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Assessment of nutritional status by composite index of anthropometric failure (CIAF): a study among preschool children of Sagar Block, South 24 Parganas District, West Bengal, India

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Abstract: Being a developing nation, rural India is still facing a serious health problem in form of undernutrition particularly among young children. To optimize this problem, the Central Government has been operating a nationwide nutritional intervention programme in the form of Integrated Child Development Service (ICDS) scheme. Unfortunately, it has failed to achieve the desired goal during last four decades. Therefore the present study was designed to measure the seriousness and severity of overall undernutrition using Composite Index of Anthropometric Failure (CIAF) among the rural Bengalee preschool children of Sagar Block, South 24 Parganas, West Bengal, India. This cross-sectional study was conducted among 656 preschool children (326 boys and 330 girls) aged 3 to 5 years. Height (cm) and weight (kg) measurements were taken according to standard procedure, age and sex specific 2 z-scores values of height-for-age, weight-for-height and weight-for-age were used to assess stunting, wasting and underweight, respectively, as per the World Health Organization Guidelines. CIAF was also computed as per standard methodology to assess the degree of undernutrition among the studied children. The overall age and sex combined prevalence of stunting, wasting, underweight and CIAF was 26.2%, 35.4%, 51.1% and 61.3%, respectively. CIAF showed a higher prevalence of undernutrition (61.28%) in comparison to other three indicators i.e., stunting, wasting and underweight. We conclude that the nutritional status of the subjects was not satisfactory. It was also established that the CIAF is a better indicator of nutritional status than traditional measures of stunting, wasting and underweight, because it determines overall (total) anthropometric failure.

Key words: composite index of anthropometric failure (CIAF), stunting, wasting, underweight

Introduction

Malnutrition is a nutritional disorder which is caused by a lack or surplus or imbalance of nutrients in the body (Hasan and Zulkifle 2010). Undernutrition includes stunting, wasting, underweight. It results as a consequence of lack of consumption of essential nutrients or using them more rapidly than they can be replaced. Overnutrition which includes overweight and obesity results from eating too-much, eating too many of the wrong things, not exercising enough, or taking much more vitamins or other dietary substitutes. Genetics has also been implicated as a cause of overnutrition.

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Chronic undernutrition in childhood is highly correlated with slower cognitive development and serious health impairments later in life that reduce the quality of life and also the economic productivity of people (Scrimshaw 1996). Children in preschool stage require more attention, as this is the period of rapid growth and development, which makes them highly vulnerable to malnutrition (WHO 2005). In rural India including West Bengal, undernutrition among pre-school children is an important public health problem (Mustaphi and Dobe 2005). In West Bengal, half of the children suffer from different types of under-nutrition (Bose et al. 2008).

India has the highest incidence of childhood undernutrition in the world (Bamji 2003). One half of the children under the age of five years in India are moderately or severely undernourished, 30 percent of newborn children are significantly underweight and nearly 60 percent of women are anaemic (Bamji 2003). The Integrated Child Development Service (ICDS) scheme was implemented to provide food supplementations to pregnant women and preschool children to improve nutritional status of mothers and children. Moreover, the Ministry of Health and Family Welfare implements programmes for tackling major micronutrient deficiencies such as vitamin A and Iodine deficiency etc, simultaneously (Economic Survey 2002–2003).

The present study focuses on composite index of anthropometric failure (CIAF) to evaluate the overall prevalence of undernutrition among Bengalee preschool ICDS children of Sagar Block, South 24 Parganas District, West Bengal, India. This study will help intensify efforts to increase public awareness about health, nutrition status and education among the preschool children.

Materials and methods

Study Area

This present cross-sectional study was undertaken at 28 Integrated Child Development Service (ICDS) scheme centres at Sagar Block of South 24 Parganas District, West Bengal, India during November 2015 to January 2017. The study area is situated at Sagar Island (Gangasagar: that is famous for the temple of Kapilmuni), Sundarban area of Kakdwip Subdivision. The inhabitants are mostly of Bengalee ethnicity. This is located approximately 130 km away from Kolkata, the provincial capital of West Bengal. The total area of Sagar Island is 282.11 Km^2 (108.92 Square miles) and it has the population of 2,12,037, according to 2011 census. This block has a population density of 750/Km^2 (1900 per square mile). Growth rate of this block was 20.38% during 2001-2011. Literacy rate of this block is 84.21%. The area is remote and mostly inhabited by Bengalee Hindus. All preschool children (3-5 years old) living in Sagar Block are enrolled at these centres.

The Subjects

The subjects were selected from 28 ICDS centres of DS-2 Gram Panchayat of Sagar block, South Parganas district, West Bengal, India. A total number of 656 children (boys = 326; girls = 330) aged 3-5 years were measured. Age of the children was ascertained from the "Anganwadi" registers and subsequently confirmed from the parents of the children and recorded on a pre-structured schedule. All the studied children were Bengalee Hindus. Most of the parents of these children were farmers. For analysis, age was

grouped into 12 months intervals. Formal ethical and administrative approvals were obtained from Vidyasagar University as well as ICDS authorities prior to the commencement of the study.

Anthropometric measurements

Anthropometric measurements of height (cm) and weight (kg) of each subject were measured by one investigator (SPG), following the standard technique (Lohman et al. 1988). The height and weight were measured using Martin's Anthropometer and standard spring balance Weighing Machine respectively. Height (cm) and weight (kg) of the subjects were measured to the nearest 0.1 cm. and 100 grams, respectively.

Assessment of Nutritional Status

Age and sex specific Z score values of height and weight were used to access stunting (low height-for-age) and underweight (low weight-for-age) respectively. Sex specific weight for height values were used to assess wasting (low weight for height). Internationally accepted World Health Organization (WHO 2006) age and sex specific –two Z-scores were followed to define stunting, underweight and wasting. Z-scores were calculated following the standard formula:

Z -Score = (X - Median of WHO 2006)/ (Standard deviation of WHO 2006)

where, X - particular score of height or weight of a child.

Three Z-scores were calculated:

Stunting: <-2 HAZ (z-score for height--for-age)

Wasting: <-2 WHZ (z-score for weight--for-height)

Underweight: <-2 WAZ (z-score for weight-for- age).

Composite Index of Anthropometric Failure (CIAF) was computed according to Nandy et al. (2005) For assessing the CIAF, Svedberg's model of six groups of children was used. These groups include children with height and weight appropriate for their age (i.e. who are not in anthropometric failure) and also children whose height and weight for their age are below the norm and thus are experiencing one or more forms of anthropometric failure (Nandy et al., 2005).

The CIAF comprises those children not in anthropometric failure (i.e. group A) and also includes all the 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 undernutrition. 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). Thus, table 1 represents the classification of children with composite index of 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 (Nandy et al., 2005).

Statistical Analysis

After collecting information and taking measurements, analyses were done using SPSS (Version 16.00) software. Student's t-test was performed to determine sex differences (age-specific) in mean height and weight. One-way ANOVA (Scheffe's procedure) was undertaken to test for age differences in mean height and weight in each sex. Level of significance was set at $p<0.05$.

Table 1. 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 2. Mean and standard deviation (SD) of body height and weight in the studied preschool children

Age (years) n	Variable					
	Height (cm)			Weight (kg)		
	Boys Mean±SD	Girls Mean±SD	*t*-value	Boys Mean±SD	Girls Mean±SD	*t*-value
3 B=119 G=120	91.55±4.31	91.91±4.03	-0.66	11.94±1.32	11.57±1.19	2.30*
4 B=103 G=110	99.12±3.70	98.62±4.16	0.93	12.90±1.47	12.76±1.39	0.74
5 B=104 G=100	105.97±4.36	104.61±3.38	2.48**	14.78±1.46	14.35±0.98	2.53**

B – boys G – girls; Significant level at *$p<0.05$, **$p<0.01$,

Results

The mean height and weight of the children are presented in table 2. Boys were taller and heavier than girls. Significant sex differences in mean weight were found at the age of 3 (t=2.30; $p<0.05$) and 5 years (t=2.53; $p<0.01$) and significant sex difference in mean height was also found at the age group of 5 years (t=2.48; $p<0.01$). Significant age variations were found in mean height (Boys: F=336.58, $p<0.001$; Girls: F=293.44, $p<0.001$) and weight (Boys: F=115.04, $p<0.001$; Girls: F=145.44, $p<0.001$).

Prevalence (%) of undernutrition among the studied children is presented in table 3. The overall (age and sex combined) prevalence of stunting, wasting, underweight and CIAF were 26.2%, 35.4%, 51.1%, and 61.3%, respectively. Maximum prevalence (age and sex specific) of stunting, wasting, underweight and CIAF were observed among 3 year old boys (44.5%), 4 year old boys (53.4%), 4 year old boys (64.1%) and 4 year old boys (69.9%), respectively. According to WHO (1995), the overall age and sex combined wasting and underweight was very high but the rate of stunting showed medium level severity of malnutrition. However, the rate of stunting among boys was high at age 3 year. Moreover, highest rates of underweight were observed at age 4 years

among boys (64.1%) and girls (56.4%).

Intensity of undernutrition based on Composite Index of Anthropometric Failure shown in table 4 and figure 2. The table and figure represent the proportions of children in each of the subgroups. Out of six subgroups (B-Y) with undernourished children, group C (containing children who are wasting and underweight) was the highest (22.1%), and children of group B (wasting only) had the lowest prevalence (5.0%) of under-nutrition in anthropometric failure. Prevalence of undernutrition among children of group D (wasting, stunting & underweight), E (stunting & underweight), F (stunting only) and Y (underweight only) were 8.2%, 12.8%, 5.2% and 7.9%, respectively. Thus, the CIAF showed a higher prevalence of undernutrition (61.3%) of the studied children suffering from anthropometric failure, in comparison to others

Table 3. Prevalence of undernutrition among the studied preschool children

Category	Age (years)						Total sample n=656
	3		4		5		
	Boys n=119	Girls n=120	Boys n=103	Girls n=110	Boys n=104	Girls n=100	
Stunting	53 (44.5)	33 (27.5)	25 (24.3)	36 (32.7)	14 (13.5)	11 (11.0)	172 (26.2)
Wasting	31 (26.0)	28 (23.3)	55 (53.4)	43 (39.1)	47 (45.2)	28 (28.0)	232 (35.4)
Underweight	53 (44.5)	57 (47.5)	66 (64.1)	62 (56.4)	55 (52.9)	42 (42.0)	335 (51.1)
CIAF	74 (62.2)	67 (55.8)	72 (69.9)	73 (66.4)	66 (63.5)	50 (50.0)	402 (61.3)

Percentages are presented in parentheses.

Table 4. Subgroups of anthropometric failure among the studied children

Group	Age (years)						Total sample n=656
	3		4		5		
	Boys n=119	Girls n=120	Boys n=103	Girls n=110	Boys n=104	Girls n=100	
A	45 (37.8)	53 (44.2)	31 (30.1)	37 (33.6)	38 (36.5)	50 (50.0)	254 (38.7)
B	4 (3.4)	4 (3.3)	5 (4.8)	3 (2.7)	10 (9.6)	7 (7.0)	33 (5.0)
C	13 (10.9)	21 (17.5)	33 (32.0)	30 (27.3)	31 (29.8)	17 (17.0)	145 (22.1)
D	14 (11.8)	3 (2.5)	17 (16.5)	10 (9.1)	6 (5.8)	4 (4.0)	54 (8.2)
E	22 (18.5)	24 (20.0)	7 (6.8)	18 (16.4)	7 (6.7)	6 (6.0)	84 (12.8)
F	17 (14.3)	6 (5.0)	1 (0.9)	8 (7.3)	1 (0.9)	1 (1.0)	34 (5.2)
Y	4 (3.4)	9 (7.5)	9 (8.7)	4 (3.6)	11 (10.6)	15 (15.0)	52 (7.9)
CIAF	74 (62.2)	67 (55.8)	72 (69.9)	73 (66.4)	66 (63.5)	50 (50.0)	402 (61.3)

Percentages are presented in parentheses

three conventional indicators (stunting, wasting and underweight). The rest of the children (38.7%) were not in anthropometric failure category, which was in group A (no failure). This higher prevalence was also noticed in every age group compared to the other three conventional nutritional indicators.

Discussion

Malnutrition is one of the most important global health problems in large number of children in developing countries (Victora et al. 1986). Nandy et al. 2005 has developed a very useful index, i.e. Composite Index of Anthropometric Failure (CIAF). It is a better tool to assess undernutrition than stunting, wasting and underweight. However, hitherto, there is no investigation from Sagar Island of West Bengal which has utilized CIAF. Thus, the present study was undertaken to evaluate the levels of stunting, wasting, underweight and also to assess the overall prevalence of undernutrition by using CIAF.

A comparison of prevalence of CIAF was made with previous studies (Table 5).

The present study shows that, overall, 61.3% of preschool children were

Table 5. Prevalence of CIAF in preschool children: A comparison with others studies

Study area	Sample size	CIAF (%)	Source
National Average, State wise data	24396	59.8	Nandy 2005
Coimbature, Tamil Nadu	405	68.6	Seetharaman et al. 2007
Chapra, Nadia, WB.	2016	60.4	Biswas et al. 2009
Purulia, WB	347	66.3	Das and Bose 2009
Arambag, Hooghly, WB	1012	73.1	Mandal and Bose 2009
Allahabad, Uttar Pradesh	371	62.8	Kumar et al. 2010
Bankura, WB	188	69.1	Mukhopadhyay and Biswas 2011
Midnapore town, WB	658	58.2	Sinha and Maiti 2012
Bankura town, WB	117	80.3	Shit et al. 2012
Kashmir, India	438	25.7	Fazili et al. 2012
Purba Medinipur, WB	225	50.2	Acharya et al. 2013
Mumbai, Maharashtra	634	47.8	Savanur and Ghugre 2015
Agra city, Uttar Pradesh	458	60.0	Agarwal et al. 2015
Singur, WB	113	32.7	Dasgupta et al. 2015
Jammu, India	250	73.2	Dewan et al. 2015
Balasore, Odisha	136	54.4	Goswami, 2016
Nagpur city	256	58.6	Dhok & Thakre 2016
Lilongwe, Malawi	4586	50.6	Ziba et al. 2017
Delhi, India	100	62.0	Gupta et al. 2017
Karbi Anglon, Assam	400	51.0	Kramsapi et al. 2018
Sagar Island, South 24 Parganas, WB	656	61.3	Present study

undernourished, which was similar to some previous studies such as Nandy et al. 2005 (59.8%), Biswas et al. 2009 (60.4%) and Gupta et al. 2017 (62%), respectively. Most importantly, it must be noted here that both the present study as well as these previous studies had reported higher rates of CIAF compare to other three (stunting, wasting and underweight) conventional measures of undernutrition. The children from Bankura town, West Bengal, India showed the highest prevalence of undernutrition (80.3%) based on CIAF (Shit et al. 2012). The lowest (25.6%) prevalence of CIAF based undernourished was found among the Kashmiri Preschool children (Fazili et al. 2012).

Most of these studies found high rates of undernutrition measured by CIAF. Thus the total burden of malnutrition measured by CIAF in preschool children of India is considerably higher (mostly above 50%). We can therefore conclude that by using the conventional measures of stunting, underweight and wasting we tend to underestimate the extent of undernutritiom . Hence, CIAF is a better indicator of anthropometric failure.

One of the limitations of our study is that it is limited by its small sample size, being only from one area of South 24 Parganas, West Bengal, India. Therefore, these results may only be representative of a small community and not representative of the state or country. Thus, to obtain a broader representation, more studies involving CIAF is to be undertaken among the children from different parts of West Bengal and India. These results will not only allow us to compare the rates of three conventional measures of under-nutrition with CIAF, but also help us to establish the improved effectiveness and use of CIAF.

Conclusion

We conclude that the nutritional status of the subjects was not satisfactory. Therefore various nutritional intervention programs can be formulated to improve their nutritional status. It was established that the CIAF is a better indicator of nutritional status than traditional measures of stunting, wasting and underweight because it determines overall (or total) anthropometric failure.

More studies dealing with CIAF should be undertaken among preschool children from different parts of India. Such investigation will help us to compare the undernutrition status with the help of CIAF. There is scope for improvement in the form of enhanced supplementary nutrition.

Recommendation

In this situation, we suggest that similar studies be undertaken amongst other ethnic preschool children, especially in rural areas, to determine the prevalence of undernutrition using CIAF. Such studies would help us to generate new data which can be used for comparison with the prevalence of undernutrition in the regional, national and global context. Better health and nutritional intervention policies can be formulated based on the findings of these investigations.

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Authors' contributions

SB undertook statistical analyses and prepared the manuscript; SPG collected the data, undertook statistical analyses and prepared the manuscript; KB supervised the study and prepared the manuscript.

Conflict of interest

We confirm that there are no known conflicts of interest associated with this publication.

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