Prevalence of Under-Nutrition Measured by Composite Index of Anthropometric Failure (CIAF) Among the Bhumij Children of Northern Odisha, India

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Abstract

Introduction: Under-nutrition continues to be a serious health problem among the children in India. In view of the paucity of recent attempts to classify under-nourished children satisfactorily the Composite Index of Anthropometric Failure (CIAF) has been implemented to measure the seriousness and severity of overall under-nutrition in a population. However, there exists scanty information of the prevalence of under-nutrition among the tribal children of Odisha and India. Therefore the objective of the present study is to evaluate the overall prevalence of under-nutrition among the Bhumij children of Northern Odisha, India. **Materials and Methods**: A total of 136 Bhumij children aged 1 to 6 years (69 boys and 67 girls) were measured. Children were considered as underweight, stunting and wasting if their weight-for-age, height-for-age and weight-for-height Z-scores below -2.0 SD of the National Center for Health Statistics (NCHS) reference data. Severe under-nutrition was assessed as Z-score below -3.0 SD. **Results**: The overall age and sex combined prevalence of stunting, underweight and wasting recorded was 32.4%, 42.6% and 25% respectively, and these rates were considered as high (30-39%), very high (≥30%) and also very high (≥15%), respectively. CIAF showed a higher prevalence of under-nutrition (54.4%) i.e., children suffering from anthropometric failure, in comparison to other three conventional indicators (stunting, underweight and wasting). **Conclusions**: Therefore various nutritional intervention programs can be formulated to improve the nutritional status of the children. It was established herein that CIAF is a better indicator of nutritional status than traditional measures of stunting, underweight and wasting because it differentiates overall and total anthropometric failure.

Key words: India, Stunting, tribe, under-nutrition, underweight, wasting, Z –Score.

Introduction

Under-nutrition among children is a serious public health problem internationally, especially in developing countries[1,2,3]. In India

one half of the children under the age of five years are moderately or severely malnourished, 30% of newborn children are significantly underweight and nearly 60% of women are anemic[4]. During pre-school age period, children have special nutritional needs because of their extensive growth and development[5,6]. Malnutrition makes a child susceptible to infections and delays recovery, thus increasing mortality and morbidity[7].

In the last five decades, mortality rates have come down by 50% and the fertility rate by 40% but reduction in under-nutrition is only 20%. In spite of the relatively slow reduction in child under-nutrition in India, the country can still accelerate the rate of reduction in childhood under-nutrition and under five mortality rate by ensuing early detection and effective management of both under-nutrition and infections.

Child growth is the universalized tool to assess adequate nutrition, health and development of individual children, and to estimate overall nutritional status and health of populations. Compared to other health assessment tools, measuring child growth is a relatively inexpensive, easy to perform and non-invasive process[5,6,8].

Three most commonly used internationally recommended indicators are stunting (low height-for-age), underweight (low weight-for-age) and wasting (low weight-for-height)[5,6].

It has been stated by the development economist Peter Svedberg that conventional indices are not sufficient for measuring the overall prevalence of under-nutrition among young children[9]. He further suggested that if children with wasting, stunting or who are underweight are all considered as undernourished, or to be in a state of “anthropometric failure”, a new aggregate indicator is needed, one that incorporates all undernourished children, by their wasted and/or stunted and/or underweight and proposed the construction of a -CIAF. The Composite index of anthropometric failure (CIAF) incorporates all undernourished children in a single category and highlights the severity of a population’s overall undernutrition more precisely than the three individual conventional measures. The CIAF has been used and validated by two previous Indian studies[11,12].

The present study focuses on the CIAF assessment to estimate the overall prevalence of undernutrition among the Bhumij children of Northern Odisha.

Materials & Methods

The present study was a cross-sectional study conducted in three villages of Remuna and Nilgiri Blocks of Baleswar District, Northern Odisha, India. The study was carried out from November 2012 to February 2013. A total of 136 preschool children aged 1-6 years (69 boys; 67 girls) were assessed. Data was collected after obtaining necessary approval from the parents, villages and the block authorities. Parents were informed about objectives of the present study and their consent was obtained.

Information on age, gender, weight and height was collected on a structured pre-tested schedule by house to house visit following the interview method and examination. Anthropometric measurements were taken on each subject following the standard techniques[12]. Technical errors of measurement were found to be within reference values[13]. Children were considered as underweight, stunting and wasting if their weight-for-age, height-for-age and weight-for-height Z-scores below -2.0 SD of the National Center for Health Statistics (NCHS) reference data[14]. Severe under-nutrition was assessed as Z-score below -3.0 SD. Thus three commonly used under-nutrition indicators, i.e. stunting (low height-for-age), underweight (low weight-for-age) and wasting (low height-for-age) were used to evaluate the nutritional status of the subjects and CIAF for the total children. The WHO classification was also followed for assessing severity in malnutrition by rate prevalence ranges of these three indicators among children[5]. The classification is shown in table-I. Student’s t-test was undertaken to test for sex differences in means of height and weight. Statistical significance was set at $p<0.05$.

After calculating different Z scores the values were then compared to the international cut offs by WHO and number of wasted (WHZ <-2SD), underweight (WAZ<-2SD) and stunted (HAZ<-2SD) students were assessed. The children on the basis of the z-score were then categorized as per the subgroups of Svedberg’s model in order to arrive at the CIAF to get the overall prevalence of under nutrition (WHO[10]).The z-score for different nutritional indices were calculated in reference to WHO international guidelines and the prevalence of underweight, stunting and wasting were calculated at cut-off level < 2SD or Z - score < -2 (WHO[10]). For assessing CIAF, Svedberg’s model was used.

For assessing the CIAF, Svedbergs model of six groups of children was used[9]. These groups include children with height and weight appropriate for their

age (i.e. who are not in anthropometric failure) and also children height and weight for their age are below the norm and thus are experiencing one or more forms of anthropometric failure[15]. These groups are defined in table-2.

The CIAF excludes those children not in anthropometric failure (i.e. group A) and includes all children who have wasting, stunting, or underweight (i.e. group B to F). It therefore provides a single measure to estimate the overall prevalence of under-nutrition. Svedberg originally suggested six sub-groups of anthropometric failure (A to F). However Nandy identified an additional subgroup: one that includes children who are only underweight but are not stunted or wasted (Group –Y)[15]. Thus, table-2 represents the classification of children with anthropometric failure (CIAF). Another theoretical combination would be "wasted and stunted" but this is physically not possible since a child cannot simultaneously experience stunting and wasting and not being underweight[15].

The current study uses the Z-score system and the Composite Index of Anthropometric Failure (CIAF) to estimate the magnitude of under-nutrition among 1-6 years Bhumij pre-school children of Northern Odisha, India.

Results

The mean height and weight of the children are presented in Table-3. There was a significant sex & age difference in all parameters, i.e. height and weight (p<0.05). It was observed that boys were heavier and taller than girls at all ages.

Table 4 presents the rates of stunting, wasting and underweight among the Bhumij pre-school children. The overall age and sex combined prevalence of stunting, underweight and wasting were 32.4%, 42.6% and 25% respectively (Fig-2). These rates were high (30-39%), very high (≥30%) and also very high (≥15%), respectively, according to WHO classification of under-nutrition severity (Table-1)[5]. Moreover, maximum prevalence of under-nutrition (underweight, stunting and wasted) was observed among the girls at the age of 2 years, 3 years and 5 years girls respectively (age and sex specific) (Fig-1). There were no significant sex differences except at the age of 1 year, 4 years and 5 years in underweight & stunting only (p<0.05). Significant age difference was observed among boys in underweight (p<0.05) only. In the present study, the rate of stunting and underweight shows more or less the same prevalence as compared to UNICEF[16].

Table 5 represents the proportions of children in each of the subgroups. Out of each subgroups (B-Y) with undernourished children, group D children who simultaneously had wasting, stunting & underweight was the highest (16.2%). Children who are only wasted (Group B), only stunted (Group F) or only underweight (Group Y) showed lower prevalence of under-nutrition. Children who are stunted as well as underweight (Group E) accounted for 15.4% and children who are wasting and underweight accounted for 7.4%. Thus, CIAF showed a higher prevalence of under-nutrition (54.4%) i.e., children suffering from anthropometric failure, in comparison to other three conventional indicators (stunting, underweight & wasting).

Table 1A: Classification assessment for severity of malnutrition by percentage prevalence ranges (WHO, 1995)

Classification	Low (%)	Medium (%)	High (%)	Very High (%)
Underweight	<10	10-19	20-29	≥30
Stunting	<20	20-29	30-39	≥40
Wasting	<5	5-9	10-14	≥15

Assessment of nutritional status.

Z-scores was calculated following the standard formula:

Z-score= (X-Median of NCHS)/Standard deviation of NCHS

Table 1B: Anthropometric Indices and Cut-off Points for Children to Assess the Severity of Malnutrition (According to WHO, 2006)

Indicator	Meaning	Cut-off Point
Wasting	Low Weight for Height (WHZ)	<— 2SD
Underweight	Low Weight for Age (WAZ)	<— 2SD
Stunting	Low Height for Age (HAZ)	<— 2SD

Table 2: Classification of children for the assessment of anthropometric failure (CIAF) according to Nandy et al. (2005).

Group name	Description	Wasting	Stunting	Underweight
A	No failure	No	No	No
B	Wasting only	Yes	No	No
C	Wasting & Underweight	Yes	No	Yes
D	Wasting, Stunting & Underweight	Yes	Yes	Yes
E	Stunting & Underweight	No	Yes	Yes
F	Stunting only	No	Yes	No
Y	Underweight only	No	No	Yes

Table 3: Mean (SD) height and weight of the preschool Bhumij children aged 1-6 years.

Age (years)	Boys (n-69)			Girls (n-67)		
	n	Height (cm)	Weight (Kg)	n	Height (cm)	Weight (Kg)
1	10	71.34 (4.01)	8.9 (1.30)	7	70.84 (4.23)	8.6 (1.21)
2	13	83.86 (4.27)*	10.2 (1.43)	14	82.16 (4.46)	9.8 (1.46)
3	14	90.97 (4.63)	12.7 (1.61)	11	90.31 (4.28)	12.2 (1.37)
4	12	98.10 (4.37)	14.5 (1.58)*	8	97.92 (4.83)	13.6 (1.50)
5	9	106.81 (4.06)*	16.8 (1.47)	15	105.25 (4.60)	16.4 (1.87)
6	11	112.73 (4.86)	19.6 (1.72)	12	112.48 (4.54)	19.2 (1.76)

Figures in parentheses are standard deviations.

*p<0.05 significant sex and age differences

Table 4: Prevalence of under-nutrition among the Bhumij children aged (1-6 years)

Category	Age in years												Overall (Age & sex combined) N-136
	1		2		3		4		5		6		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
	n-10	n-7	n-13	n-14	n-14	n-11	n-12	n-8	n-9	n-15	n-11	n-12	
Underweight	5*(50.0)	2*(28.6)	5(38.5)	6(42.9)	6(42.9)	5(45.5)	5*(41.7)	5*(62.5)	5*(55.6)	4*(26.7)	5(45.5)	5(41.7)	58(42.6)
Stunting	3*(30.0)	3*(42.9)	4(30.8)	5(35.7)	4(23.6)	4(36.7)	5*(41.7)	2*(25.0)	2*(22.2)	6*(40.0)	3(27.2)	3(25.0)	44(32.4)
Wasting	2(20.0)	2(28.6)	4(30.8)	3(21.4)	4(28.6)	2(18.1)	2(16.7)	1(12.5)	2(22.2)	5(33.3)	3(27.2)	4(33.3)	34(25.0)

Figures in parentheses are percentages

* Significant sex differences at p<0.05

Table 5: Subgroups of anthropometric failure among the studied children.

Group	Age in years												Overall (age & sex combined)
	1 year		2 year		3 year		4 year		5 year		6 year		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
	n-10	n-7	n-13	n-14	n-14	n-11	n-12	n-8	n-9	n-15	n-11	n-12	N-136
A (No Failure)	5(50.0)	3(42.9)	7(53.8)	6(42.9)	5(35.7)	6(54.5)	4(33.3)	3(37.5)	4(44.4)	8(53.3)	5(45.5)	6(50.0)	62(45.6)
B (Wasting only)	-	-	1(7.7)	1(7.1)	2(14.3)	-	2(16.7)	-	-	-	1(9.1)	-	7(5.1)
C (Wasting & Underweight)	1(10.0)	1(14.3)	1(15.4)	-	2(14.3)	1(9.1)	-	1(12.5)	-	2(13.3)	-	1(8.3)	10(7.4)
D (Wasting, stunting and underweight)	1(10.0)	1(14.3)	2(15.4)	3(21.4)	1(7.1)	2(18.2)	4(33.3)	1(12.5)	1(11.1)	1(6.7)	3(27.3)	2(16.7)	22(16.2)
E (Stunting & underweight)	2(20.0)	-	2(15.4)	3(21.4)	3(21.4)	2(18.2)	1(8.3)	1(12.5)	2(22.2)	3(20.0)	2(18.2)	-	21(15.4)
F (Stunting only)	-	2(28.6)	-	1(7.1)	1(7.1)	-	1(8.3)	-	-	1(6.7)	-	1(8.3)	7(5.1)
Y (Underweight only)	1(10.0)	-	-	-	-	-	-	2(25.0)	2(22.2)	-	-	2(16.7)	7(5.1)
CIAF	5(50.0)	4(57.1)	6(46.2)	8(57.1)	9(64.3)	5(45.5)	8(66.6)	5(62.5)	5(55.6)	7(46.7)	6(54.5)	6(50.0)	74(54.4)

Group A indicates normal (No anthropometric failure); N=A+CIAF = Composite Index of Anthropometric Failure

Figures in parentheses are percentages

Table 6: Prevalence of CIAF in Pre-school children: A comparison with other studies from India.

S. No	Sample Size (n)	Study area	CIAF(%)	Source
1	NFHS-2 (98/99)	National Average	59.8	Nandy, 2005
2	-	Coimbature, Tamil Nadu	68.6	Seetharaman et al (2007)
3	2016	Chapra, Nadia, WB	60.4	Biswas et al (2009)
4	347	Purulia, WB	66.3	Das & Bose (2009)
5	-	Arambagh, Hoogly, WB	73.1	Mandal & Bose (2009)
6	188	Bankura, WB	69.1	Mukhopadhyay & Biswas (2011)
7	438	Kashmir, India	25.58	Fazili et al (2012)
8	225	Purba Medinipur, WB	50.2	Acharya et al (2013)
9	136	Balasore, Odisha	54.4	Present Study

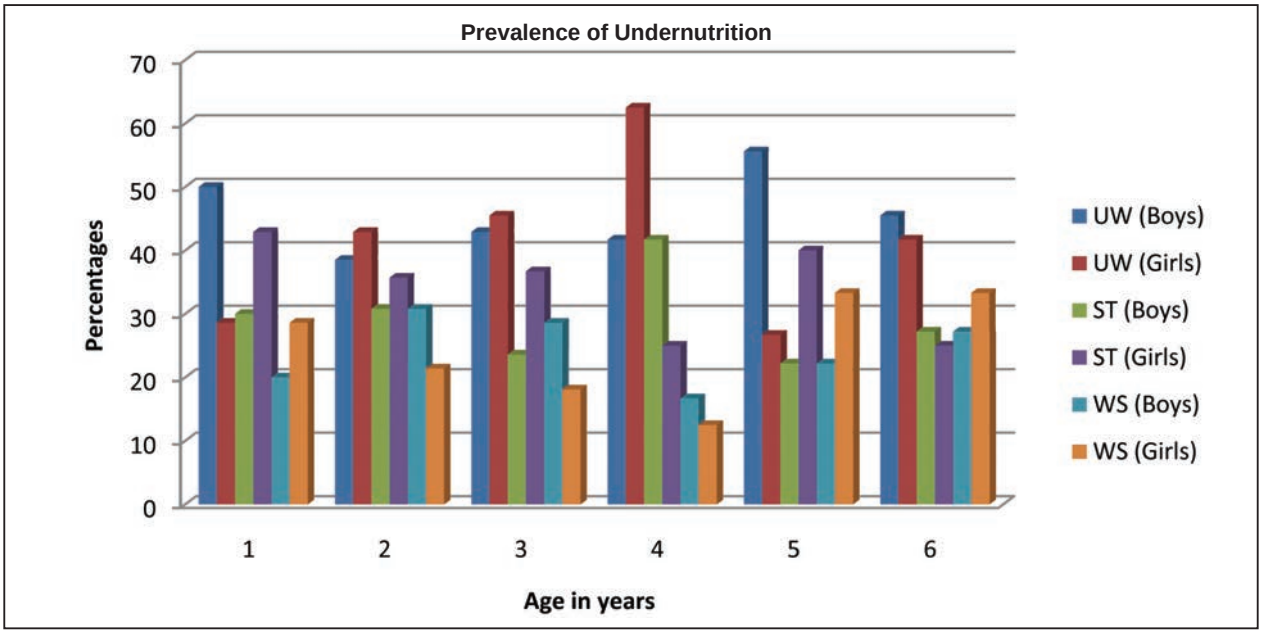

Fig 1: Undernutrition Prevalence (%) using different indicators

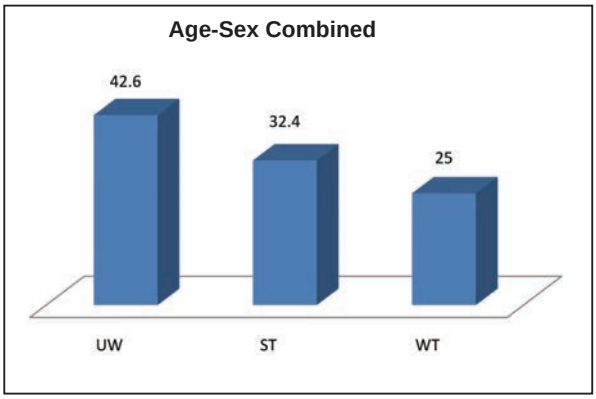

Fig 2: Prevalence of Undernutrion (%) among the Bhumij Children (Age-Sex Combined)

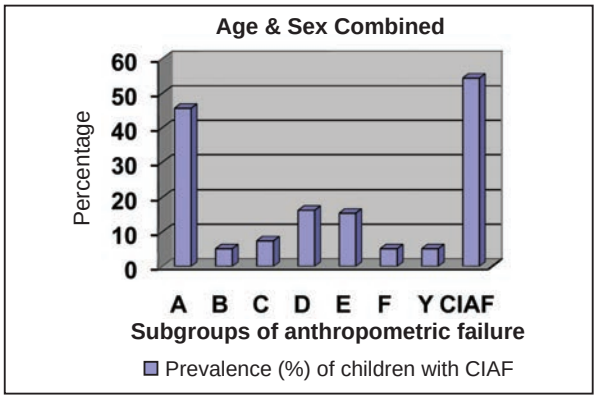

Fig 3: Subgroups of Anthropometric Failure

Discussion

Malnutrition in children under five years of age is one of the most serious health problems in developing countries[17]. It is also a major cause of child mortality in India, where the World Bank report of 2005 confirmed that 47 percent of Indian children below the age of five were malnourished. Further, reported that India has the highest incidence of childhood malnutrition in the world[18]. A recent study has developed a new index i.e. Composite Index of Anthropometric Failure (CIAF)[15]. Studies on health and nutritional assessment have been conducted in different parts of India among the

tribal & non-tribal children[19,20,21,15,22,23,17,24]. But nutritional assessment and CIAF anthropometrical data among the tribal children of Northern Odisha was nonexistent or until now it has not been investigated. Therefore the present study was undertaken to evaluate the levels of stunting, underweight and wasting and also to assess the overall prevalence of under-nutrition by using CIAF among the Bhumij tribal children (1-6 years) of Northern Odisha. Very few studies have been reported from India which have dealt with CIAF especially in school going children[25].

The total burden of malnutrition measured by CIAF in young Indian children is considerably higher. This is the country with largest child population in the world[26]. Nationwide survey showed definite improvement in nutritional profile of Indian children, though the picture is still gloomy[27,28].

Fig 3 shows that CIAF sub-groups of under-nourished children, with 15.3% having single anthropometric failure (Groups B, F and Y) and 39% having multiple anthropometric failure (Groups C, D and E). After summation in Groups B-Y, it is found that 54.4% of the Bhumij children had a high prevalence of under-nutrition with some form of anthropometric failure.

The overall prevalence of stunting, underweight and wasting in the present study demonstrated slightly better results (44.2% stunting, 44.0% underweight and 15.8% wasting respectively) compared to the Indian situation[17]. The present study shows more or less the same prevalence (54.4%) of overall undernutrition (by CIAF) with the recent study (CIAF-50.2%) done by[29] Acharya et al (2013). Most importantly, it must be noted here that the findings of the present study are in accordance with those of, who also reported higher rates of CIAF compared to the other three (Underweight, stunting and wasting) more conventional measures of under-nutrition[15,17,25]. The use of CIAF in the present study establishes that 54.4% of Bhumij children had some form of anthropometric failures. Although under-nutrition measured by CIAF is considerably lower than that recorded in other studies, but this scenario is extremely alarming[30,31,32,15,18,17]. Children with multiple anthropometric failures were more likely to experience ill-health and were at more risk of dying than those with single anthropometric failure[36].

The findings of widespread prevalence of under-nutrition among tribal & non-tribal children in India were also corroborated in this study (Table-6).

Previous studies from India have recorded the nutritional burden (CIAF) existing among the children. These include Nandy et al (2005) (59.8%); Seetharaman et al (2007) (68.6%); Biswas et al (2009) (60.40%); Das and Bose (2009) (66.3%); Mondal and Bose (2009) (73.1%); Mukhopadhyay & Biswas (2011) (69.1%); Fazili et al (2012) (25.58%); Acharya et al (2013) (50.2%); Present study (2014) (54.4%)[15,17,30,31,16,25,29]. All these studies found high rates of under-nutrition measured by CIAF. Thus the total burden of malnutrition measured by CIAF in rural and tribal children of India is considerably higher (mostly above 60%). This situation is not only distressing but very alarming since childhood is the foundation for both physiological & psychological development.

The present study is limited by its small sample size, being only from one area of Odisha, India. These results may therefore only be representative of a small community and not representative of the state or country. Therefore, to obtain a broader representation, more studies involving CIAF is to be undertaken among children of other tribal populations of not only Odisha but also from different parts of India. These results will not only allow us to compare the rates of three conventional measures of under-nutrition with CIAF, but also helps us to establish the improved effectiveness and use of CIAF.

Conclusion

The present study establish the overall prevalence of undernutrition using the Z Score and the composite index of anthropometric failure among the Bhumij children (1-6 years) of Northern Odisha, India. The study reflects that 54.4% of the children had some form of anthropometric failure and 39% of the children experienced multiple anthropometric failure. Thus it is concluded that these children are under acute and chronic undernutrition. The present study, by disintegrating the undernourished children into different groups, helps in identifying children with multiple anthropometric failures and these children with multiple anthropometric failures form the priority group for planners and policy makers.

Recommendations

It is therefore recommended that similar studies should be undertaken using the CIAF assessment among the children of other tribal populations of not only Odisha but also other parts of India. Various valuable nutritional intervention programs can be formulated to improve the nutritional status of the children with a priority towards children with multiple anthropometric failures. Moreover improvement of their nutritional status is of paramount importance from the national public health perspective.

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