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NUTRITIONAL ANTHROPOMETRY OF TRIBAL ADOLESCENT GIRLS USING Z SCORES: ITS ASSOCIATION WITH SOCIOECONOMIC STATUS

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ABSTRACT

The tribal societies in India are undisputedly considered to be the weakest sections of the population in terms of common socioeconomic and socio-demographic factors such as poverty, illiteracy, lack of developmental facilities, lack of adequate primary health facilities etc. The present investigation was undertaken to study the nutritional status of tribal adolescent girls through anthropometry. In all 387 tribal adolescent girls (13 to 18 years old) were purposively selected from four *Ashram shalas* of tribals located at *Higna, Ramtek, Deolapar* and *Navegaon* taluka places of Nagpur District. The anthropometric measurements viz., height and weight were recorded using standard procedures. BMI was computed, compared and classified according to WHO (2007) standards. The Z scores of height, weight and BMI were computed and classified according to the Indian Academy of Paediatrics (IAP) 2015 Standards. The results of the study showed that according to the height Z score classification, 91.99% of girls were normal, 6.46% were stunted and 1.55% were severely stunted. As per the Weight Z Score classification, 96.90 % of girls were normal, 2.84% were wasted and 0.26 % were severely wasted. The BMI Z classification showed 90.44 % normal whereas 0.78%, 2.33%, 5.94% and 0.52% as severe underweight, underweight, overweight and obese respectively. The statistical analysis did not show any association between the z scores and age groups of the adolescent girls ($p>0.05$). It can be concluded that intervention programmes based on nutrition awareness among tribal adolescent girls may help to achieve the SDG goals for zero hunger.

Introduction

Adolescence is one of the most important and vulnerable periods of human life in terms of growth, development and maturation. It is a period of gradual transition from childhood to adulthood normally begins with the onset of signs of puberty and is characterized by important psychological and social changes, along with physiological changes (1). The main nutrition problems affecting adolescent populations worldwide include under nutrition in terms of stunting and thinness, catch-up growth, and intrauterine growth retardation in pre-adolescent girls, iron deficiency and anemia, iodine deficiency, vitamin A deficiency, calcium deficiency, other specific nutrient deficiencies, e.g. zinc, folate and obesity (2).

The tribal population of India is approximately 8.6% and are socially and economically underprivileged. In general, data are scanty on the anthropometric and nutritional status of

various tribal populations of India (3). It has been recently suggested that there is an urgent need to evaluate the nutritional status of various tribes of India (4). Based on the above observations, the present study is an attempt to assess the nutritional anthropometry of tribal adolescent girls using z scores and to evaluate the association of Z Scores with socioeconomic status.

Methodology

In all 387 tribal adolescent girls (13 to 18 years old) were purposively selected from four *Ashram shalas* of tribals located at *Higna, Ramtek, Deolapar* and *Navegaon* taluka places of Nagpur District. The written consents were obtained from the subjects of *Ashram Shala* before conducting the survey. The demographic profile of the adolescent girls viz., type of family, number of family members, educational qualification and occupation of parents and income were recorded using a structured questionnaire. The socioeconomic status was computed using Modified Kuppuswamy Scale (5). The anthropometric measurements viz., height and weight were recorded using standard procedures (6). BMI was computed. The Z scores of heights, weights and BMIs were computed and classified according to the Indian Academy of Paediatrics (IAP) 2015 Standards (7). The statistical analysis was computed for Chi Square test using SPSS version 25. The confidence interval was set at 95%.

Results

The demographic profile of the Trible adolescent girls has been presented in Table 1.

Table 1: Demographic profile of Trible Adolescent Girls

SN	Demographic Profile	Age in Years	Percent (N)
1	Age in Years	13	18.7 (72)
		14	28.1 (108)
		15	26 (100)
		16	17.4 (67)
		17	8.3 (32)
		18	1.6 (6)
		Mean ± Std. Dev	14.74 ±1.268
2	Type of family	Nuclear Family	23.1 (89)
		Nuclear + One Dependent	30.4 (117)
		Nuclear + Two Dependents	27 (104)

		Joint Family	19.5 (75)
3	Number of Family Members	Up to 3 members	3.9 (15)
		4 - 5 members	77.4 (298)
		7 - 9 members	17.9 (69)
		More than 9 members	0.8 (3)
4	Education qualification of Mother	Up to Primary Education	49.6 (191)
		Secondary School	34.3 (132)
		SSC	13.8 (53)
		HSSC	1.8 (7)
		Graduate	0.5 (2)
5	Education qualification of Father	Up to Primary Education	31.4 (121)
		Secondary School	29.1 (112)
		SSC	26 (100)
		HSSC	12.2 (47)
		Graduate	1.3 (5)
6	Occupation of Mother	Government job	0.5 (2)
		Private Job	4.7 (18)
		Daily Wage	44.7 (172)
		Housewife	49.4 (190)
		Farm Labour	0.8 (3)
7	Occupation of Father	Government job	2.3 (9)
		Private Job	16.9(7)
		Daily Wage	59 (227)
		Driver	0.3 (1)
		Farm Labour	21.6 (83)
8	Socioeconomic Status Classification using Modified Kuppuswamy Scale 2024)	Upper Lower	73.8 (284)

		Lower Middle	25.2 (97)
		Upper Middle	1 (4)
		Total	**100**

(Numbers in parenthesis indicate number of cases)

Table 1 shows distribution of tribal adolescent girls according to their demographic profile. The average age of tribal adolescent girls was 14.74 ±1.26 years. A majority of tribal girls (30.4%) were from Nuclear + one dependent family and 19.5% were from joint family. About 77.4 % tribal girls had 4-5 family members and 0.8% girls had more than nine members in the family. Most mothers (49.4%) and fathers (31.4%) of tribal girls were educated up to primary and only 0.5 % mothers and 1.3% fathers were graduate. The majority of (49.4%) mothers of tribal girls were housewives and only 0.5% mothers had government jobs. About 59% fathers were engaged in daily wages and 0.3% fathers were working as drivers. The Kuppuswamy Socioeconomic Scale showed that 73.8 % girls belonged to upper lower socioeconomic status whereas only 1% girls were from upper middle socioeconomic status.

Anthropometric Measurements

Anthropometric measurements like body height and weight are widely used to predict body composition [1, 3]. The age wise mean anthropometric measurements of the tribal girls of the study are presented in Table 2.

Table 2: Age wise mean anthropometric measurements of Trible Girls

Age in years	N	Height (cm)		Weight (kg)		BMI (Kg/m2)		Height for Age Z Score		Weight for Age Z Score		BMI Z Score	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
13	71	148.00 ab	6.35	39.80 ab	6.01	18.14	2.30	-0.60	0.91	-0.49	0.72	-0.26	0.74
14	107	150.33 cd	8.20	40.47 cd	5.92	17.92	2.43	-0.66	1.22	-0.74	0.75	-0.53	0.78
15	100	151.69	5.73	42.01 efg	5.07	18.26	2.07	-0.69	0.89	-0.78	0.64	-0.56	0.69
16	67	154.36 ac	8.24	44.99 aceg	5.31	18.97	2.48	-0.43	1.32	-0.59	0.65	-0.47	0.82
17	32	155.47 bd	10.85	46.62 bdf	5.58	19.45	2.92	-0.40	1.85	-0.55	0.70	-0.45	0.91
18	6	154.17	3.19	46.37	4.50	19.57	2.49	-0.63	0.56	-0.73	0.63	-0.51	0.84
Total	383	151.45	7.84	42.14	5.99	18.39	2.41	-0.60	1.17	-0.66	0.70	-0.47	0.77
F test		7.459		12.737		3.402		0.625		1.972		1.466	
Significance		0.000		0.000		0.005		0.681		0.082		0.200	

(Similar superscripts differ significantly)

The overall mean height of adolescent girls was 151.45 cm. The mean heights of the 13-, 14- and 16-year adolescent girls were 148.00, 150.33 and 154.36 cm respectively whereas for the 17 year old, it was 155.47 cm. The mean heights of the tribal adolescent girls were found to be increasing with age and showed significant difference (p=0.000). The mean height further decreased slightly for 18-year-old girls but did not show any significant difference with mean heights of other age groups.

The overall mean weight of adolescent girls of all age groups was 42.14 kg. The mean weights of the 13-, 14,15- and 16-year adolescent girls were 39.80, 40.47, 42.01 and 44.99 kg respectively whereas for the 17-year-old, it was 46.62 kg. The age wise mean weight of the tribal adolescent girls was found to be increasing with age and showed significant difference (p= 0.000).

The mean BMI of adolescent girls was 18.39 kg/m2 which is in the underweight category. The mean BMI of 13-, 14- and 15-year girls were less than 18.5 kg/m^2 and can be categorized in underweight category. The mean BMI of 16-, 17- and 18-year-old girls were in normal

categories (between18.5 to 22.9 kg/m^2). The age wise mean BMI of tribal adolescent girls was found to be increasing with age except for 14 years and showed significant difference (p= 0.005).

The mean Height Z Scores of the adolescent girls ranged between -0.40 to -0.69 whereas the mean Weight Z Scores ranged between -0.49 to -0.78. The mean BMI Z Scores of the adolescent girls ranged between -0.26 to -0.56. However, the mean Height Z Scores, Weight Z Scores and BMI Z scores did not show any significant difference (>0.05) with respect to the age of the adolescent girls.

Height Z Score of Adolescent Girls

Height Z Score Wise classification of adolescent tribal girls is presented in Table 3.

Table 3: Height Z Score Wise Classification of Adolescent Tribal Girls

Height Z score	13th year	14th year	15th Year	16th Year	17th year	18th Year	Total
Normal (>-2)	67 (17.31)	96 (24.81)	93 (24.03)	64 (16.54)	30 (7.75)	6(1.55)	356 (91.99)
Stunted (between ≥ -3 SD & ≤ -2 SD)	5 (1.29)	11 (2.84)	6 (1.55)	2 (0.52)	1 (0.26)	0 (0.00)	25 (6.46)
Severely Stunted (≤ -3 SD)	0(0.00)	2(0.00)	1(0.26)	1(0.26)	2(0.52)	0(0.00)	6 (1.55)
Total	72	109	100	67	33	6	387 (100.0)

(Numbers in parenthesis indicate per cent cases) (χ^2 =10.94, p=0.362)

Table 3 shows that 91.99% girls had normal height-for-age (Z-score > -2 SD). The highest proportion of these normal cases was observed among 14-year-olds (24.81%), followed closely by 15-year-olds (24.03%), 13-year-olds (17.31%), and 16-year-olds (16.54%). A total of 6.46% of the girls were classified as *stunted* (Z-score between ≥ -3 SD and ≤ -2 SD), with the highest prevalence observed among 14-year-olds (2.84%), followed by 15-year-olds (1.55%) and 13-year-olds (1.29%). The percentage of *severely stunted* girls (Z-score ≤ -3 SD) was 1.55%, distributed among 15-, 16-, and 17-year-olds (each contributing 0.26%–0.52%).

Weight Z Score of Adolescent Girls

Weight Z Score wise classification of adolescent tribal girls is presented in Table 4.

Table 4: Weight Z Score wise Classification of Adolescent Tribal Girls

Weight Z score	13th year	14th year	15th Year	16th Year	17th year	18th Year	Total
Normal (Greater than -2)	71(18.35)	101(26.10)	98(26.32)	66(17.05)	33(8.53)	6(1.55)	375 (96.0)
Wasted (greater than and equal to -2/ Greater than -3)	1(0.26)	8(2.07)	1(0.26)	1(0.26)	0(0.00)	0(0.00)	11 (2.84)
Severely Wasted (Less than equal to -3)	0(0.00)	0(0.00)	1(0.26)	0(0.00)	0(0.00)	0(0.00)	1 (0.26)
Total	72	109	100	67	33	6	387 (100.0)

(Numbers in parenthesis indicate per cent cases) (χ^2 =12.08, p=0.280)

The data presented in Table 4 reveals that 96.9% adolescent tribal girls, had normal weight-for-age (Z score > -2 SD), indicating an overall satisfactory nutritional status among the surveyed population. The highest proportion of normal-weight cases were recorded among 15-year-olds (26.32%) and 14-year-olds (26.10%). Only 2.84% of the girls were categorized as *wasted* (Z score between ≥ -3 SD and ≤ -2 SD), and a mere 0.26% were *severely wasted* (Z score ≤ -3 SD). The highest occurrence of wasting was observed among 14-year-olds (2.07%).

BMI Z Score

The age-wise BMI Z score of the adolescent girls has been presented in Table 5.

Table 5: BMI Z Score wise Classification of Adolescent Tribal Girls

BMI Z score	**13th year**	**14th year**	**15th Year**	**16th Year**	**17th year**	**18th Year**	**Total**
Severe Underweight (≤ -2.3)	0 (0.00)	1 (0.26)	0 (0.00)	2 (0.52)	0 (0.00)	0 (0.00)	3 (0.78)
Underweight (≤ -1.88 and > -2.3)	1 (0.26)	4 (1.03)	1 (0.26)	2 (0.52)	0 (0.00)	1 (0.26)	9 (2.33)
Normal (< 0.67 and > -1.88)	65(16.80)	98(25.32)	95(24.55)	5(14.99)	29(7.49)	5(1.29)	350 (90.44)
Overweight (≥ 0.67 and < 1.64)	6(1.55)	4(1.03)	4(1.03)	5 (1.29)	4 (1.03)	0 (0.00)	23 (5.94)

Obese (≥1.64)	0 (0.00)	2 (0.52)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (0.52)
Total	72	109	100	67	33	6	387 (100.0)

(Numbers in parenthesis indicate per cent cases) (χ^2 =24.545, p=0.219)

The data in Table 5 reveals that 90.44 % girls were within the *normal BMI range* (BMI Z score between -1.88 and 0.67), suggesting a generally healthy nutritional status among the majority of the study population. The highest number of normal-weight girls were in the 14-year (25.32%) followed by 15-year (24.55%) age groups. A small fraction, 0.78%, of girls were classified as *severely underweight* (BMI Z score ≤ -2.3), with the majority in the 16-year age group (0.52%). Additionally, 2.33% of the girls were *underweight* (BMI Z score between > -2.3 and ≤ -1.88), with the highest occurrence in the 14-year group (1.03%). Approximately 5.94% of the girls were found to be *overweight* (BMI Z score ≥ 0.67 and < 1.64) and a small percentage (0.52%) of girls were *obese* (BMI Z score ≥ 1.64).

Relationship Between Socioeconomic Status and Z Scores

The association between socioeconomic variables and Z scores of Heights, Weight and BMI have been presented in Table 6.

Table 6: The association between socioeconomic variables and Z scores of Heights, Weight and BMI

SN	Socioeconomic Variables	Chi Square (χ)	P value
	Height Z Score		
1.	Type of family	6.605	0.359
2.	Number of family members	2.159	0.905
3.	Education qualification of mother	4.666	0.793
4.	Education qualification of father	21.223	0.007**
5.	Occupation of mother	7.888	0.445
6.	Occupation of father	0.731	0.999
7.	Kuppuswamy Socioeconomic Scale	17.228	0.002**
	Weight Z Score		
1	Type of family	12.971	0.044*
2	Number of family members	1.352	0.969

3	Education qualification of mother	3.460	0.902
4	Education qualification of father	5.602	0.692
5	Occupation of mother	5.294	0.726
6	Occupation of father	2.679	0.953
7	Kuppuswamy Socioeconomic Scale	1.851	0.933
	BMI Z Score		
1	Type of family	12.20	0.430
2	Number of family members	70.399	0.000**
3	Education qualification of mother	17.234	0.371
4	Education qualification of father	10.823	0.820
5	Occupation of mother	10.544	0.837
6	Occupation of father	10.732	0.826
7	Kuppuswamy Socioeconomic Scale	12.027	0.443

*Significant at 5%, ** Significant at 1% level

The data presented in Table 6 reveals that Height Z Score had a significant association with education qualification of father (p = 0.007) and Kuppuswami Socioeconomic Scale (p = 0.002). The present study did not show any significant associations between height Z score and other variables such as type of family, number of family members, or mother's education, indicating that paternal influence and overall economic status play a more dominant role in determining height-related growth outcomes in this population.

In the present study, the Weight Z score showed a significant association with the type of family (P= 0.04). Girls from joint or extended family structures may benefit from shared food resources or suffer due to resource constraints, both of which may impact weight .However, no significant relationships were found between weight Z scores and parental education, occupation, or the Kuppuswamy socioeconomic scale, suggesting that short-term weight fluctuations may be influenced more by immediate household conditions and dietary access than broader educational or occupational factors.

The Table 6 further shows that the number of family members was significantly associated with BMI Z Score (χ^2 = 70.399, p = 0.000), indicating that household size may influence overall caloric availability, food distribution, and dietary quality among adolescents. No other socioeconomic variables showed significant association with BMI Z Score, indicating that

BMI—which reflects both chronic and acute nutritional status—might be more sensitive to household size than individual parental attributes.

Discussion

In the present study, the overall mean height and weight of adolescent girls were 151.45 cm and 42.14 kg respectively. Several researchers have reported the mean height and weight of adolescent girls; a study showed the mean height and weight of the study subjects in all age groups were 148.074cm ± 5.68 and 42.89kg ± 5.43 respectively; another study on semi urban Nepalese adolescent girls found the mean height and weight of all girls was 150.1± 6.7cm and 42.89kg ± 6.2kg respectively (8). According to a study the mean height of subjects was 147.1 cm and 38.7 kg. The maximum increase in the height was observed between 10 and 14 years of age and later it got stabilized. The maximum increase in the weight was observed between 10 and 14 years of age and later it got stabilized (9).

The mean BMI of adolescent girls in the present study was 18.39 kg/m2 which is in the underweight category. According to a study the mean BMI of girls was 15.38 (SD 3.18) and further demonstrated that the tribal vulnerable group tend to higher rates of growth retardation and prevalence of undernutrition. It may be due to inadequate food intake, health care facilities and socio-economic inconvenience among these tribal populations propagate the vicious cycle of undernutrition (10).

Weight-for-age, expressed as percentage or Z-score of individual weight to the median or 50th percentile of the international population references (i.e., WHO/NCHS growth references) is generally considered as one of the indicators of underweight (11). Height-for-age is considered as one of the best indicators of stunting or short stature of individuals due to under-nutrition (11). The present study showed that the mean Height Z Scores of the adolescent girls ranged between -0.40 to -0.69 whereas the mean Weight Z Scores ranged between -0.49 to -0.78 A study also reported the negative Z scores for height and weight of adolescent girls -1.59±1.04 z-score and -0.35±2.76 respectively (12).

The present study shows that 6.46% and 1.55% adolescent girls were stunted and severely stunted respectively. This finding indicate that while the majority of tribal adolescent girls exhibit normal growth patterns, a small but notable percentage still experience growth retardation. When compared with other studies, the present study showed a relatively lower prevalence of stunting. For instance, a study conducted among girls aged 5–18 years in Sagar

(Central India), reported a slightly lower stunting rate of 5.4%. However, higher stunting rates have been reported in other regions (13). The researchers observed a 29.7% prevalence among rural adolescent girls in North India (14), while another reported 43.5% mildly stunted, 28% moderately stunted, and 5% severely stunted cases (15).

The fundamental cause of stunting lies in long-term, cumulative deficiencies in nutrition and healthcare, particularly during early childhood (12). A study reported that 76.7% of adolescent girls were stunted based on height-for-age Z-scores, with 42% moderately stunted and 34.7% severely stunted, leaving only 23.3% within the normal range (16). Several research studies on tribal population of India reported that prevalence of chronic energy deficiency was high among tribal population (17).

These findings are encouraging compared to other studies. For instance, a study reported that 43% of adolescent girls in rural West Bengal were underweight, a stark contrast to the low percentage of wasting observed in the present study (18). Similarly, an another study found a 27% prevalence of underweight among adolescent girls in tribal areas of Madhya Pradesh, which again is significantly higher than our study's findings (19). A study involving tribal adolescents across India, 52% were reported to be underweight based on weight-for-age data. In comparison, the present findings reflect a significantly better nutritional profile among the tribal adolescent girls (20).

The prevalence of underweight (3.11%) and overweight/obesity (6.46%) in current population is relatively low when compared to national and regional studies. For instance, a conducted in Eastern Uttar Pradesh found that 23.1% of adolescent girls were underweight and 7.3% were overweight or obese (21). Similarly, another study reported 18.8% undernutrition among tribal adolescent girls in Gujarat (22). On the other hand, the overweight and obesity levels observed in this study are comparable to findings which reported that 6.3% of Indian adolescents were overweight or obese, highlighting the early signs of a nutrition transition among adolescent populations even in tribal and rural areas (23).

Association between Socioeconomic Status and Anthropometric Measurements

The present study aimed to assess the association between various socioeconomic variables and the Z scores of heights, weight, and BMI among children. Several significant relationships were observed, indicating the influence of parental education, family structure, and socioeconomic status on the nutritional status and growth parameters of children.

Height Z Score

A statistically significant associations were observed between father's educational qualification (p = 0.007) and the socioeconomic status (p = 0.002) with the height Z scores. These findings suggest that children from families where fathers are more educated and from higher socioeconomic backgrounds have better linear growth outcomes.

This is consistent with prior research which emphasized the impact of parental education and income on adolescent growth outcomes, particularly in tribal and rural populations (24). Moreover, another study also highlighted that socioeconomic indicators such as parental education and occupation directly influence long-term nutritional outcomes like stunting and height (25). This finding aligns with observations by experts who noted that family structure can influence dietary habits and food distribution among children and adolescents (26). Larger families may experience resource dilution, where per capita food and nutrition access is reduced, especially in low-income groups (27).

Other factors like mother's education, type of family, and parental occupations were not significantly associated with height Z scores, suggesting these may play a secondary or indirect role.

Weight Z Score

Among the tested variables, only the type of family showed a statistically significant association with weight Z scores (p = 0.044). Children from joint families may benefit from enhanced caregiving and social support, potentially leading to better nutritional outcomes.

This finding is consistent with a study which found that children in extended families had better weight-for-age scores compared to those in nuclear families due to shared resources and improved caregiving (28). Other variables, including education and occupation of parents and socioeconomic status, did not show a significant correlation with weight, although several studies have indicated mixed results on this association. For example, a study suggested that SES and parental education influence weight indirectly through access to food and health services (29).

BMI Z Score

A highly significant association was found between number of family members and BMI Z scores (p = 0.000). This indicates that larger families might face resource constraints, leading to nutritional disparities among children.

This is supported by findings from a study which reported that children from larger families were at greater risk of undernutrition due to limited food availability and reduced individual care (31). The lack of significance in other variables such as parental education, occupation,

and SES for BMI Z scores may suggest that BMI is more sensitive to immediate household dynamics rather than broader socioeconomic indicators.

Conclusion

This study demonstrates that different socioeconomic variables influence various aspects of child growth and nutrition. Specifically, the Height Z scores were significantly influenced by father's education and socioeconomic status; Weight Z scores were influenced by family structure and ;BMI Z scores were closely associated with the number of family members.

These findings align with previous research and underscore the importance of considering specific socioeconomic dimensions in nutritional assessments and interventions for children. Efforts to improve child nutrition must address educational, economic, and familial factors simultaneously to be effective.

Declarations

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Authors' Contributions

Conceptualization: RS; Methodology: MS; Investigation: MS; Formal analysis: RS; Data curation: MS; Writing original draft: MS; Writing review and editing: MS; Supervision and project administration: RS. All authors approved the final manuscript.

Ethics statement

All participants provided informed consent prior to participation. Participation was voluntary, and confidentiality of responses was strictly maintained. The study was conducted in accordance with the principles of the Declaration of Helsinki and applicable local regulations.

Conflict of Interest Declaration

The authors declare that they have no affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript.

AI tool use Disclosure

AI tools were not used for data generation or analysis. They were used only for language and reference editing. The authors take full responsibility for the final manuscript.

Data Availability

Data is available with the first author. Individual level data are not publicly shared to protect participant privacy but may be provided upon reasonable request.

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References:

1. Priyadarshini V and Biswal G. Anthropometry assessment of nutritional status of tribal adolescent girls of Keonjhar District, Odisha, *2023;J. Res. ANGRAU. 51 (2) 77-88.* https://doi.org/10.58537/jorangrau.2023.51.2.09

2. Karuppiaha J and Santhanam G. Anthropometrical profile and knowledge on nutrition among tribal adolescent girls in Kodaikanal. *National Journal of Advanced Research.2016, 2 (2) 25-27. https://www.thestudiesjournal.com/assets/archives/2016/vol2issue2/2-2-23-866.pdf*

3. Majee A.M and Roy D. Anthropometric Characteristics, Body Composition and Nutritional Status of Sabar Tribal People of Jhargram District of West Bengal, India. *International Journal of Medical Science and Dental Research. (2023); 6 (3):19-38* https://doi.org/10.18203/2394-6040.ijcmph20220717

4. Beck P. and Mishra BK. Anthropometric Profile and Nutritional Status of Selected Oraon Tribals in and Around Sambalpur Town, Orissa. Stud *Tribes Tribals.(2011); 9(1): 1-9* https://doi.org/10.1080/0972639X.2011.11886623

5. Mandal I, Hossain S R. Update of modified Kuppuswamy scale for the year. Int J Community Med Public Health.2024; 11:2945-6. .https://doi.org/10.18203/2394-6040.ijcmph20241863

6. Jelliffe D B. The assessment of the nutritional status of the community. World Health Organization Monograph, Series No. 53, Geneva. (1966) ; 50-84 https://pubmed.ncbi.nlm.nih.gov/4960818/

7. Khadilkar, V., Yadav, S., Agrawal, K. K., Tamboli, S., Banerjee, M., Cherian, A., Goyal, J. P., Khadilkar, A., Kumaravel, V., Mohan, V., Narayanappa, D., Ray, I., & Yewale, V. Revised Indian Academy of Paediatrics Growth Charts for height, weight and body mass index for 5- to 18-year-old Indian children. *Indian Pediatrics*, (2015); *52*(1): 47–55. https://doi.org/10.1007/s13312-015-0566-5

8. Nanda S and Dhar R.N. A Study on Health Status of Adolescent Girls of Dongria Kondh Tribe. *Scholars Journal of Applied Medical Sciences (SJAMS) .2018; 6(3): 964-968* DOI: 10.36347/sjams.2018.v06i03.031

9. A. Saibaba, M. Mohan Ram, G.V. Ramana Rao, Uma Devi, T.S. Syamala..Nutritional status of adolescent girls of urban slums and the impact of IEC on their nutritional knowledge and practices .*Indian Journal of Community Medicine.2002; Vol. XXVII:4. https://www.researchgate.net/publication/45261755_*
doi: 10.1017/S002193200600160X. Epub 2006 Nov 3. PMID: 17083747

10. Maiti.S, Ghosh.D, Paul.S. Determinants of nutritional status among tribal adolescent in girls Paschim Medinipur district of west Bengal.Int J Prev Med. 2012; 4:298-9. https://pmc.ncbi.nlm.nih.gov/articles/PMC3354402/

11. Maken. T and Varte L.R. Nutritional status of children as indicated by Z scores of the Hmars: A tribe of N.E. India*Antrocom Online Journal of Anthropology 2012*.(2016); *8. (1): 1973 – 2880* *https://antrocom.net/wp/wp-content/uploads/2024/06/Antrocom-8-1-2012.pdf*

12. Kuiti B.K., Acharya S., Satapathy K.C, Barik D.K. and Patra P.K. Composite index of anthropometric failure(ciaf) among juang children and adolescents of Keonjhar District in Odisha, India. *Man, environment and society* (2022): *3(1): 133-154* https://DOI: 10.47509/ MES.2022.v03i01.10

13. Thakur R. and Gautam R.K. Assessment of nutritional status among girls of 5-18 years of ageof a Central Indian City (Sagar) *Human Biology Review (ISSN 2277 4424).* (2015); *4(4): 325-336* https://www.humanbiologyjournal.com/article/assessment-of-nutritional-status-among-girls-of-5-18-years-of-age-of-a-central-indian-city-sagar/

14. Malhotra A, Passi SJ. Diet quality and nutritional status of rural adolescent girl beneficiaries of ICDS in north India. AsiaPac J Clin Nutr. 2007; 16:8-16.

15. Jeyakumar. A and Ghugre. P. Is lack of breakfast contributing to nutrient deficits and poor nutritional indicators among adolescent girls?. Article *in Nutrition and Health* .(2017); DOI: 10.1177/0260106017721074

16. Das D. and Gautam. R.K. Growth and nutritional status among adolescents of Dongria Kondh- a PVTG of Niyamgiri hills of Odisha, India. Human Biology Review (ISSN 2277 4424) (2022); 11(1): 54-65 https://www.researchgate.net/publication/358199762

17. Parvin N and Khan I. Anthropometric assessment of nutritional status among the birhor females of purulia district, west Bengal, India . *International Journal of Bio-Science and Bio-Technology (IJBSBT) .2020; 12* *https://thinkindiaquarterly.org/index.php/ijbsbt/article/download/19920/14741*

18. Ghosh, S. Exploring socio-cultural context of nutritional status of adolescent girls in rural West Bengal*Indian Journal of Maternal and Child Health*.(2014); *16*(2): 1–8.

19. Choudhary, S., Mishra, C. P., & Shukla, K. P. Nutritional status of adolescent girls in tribal block of Chhattisgarh.*Indian Journal of Preventive & Social Medicine*.(2014);*46*(1-2):26–30 Doi: 10.4103/ijcm.IJCM_369_18

20. Toteja, G. S., Singh, P., Dhillon, B. S., Saxena, B. N., Ahmed, F. U., Singh, R. P., & Singh, Y . *Micronutrient deficiency disorders in 16 districts of India*. New Delhi: Indian Council of. Medical Research. (2006); DOI: 10.1007/BF02722689

21.Singh, N., and Mishra, C. P. Nutritional status of adolescent girls of a slum community in Varanasi. *Indian Journal of Community Health*. (2017); *29*(1): 78–83.

22.Mehta, M. N, Shah, R. S., & Gandhi, M. R. Nutritional status of adolescent girls from an urban slum area in Western India. *Indian Journal of Medical Sciences*.(2013); *67*(5-6): 247–252. PMID: 19390806 DOI: 10.1007/s12098-009-0077-2

23. Venkaiah, K, Damayanti, K., Nayak, M. U., & Vijayaraghavan, K. Diet and nutritional status of rural adolescents in India. *European Journal of Clinical Nutrition.* (2002); *56*(11): 1119–1125. PMID: 12428178DOI: 10.1038/sj.ejcn.1601457

24. Kumar, R, Singh, M, & Singh, R. Effect of socioeconomic status and parental education on adolescent nutritional health in tribal areas of Jharkhand. *Indian Journal of Nutrition and Dietetics*. (2018);*55*(1):43–50.

25. Sharma, A, & Mahajan, R. Impact of parental education on the nutritional status of adolescents: A cross-sectional study in Northern India. *Asian Journal of Clinical Nutrition*. (016); *8*(3): 52–60.

26. Agarwal. S, Srivastava, A., & Agarwal, A. Socioeconomic determinants of nutritional status among adolescents in India: A review. *International Journal of Community Medicine and Public Health*.(2017);*4*(3):624–628. https://www.researchgate.net/publication/327223791

27. Patel, N., and Singh, K . Association between family size and nutritional status among adolescent girls in rural Uttar Pradesh.*Journal of Social Health and Nutrition*. (2020); *2*(1): 1 DOI: https://doi.org/10.17511/ijpr.2021.i02.025–20.

28. Deshmukh, P. R, Dongre, A. R, Gupta, S. S, et al. Nutritional status of adolescents in rural Wardha. *Indian Journal of Paediatrics.(*2010) ;77(2):171–174.

29. Singh, R. K, Patra, S. Effect of parental education on nutritional status of children in India. *Maternal and Child Health Journal*.(2019);23(8):1112–1120. https://doi.org/10.1007/s10995-019-02762-7

30. Agarwal K. N, Agarwal, D. K, et al. Impact of family size and birth order on nutritional status of under-five children in India. *Indian Pediatrics*. (2016); 53(10): 837–840. doi: 10.12669/pjms.336.13689