportion of underweight children (53.5%) was observed in 36-47 months and the highest proportion of stunting (63.4%) was observed in 24-35 months while the highest proportion of wasting (17.8%) was observed in children 12-23 months age group.

Table 1 : The prevalence rate of underweight, wasting and stunting by age groups and sex among children under five years of age (n=372)

Characteristics	Children	Malnut ration					
		Underweight		Wasting		Stunting	
		% < -2SD*	% < -3SD	% < -2SD	% < -3SD	% < -2SD	% < -3SD
Age groups							
06-11	65	17 (26.4)	5 (7.7)	5 (7.7)	2 (3.0)	24 (37.0)	13 (20.0)
12-23	73	27 (37.0)	10 (13.7)	13 (17.8)	2 (2.7)	30 (41.1)	20 (27.4)
24-35	82	36 (43.9)	9 (11)	14 (17.1)	3 (3.7)	52 (63.4)	25 (30.5)
36-47	86	46 (53.5)	15 (17.4)	14 (16.3)	3 (3.5)	48 (55.8)	21 (24.4)
48-60	66	33 (50.0)	9 (13.6)	10 (15.2)	1 (1.5)	32 (48.5)	11 (16.7)
		X ² =15.13, p=0.057		X ² =5.05, p=0.752		X ² =20.33, p=0.00	
Sex							
Girls	176	75 (42.6)	27 (15.3)	26 (14.8)	6 (3.4)	87 (49.4)	45 (25.6)
Boys	196	84 (42.9)	21 (10.7)	30 (15.3)	5 (2.6)	99 (50.5)	45 (15.6)
		X ² =2.28, p=0.320		X ² =0.38, p=0.826		X ² =0.77, p=0.680	

* %<-2SD includes %<-3SD, below 2SD indicates undernutrition and below 3SD indicates severe undernutrition

Table 2 : Subgroups of anthropometric failure

Group	No. of Children (%)
A (no failure)	147 (39.5)
B (wasting only)	8 (2.2)
C (wasting and underweight)	21 (5.7)
D (wasting, stunting and underweight)	27 (7.3)
E (stunting and underweight)	101 (27.2)
F (stunting only)	58 (15.6)
Y** (underweight only)	10 (2.7)
Total	372

**subgroup Y as suggested by Nandy S et al⁸

The lowest proportion of underweight, wasting and stunting were observed in 0-11 months age group. Across the age categories results were statistically significant for height-for-age (p<0.001). The differences between boys and girls were not statistically significant

Table 2 presents the prevalence of child undernutrition based on different classifications of CIAF. Of the six subgroups with undernourished children, group E (containing children who are stunted and underweight) was the largest (27.1%) followed by 'stunting only' (15.6%). Children who are simultaneously have of underweight, wasting and stunting (those in group D) accounts for 7.3% children in the sample.

Table 3. Presents the prevalence of child under-nutrition based on different child and mother's characteristics. Childhood malnutrition worsened with increasing age of children. Children in the younger age group 0-23 months had a significantly lower rate of undernutrition. Across chil-

dren's age categories differences in the prevalence of all categories of CIAF were statistically significant ($p < 0.05$). The differences were also observed across the categories of mothers' age, birth order and number of siblings but results were not statistically significant.

Table 3: Prevalence of undernutrition among children under five years of age based on the different classification across baseline characteristics

Characteristics	CIAF	No failure	Wasting only	Wasting and Underweight	Wasting, Stunting & Underweight	Underweight and Stunting	Stunting only	Underweight only
	A	B	C	D	E	F	Y	
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Age groups								
0-11	29 (44.6)	36 (55.4)	1 (1.5)	3 (4.6)	1 (1.5)	12 (18.5)	11 (16.9)	1 (1.5)
12-23	36 (49.3)	37 (50.7)	2 (2.7)	4 (5.5)	7 (9.6)	16 (21.9)	7 (9.6)	0
24-35	60 (73.2)	22 (26.8)	2 (2.4)	5 (6.1)	7 (8.5)	23 (28.0)	22 (26.8)	1 (1.2)
36-47	58 (67.4)	28 (32.6)	2 (2.3)	3 (3.5)	9 (10.5)	29 (33.7)	10 (11.6)	5 (5.8)
48-60	42 (63.6)	24 (36.4)	1 (1.5)	6 (9.1)	3 (4.5)	21 (31.8)	8 (12.1)	3 (4.5)
Gender								
Girl	104 (59.1)	72 (40.9)	5 (2.8)	8 (4.5)	13 (7.4)	50 (28.4)	24 (13.6)	4 (2.3)
Boy	121 (61.7)	75 (38.3)	3 (1.5)	13 (6.6)	14 (7.1)	51 (26.0)	34 (17.3)	6 (3.1)
Mothers' age								
≤ 20	58 (59.2)	40 (40.8)	2 (2.0)	3 (3.1)	8 (8.2)	27 (27.6)	16 (16.3)	2 (2.0)
> 20-29	99 (60.0)	66 (40.0)	3 (1.8)	9 (5.5)	12 (7.3)	42 (25.5)	27 (16.4)	6 (3.6)
≥ 30	68 (62.4)	41 (37.6)	3 (2.8)	9 (8.3)	7 (6.4)	32 (29.4)	15 (13.8)	2 (1.8)
Birth order								
1	78 (60.0)	52 (40.0)	5 (3.8)	4 (3.1)	11 (8.5)	30 (23.1)	22 (16.9)	6 (4.6)
2	73 (57.9)	53 (42.1)	0	7 (5.6)	9 (7.1)	36 (28.6)	18 (14.3)	3 (2.4)
≥ 3	74 (63.8)	42 (36.2)	3 (2.6)	10 (8.6)	7 (6.0)	35 (30.2)	18 (15.5)	1 (0.9)
No. of Siblings								
0	41 (66.1)	21 (33.9)	2 (3.2)	3 (4.8)	4 (6.5)	21 (33.9)	10 (16.1)	1 (1.6)
1	48 (48.5)	51 (51.5)	1 (1.0)	4 (4.0)	8 (8.1)	18 (18.2)	15 (15.2)	2 (2.0)
2	74 (68.5)	34 (31.5)	2 (1.9)	8 (7.4)	10 (9.3)	31 (28.7)	19 (17.6)	4 (3.7)
≥ 3	62 (60.2)	41 (39.8)	3 (2.9)	6 (5.8)	5 (4.9)	31 (30.1)	14 (13.6)	3 (2.9)
Mothers' education level								
Illiterate	72 (69.9)	31 (30.1)	2 (1.9)	6 (5.8)	8 (7.8)	39 (37.9)	14 (13.6)	3 (2.9)
Primary	79 (59.4)	54 (40.6)	3 (2.3)	8 (6.0)	13 (9.8)	31 (23.3)	22 (16.5)	2 (1.5)
Secondary	59 (53.6)	51 (46.4)	2 (1.8)	4 (3.6)	5 (4.5)	27 (24.5)	17 (15.5)	4 (3.6)
HS & above	15 (57.7)	11 (42.3)	1 (3.8)	3 (11.5)	1 (3.8)	4 (15.4)	5 (19.2)	1 (3.8)

HS=Higher secondary

DISCUSSION

Results showed that the prevalence of stunting as past or chronic malnutrition was 50% while underweight and wasting as acute malnutrition were 42.7% and 15% respectively. These rates were almost in consistent with other studies. The National Family Health survey (NFHS)-3 showed that at national level the rates of under-nutrition for children younger than five years of age were 43% for underweight, 48% for stunting and 20% for wasting and the corresponding values for Gujarat were 47%, 42% and 17%⁹. Currently classification based on weight-

for-age is followed in the anganwadi centers' throughout the country under the Integrated Child Development Services (ICDS) and as revealed by Table. 2 this system fails to identify 17.8% of undernourished children.

The results of this study indicated that a gender differences in childhood nutrition not observed. The risk of undernutrition increases with age. Children in the youngest age group (0-11 months) had a significantly lower risk of being undernourished. This low risk may be due to the protective effect of breastfeeding. Results also indicated that highest risk of stunting was

among children 24-35 months age group. These high rates are linked to inappropriate food supplementation during the weaning period and thereafter along with stopping breastfeeding.

Children were also assessed for anthropometric failure using CIAF, which permits us disaggregation of the undernourished children in to different subgroups for further analyses. In Table 2 we see overall only 39.5% of the children were anthropometrically normal. 60.5% of the children were sufferings from one or other form of anthropometric failure. By using low weight for age (underweight) as the sole criterion for undernutrition we can identify 42.9% children from subgroups C, D, E and Y, but will be missing those in subgroups B and F- children who were stunted and wasted but not underweight in the present study and therefore 17.8 % such children would be missed out as not undernourished similarly stunting misses groups B, C and Y(10.6% of children); and wasting misses those children in groups E, F and Y (45.5% of children). It demonstrates that large number of undernourished children not identified by using current methods. It might also be noted that underweight may be exaggerating the magnitude of change while comparing the rate of underweight over the years¹⁰.

Our analysis also showed that family and maternal factors were associated with the children's nutritional status. The lowest rate of undernourishment was found in the children who had only one sibling this may be due to better care given by the experienced mother. Birth order three or more associated with higher rate of malnutrition this was possibly observed due to close and frequent pregnancies with large family size. More number of children found to be undernourished in older mothers (>30 years). This was due to increased likelihood of giving birth to babies with low birth weight. Undernutrition was further found to have an inverse relationship with educational status of mother. Previous studies showed that literate mothers had adequate health knowledge, lower fertility, better care and full use of available health care services for the child¹¹

We should point to potential limitations of this study. First, due to the cross sectional design of this study, the causal relationship between undernutrition and mother-child characteristics cannot be established. Second the observed differences may be subject to many unobserved confounding factors like information on chil-

dren's diet and mothers' nutritional status were not available. Another limitation is that population size was small for detecting events and therefore there may be an overestimation of strengths. This may be taken in account while interpreting results.

However, this study has still provided the most updated information on childhood undernutrition and filled a gap in knowledge of this geographical region.

CONCLUSIONS

Only 39.5% of the children were anthropometrically normal. This is a serious problem at any scale. Current estimates of child undernutrition underestimate the extent of the problem by using only underweight as the sole criteria to classify as undernourished. In this paper shown that Composite Index of Anthropometric Failure (CIAF) can be constructed to provide a single aggregated figure of the number of undernourished children in community. This information will be valuable for clinicians, health care workers, planners or policy makers who need to responds differently to different forms of undernutrition.

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