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**Original Research Article**

# A cross-sectional study: assessment of undernutrition and anaemia prevalence among early adolescents of Bhandarahalli village, North Karnataka, India

**Chandana M., Netravati Hiremath***

Department of Nutrition and Dietetics, JSS AHER, Mysuru, Karnataka, India

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***Correspondence:**
Dr. Netravati Hiremath,
E-mail: netravatih@jssuni.edu.in



## ABSTRACT

**Background:** Adolescence is one of the critical periods in the life cycle phases in which each individual undergoes various physiological and psychological changes. Hidden hunger and undernutrition during adolescence are associated with growth impairment, poor cognition, lower immunity and higher susceptibility towards degenerative diseases in later periods. The purpose of the study was to assess undernutrition and anaemia prevalence among early adolescents in a rural area of Bhandarahalli, Karnataka.
**Methods:** A community-based cross-sectional study was conducted on government rural school children to assess their nutrition status including anaemia prevalence. Both male and female children (n=115) aged between 11 to 14 years were screened with the prior parent consent of participation acceptance. Anthropometric measurements and haemoglobin levels were measured by using standard tools and protocols. Screened adolescents were categorised based on the world health organisation's body mass index Z score.
**Results:** The study revealed a higher prevalence of anaemia among screened subjects where 59.26% of girls and 44.44% of boys are anaemic with a haemoglobin level of below 11 g/dL. Body mass index Z score for age revealed a higher prevalence of undernutrition among both genders.
**Conclusions:** The notably higher prevalence of anaemia and underweight among adolescents negatively affects the overall academic performance, productivity, and general well-being of adolescents; therefore, effective strategies need to be implemented to address these nutritional problems.

**Keywords:** Adolescents, Anaemia, Underweight, Nutritional status

## INTRODUCTION

Adolescence is one of the important milestones in the life cycle stages, in which each individual undergoes various physiological and psychological changes. Pubertal maturation marks the onset of adolescence and is predominantly driven by testosterone and oestrogen hormones in boys and girls respectively.[1,2] Rapid physical changes including skeletal growth and onset of menarche, and psychological changes in adolescents elevate the nutrient demands. In the adolescent phase, children gain around 40 per cent of their adult weight and15 per cent of their height, and up to 50 per cent of their skeletal mass in their adulthood.[3] It is considered to be a nutritionally vulnerable period due to the increased demand for nutrients to meet the growing requirements. Anaemia is one of the prominent manifestations of micronutrient deficiencies which is commonly prevalent among the vulnerable population including adolescents. In addition to this, undernutrition is also a common nutritional problem which has no apparent solutions and is a global issue, particularly among adolescents.[4] Micronutrient deficiencies and undernutrition in adolescence are associated with impaired growth, poor cognition, lower

immunity and higher susceptibility of children towards degenerative diseases in later periods. This in turn diminishes the school performance of adolescents and can hinder their growth and sexual maturation which in turn affects reproductive health outcomes, especially in girls.[5] Even though ample research work has been carried out on nutritional status assessment studies among adolescents, rural region-related studies in India are scanty. Therefore, the present study was undertaken to assess anaemia and undernutrition prevalence among school adolescents in Bhandarahalli village, North Karnataka, India.

## METHODS

### *Type of study and study population*

A community-based cross-sectional study was conducted in the government school of Bhandarahalli, one of the villages in the North Karnataka region. The study was carried out from February 2024 to March 2024. Early adolescent children aged between 11-14 years (n=115) were randomly chosen from the government school. In this study, both boys (n=61) and girls (n=54) of the same age group were randomly selected for the study.

### *Sample size calculation*

The sample size was determined using the sample size determination formula for a finite population of Bhandarahalli village (n=184). The sample size calculation was performed using the formula-

$n=Z^2 \times p \times (1-p)/e^2$

where Z (z-value) is 1.96 for a 95% confidence level, p is the estimated proportion of the population i.e. 0.5, e is the margin of error 0.05. Since the population is finite (184 adolescents), adjusted the sample size using the finite population correction: n adj=n ÷ 1 + (n-1/N) and the sample size was adjusted to 124 to account for the finite population size of 184 adolescents. The total sample size for the final screening was selected with the±10% difference.

### *Ethical consideration*

An ethical clearance certificate was obtained at the institutional level (JSSMC /IEC/260822/31NCT/2022-23) from the institutional ethical committee of JSS academy of higher education and research, Mysuru to conduct the study. Written informed consent was taken in the local language 'Kannada' from each adolescent's parent for the enrolment of each student under the study.

### *Inclusion and exclusion criteria*

Adolescent boys and girls aged between 11-14 years were selected for the study and adolescents suffering from any disease were excluded.

### *Data collection*

A preformed and validated questionnaire was used to collect information on socio-demographic status. The socioeconomic characteristics of the adolescents screened were investigated using Kuppuswamy's socio-economic scale.[6] Body composition and anthropometric parameters were assessed to know about malnutrition status by using standard protocols.[7] Anthropometric parameters *viz.,* height, weight, circumferences and skinfold thickness at different regions were assessed by using appropriate tools and techniques. Height was measured through a stadiometer with an accuracy nearest to 0.1 cm, and the weight of each student was measured to the nearest weight of 0.1 kg with accuracy. Body mass index (BMI) was derived from the previously measured height and weight by using the formula body weight divided by height squared in meters ($kg/m^2$). Harpenden calliper was used to measure skinfold thickness at different regions. Three consecutive values were taken for each anthropometric parameter. The mean of the three consecutive measurements was used as the representative value for each parameter. Body composition was analysed by Omron Hbf 702T digital body composition monitor.

### *Categorisation of adolescents according to WHO standard*

Further, screened adolescents were categorised based on BMI Z score for age given by the WHO. BMI Z score for age, specific for each gender was used to classify the adolescent's nutritional status as thin (BAZ<-2 SD), overweight with scores≥+1 SD to ≤+2 SD and obese with >+2 SD scores.[8]

### *Haemoglobin test*

To assess the anaemia prevalence, the blood sample was collected from the subjects with the assistance of a trained nurse. Haemoglobin content was analysed in whole blood obtained through the intravenous route and was drawn and taken from the acknowledged participants (n=108). Haemoglobin content was analysed in the intravenous blood through the cyanmethemoglobin method.[9] Adolescents with a haemoglobin level below 8 g/dL were categorised under the severely anaemic group, >8 gm/dl to <10.9 gm/dl grouped under moderately anaemic, and 11-11.9 g/dL as mildly anaemic, and Hb of 12 g/dL and above was considered as normal.[10]

### *Statistical analysis*

Data entry was done in MS excel and the result was analysed by using SPSS v29. The socio-demographic profile of the screened adolescents is expressed in percent. All measurements including anthropometric measurements are expressed with mean value along with standard deviation. Different categories of BMI Z scores according to age are expressed in percent. The categorical variable was appropriately coded for data entry.

Numerical data like age, weight, height, waist and hip circumference were entered as such. Statistical measures used were mean, median, standard deviation, and percentage. Z-statistic, t-test, Mann Whitney U test and chi-square test were applied as tests of significance. The statistical significance was evaluated at a 95% confidence level ($p<0.05$). Results were represented in tables.

## RESULTS

The details of the socio-demographic profile of the screened adolescents are presented in Table 1. In the present study, out of the 115 children, there were 54 girls and 61 boys with the age range between 11-13 years. Among the screened subjects, most of the adolescent children (83%) belonged to the Hindu religion and only 17% were from the Muslim religion. From the occupational data, it was revealed that most of the respondents' father's major occupation was farming which accounted for about 85%. Most families were nuclear type (77%) and only 23% belonged to joint families. According to the Kuppuswamy socioeconomic classification scale, it was found that 34% of families belonged to a lower middle class, 45% to the upper middle class and 21% of them were in the upper-class category.

The graphs illustrated the normal distribution of height and weight among boys and girls aged between 11-14 years. The blue curve represents the normal distribution fitting the height data, with a peak around 1.42±0.09 meters and 1.44±0.10 meters among boys and girls respectively, Similarly, the red curve represents the normal distribution fitting the weight data, which approximates a normal distribution but with a slightly wider spread compared to height. The histogram bars revealed that the most common weight among the boys was around 31.70±6.01 kgs and among girls 34.39±8.61 kgs. These distributions show that while height closely follows a normal distribution, weight shows greater variability, reflecting a wider range of weights in this age group as shown in (Figures 1 and 2).

The body composition of data of screened adolescents is presented in Table 2, it was revealed that mean fat per cent in girls and boys were 21.15±5.40 and 19.59±5.03 respectively. The average subcutaneous fat percent was 15.06±3.11 in girls whereas in boys it was 14.12±3.04. Total muscle per cent in screened girls and boys was 30.18±6.04 and 30.24±6.80 respectively.

To analyse the undernutrition status, the BMI Z score for age as given by the WHO was used as a reference, screened adolescents were categorised into different categories as normal, severely thin, thin, overweight and obese and the nutritional status is presented in Table 3. Among the screened subjects, a total of 46.09% (n=53) adolescents were in a normal category with a BMI Z score between -2SD to +1SD based on their age, where girl and boy adolescents account for 48.14% and 44.26% respectively.

Around 13.91% (n=16) fall under the severely thin BMI Z score (<-3 SD) category and a comparatively higher prevalence of severe thinness was found in boys (19.67%) as compared to girls (7.41%). A total of 28.70% were fall under the thin (BMI<-2SD) category and were according to the BMI Z score for age. A total of 10.44% were found to be overweight and a negligible per cent of obesity was observed.

Anaemia prevalence among screened subjects is presented in Table 4. Among girls, 35.19% (n=19) have moderate anaemia, with a mean haemoglobin of 10.03±0.54 g/dL whereas in boys it was found to be 22.22% (n=12) with an average haemoglobin value of 9.63±0.78 g/dL.

A higher prevalence of anaemic magnitude was observed in girls (59.26%) compared to that of boys (44.44%).

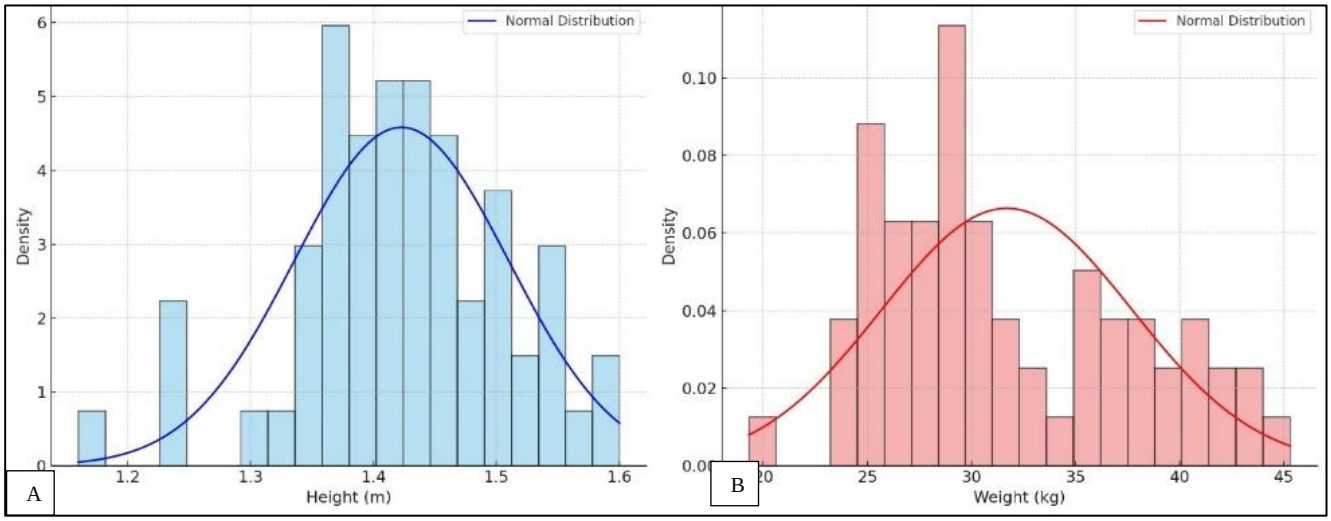


**Figure 1 (A and B): Normal distribution of height and weight among adolescent boys.**

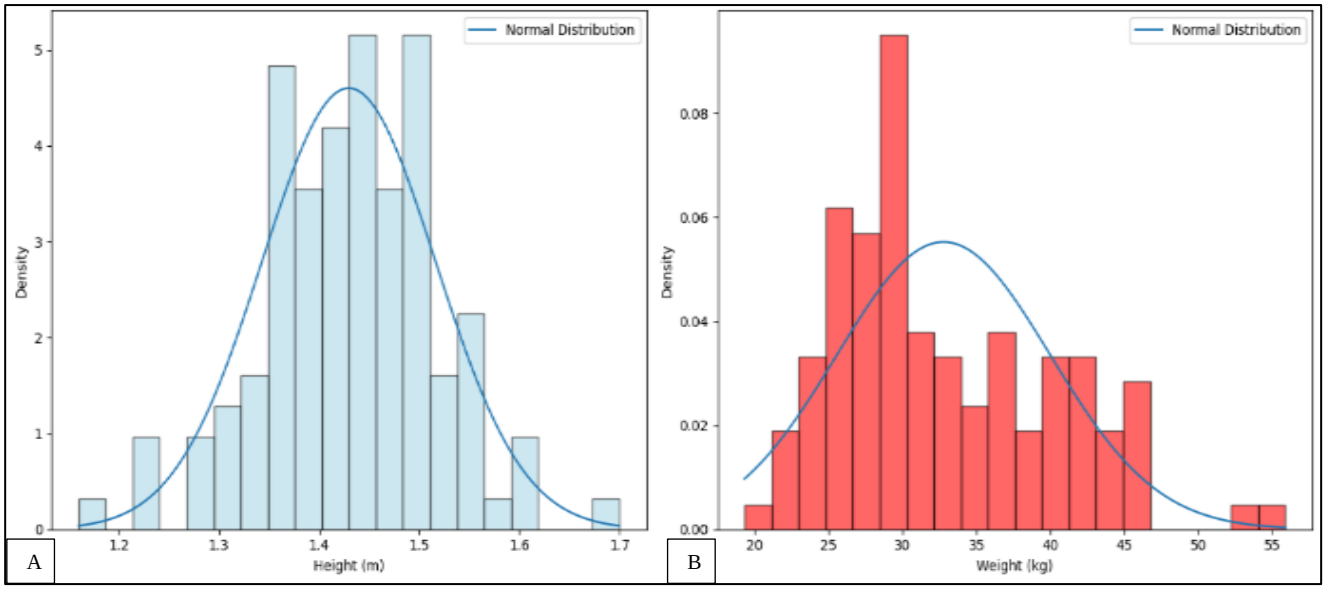


**Figure 2 (A and B): Normal distribution of height and weight among adolescent girls.**

**Table 1: Socio-demographic profile of the screened adolescents.**

| Socio-demographic characteristics | Girls, n=54 | | Boys, n=61 | | Total, n=115 | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| **Religion** | | | | | | |
| Hindu | 46 | 85 | 50 | 82 | 96 | 83 |
| Christian | 0 | 0 | 0 | 0 | 0 | 0 |
| Muslim | 8 | 15 | 11 | 18 | 19 | 17 |
| **Occupation of father** | | | | | | |
| Farmer | 47 | 87 | 51 | 84 | 98 | 85 |
| Driver | 2 | 4 | 5 | 8 | 7 | 6 |
| Laborer | 0 | 0 | 2 | 3 | 2 | 2 |
| Other | 5 | 9 | 3 | 5 | 8 | 7 |
| **Occupation of mother** | | | | | | |
| Housewife | 49 | 91 | 50 | 82 | 99 | 86 |
| Laborer | 1 | 2 | 5 | 8 | 6 | 5 |
| Farmer | 0 | 0 | 0 | 0 | 0 | 0 |
| Other | 4 | 7 | 6 | 10 | 10 | 9 |
| **Type of house** | | | | | | |
| Rented | 9 | 7 | 8 | 13 | 17 | 15 |
| Own | 45 | 83 | 53 | 87 | 98 | 85 |
| **Own land** | | | | | | |
| Yes | 51 | 94 | 46 | 75 | 97 | 84 |
| No | 3 | 6 | 15 | 25 | 18 | 16 |
| **Provision store/poultry** | | | | | | |
| Yes | 5 | 9 | 7 | 11 | 12 | 10 |
| No | 49 | 91 | 54 | 89 | 103 | 90 |
| **Monthly income of family in rupees (score)** | | | | | | |
| <2000 (lower) | 0 | 0 | 0 | 0 | 0 | 0 |
| <5000 (upper lower) | 0 | 0 | 0 | 0 | 0 | 0 |
| <9307 (lower middle class) | 14 | 26 | 25 | 41 | 39 | 34 |
| 9307-27882 (upper middle class) | 29 | 54 | 23 | 38 | 52 | 45 |
| 27883-46474 (upper class) | 11 | 20 | 13 | 21 | 24 | 21 |
| **Type of family** | | | | | | |
| Joint family | 13 | 24 | 13 | 21 | 26 | 23 |
| Nuclear family | 41 | 76 | 48 | 79 | 89 | 77 |
| Extended family | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 2: Fat and muscle distribution in early adolescents aged between 11-14 years.**

| Age (in years) | Fat (%) | | Subcutaneous fat (%) | | Muscle (%) | |
|---|---|---|---|---|---|---|
| | Girls | Boys | Girls | Boys | Girls | Boys |
| 11 | 22.44±7.44 | 20.59±5.43 | 15.47±3.65 | 14.26±3.76 | 28.58±7.36 | 30.93±5.89 |
| 12 | 22.10±4.75 | 20.98±4.89 | 15.63±2.45 | 14.6±1.91 | 30.17±6.46 | 29.25±8.27 |
| 13 | 19.89±3.41 | 17.92±4.44 | 14.57±2.92 | 13.70±2.97 | 31.36±4.63 | 30.26±6.77 |
| Total | 21.15±5.40 | 19.59±5.03 | 15.06±3.11 | 14.12±3.04 | 30.18±6.04 | 30.24±6.80 |

**Table 3: Categorisation of screened adolescents according to BMI Z score for age (WHO).**

| Categories based on Z score BMI for age | Total frequency, n (%) | | Total (%) |
|---|---|---|---|
| | Girls (54) | Boys (61) | |
| Severely thin (<-3 SD) | 4 (7.41) | 12 (19.67) | 13.91 |
| Thin (<-2 SD>) | 16 (29.63) | 17 (27.87) | 28.70 |
| Normal (<-2SD to <+1 SD) | 26 (48.14) | 27 (44.26) | 46.09 |
| Overweight (>+1SD) | 8 (14.81) | 4 (6.56) | 10.44 |
| Obese (>+2SD) | 0 (0) | 1 (1.64) | 0.87 |

**Table 4: Prevalence of anaemia among screened adolescents, (n=108).**

| Age (in years) and sample size | Mild anaemia | | | | Moderate anaemia | | | | Total anaemic | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Girls | | Boys | | Girls | | Boys | | Girls | | Boys | |
| | Hb (g/dl) | % (N) | Hb (g/dl) | % (N) | Hb (g/dl) | % (N) | Hb (g/dl) | % (N) | Hb (g/dl) | % (N) | Hb (g/dl) | % (N) |
| 11 (n=19[a], 19[b]) | 11.08± 0.15 | 21.05 (4) | 11± 00 | 35.19 (1) | 10.13± 0.62 | 21.05 (4) | 10.12± 0.64 | 26.3 2 (5) | 10.60± 0.66 | 14.81 (8) | 10.27± 0.67 | 31.58 (6) |
| 12 (n=9[a], 12[b]) | 11.57± 0.16 | 33.33 (3) | 11.50± 0.10 | 25 (3) | 9.86± 0.76 | 55.56 (5) | 9.08± 0.54 | 50 (6) | 10.50± 1.06 | 14.81 (8) | 9.89± 1.28 | 75 (9) |
| 13 (n=26[a], 23[b]) | 11.33± 0.24 | 23.08 (6) | 11.26± 0.34 | 34.78 (8) | 10.08± 0.42 | 38.46 (10) | 10.50± 00 | 4.35 (1) | 10.55± 0.72 | 29.63 (16) | 11.18± 0.41 | 39.13 (9) |
| 11-13 years (n=54[a], 61[b]) | 11.31± 0.26 | 13 (24.07) | 11.30± 0.31 | 22.22 (12) | 10.03± 0.54 | 35.19 (19) | 9.63± 0.78 | 22.2 (12) | 10.55± 0.78 | 59.26 (32) | 10.47± 1.03 | 44.44 (24) |

*Haemoglobin (Hb) content is mentioned as mean with standard deviation (SD); a and b: Total number of girls (a) and boys (b) assessed in the representative age.

## DISCUSSION

This cross-sectional study was undertaken to assess undernutrition and anaemia prevalence among early adolescents of Bhandarahalli village, North Karnataka, India. From the occupational information, it was revealed that most of the parents were from a farming section background as 85% of respondents' parent occupation was farming and it was also found that nearly 45% of families belonged to the upper middle class indicating the good economic strata, reported that in rural areas, majority of the upper-class households are self-employed in agriculture, among middle class, the largest proportion of households have members engaged as regular wage employees and a greater proportion of lower-class households are self-employed in non-agriculture or working as casual labourers.[11]

Study results revealed a higher prevalence of undernutrition and anaemia among screened adolescents. Less than 50% (46.09%) of adolescents were in a normal category based on their age for BMI Z score. Comparatively higher prevalence of severe thinness was found in boys (19.67%) as in comparison with the girls (7.41%). A study conducted in rural Kalyana Karnataka, which is in North Karnataka province showed a similar study finding as underweight was high among boys as compared to the girls of the adolescent age group.[12] A total of 28.70% were in the thin (BMI<-2SD) category according to the BMI Z score for age. Indicating the higher under-nutrition incidence in screened adolescents. Similar results were observed in the comprehensive national nutrition survey data study conducted in all states of India, where the thinness was 24.4% in the screened adolescents (n=7,896).[13] Adequate nutrition and healthy lifestyles are the major concerns, that need to be considered and addressed in adolescents to meet their nutritional requirements. The promotion of health through nutrition education is necessary to address the problem. Educating adolescents as well as their parents about good

dietary habits through campaigns, and nutritional awareness programs can play a vital role. Both girls and boys show a decrease in fat percentage as they grow older. This may be attributed to the natural changes in body composition during puberty. The decrease in fat percentage is more pronounced in boys, with a significant drop between ages. The data showed a slightly higher subcutaneous fat percentage in both genders as they progressed from 11 to 12 years, followed by a slight decrease by age 13. Muscle percentage appears to be higher in boys than girls at all ages.

In the present study, the prevalence rate of 'moderate anaemia' was found to be high and severe anaemia was found to be less. The overall magnitude of anaemia was found to be high in the case of girls (59.26%) compared to that of boys (44.44%). In the present study, in the screened anaemic adolescent girls, most of them had attained their menarche and few of them were reported about worm passing in stools, which is not tabulated in the present study. The prevalence report of anaemia in the case of adolescent girls in a cross-sectional study conducted on adolescent girls in North Karnataka schools reported 44.4% of anaemia.[14] However, the age range selected in this study was wider compared to the present study. The present study result of anaemia was in contrast to the report, which showed a higher prevalence rate of anaemia among adolescent girls with 96.88% in the Davangere rural region of Karnataka.[15] However, various genetical, physiological, economic and lifestyle factors contribute towards anaemia prevalence. In the present study, none of the girls or boys fall into the category of severe anaemia as their haemoglobin levels are above 7 g/dL, which is the lower limit of the reference range for severe anaemia (Below 7 g/dL). On par prevalence rate was also revealed by many other research studies conducted on Indian adolescents. The current study could not establish causality between predictors and anaemia status of screened adolescent boys and girls. The data is not pan-India and is limited to one specific village of North Karnataka therefore, findings shall not be generalized to the country population, further investigation needs to be done to know the prevalence of anaemia and undernutrition by screening the large representative population of Karnataka and India However, the present study contributes to know the prevalence rate in rural region of North Karnataka with good representative population size at village level.

## CONCLUSION

This study highlights that undernutrition and anaemia are the major concerns in the screened rural region. The burden of undernutrition and anaemia indicates poor health outcomes in adolescents. Micronutrient deficiencies and undernutrition in adolescence are associated with impaired growth, poor cognition, lower immunity and higher susceptibility of children towards degenerative diseases in later periods. This in turn diminishes the school performance of adolescents and can hinder their growth and sexual maturations which in turn affect reproductive health outcomes, especially in girls. Even though ample research work has been carried out on nutritional status assessment studies among adolescents, rural region-related studies in India are scanty. Therefore, the present study on adolescents in rural areas gives insight into nutrient problem prevalence among rural adolescents. These findings can prioritize interventional strategies at the district and state levels to eliminate nutrition-related problems among adolescents. Nutritional surveillance in this age group coupled with targeted nutritional programs for undernutrition and lifestyle changes helps in correcting nutritional problems in this crucial age group.

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