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COMPOSITE INDEX OF ANTHROPOMETRIC FAILURE (CIAF) AMONG JUANG CHILDREN AND ADOLESCENTS OF KEONJHAR DISTRICT IN ODISHA, INDIA

Binoy Kumar Kuiti[1], Subhendu Acharya[2], Kanhu Charan Satapathy[3], Dilip Kumar Barik[4] and Prasanna Kumar Patra[*]

[1]Postdoctoral Fellow, Centre of Excellence in Tribal & Marginalized Communities (CoE in STMC), Utkal University, Bhubaneswar
[2]Scientist C, Regional Medical Research Center (ICMR), Bhubaneswar
[3]Associate Professor, Department of Anthropology, Utkal University, Bhubaneswar
[4]Research Assistant, Centre of Excellence in Tribal & Marginalized Communities (CoE in STMC), Utkal University, Bhubaneswar
[*]Corresponding author Email id: pkpatrastmc71@gmail.com

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Abstract: *Background*: Assessment of the overall nutritional status among children by CIAF is an important technique. For achieving the goal of sustainable development, CIAF stands concrete evidence of the real picture of undernutrition.

Objectives: The objective of the present study is to determine the total anthropometric failure among Juang children and adolescents.

Material and Methods: The present cross-sectional study was carried out among 237 (106 male and 131 female) Juang children and adolescents aged 1 to 17 years.

Results: The prevalence of Underweight, Stunting and Underweight children are 5.91%, 6.33% and 4.22% respectively; and other combined anthropometric failures of Stunting and Underweight; Wasting and Underweight; and Underweight, Stunting and Wasting are 2.95%, 16.46% and 16.03% respectively.

Conclusion: In the present study, the overall anthropometric failure is a very serious condition. Immediate intervention programmes based on food, and correct health awareness among parents may help to achieve the SDG goals for zero hunger.

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Introduction

Children's health is one of the important future assets of any nation. The nutritional status of children is an indicator of a number of phenomena, such as access to food, availability of medical services and their use, care given to the children, and allocation of food among the household members (Khan & Raza, 2014). Undernutrition continues to be a major public health problem in India despite years of incessant preventive measures. The composite index of anthropometric failure (CIAF) provides the burden of under-nutrition as a single measure and helps in the detection of children with multiple anthropometric failures (Dasgupta *et al.* 2014, Sen & Mondal 2012). Therefore, the improvement of children's nutritional status increases the chances of child survival and is considered as a precondition for their contribution to the community as well as human development (UNICEF, 1998). The Sustainable Development Goal (SDG) Index tracks the performances of countries on the 17 SDGs criteria which is agreed upon by the international community in 2015. In this concerning index, every 17 goals of SDGs are equally weighted. This score of the SDG index elucidates a country's position between the worst (0) and the best or target (100) outcomes. According to the Sustainable Development Report (2019), the SDG index in India is 61.1 and its position in global rank is 115. This country is also part of the BRICS grouping countries that are also sharing 3.5% GDP in the world economy and 17% share in world trade partnership. According to the same report (SDR 2019) on SDG Dashboard, India is facing major and significant challenges (red and orange colour points) to get the SDG achievement (green colour point) in SDG-2.2 (by 2030, to *"end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons"*) goal. Inter-agency Expert Group (IAEG-SDGs 2016) has proposed different targets to fulfilling the criteria of the SDG-2.2goal. Exertions of the United Nations, the Sustainable Development Goals (SDGs) precisely focus on courtesy and reserves on this substantial issue, and public health and epidemiological research try to find to explain its causes and importance, using the conformation pointers of growth standard: Wasting, Stunting and Underweight (Cesare *et al.* 2015: e237; Nabwera *et al.* 2017: e209).

These three indices i.e. Stunting (Height-for-Age, HAZ score), Underweight (Weight-for-Age, WAZ score) and Wasting (Weight-for-Height, WHZ score) have been discriminated of their position is below the normal range of the multicentric international reference. In the applied aspect, stunting is detecting long-term undernutrition with deprivation of food or exposure to infection; wasting is a well-known indicator of acute undernutrition or recent weight loss and underweight is used as a composite measure of wasting and stunting (WHO 1995:25). For their functional uniqueness, these indices separately cannot provide a single conclusion about the overall burden of undernutrition among children in a population. Ending this hierarchal conclusion of undernutrition, Svedberg (2000:194-6) has presented the relationship between three indices and made six compartmental alphabetic models i.e. 'A' (for Normal), 'B' (for Wasted only), 'C' (for Wasted and Underweight), 'D' (for Wasted, Stunted and Underweight), 'E' (for Stunted and Underweight), and 'F' (for Stunted only). After a few years of Svedberg invented CIAF, Shailen Nandy and his co-workers (2005) added a new compartment 'Y' which denotes only the underweight children (Nandy *et al.* 2005: 211). At present, Svedberg's revised model has become a most useful policy-making tool for developmental planners in designing intervention programmes to reduce undernutrition in developing countries (Nandy and Miranda 2008: 1966). However in the year 2010, for effective health promotion and to detect the correct pathways of nutritional intervention programmes, Bose and Manadal formulated three new indices i.e. Stunting Index (Stunted/CIAF), Underweight Index (Underweight/CIAF) and Wasting Index (Wasted/CIAF) (Bose and Mondal 2010: 134). The unique value of these three indices is that they produce informative answers about the relative severity of stunting, underweight and wasting concerning total undernutrition in a population.

According to the Census of India (2011), the enumeration of the total Scheduled Tribes population is 10,42,81,034 (males 5,24,09,823 and females 4,71,26,341) and comprising 8.6 per cent of the total population of this country. India has 49% underweight children, which shares 39% of the world's underweight children. Numerically, 57 million children are underweight in India (UNICEF 2006: 30). According to National Family Health Survey (NFHS - 4), a total of 38.4%, 21.0% and 35.7% of under-5 children are stunted, wasted and Underweight respectively. However, the prevalence of three indices among rural under-5 children (41.2%, 21.5% and 38.3% respectively) is higher than urban children (31.0%, 20.0% and 29.1% respectively). In India, Odisha has the second-highest percentage of the tribal population and in the state basis overall population, this tribal population constitute 22.85% (Census of India 2011). In this state of Odisha, around 34.1%, 20.4% and 34.4% of under-5 children are stunted, wasted and underweight respectively. However, among tribal preschool children in Odisha, the prevalence of underweight, wasting and stunting was 58%, 65% and 20% respectively (Meshram *et al.* 2014: 478). Although, for assessing the overall magnitude of undernutrition and identifying children with multiple anthropometric failures, CIAF become more useful than the three conventional indices i.e. stunting, wasting and underweight (Nandy *et al.* 2005: 211; Nandy and Miranda 2008: 1964; Nandy and Svedberg 2012: 128; Sen and Mondal 2012: 131; Savanur and Ghugre 2015: 2). Several researchers have also informed the magnitude of overall undernutrition status using the proposed categories of CIAF among under-5 or preschool children (Das and Bose 2011: 83; Mukhopadhyay and Biswas 2011: 312; Sinha and Maiti 2012: 7; Shit *et al.* 2012: 306; Acharya *et al.* 2013: 113; Dasgupta *et al.* 2014: 134; Solanki *et al.* 2014: 436; Boregowda *et al.* 2015: 5; Dasgupta *et al.* 2015: 417; Gupta *et al.* 2015: 631; Keri *et al.* 2016: 11; Dewan *et al.* 2016: 1060; Dhok and Thakre 2016: 2016; Goswami 2016: 64; Ramesh *et al.* 2017: 1497; Akhade 2018: 260; Kherde *et al.* 2018: 890; Kramsapi *et al.*2018: 8) and above 5 years children or adolescents (Sen *et al.* 2011: 175; Anjum *et al.* 2012: 47; Rajeev J 2014: 40; Thakur and Gautam 2014: 372; Thakur and Gautam 2015: 207) in India. On the other hand in Odisha, only one CIAF-related study has been reported (Goswami 2016: 65). To the best of our knowledge, no previous investigation has dealt with anthropometric failure among children and adolescents of the Juang – a particularly vulnerable tribal group (PVTG) who live in hilly-forest areas of Keonjhar district of Odisha, India. Our objective for the present study is to detect the pattern of anthropometric failure and find out the age group and sex-specific prevalence of overall undernutrition or total anthropometric failure among Juang children and adolescents.

Material and Method

This community-based cross-sectional study was conducted in four different villages (namely: Kundhei, Tala Kansa, Ghungi and Toranipani) of Banspal block, Keonjhar District, that are situated about 184 km from Bhubaneswar, the state capital of Odisha, India. This study was carried out from January 2020 to February 2020. A total of 237 (106 boys and 131 girls) aged 1-17 years Juang preschool, school-going children and adolescents were measured. Data were collected after obtaining necessary approval from the parents, villages and block authorities, and parents were informed of the aims of the study before the commencement of measurement. The study has got ethical clearance from the Institutional Ethics Committee (IEC) at Utkal University. The information about age, gender, weight and height was collected on a pre-tested questionnaire by door-to-door visit, following interviews and examination. Height and weight measurements were taken from each child and adolescent by the trained research assistants following standard techniques (Lohman *et al.* 1988). The three commonly used undernutrition indicators, stunting, underweight and wasting were used to evaluate the nutritional status of the subjects and CIAF for the total children and adolescents.

According to the 2011 census, a total of 47,095 Juang are inhabitants of Odisha of which 43.58% are males and 56.42% are females. The sex ratio is 1039 i.e. 1039 females per 1000 males. The Juang constitute 4.04% of the total population of the Keonjhar District. The ratio of child population (0-6 years) in the total population is 0.17:1. The Juangs belong to the Austro-Asiatic racial group and the Mundari linguistic group (Mohanty 2007: 272).

Anthropometry is an essential indicator of child health supervision and is also used for epidemiological assessment of the nutritional status of a defined population of children.

Therefore, the use of standard anthropometric charts in public health clinics, supplemental feeding programs, community health and nutrition surveys and physicians' offices can assist in the identification of individuals with growth or nutritional abnormalities. The internationally accepted standard growth reference of the National Center for Health Statistics (NCHS) (Hamill *et al.* 1979) was used as reference data for the assessment of nutritional status. The reference population consisted of the children from various segments of the United States population measured in the 1960s and 1970s. The criterion of failure was a z-score below -2. The Z-scores were calculated following the standard formula:

$$Z\ score = \frac{X - Median\ of\ NCHS}{Standard\ Deviation\ of\ NCHS}$$

Where X is an individual value of length/height and weight, the three Z scores were calculated: HAZ = height-for-age Z score; WAZ = Weight-for-Age Z score; WHZ = Weight-for Height Z-score was based on WHO (1995), undernutrition was defined as follows:

Stunting: HAZ < –2SD (Standard Deviation)

Underweight: WAZ < –2SD

Wasting: WHZ < –2SD

For assessing the 'anthropometric failure' (Nandy *et al.* 2005) among studied children by seven groups model (A to Y) has been used. These groups include with height and appropriate for their age (that is, above -2 z-scores) and who are not in "anthropometric failure", and those children whose height and weight for their age are below the normal (that is, below -2 z-scores) and thus experiencing one or more forms of "anthropometric failure". The CIAF excludes those children, not in anthropometric failure (group A) and includes all who are stunted or underweight or wasted and their combinations (groups B to F and Y) (see Table 1). All statistical analyses were undertaken using the SPSS (Statistical

Table 1: Classification of children with the composite index of anthropometric failure**

Groups	*Description*	*Wasting*	*Stunting*	*Underweight*
A	No Failure	×	×	×
B	Wasting only	√	×	×
C	Wasting and Underweight	√	×	√
D	Wasting, Stunting and Underweight	√	√	√
E	Stunting and Underweight	×	√	√
F	Stunting only	×	√	×
Y	Underweight only	×	×	√

** Classification based on Nandy *et al.,* (2005); × = absent and √ = present.

Package for Social Science) version 20.0. In this paper, we have used three new indices for assessing childhood undernutrition.

The formulas of the three indices are (Bose and Mandal 2010):

$$Stunting\ Index\,(SI) = \frac{Stunting}{CIAF}$$

$$Underweight\ Index\,(UI) = \frac{Underweight}{CIAF}$$

$$Wasting\ Index(WI) = \frac{Wasting}{CIAF}$$

These indices do not have any unit.

Results

Table 2a: Descriptive statistics on Weight-for-Age z-score

Age groups	*Total children*			*Boys*			*Girls*			*t' test*
	N	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	
Preschool children	66	-1.35	0.74	26	-1.59	0.68	40	-1.20	0.75	-2.101*
School going children	85	-2.29	1.21	47	-2.14	1.24	38	-2.48	1.15	1.294
Adolescents	86	-1.03	2.60	33	-2.12	1.90	53	-0.35	2.76	-3.247**
ANOVA	F=11.661, p<0.001			F=1.551, ns			F=13.828, p<0.001			

Table 2a presents the gender-specific mean WAZ among the Juang pre-school, school-going children and adolescents. The results revealed that all means of WAZ are staying in between the ranges of median value (-0.35 z-score or 37 percentile to -2.5 z-score or 1 percentile) of the NCHS reference population. The negative z-scores results found in preschool (-1.35±0.74 z-score), school-going (-2.29±1.21 z-score) children and adolescents (-1.03±2.60 z-score); and in gender-specific observation, the mean Z-score among boys is -1.59±0.68 z-score, -2.14±1.24 z-score and -2.12±1.90 z-score respectively; and girls have -1.20±0.75 z-score, -2.48±1.15 z-score and -0.35±2.76 z-score respectively. In sexual dimorphism cases on the mean of WAZ, boys and girls children have shown significant differences at preschool and adolescent stages (t = -2.101, p<0.05 and t = -3.247, p<0.01 respectively). Remarkably, the results of analysis of variance (ANOVA) on WAZ, only girls children and total children have shown significant (F = 11.661, p<0.001 and F = 13.828, p<0.001) differences within their respective stages.

Table 2b: Descriptive statistics on height-for-age z-score

Age groups	*Total children*			*Boys*			*Girls*			*t' test*
	N	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	
Preschool children	66	-1.08	0.78	26	-1.24	0.86	40	-0.98	0.71	-1.246
School going children	85	-1.31	0.87	47	-1.19	0.87	38	-1.46	0.86	1.443
Adolescents	86	-1.77	1.01	33	-2.07	0.89	53	-1.59	1.04	-2.226*
ANOVA	F=11.740, p<0.001			F=11.093, p<0.001			F=5.415, p<0.01			

The situations of HAZ-score of present study children, the table 2b revealed that all means of HAZ is staying in the ranges of median value (-0.98 z-score or 18 percentile to -2.07 z-score or 2 percentile) of the NCHS reference population. The negative z-scores results found in preschool (-1.08±0.78 z-score), school-going (-1.31±0.87 z-score) children and adolescents (-1.77±1.01 z-score); and in gender-specific observation, the mean Z-score among boys is -1.24±0.86 z-score, -1.19±0.87 z-score and -2.07±0.89 z-score respectively; and girls have -0.98±0.71 z-score, -1.46±0.86 z-score and -1.59±1.04 z-score respectively. The sexual dimorphism of mean HAZ between both sexes and children has shown significant differences at only adolescent stages (t = -2.226, p<0.05). The remarkable findings from analysis of variance (ANOVA) on HAZ; girls, boys and total children have shown significant (F = 5.415, p<0.01; F = 11.093, p<0.001 and F = 11.740, p<0.001) mean differences within their respective stages.

Table 2c: Descriptive statistics on Height-for-Age z-score

Age groups	*Total children*			*Boys*			*Girls*			*t' test*
	N	*Mean*	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*	
Preschool children	66	-1.11	0.46	26	-1.28	0.42	40	-1.01	0.46	-2.423*
School going children	85	-2.02	0.46	47	-2.07	0.49	38	-1.97	0.43	-1.033
Adolescents	86	-1.49	1.27	33	-2.07	0.86	53	-1.12	1.36	-3.552**
ANOVA	F=21.952, p<0.001			F=16.179, p<0.001			F=12.546, p<0.001			

The third nutritional assessment indicator is the WHZ-score which means results also stay in the ranges of median value (-1.01 z-score or 16 percentile to -2.07 z-score or 2 percentile) of the NCHS reference population (Table 2c). The negative z-scores results of total children, found in preschool (-1.11±0.46 z-score), school-going (-2.02±0.46 z-score) children and adolescents (-1.49±1.27 z-score); and in gender-specific observation, the mean

Z-score among boys is -1.28±0.42 z-score, -2.07±0.49 z-score and -2.07±0.86 z-score respectively; and girls have -1.01±0.46 z-score, -1.97±0.43 z-score and -1.12±1.36 z-score respectively. The sexual dimorphism of mean WHZ between both sexes children has shown significant differences at preschool children and adolescent stages ($t = -2.423, p<0.05$ and $t = -3.552, p<0.01$). The remarkable findings from analysis of variance (ANOVA) on WHZ; boys, girls and total children have shown significant ($F = 16.179, p<0.001$; $F = 12.546, p<0.001$ and $F = 21.952, p<0.001$) mean differences within their respective stages.

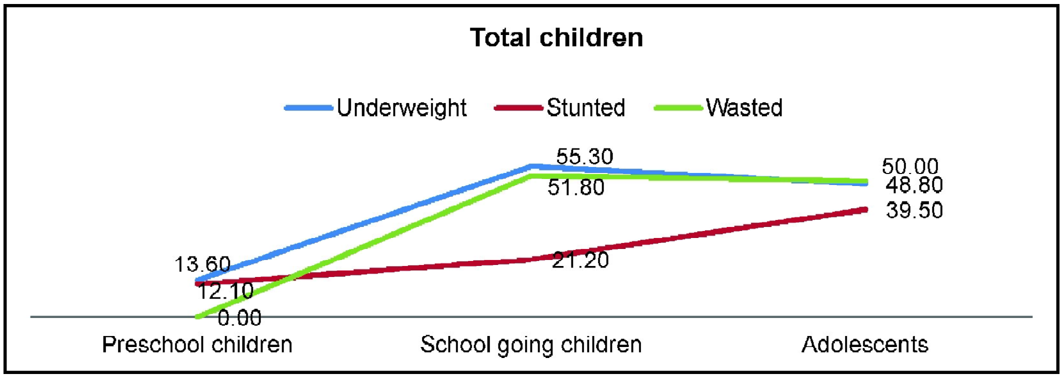

Figure 1a: Prevalence of underweight, stunted and wasted of total studied children

Figures 1a (total children), 1b (boys) and 1c (girls) present the age groups (preschool children, school-going children and adolescents) wise distribution of prevalence of underweight, stunting and wasting. From the first figure (1a), we found that the preschoolers are not wasted but some children have been reported as underweight (13.60%) and stunted (12.10%). The association between each nutritional indices with three stages of age groups

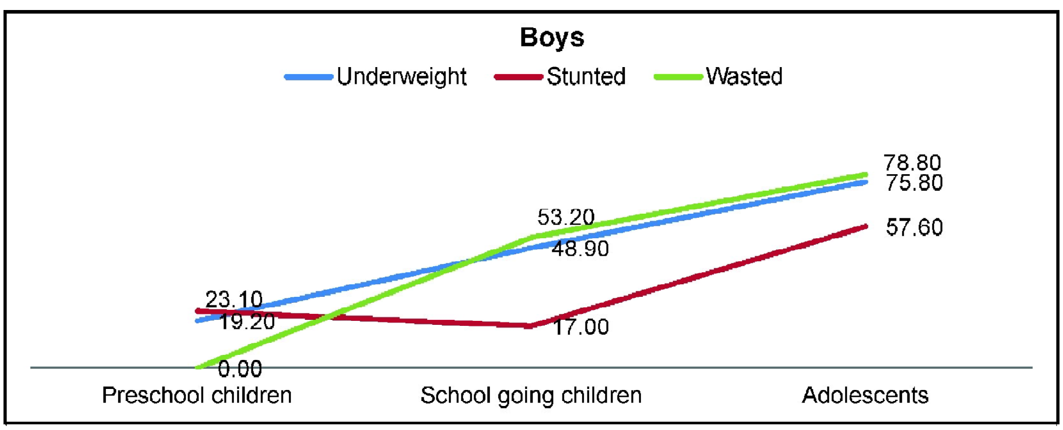

Figure 1b: Prevalence of underweight, stunted and wasted among boys children

show significant results (underweight: $\chi^2 = 29.71$, p<0.001; stunting: $\chi^2 = 16.04$, p<0.001and wasting: $\chi^2 = 53.11$, p<0.001).

The second figure 1b depicts that the preschooler boys are not wasted but some boys have been reported as underweight (19.20%) and stunted (23.10%). The association between each nutritional indices and three stages of age groups among studied boys are show significant results (underweight: $\chi^2 = 18.63$, p<0.001; stunting: $\chi^2 = 15.92$, p<0.001and wasting: $\chi^2 = 37.03$, p<0.001) respectively.

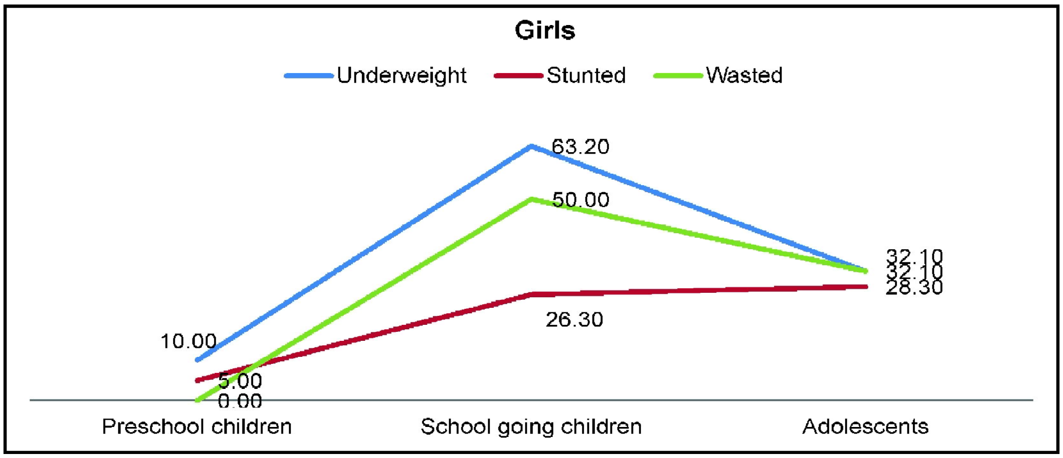

Figure 1c: Prevalence of underweight, stunted and wasted among girls children

Lastly, the first figure 1c describes the preschooler girls are not wasted but some girls have been described as underweight (10.00%) and stunted (5.00%). The association between each nutritional indices and three stages of age groups among studied girls are show significant results (underweight: $\chi^2 = 24.62$, p<0.001; stunting: $\chi^2 = 8.63$, p<0.05 and wasting: $\chi^2 = 25.39$, p<0.001).

Table 3a: Prevalence of CIAF subgroups of anthropometric failure among preschool children

Groups	*Category of anthropometric failures*	*Total*		*Boys*		*Girls*		χ^2
		N	%	N	%	N	%	
A	Normal	51	77.27	17	65.38	34	85.00	5.766, ns
Y	Underweight only	7	10.61	3	11.54	4	10.00	
F	Stunting only	6	9.09	4	15.38	2	5.00	
E	Stunting and Underweight	2	3.03	2	7.69	0	0.00	
B	Wasting only	0	0.00	0	0.00	0	0.00	
C	Wasting and Underweight	0	0.00	0	0.00	0	0.00	
D	Underweight, Stunting and Wasting	0	0.00	0	0.00	0	0.00	

In the present study, the sex-specific prevalence of CIAF subgroups among preschool, school-going children and adolescents are discussedin tables 3a, 3b and 3c. At first, from table 3a, we found that the prevalence of groups Y, F and E among total preschool children is 10.61%, 9.09% and 3.03% respectively. The sex-specific prevalence of groups Y, F and E are slightly higher among boys (11.54%, 15.38% and 15.38% respectively) than girls (10.00%, 5.00% and 0.00% respectively). But from this table, we also found that the Juang preschool children are unaffected by group B, C and D categories. The association between sex and categories of CIAF is not significant ($\chi^2 = 5.766$).

Table 3b: Prevalence of CIAF subgroups of anthropometric failure among school-going children

Groups	*Category of anthropometric failures*	*Total*		*Boys*		*Girls*		χ^2
		N	*%*	*N*	*%*	*N*	*%*	
A	Normal	32	37.65	20	42.55	12	31.58	5.239, ns
Y	Underweight only	5	5.88	1	2.13	4	10.53	
F	Stunting only	0	0.00	0	0.00	0	0.00	
E	Stunting and Underweight	4	4.71	1	2.13	3	7.89	
B	Wasting only	6	7.06	4	8.51	2	5.26	
C	Wasting and Underweight	24	28.24	14	29.79	10	26.32	
D	Underweight, Stunting and Wasting	14	16.47	7	14.89	7	18.42	

From table 3b, we observed that except for group F, the prevalence of groups Y, E, B, C and D among total school-going children is 5.88%, 4.71%, 7.06%, 28.24% and 16.47% respectively. The sex-specific prevalence of group Y, E, B, C and D among boys are 2.13%, 2.13%, 8.51%, 29.79% and 14.89% respectively; and girls are 10.53%, 7.89%, 5.26%, 26.32% and 18.42% respectively. The association between sex and categories of CIAF is not significant ($\chi^2 = 5.239$).

Table 3c shows that the prevalence of groups Y, F, E, B, C and D among total adolescents is 2.33%, 10.47%, 1.16%, 4.65%, 17.44% and 27.91% respectively. Except for group Y, the prevalence of groups F, E, B, C and D among boys are 6.06%, 3.03%, 6.06%, 24.24% and 48.48% respectively; and among the girls' cases, except for group E, the prevalence of group Y, F, B, C and D are 3.77%, 13.21%, 3.77%, 13.21% and 15.09% respectively. Association between sex and categories of CIAF is highly significant ($\div^2 = 22.121$, $p<0.01$). That means adolescent boys are more susceptible to CIAF than girls counterparts.

Table 3c: Prevalence of CIAF subgroups of anthropometric failure among adolescents

Groups	*Category of anthropometric failures*	*Total*		*Boys*		*Girls*		χ^2
		N	*%*	*N*	*%*	*N*	*%*	
A	Normal	31	36.05	4	12.12	27	50.94	22.121, p<0.01
Y	Underweight only	2	2.33	0	0.00	2	3.77	
F	Stunting only	9	10.47	2	6.06	7	13.21	
E	Stunting and Underweight	1	1.16	1	3.03	0	0.00	
B	Wasting only	4	4.65	2	6.06	2	3.77	
C	Wasting and Underweight	15	17.44	8	24.24	7	13.21	
D	Underweight, Stunting and Wasting	24	27.91	16	48.48	8	15.09	

Table 4a: Prevalence of single and multiple failures among preschool children

Type of anthropometric failure	*Total*		*Boys*		*Girls*		
	N	*%*	*N*	*%*	*N*	*%*	*X*
Normal	51	77.27	17	65.38	34	85.00	4.999, ns
Single failure	13	19.70	7	26.92	6	15.00	
Multiple failures	2	3.03	2	7.69	0	0.00	
Total CIAF	15	22.73	9	34.62	6	15.00	

Tables 4a, 4b and 4c are presenting the prevalence of single failures (Groups: B+F+Y), multiple failures (Groups: C+D+E) and total failures (Groups: B+C+D+E+F+Y) among preschool, school-going children and adolescents. From the table 4a, we found that around 19.70%, 3.03% and 22.73% of preschool children belong to single, multiple and total failures respectively; and the sex-specific prevalence of single, multiple and total failures

Table 4b: Prevalence of single and multiple failures among school-going children

Type of anthropometric failure	*Total*		*Boys*		*Girls*		
	N	*%*	*N*	*%*	*N*	*%*	*X*
Normal	32	37.65	20	42.55	12	31.58	1.247, ns
Single failure	11	12.94	5	10.64	6	15.79	
Multiple failures	42	49.41	22	46.81	20	52.63	
Total CIAF	53	62.35	27	57.45	26	68.42	

among boys have 26.92%, 7.69% and 34.62% respectively but in girls, except multiple failures, around 15.00% girls children are a single failure and also 15.00% total failures. The association between sex and type of anthropometric failures is not significant (χ^2= 4.999).

Table 4b depicts that the prevalence of single, multiple and total failure among school-going children is 12.94%, 49.41% and 62.35% respectively; and the sex-specific prevalence among boys is(10.64%, 46.81% and 57.45% respectively) slightly lower than girls (15.79%, 52.63% and 68.42% respectively). The association between sex and type of anthropometric failures is not significant (χ^2= 1.247).

Table 4c: Prevalence of single and multiple failures among adolescents

Type of anthropometric failure	*Total*		*Boys*		*Girls*		
	N	*%*	*N*	*%*	*N*	*%*	*X*
Normal	31	36.05	4	12.12	27	50.94	19.219, p<0.001
Single failure	15	17.44	4	12.12	11	20.75	
Multiple failures	40	46.51	25	75.76	15	28.30	
Total CIAF	**55**	**63.95**	**29**	**87.88**	**26**	**49.06**	

From table 4c, we observe that the single, multiple and total failures among adolescents is 17.44%, 46.51% and 63.95% respectively; and the sex-specific prevalence among boys is12.12%, 75.76% and 87.88% respectively and for girls is 20.75%, 28.30% and 49.06% respectively. The association between sex and type of anthropometric failures among adolescents is highly significant (χ^2= 19.219, $p<0.001$).

Table 5: Binary logistic regression analysis of CIAF predicted by age groups and sex

CIAF with Age and Sex	*Sub-groups*	*N*	*%*	*χ^2*	*Odd-ratio*	*95% C.I. for OR*
Age	Preschool children®	15	22.70	31.226, p<0.001		
	School going children	53	62.40		5.275***	2.535 -10.980
Sex	Adolescents	55	64.00		6.390***	3.053 -13.371
	Girls®	58	44.30	6.820, p<0.01		
	Boys	65	61.30		2.030*	1.152 -3.578

The logistic regression analysis is utilized to examine the contribution of age groups (preschool children, school-going children and adolescents) including sexes on CIAF. Results (Table 5) reveal that the Juang boys had two times more chances for affective with anthropometric failure [(Odd Ratio (OR) = 2.030; 95% Confidence Interval (CI) = 1.152-3.578)] than Juang girls. Another independent variable is the age group where school-going children and adolescents had five to six times more chances for affective with anthropometric failure (School-going children: OR = 5.275; 95% CI = 2.535 – 10.980; Adolescents: OR = 6.390; 95% CI = 3.053 – 13.371) than Juang preschool children. When two variables entered into the model where they significantly predict CIAF ($\chi^2 = 289.664$; $p<0.001$; $R^2 = 0.200$). The overall correct prediction is 67.1% (87.8% for CIAF; 44.7% for normal).

Table 6a: Values of the underweight index, stunting index and wasting index among preschool children

Index	*Boys (CIAF = 9)*	*Girls (CIAF = 6)*	*Total preschool children (CIAF = 15)*
UI (Underweight/CIAF)	5/9 = 0.556	4/6 = 0.667	9/15 = 0.600
SI (Stunting/CIAF)	6/9 = 0.667	2/6 = 0.333	8/15 = 0.533
WI (Wasting/CIAF)	0/9 = 0.000	0/6 = 0.000	0/15 = 0.000

Tables 6a, 6b and 6c present the sex-specific as well as sex-combined values of the three new indices, SI, UI and WI among preschool children, school-going children and adolescents. From table 6a, we are observing that except WI, the sex-combined overall values of SI and UI are 0.533 and 0.600 respectively. The corresponding values among boys are 0.667 and 0.556. Among girls, they are 0.333 and 0.667 respectively.

Table 6b: Values of the underweight index, stunting index and wasting index among school-going children

Index	*Boys (CIAF = 27)*	*Girls (CIAF = 26)*	*Total preschool children (CIAF = 53)*
UI (Underweight/CIAF)	23/27 = 0.852	24/26 = 0.923	47/53 = 0.887
SI (Stunting/CIAF)	8/27 = 0.296	10/26 = 0.385	18/53 = 0.339
WI (Wasting/CIAF)	25/27 = 0.926	19/27 = 0.704	44/53 = 0.830

Table 6b depicts that the sex combined overall values of UI, SI and WI among school-going children are 0.887, 0.339 and 0.830 respectively. The corresponding values among boys are 0.852, 0.296 and 0.926 respectively and for girls are 0.923, 0.385 and 0.704 respectively.

Table 6c: Values of the underweight index, stunting index and wasting index among adolescents

Index	*Boys (CIAF = 29)*	*Girls (CIAF = 26)*	*Total preschool children (CIAF = 55)*
UI (Underweight/CIAF)	25/29 = 0.862	17/26 = 0.654	42/55 = 0.764
SI (Stunting/CIAF)	19/29 = 0.655	15/26 = 0.577	34/55 = 0.618
WI (Wasting/CIAF)	26/29 = 0.897	17/26 = 0.654	43/55 = 0.782

Table 6c reveals that the sex combined overall values of UI, SI and WI among adolescents are 0.764, 0.618 and 0.782 respectively. The corresponding values among boys are 0.862, 0.655 and 0.897respectively and for girls are 0.654, 0.577 and 0.654 respectively.

Discussion

In the present study the three conventional anthropometric indices i.e. stunting, underweight and wasting are used to assess the undernutrition status among children, but these indices are unable to estimate the actual overall burden of the undernourished population due to overlapping in nature (Svedberg 2000: 194-6; Nandy *et al.* 2005: 211; Nandy and Miranda 2008: 196; Nandy and Svedberg, 2012: 127). The estimation of the overall prevalence of undernutrition in a population involves the incorporation of an aggregate index of undernutrition (i.e., CIAF) (Sen and Mondal, 2012: 131; Vollmer *et al.* 2017: 3). Consequently, this might be a possible instrument for health researchers and health planners for considering the CIAF to assess the actual burden of undernutrition in the most vulnerable section of the population. The present study attempts to evaluate the prevalence of undernutrition among Juang preschool, school-going children and adolescents by using both conventional anthropometric measures and CIAF.

Of the overall Juang preschool children, only 22.73% (boys: 34.62%, girls: 15.00%) children were suffering from different grades of anthropometric failure (Table 4a). A comparison of undernutrition using conservative anthropometric measures and CIAF among Indian children with the present study is depicted in Figure 2. The comparison with the present study was found to be lower than the slum children (80.30%) of Bankura district, West Bengal (Shit *et al.* 2017: 306); followed by urban slum children (73.20%) of Jammu (Dewan *et al.* 2016: 1060); tribal children (69.10%) of Bankura district, West Bengal(Mukhopadhyay and Biswas 2011: 312); slum children (62.10%)of Raipur,

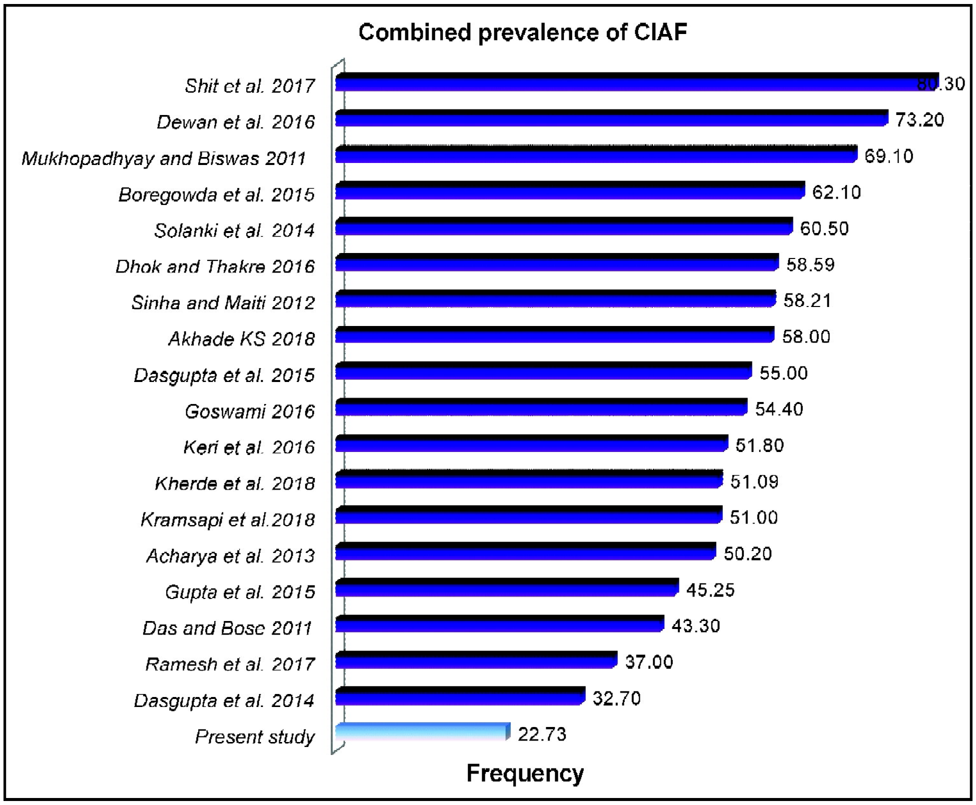

Figure 2: Comparison of CIAF among preschool children in different studies

Chhattisgarh (Boregowda *et al.* 2015: 5); slum children (60.50%) of Ahmedabad, Gujarat (Solanki *et al.* 2014: 436); under-5 children (58.59%) of Nagpur city, Maharashtra (Dhok and Thakre 2016: 2016); preschool children (58.21%) of Medinipur town, West Bengal (Sinha and Maiti 2012: 7); urban slum children (58.00%) of Bandra, Maharashtra (Akhade 2018: 260); urban slum children (55.00%) of Kolkata, West Bengal (Dasgupta *et al.* 2015: 417); Bhumij children (54.40%) of Nilgiri in Baleswar district, Odisha(Goswami 2016); anganwadi children (51.80%) at Bangalore, Tamilnadu(Keri *et al.* 2016: 11); under-5 children (51.09%)of Nagpur, Maharashtra (Kherde *et al.* 2018: 890); preschool children (51.00%) of Assam (Kramsapi *et al.* 2018: 8); ICDS children (50.20%) of PurbaMedinipur district, West Bengal (Acharya *et al.* 2013: 113); ICDS children (45.25%) of Rohtak district, Haryana (Gupta *et al.* 2015: 631); Santal children (43.30%) of Bankura district, West Bengal (Das and Bose 2011: 83); urban slum children (37.00%)of Chennai, Tamilnadu(Ramesh *et al.* 2017: 1497) and ICDS children (32.70%) of Singur, West Bengal (Dasgupta *et al.* 2014: 134).

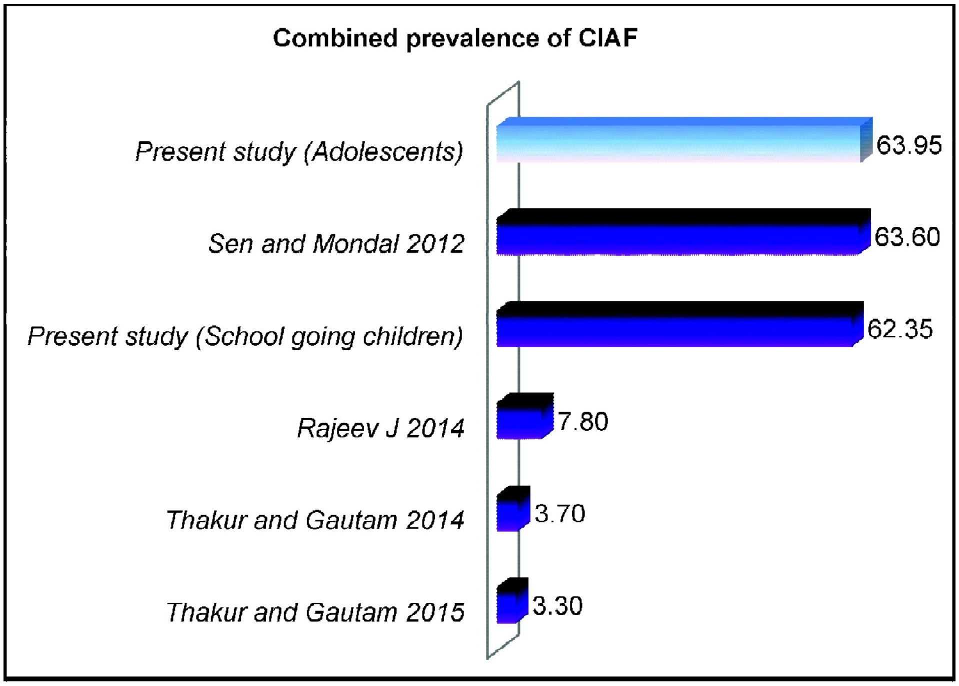

Figure 3: Comparison of CIAF among school children and adolescents in different studies

Another two results on the overall prevalence of CIAF among school-going children and adolescents are 62.35% (boys: 57.45%; girls: 68.42%) and 63.95% (boys: 87.88%, girls: 49.06%) respectively (Tables 4b and 4c). When compared with data available on CIAF among school-going children and adolescents from other population groups (Figure 3), the Juang school-going children (62.35) and adolescents (63.95) show higher levels of prevalence of CIAF than children (3.70% and 3.30%) of Sagar district Madhya Pradesh (Thakur and Gautam 2014: 372; Thakur and Gautam2015: 207); children (7.80%) of Kerala (Rajeev 2014) but among the Bengalee children (63.60%) of West Bengal (Sen and Mondal 2012) is higher than school-going children and lower than Juang adolescents.

Figure 4 above depicts the overall rate of undernutrition by using three new indices SI, UI, and WI among preschool children of Juang. The rate of SI in the present study (0.533) is higher than that reported in four studies 0.509 (Dasgupta *et al.* 2015: 418), 0.459 (Dasgupta *et al.* 2014: 134), 0.454 (Ramesh *et al.* 2017: 1498) and 0.362 (Mukhopadhyay and Biswas 2011: 312); and lower than eleven studies 0.826 (Solanki *et al.* 2014: 437), 0.754 (Boregowda *et al.* 2015: 5), 0.697 (Sinha and Maiti 2012: 207), 0.696 (Kramspi *et al.* 2018: 9), 0.690 (Gupta *et al.* 2015: 632), 0.628 (Akhade 2018: 260), 0.612 (Acharya *et al.* 2013: 114), 0.607 (Das and Bose 2011: 83), 0.596 (Goswami 2016: 66), 0.593 (Dhok and Thakre

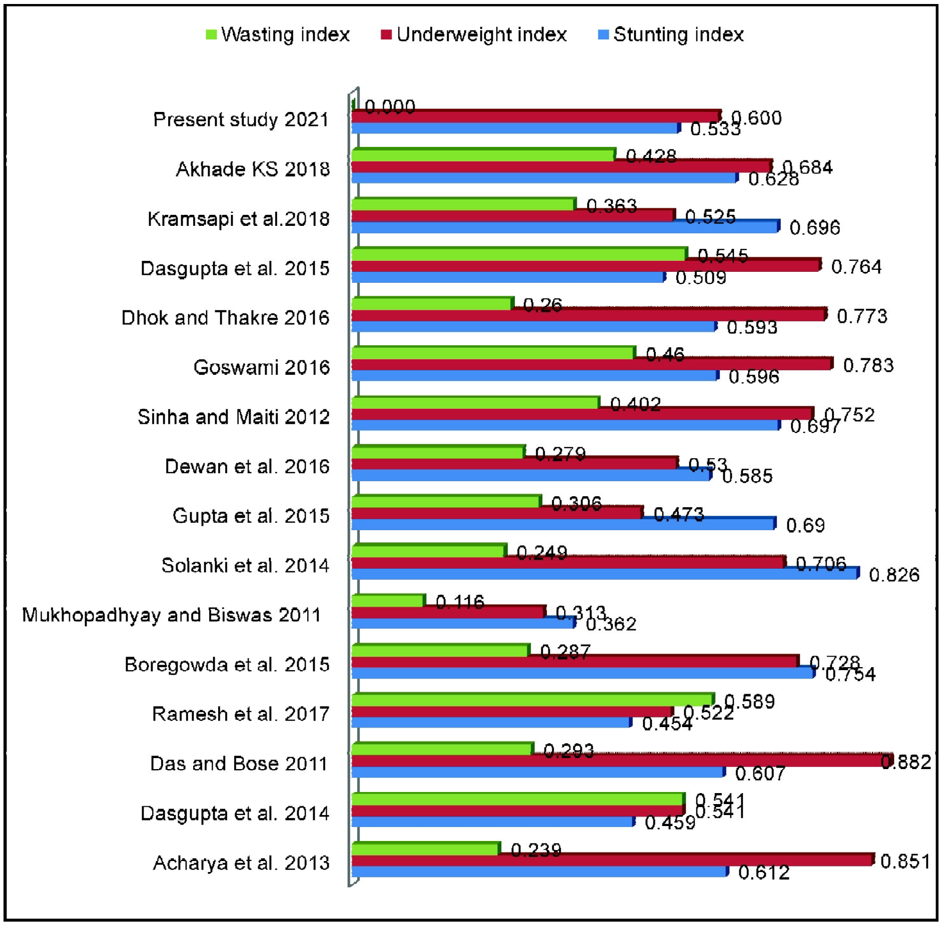

Figure 4: Comparison of WI, SI and UI among preschool children of different studies

2016: 2017) and 0.585 (Dewan *et al.* 2016: 1061). For UI, the rate (0.600) is also much higher than that reported in the other studies 0.541 (Dasgupta *et al.* 2014: 135), 0.530 (Dewan *et al.* 2016: 1061), 0.525 (Kramspi *et al.* 2018: 9), 0.522 (Ramesh *et al.* 2017: 1498), 0.473 (Gupta *et al.* 2015: 632) and 0.313 (Mukhopadhyay and Biswas 2011: 312); and lower than 0.882 (Das and Bose 2011: 83), 0.851 (Acharya *et al.* 2013: 113), 0.783 (Goswami 2016), 0.773 (Dhok and Thakre 2016), 0.764 (Dasgupta *et al.* 2015), 0.752 (Sinha and Maiti 2012: 7), 0.728 (Boregowda *et al.* 2015: 5), 0.706 (Solanki *et al.* 2014: 437) and 0.684 (Akhade 2018: 260). But in the present study, there is no WI rate for preschool children among the Juang tribe.

From the result and comparative assessment, it can be concluded that the present nutritional condition of Juang preschool children is improving, but the school-going children and adolescents are unable to secure a wealthy position. However, a few studies have suggested that the incidence of stunting, underweight, and wasting is higher at a young age than at an older age (Thakur & Gautam 2014: 376).

According to the study findings (table 5), the prevalence of 'anthropometric failure' increased with age groups (pre-school children-22.70%; school-aged children-62.40%; and adolescents-64.00%) and sexes (boys-61.30% and girls-44.30%). As a result, school-aged children and adolescents are more likely to be affected by undernutrition and related diseases. The Juang community, a majority of them, live in dense forest and hilly regions, and their livelihood is largely dependent upon agriculture and forest collection. In this type of subsistence economy, the adult members, especially parents, are unable to make provisions for adequate nutritional intake for their children. During field observations, we found that most Juang adult members get up at around 5:00 a.m., had a short tiffin, went to their workplaces, and returned to their homes at 6:00 p.m. In this long time gap, the children and adolescents are cared for by the young brothers and sisters of the Juang families. Young children and adolescents might have failed to catch up with normal growth as they lacked proper nutrition and care from adult members or parents.

Another interesting finding is about the gender-based differences in the prevalence of CIAF i.e. the boys are more affected than girls. Because Juang school-going children are provided with a variety of foods and good health & hygiene at their schools, and adolescent girls stay at the hostel in the nearby residential school (Kudhei High School), where they get better food. In the case of adolescent boys, since there is no residential school available for them, getting better nutrition is not guaranteed, thereby the gender-based difference in CIAF.

Conclusion

Though the result from this study is based on relatively small sample size but it provides some interesting indications about the socio-economic and nutritional changes taking place in the Juang community. First, the Juang livelihood is going through a transition where a substantial number of them are migrating out of their traditional ecology, based on high hills and forests. Their migration to low lands and consequent limiting access to traditional seasonal forest produces on the one hand and an increasing dependency on state-supported subsidized or free food, especially to school-going children and adolescents on the other has to determine the effect on their growth outcomes. As has been demonstrated through the study on CIAF, there is a serious issue with school-going children and adolescents sections of the society, but not with preschool children. The distinctive gender-based difference in higher age groups i.e. among the school-going children and adolescents can be explained through the differential access to residential schools and resultant better access to foods by girls compared to boys. However, in order to get a broader picture of the PVTGs in general and Juang in particular, further studies involving SI, UI and WI among pre-school children, school-going children and adolescents are required. Further, as evident from this study, the overall anthropometric failure is a very serious condition, among the Juang. Therefore, immediate intervention programmes based on food and nutrition, and correct health awareness among parents may help to achieve the SDG goals for zero hunger.

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References

Acharya, A., G.C. Mandal, K. Bose. (2013). Overall burden of under-nutrition measured by a Composite Index in rural pre-school children in Purba Medinipur, West Bengal, India. *Anthropological Review*, 76(1): 109-116.

Akhade, K.S. (2018). Measuring malnutrition: needs a comprehensive indicator. *Int J Community Med Public Health*, 5: 258-61. DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20175793

Anjum, F, M.I. Pandit, A.A. Mir, I.A. Bhat. (2012). Z score and CIAF – A comprehensive measure of magnitude of under nutrition in a rural school going population of Kashmir, India. *Global Journal of Medicine and Public Health*, 1(5): 46-49.

Boregowda, G.S., G.P. Soni, K. Jain, S. Agarwal. (2015). Assessment of Under Nutrition Using Composite Index of Anthropometric Failure (CIAF) amongst Toddlers Residing in Urban Slums of Raipur City, Chhattisgarh, India. *Journal of Clinical and Diagnostic Research*, 9(7): LCO4-LCO6.

Bose, K., Mandal, G.C. (2010). Proposed new anthropometric indices of childhood undernutrition. *Malaysian Journal of Nutrition*. 16(1):131-6. PMID: 22691860.

Census 2011, Census Report 2011, Office of the Registrar General & Census Commissioner of India, Ministry of Home Affairs, Govt. of India, as available on the website: *http://www.censusindia.gov.in/2011census*

Cesare, M.D., Z. Bhatti, S.B. Soofi, L. Fortunato, M. Ezzati, Z.A. Bhutta. (2015). Geographical and socioeconomic inequalities in women and children's nutritional status in Pakistan in 2011: An analysis of data from a nationally representative survey. *The Lancet Global Health,* 3(4), e229 –e239. https : // do i. org/10.1016/s2214-109x(15)70001-x.

Das, S., K.Bose. (2011). Assessment of Nutritional Status by Anthropometric Indices inSantal Tribal Children. *J Life Sci*, 3(2): 81-85.

Dasgupta, A.R. Parthasarathi, R.V. Prabhakar, R. Biswas, A. Geethanjali. (2014). Assessment of Under Nutrition with Composite Index of Anthropometric Failure (CIAF) Among Under-Five Children in a Rural Area of West Bengal. *Indian Journal of Community Health,* 26(2): 132-138.

Dasgupta, A., S.K. Sahoo, P. Taraphdar, P.S. Preeti, D. Biswas, A. Kumar, I. Sarkar. (2015). Composite index of anthropometric failure and its important correlates: a study among under-5 children in a slum of Kolkata, West Bengal, India. *Int J Med Sci Public Health*, 4: 414-419

Dewan, D, D. Kumar, R. Gupta. (2016). Predictors of anthropometric failure among under five slum children of Jammu, India. *International Journal of Community Medicine and Public Health,* 3(1): 367-372. DOI: http://dx.doi.org/10.18203/2394-6040.ijcmph20151593

Dhok, R.S., S.B. Thakre. (2016). Measuring undernutrition by composite index of anthropometric failure (CIAF): a community-based study in a slum of Nagpur city. *International Journal of Medical Science and Public Health,* 5(10): 2013-2018.

Goswami, M. (2016). Prevalence of Under-Nutrition Measured by Composite Index of Anthropometric Failure (CIAF) Among the Bhumij Children of Northern Odisha, India. *J Nepal PeadiatrSoc,* 36(1): 61-67. doi: http://dx.doi.org/10.3126/jnps.v36i1.14390

Gupta, V., D. Mohapatra, V. Kumar. (2015). Nutritional assessment among children (under five years of age) using various anthropometric indices in an urban area of district Rohtak, Haryana, India. *International Journal of Biomedical Research*, 6(9): 629-634.

IAEG-SDGs.Compilation of Metadata for the Proposed Global Indicators for the Review of the 2030 Agenda for Sustainable Development. IAEG-SDG 3rd meeting in March 2016, UN Agencies

Keri, V.C., S. Mangala, S.J.Sumukh, B.V. Karthik, B. Gautham, B. Santhosh. (2016). Composite Index of Anthropometric Failure among Anganwadi Children in Rural Field Practice Area of Vydehi Institute of Medical Sciences and Research Centre. *IOSR Journal of Dental and Medical Sciences,* 15(3): 09-13. DOI: 10.9790/0853-1503070913.

Khan, R.E.A. and M.A. Raza. (2014). Nutritional Status of Children in Bangladesh: Measuring Composite Index of Anthropometric Failure (CIAF) and its Determinants. *Pakistan Journal of Commerce and Social Sciences,* 8 (1): 11-23.

Kherde, A., C.R. Patil, J. Deshmukh, P.B. Petkar. (2018). Composite index of anthropometric failure among under 5 children attending the Immunoprophylaxis clinic in a tertiary care hospital in Nagpur, Maharashtra, India. *Int J Contemp Pediatr*, 5: 888-92. DOI: http://dx.doi.org/10.18203/2349-3291.ijcp20181508

Kramsapi, R., Singh, Kh. N., Mondal, N. (2018). Composite Index of Anthropometric Failure (CIAF) among pre-school (2-5 years) tribal children of Assam (India). *Human Biology Review*, 7 (1), 1-18

Meshram, I.I., N. Balakrishna, N. Arlappa, K.M. Rao, A. Laxmaiah, G.N.V. Brahmam. (2014). Prevalence of Undernutrition, Its Determinants, and Seasonal Variation Among Tribal Preschool Children of Odisha State, India. *Asia-Pacific Journal of Public Health,* 26(5): 470-480.

Mohanty, S.C. (2007). Socio-Economic Impact of Deforestation on the Juang of Gonasika with special reference to their subsistence activities. *ADIVASI*, 47: 125-138

Mukhopadhyay, D.K., A.B. Biswas. (2011). Food Security and Anthropometric Failure Among Tribal Children in Bankura, West Bengal. *Indian Pediatrics*, 48: 311-314.

Nabwera, H.M., A.J. Fulford, S.E. Moore, A.M. Prentice. (2017). Growth faltering in rural Gambian children after four decades of interventions: A retrospective cohort study. *The Lancet Global Health,* 5(2), e208 –e216.ht tps: //do i. org/10 .10 16/ s22 14- 109 x (16) 303 55- 2.

Nandy, S, M. Irving, D. Gordon, S.V. Subramanian, G.D. Smith. (2005). Poverty, child undernutrition and morbidity: New evidence from India. *Bull World Health Organ*, 83: 210-216. doi: S0042-96862005000300014

Nandy, S., J.J. Miranda. (2008). Overlooking undernutrition? Using a composite index of anthropometric failure to assess how underweight misses and misleads the assessment of undernutrition in young children. *SocSci Med*, 66: 1963-1966. doi: 10.1016/j.socs -cimed.2008.01.02

Nandy, S, P. Svedberg. (2012). The Composite Index of Anthropometric Failure (CIAF): An alternative indicator for malnutrition in young children. Preedy VR, Ed. *Handbook of anthropometry: physical measures of the human form in health and disease,*127–36. New York: Springer Verlag.

Rajeev, J. (2014). *Assessment of the Nutritional Status of Primary School Children who are the Beneficiaries of Mid-Day Meal Scheme: A Cross-Sectional Study in Kanjirappally Block Panchayath, Kottayam*. A dissertation copy was submitted to Shree ChitraTirunal Institute for Medical Sciences and Technology. Thiruvananthapuram, Kerala.

Ramesh, S.,S. Sundari, J. Ramesh. (2017). Assessment of Nutritional Status by Composite Index of Anthropometric Failure (CIAF): A Study among under-5 Children in Chennai, Tamil Nadu, India. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 8(3): 1495-1499.

Sachs, J., G. Schmidt-Traub, C. Kroll, G. Lafortune, G. Fuller. (2019). *Sustainable Development Report 2019*. New York:Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN).

Savanur, M.S., Ghugre, P.S. (2015). The magnitude of undernutrition in children aged 2 to 4 years using CIAF and conventional indices in the slums of Mumbai city. J Health Popul Nutr, 33: 3; doi: 10.1186/s41043-015-0017-x.

Sen, J., S. Dey, N. Mondal. (2011). Conventional nutritional indices and Composite Index of Anthropometric Failure: which seems more appropriate for assessing under-nutrition among children? A cross-sectional study among school children of the Bengalee Muslim Population of North Bengal, India. *Italian Journal of Public Health*, 9(8): 172-185.

Sen, J. and N. Mondal (2012). Socio-economic and demographic factors affecting the Composite Index of Anthropometric Failure (CIAF), *Annals of Human Biology*, 39:2, 129-136

Sen, J., N. Mondal. (2012). Socio-economic and demographic factors affecting the Composite Index of Anthropometric Failure (CIAF). *Ann Hum Biol*, 39: 129–36.

Shit, S., P. Taraphdar, D.K. Mukhopadhyay, A. Sinhababu, A.B. Biswas. (2012). Assessment of Nutritional Status by Composite Index for anthropometric Failure: A Study Among Slum Children in Bankura, West Bengal. *Indian Journal of Public Health*, 56(4): 305-307. DOI: 10.4103/0019-557X.106421

Sinha, N.K., S. Maiti. (2012). Prevalence of Undernutrition among Underprivileged Preschool Children (2-6 yrs) of Midnapore Town, India. *Malaysian Journal of Pediatrics and Child Health Online Early*, 6: 1-11.

Solanki, R., T. Patel, H. Shah, U.S. Singh. (2014). Measuring Undernutrition through Z-Scores and Composite Index of Anthropometric Failure (CIAF): A Study among Slum Children in Ahmedabad City, Gujrat. *National Journal of Community Medicine*, 5(4): 434-439.

Svedberg, P. (2000). Poverty and Undernutrition: Theory, Measurement, and Policy. Oxford, England, UK: Oxford University Press.

Thakur, R., R.K. Gautam. (2014). Prevalence of undernutrition among School-going boys (5-18 years) of a Central Indian city (Sagar). *Human Biology Review*, 3(4): 364-384.

Thakur, R., R.K. Gautam. (2015). Nutritional status among boys and girls of a central Indian Town (Sagar). *Anthropological Review*, 78(2): 197-212.

UNICEF (2006). Progress for Children. A report card on nutrition - Number 4. United Nations Children's Fund (UNICEF), New York.

Vollmer, S., Harttgen, K., Kupka, R., Subramanian, S. (2017). Levels and trends of childhood undernutrition by wealth and education according to a composite index of anthropometric failure: evidence from 146 demographic and health surveys from 39 countries. *BMJ Glob Health,* 2(2): 1-9. e000206. https://doi.org/10.1136/bmjgh-2016-000206.

World Development Indicators. D.C. Washington. (2014). *World Bank 2014*. Doi: 10.1596/978- 1-4648-0163-1.

World Health Organization (WHO). (1995). *Physical status: The use and interpretation of anthropometry.* World Health Organ Tech Rep Ser, 1-452.