

Nutritional Status and Dietary Diversity among Adolescents in Rural Koraput, India

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Abstract

Adolescent nutrition is vital for healthy growth, preventing health complications and breaking the cycle of malnutrition. In India, addressing this issue is crucial, as studies indicate a high prevalence of stunting and undernutrition among adolescents. This study aims to assess the nutritional status and dietary diversity patterns among rural adolescents in Koraput district, Odisha, India. A cross-sectional study was conducted among 305 adolescents aged 10–19 years. Body Mass Index (BMI) was calculated using WHO Anthro-Plus, and dietary patterns were assessed via a 24-hour recall method following FAO (2010) guidelines. Underweight was present in 56.1% of these adolescents. There was no significant difference in BMI between males and females. The Individual Dietary Diversity (IDD) score of most individuals ranged from 5 to 8, and the mean IDD score was 6 out of 12. The IDD score had a positive and statistically significant correlation with BMI. The study revealed that both BMI and IDD are influenced by inadequate dietary diversity and limited food choices. This highlights the need for interventions to promote healthy nutrition and ensure overall growth.

Keywords: Nutritional assessment, Dietary diversity, Adolescents, Body mass index, Dietary score, Malnutrition

1 Introduction

Nutritional assessment helps to discover and treat dietary deficiencies, imbalances, and other nutritional issues that may harm health. Nutritional assessment and therapy are effective ways to break the cycle of malnutrition and nutritional deficits (Kesari & Noel, 2022). Rapid physical, mental, and physiological growth during adolescence requires proper diet and care. Adolescent undernutrition can cause stunted growth, immune system weakness, anaemia, and cognitive impairment (Ersado et al., 2023).

Individual Dietary Diversity (IDD) is a measure for the variety and quality of an individual's food over a specified time period and can be used to assess dietary adequacy. Studies found that the use of nutrition screening and assessment in the community setting resulted in reduced healthcare costs by preventing or treating malnutrition-related complications (Reber et al., 2019). In India, the National Family and Health Survey uses adult nutritional status cutoffs to estimate undernutrition and overnutrition in the 15–19 age range. According to NFHS-5 (2021) data, in Odisha, 36% of women aged 15–19 years have a BMI below 18.5, while 6.4% of females and 32.9% of males in the same age group are overweight or obese. Adolescent nutrition in Odisha has remained poor for decades, with minimal signs of improvement. According to the International Institute for Population Sciences (2021), approximately 23.2% of girls aged 15–19 years in the state have a BMI below the normal range, reflecting widespread undernutrition. Dietary deficiencies are also evident, as only 45% of adolescents reported making an effort to consume iron-rich foods daily.

Monitoring trends in undernutrition and dietary diversity is crucial for evaluating the effectiveness of past and ongoing programs, as well as for formulating appropriate policies and interventions. While

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most studies on adolescent nutrition in Odisha have focused either on anthropometric measurements or on dietary intake, very few have sought to establish a correlation between the two. According to statistics from the District Nutrition Profile, Koraput district of Odisha, where the present study was conducted, ranks 541 out of 599 Indian districts (Singh, 2022). Moreover, Koraput district, predominantly inhabited by tribal communities, relies mainly on cereal-based diets that lack substantial amounts of fruits, vegetables, animal-source foods, and dairy products, resulting in very low dietary diversity (Nithya & Bhavani, 2018). Malnutrition during adolescence impairs linear growth and sexual maturation, weakens the immune system, reduces cognitive ability, lowers educational performance, and increases the lifetime risk of anaemia, infections, heart disease, and adverse pregnancy outcomes (Black et al., 2013; Patton et al., 2016). These health consequences are further exacerbated by food insecurity, recurrent infections, and structural exclusion among tribal communities in India, perpetuating undernutrition across generations (Ministry of Health . . . & ICMR, 2018).

Thus, the current study seeks to determine the nutritional status among rural adolescents in the Koraput district using anthropometric and dietary measurements and the relationship between these two parameters.

2 Methods

2.1 Study design and setting

A community-based cross-sectional study was conducted in five villages of Koraput district, Odisha, a predominantly tribal region characterized by limited access to diversified diets and poor socioeconomic conditions.

2.2 Study population and sample size

A total of 305 adolescents aged 10–19 years (WHO, 2024) participated in the study. Among them, 215 were recruited through schools using class registration lists in collaboration with teachers, while 90 were recruited through door-to-door household visits.

The adequacy of the sample size was established using the single population proportion formula:

$$n = \frac{Z^2 p(1-p)}{d^2}, \quad (1)$$

where n is the required sample size, Z is the standard normal deviate at 95% confidence level (1.96), p is the estimated prevalence of undernutrition (25% based on NFHS-5, Odisha; NFHS-5, 2021), and d is the margin of error (0.05). Based on this calculation, the minimum required sample size was $n = 288$. Considering possible non-response, a total of 305 adolescents were recruited, which was statistically adequate to generalize the findings.

2.3 Inclusion and exclusion criteria

The study included adolescents aged 10–19 years who were permanent residents of the selected villages and available at the time of data collection. Adolescents with visible physical deformities, chronic illness, or acute illness on the day of measurement were excluded to avoid anthropometric inaccuracies.

2.4 Anthropometric Assessment

Height was measured using a portable anthropometric rod with participants standing upright and barefoot, while weight was recorded using a calibrated digital weighing scale with participants in light clothing and without footwear. Height and weight were recorded in cm and kg, respectively. Body mass index (BMI)

was calculated and analysed using WHO AnthroPlus software. Nutritional status was classified according to BMI-for-age Z-scores (BAZ) based on the WHO (2007) growth reference. Severe thinness was defined as $BAZ < -3SD$, thinness as $BAZ < -2SD$, normal weight as BAZ between $-2SD$ and $+1SD$, overweight as $BAZ > +1SD$, and obesity as $BAZ > +2SD$.

2.5 Dietary assessment

Individual Dietary Diversity (IDD) was assessed using the 24-hour recall method and a questionnaire developed by FAO (2010). The questionnaire covered 12 food groups, and each group consumed within the recall period contributed a score of one point. Based on FAO recommendations, a score of 1–4 was categorized as poor dietary diversity, 5–8 as fair, and 9–12 as good. Although based on a 24-hour recall, consumption patterns were observed to be consistent over time.

2.6 Statistical analysis

Data were first entered in Microsoft Excel and subsequently analyzed using SPSS version 22.0. Descriptive statistics, including mean and standard deviation for continuous variables and frequencies with percentages for categorical variables, were used to summarize the data. Independent-samples t-tests were applied to compare continuous variables such as BMI and IDD between boys and girls, while χ^2 tests were used for categorical variables. The Pearson correlation coefficient was employed to assess the relationship between BMI and IDD. A p-value of less than .05 was considered statistically significant.

3 Results

Koraput is a tribal-dominated area with limited economic opportunities. As shown in Table 1, the mean age of the adolescents was 14.32 years, with a higher proportion in the 15–19-year age group (62.6%). Males constituted 62.9% of the sample. A large majority (86.6%) were students, while only 11.5% worked as daily wage labourers. Educational attainment was mostly up to the secondary level, and substance use such as smoking or tobacco consumption was negligible (<1%).

Table 1: Socio-demographic and lifestyle information, $n = 305$

Variables	Frequency	%
<i>Gender</i>		
Male	192	62.9
Female	113	37.1
<i>Age (in years)</i>		
10–14	114	37.4
15–19	191	62.6
Mean age (SD)	14.32 ± 2.04	
<i>Educational qualification</i>		
5 th –6 th	112	36.7
7 th –10 th	189	62.0
Others (ITI, diploma, intermediate & graduate)	4	1.3
<i>Occupation</i>		
Student	264	86.6
Labourer	35	11.5

Table 1 (continued)

Variables	Frequency	%
Other (potter, driver)	6	1.9
Vices		
Smoking	1	0.3
Tobacco	3	1.0
No substance use	301	98.7

Table 2 depicts the gender-wise distribution of mean height, weight, and BMI among the studied population. The analysis revealed that males had significantly greater mean height, while differences in BMI and weight between genders were not statistically significant.

Table 2: Gender-wise distribution of mean height, weight, and BMI (mean $\pm$ standard deviation), with t statistic and p value for the sex differences

Variable	Total	Female	Male	t	p
BMI	17.35 $\pm$ 2.44	17.66 $\pm$ 2.55	17.18 $\pm$ 2.30	2.02	0.06
Height	151.30 $\pm$ 10.46	149.10 $\pm$ 8.50	152.60 $\pm$ 11.70	2.85	0.01
Weight	40.27 $\pm$ 9.17	39.20 $\pm$ 8.10	40.90 $\pm$ 9.70	1.56	0.12

Note. Values are mean $\pm$ SD. t = Student's t statistic; p = two-tailed p value.

Table 3 depicts the BMI status of the studied individuals. A higher proportion of participants were underweight (56.07%), while 31.8% had a normal BMI. The combined prevalence of overweight and obesity was relatively low, accounting for 12.13% of the total population.

Table 3. BMI status of the adolescents

Table 3: BMI status of the adolescents by sex (counts and percentages).

Categories	Total		Boys		Girls		p-value χ^2
	No.	%	No.	%	No.	%	
Underweight	171	56.1	113	59.5	58	50.4	0.37 (3.55)
Normal	97	31.8	58	30.5	39	33.9	
Overweight	25	8.2	12	6.3	13	11.3	
Obese	12	3.9	7	3.7	5	4.4	

Note. p -values from Pearson's χ^2 test. Totals equal boys + girls by construction.

Figure 1 depicts the BMI distribution of the studied individuals in comparison to the WHO (2007) BMI-for-age reference. The graph of the studied population was shifted to the left, indicating that a higher number of adolescents had lower BMI values compared to the WHO standard. The classification of underweight was based on WHO cut-off values, with adolescents below -2 SD categorized as underweight.

Table 4 presents the distribution of various food groups by gender. Cereals, legumes, nuts, seeds, oils, and fats were staple food items for the studied population, with the main staples consumed daily. Although some dietary differences existed, most fruits, meat, fish, and other seafood were not commonly consumed. To assess gender-based differences in food consumption, a χ^2 test was performed for each food group independently. The overall p value of .28 indicated no significant differences in consumption between males and females.

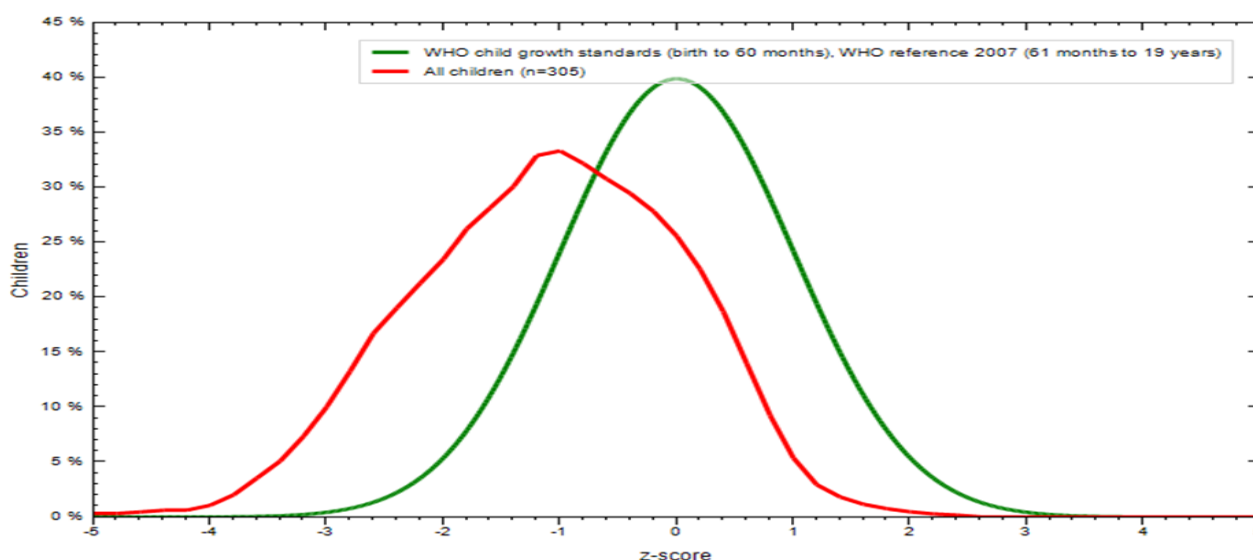


Figure 1: BMI distribution of the studied adolescents compared with the WHO (2007) reference sample

Table 4: Gender-wise distribution of different food groups (n = 305)

Food groups	Total		Female		Male	
	No.	%	No.	%	No.	%
Cereals	305	100	113	100	192	100
White tubers & roots	14	4.6	5	4.4	9	4.7
Vegetables	305	100	113	100	192	100
Fruits	3	1.0	3	2.7	0	0
Meat	11	3.6	1	0.9	10	5.2
Eggs	12	3.9	6	5.3	6	3.1
Fish & other seafood	3	1.0	1	0.9	2	1.0
Legumes, nuts, seeds	291	95.4	111	93.2	180	93.8
Milk & milk products	38	12.5	16	14.6	22	11.5
Oil & fats	301	98.7	111	98.2	190	99.0
Sweets	41	13.4	17	15.0	24	12.5
Spices	303	99.2	113	100	190	99.0

Table 5 presents the gender-wise distribution of IDD scores among the studied individuals. The scores were categorized into three ranges: 1–4 (poor), 5–8 (fair), and 9–12 (good). The results show that the vast majority of individuals had scores within the 5–8 range, indicating moderate dietary diversity, while only a few had poor or good dietary diversity scores. The χ^2 test indicated no significant differences in IDD scores between males and females.

Table 5. Gender-wise distribution of IDD scores among the studied individuals**Table 5:** Gender-wise distribution of IDD scores among the studied individuals.

Score range	Total No.	Total %	Female No.	Female %	Male No.	Male %	p-value χ^2
1 to 4 (poor)	7	2.3	1	0.9	6	3.1	0.66 (1.72)
5 to 8 (fair)	297	97.4	111	98.2	186	96.9	
9 to 12 (good)	1	0.3	1	0.9	0	0.0	

Note. Values are counts and percentages. *p*-value from Pearson's χ^2 test.

Table 6 presents the relationship between mean BMI and IDD scores. For analytical purposes, the IDD scores were dichotomized at a cut-off of 6, which represents the midpoint of the “fair” dietary diversity range (5–8). This cut-off was selected to differentiate individuals with relatively lower dietary diversity from those with relatively higher dietary diversity within the fair category. The correlation analysis showed a significant positive association between IDD and BMI ($r = .33$, $p < .05$). Furthermore, the mean BMI was significantly higher among individuals with IDD scores ≥ 6 compared to those with IDD scores < 6 , as indicated by the independent sample t-test.

Table 6: Association of IDD score with BMI

IDD score	Mean BMI ($\pm$ SD)	<i>t</i> value (<i>p</i>)
< 6	16.4 $\pm$ 2.4	3.18 (0.002)
≥ 6	17.5 $\pm$ 2.4	

4 Discussion

According to the current study, the prevalence of undernutrition among adolescents in Koraput is 56.1%, based on BMI-for-age Z-score classifications. The mean BMI of 17.35 provides further context for understanding the overall nutritional status of the study population. This high number raises concerns about this group's nutritional status and overall health. Individuals who are malnourished, as indicated by being underweight, are at risk of weakened immunological function and stunted growth. Earlier research conducted in rural West Bengal revealed a 52.5% prevalence of undernutrition and stunting (Das et al., 2007). The available literature on adolescent nutrition in Koraput appears limited, and studies specifically focusing on this district are relatively scarce. The prevalence of overweight across Indian adolescents has been reported to range between 2.28% and 21.9%, and obesity between 2.4% and 17.6% (Sharma et al., 2024). These findings suggest that while the prevalence of obesity among Indian adolescents varies regionally, many are at risk of developing obesity-related health problems such as diabetes, heart disease, joint problems, and other chronic disorders in adulthood (Anderson & Durstine, 2019). However, in this study, the prevalence of overweight and obesity was low, which suggests that adolescents in this district are not currently facing the ‘double burden of malnutrition’ that is observed in many other parts of India.

Tobacco, alcohol, and smoking are prevalent among the adult population of Koraput (Bindhani et al., 2024). In the present study, only 0.33% of adolescents reported smoking and 0.98% reported consuming tobacco. Although the prevalence is relatively low, this stage of life may represent the period when individuals begin experimenting with such habits. Early initiation, even on a small scale, can gradually

progress into addiction in later years, which in turn can negatively influence nutritional status and overall health. Therefore, proper awareness and preventive interventions at school, family, and community levels are essential to discourage the adoption of such risky behaviours during adolescence. Similar studies have revealed that adolescents who smoke or use tobacco often make poor food choices, which can contribute to inadequate nutritional intake (Dowdell & Santucci, 2004).

The present study emphasizes the importance of dietary diversification among adolescents. According to the data, 97.4% of individuals had dietary diversity scores ranging from 5 to 8, indicating moderate dietary diversity. However, targeted interventions and nutrition education may still be useful to improve overall dietary habits (Ekesa et al., 2011). The low dietary diversity observed in this study is likely influenced by economic constraints, as many families cannot afford costlier food items such as meat, fish, eggs, milk, and fruits. Other contributing factors may include intra-familial distribution of food, food taboos, and dietary restrictions, which can all shape dietary intake and food selection among adolescents (Kera et al., 2024). A key recommendation to address this issue is the implementation of poverty alleviation measures. The unexpectedly low consumption of fruits in our study may be linked to seasonal availability.

The analysis of individual dietary diversity, assessed using the 24-hour dietary recall method, revealed that a considerable proportion of participants with lower dietary diversity scores also exhibited BMI values below the normal range (see Table 6). This suggests that the economic constraints that lead to undernutrition also restrict dietary diversity. Ensuring access to a wider variety of nutritious foods could therefore play an important role in improving their overall nutritional status. Similar studies have highlighted the importance of addressing nutritional concerns that extend beyond overweight and obesity (Gittelsohn & Sharma, 2009). In the present study, the predominant dietary pattern consisted mainly of cereals, legumes, nuts, seeds, oils/fats, and vegetables, with relatively lower consumption of fruits, meat, fish, and shellfish. Evidence from other impoverished settings has shown that adolescents are likely to experience malnutrition due to limited access to diverse food groups, particularly protein-rich items such as meat, fish, and milk (Ravula et al., 2024).

Cultural and socioeconomic factors have an impact on people's eating patterns, highlighting the significance of implementing particular nutritional interventions. There is no tradition of vegetarianism among the studied population; rather, they consume one or more varieties of non-vegetarian food items. Studies also revealed that there remains a close relationship between dietary intake and cultural and socioeconomic factors (Li, Y., 2020). According to the present study, all participants consumed cereals and vegetables (100%), while almost all consumed legumes, nuts, and seeds (95.4%) and oils/fats (98.7%). In contrast, the intake of fruits (1%), fish/seafood (1%), and meat (3.6%) was very low. Milk and milk products were consumed by only 12.5% of participants, and eggs by 3.9%. It is noteworthy that there was a gender-based disparity in consumption. For example, fruit consumption was reported only among females (2.7%), while no males consumed fruits. Meat consumption was much higher among males (5.2%) than among females (0.9%). Similarly, females reported slightly higher intake of eggs (5.3% vs. 3.1%) and milk products (14.6% vs. 11.5%). This suggests a potential association with gender-based nutritional requirements or preferences. Possible reasons for this variation include differences in growth rates, body composition, and metabolic needs during adolescence, which may lead to varying dietary preferences and consumption patterns. Additionally, cultural factors such as food taboos prevalent in this tribal region could also contribute to these differences.

Overall, most participants consumed between 5 and 8 food groups, indicating a moderate level of dietary diversity. However, a more quantitative assessment of food intake based on nutrient guidelines would provide a clearer understanding of diet adequacy. Further research is needed to analyse the precise nutrient composition of these diverse meals to evaluate their ability to meet nutritional requirements (Remans, 2011).

5 Conclusion

This study highlights the concerning prevalence of undernutrition among adolescents in rural Koraput, with 56.1% of the studied population classified as underweight. In contrast, the prevalence of overweight and obesity remains relatively low, at 8.2% and 3.9% respectively. The findings suggest that economic constraints and limited access to diverse food groups have contributed to the observed dietary patterns, with most adolescents primarily consuming cereals, legumes, nuts, seeds, oils, and fats, while the intake of fruits, meat, fish, and dairy products is comparatively low. The study also found no significant difference in BMI between males and females, although slight variations in dietary diversity were observed based on gender, which may be influenced by growth-related nutritional needs and cultural food taboos. The Individual Dietary Diversity (IDD) score analysis revealed that 97.4% of adolescents had a moderate level of dietary diversity (scores ranging from 5 to 8). Furthermore, a positive correlation between IDD and BMI was observed ($p < .05$), suggesting that a more varied diet contributes to better nutritional status.

These findings emphasize the urgent need for targeted nutritional interventions focusing on poverty alleviation, dietary education, and improved access to diverse food sources. Future research should explore the long-term impact of existing nutritional programs and develop sustainable strategies to enhance dietary diversity and nutritional adequacy in this vulnerable population. Addressing these challenges is essential for improving adolescent health outcomes and mitigating the long-term consequences of malnutrition in Koraput and similar rural regions of India.

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