

# Association of BMI, socioeconomic status and menarche age with anemia in rural school going adolescent girls

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## Abstract:

**Background:** India has the world's highest prevalence of anemia among women and adolescent girls. Rural adolescent girls are particularly vulnerable to develop anemia. **Aims and Objectives:** To study the prevalence of anemia in rural school going adolescent girls and its associated factors like BMI, socioeconomic status and age at menarche. **Materials and Methods:** A prospective study was carried out among 1200 adolescent girls (12-16 yrs) of 10 randomly selected government schools. BMI, Socioeconomic status by modified kuppusswami Classification, Menarche age by history and hemoglobin by cyanmethemoglobin method of all adolescent girls were obtained and analysed statistically. **Results:** The overall prevalence of anemia in rural adolescent girls was 54.2%, highest 63.3% was in the age group of 13 to 14 yrs, 30% suffered from moderate anemia. BMI categorization showed 48.6%, 42.2%, 9% and 1.2% adolescent girls were normal, underweight, overweight and obese respectively. Underweight adolescent girls were significantly anemic (74.2%) compared to normal 48.6%, overweight 39.2% and obese 40%. Class V and IV of socioeconomic status adolescent girls were significantly anemic 74.7% and 60% respectively when compared to Class III (42.6%), Class II (42.85%) and Class I (12%). The adolescent girls having menarche  $\leq 13$  yrs had significant anemia. **Conclusion:** The prevalence of anemia in rural adolescent girls was high. Under weight, class V and IV socioeconomic status and earlier age at menarche girls were at risk of developing anemia. The governments anemia prevention and control programme should focus on rural adolescent girls.

**Keywords:** Adolescent girls, Anemia, BMI, Menarche, Socioeconomic status

## Introduction

Anemia is defined as a low level of hemoglobin in the blood and it is one of the world's most widespread nutritional problems [1]. The prevalence of anemia among adolescents is 27% in developing countries and 6% in developed countries [2]. India has the world's highest prevalence of iron deficiency anemia among women, with 60-70% of the adolescent girls being anemic [3]. It has an impact on psychological and physical development, behavioural and work performance [4]. Association of anemia with adverse maternal outcome such as puerperal sepsis, antepartum haemorrhage and maternal mortality is no longer a

debatable subject [5]. Apart from the risk to the mother, it is also responsible for increased incidence of premature births, low birth weight babies and high perinatal mortality [6].

Adolescence is a period of transition between childhood and adulthood occurring between 12-18 yrs of age. During adolescence anemia is more prevalent due to growth spurt, onset of menarche, poor nutrition and poverty. Anemia prevalence is usually higher in rural areas than urban areas. This stresses the need to investigate the factors associated with prevalence of anemia. Prevention of anemia is effective when the strategy is focused right from adolescence for their future reproductive life. There are very few studies focussing on anemic adolescent girls [7,8,9,10,11].

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The present study was designed to study the prevalence of anemia in rural school going adolescent girls and its associated factors like body mass index, socioeconomic status and age at menarche.

## Materials and Methods

This prospective study was conducted in ten government schools of rural Kolhapur, among apparently healthy 1200 adolescent girls. Schools were chosen randomly and from each school 120 adolescent girls and from each Class 30 adolescent girls were selected randomly from attendance register. The girls between the age 12-16yrs were selected for the study. The study was carried out after approval by Institutional ethical committee and permission from school principal/ headmaster. Informed consent from parents/ guardian was also taken.

Body weight was measured with light clothing and without shoes in the upright position to the nearest 100 grams, using calibrated electronic balance. Height was measured without shoes to the nearest 0.1 cm using calibrated portable stadiometer. Body mass index (BMI) was calculated by weight in kg divided by height squared in meter square. As per recommendation of Khadilkar et al [12], adolescent girls were categorised according to their BMI using BMI percentile curves for Indian girl from 5 to 18 yrs. They were Classified as: underweight (BMI <3<sup>rd</sup> percentile), normal (BMI 3<sup>rd</sup> percentile to adult equivalent of BMI <23), overweight (Adult equivalent of BMI 23 to adult equivalent of 27.99) and obese (adult equivalent of BMI ≥28). Modified kuppuswami socio-economic status was used to divide the study groups into five Classes: Class I (upper), Class II (upper middle), Class III (lower middle), Class IV (upper lower), Class V (lower). [13] This is an important tool in hospital and community based research in India. This scale takes account of education, occupation and income of family to Classify

study group in five Classes depending upon score. Taking inflation and price rise this has been modified with conversion factor for the income. All adolescent girls were asked to recall their age at menarche and menstrual history were also obtained. Hemoglobin level was determined by cyanmethemoglobin method (type of colorimetric method). Blood was collected by finger prick, 20 microliter of blood sample was mixed with 5 ml of Drabkin's solution at the spot by micro pipette. Hemoglobin in the blood is converted into cyanomethemoglobin. The absorbance of cyanomethemoglobin was measured at 540 nm by photoelectric colorimeter on the same day of sample collection. As per WHO recommendations anaemia was diagnosed when Hb <12g/dL in 10-18 years girls [14]. The severity of anaemia was graded as mild (Hb >10g/dL), moderate (Hb 7-9.9 g/dL) and severe (Hb <7g/dL). [15] All observations were recorded, tabulated and subjected to statistical analysis by Chisquare test, in which P < 0.05 was significant. The P value was determined by using the primer of biostatistics and MS Excel 2007.

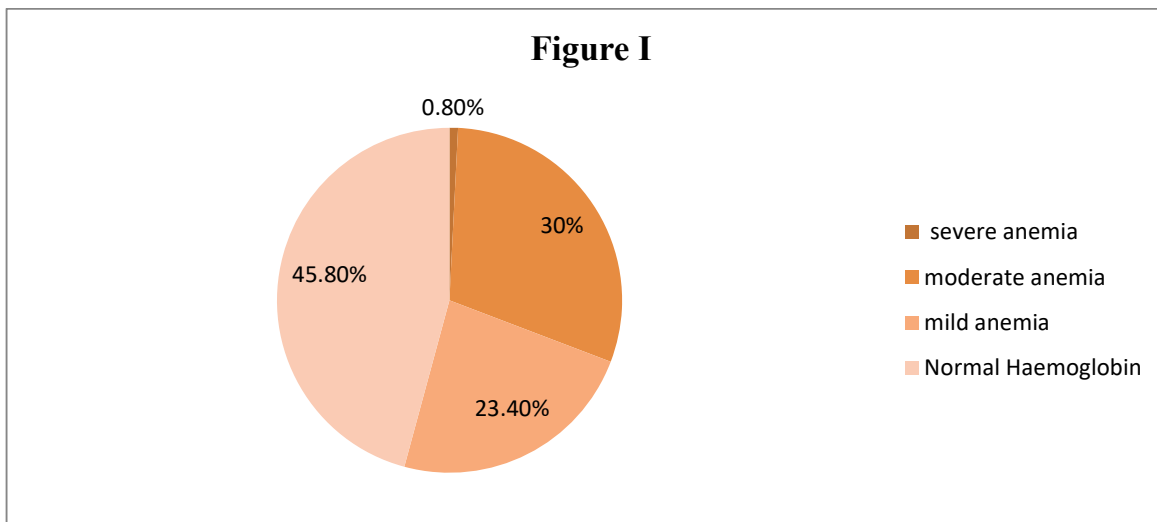
## Results

A total 1200 adolescent girls, from 10 schools, 120 girls from each school and 30 girls from each Class randomly selected were included in this study. The study showed that the overall prevalence of anemia was 54.2% (1200/650) in rural school going adolescent girls. The study results emphasised the high prevalence of anemia among all age groups of adolescent girls.

The highest prevalence is in the age group of 13-14 yrs (63.3%) and minimum in the age group of 12-13yrs (46%) [Table- I] 30% adolescent girl suffered from moderate anemia while 23.4% and 0.8% suffered from mild and severe anemia respectively [Figure I]

**Table I:** Age wise distribution of anemic adolescent girls. ( $\chi^2=21.523$  with 3 degrees of freedom; P=0.000)

| Age in yrs   | Adolescent girls |             |            |             |             |            |
|--------------|------------------|-------------|------------|-------------|-------------|------------|
|              | Anemic           |             | Non anemic |             | Total       |            |
|              | No               | %           | No         | %           | No          | %          |
| 12-13        | 138              | 46          | 162        | 54          | 300         | 100        |
| 13-14        | 190              | 63.3        | 110        | 36.7        | 300         | 100        |
| 14-15        | 172              | 57.4        | 128        | 42.6        | 300         | 100        |
| 15-16        | 150              | 50          | 150        | 50          | 300         | 100        |
| <b>Total</b> | <b>650</b>       | <b>54.2</b> | <b>550</b> | <b>45.8</b> | <b>1200</b> | <b>100</b> |



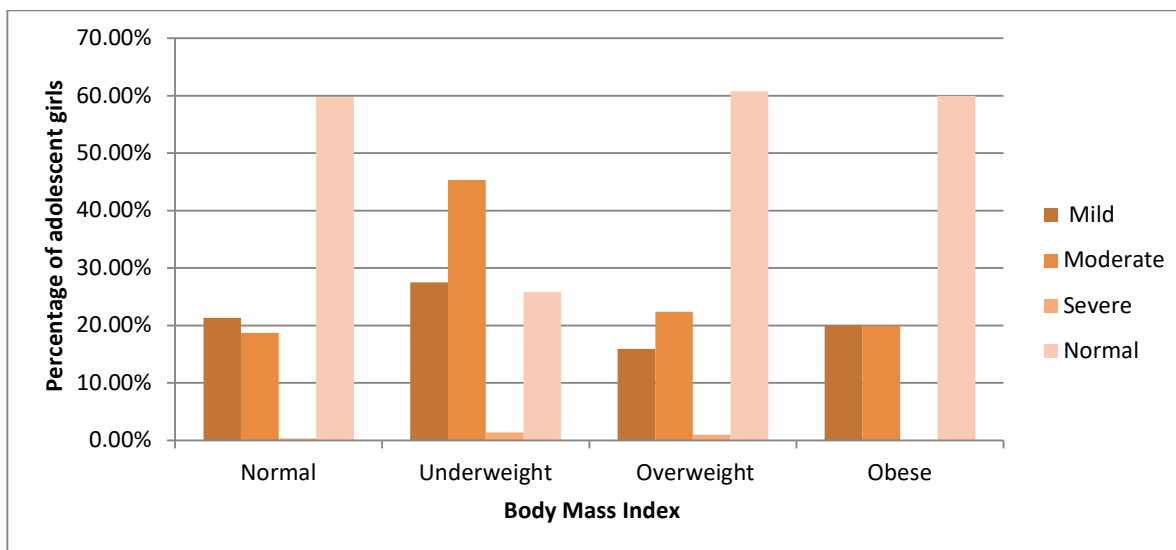
**Figure-I:** Severity of anemia in adolescent girls.

The study result showed 48.6%, 41.2%, 9% and 1.2% adolescent girls were from normal, underweight, overweight and obese respectively in BMI category. Underweight adolescent girls had significant prevalence of anemia (74.2%) as compared to normal 48.6%, overweight 39.2% and obese 40% [Table II]. When severity of anemia was compared, underweight adolescent girls were significantly had severe (1.4%) moderate (45.3%) and mild (27.5%) anemia as compared to normal, overweight and obese adolescent girls. [Figure II]

**Table II:** Association between body mass index and anemia.

( $X^2 = 135.449$  with 3 degrees of freedom;  $P = 0.000$ )

|            | Normal |      | Underweight |      | Overweight |      | Obese |     |
|------------|--------|------|-------------|------|------------|------|-------|-----|
|            | No     | %    | No          | %    | No         | %    | No    | %   |
| Anemic     | 235    | 40.3 | 367         | 74.2 | 42         | 39.2 | 6     | 40  |
| Non anemic | 348    | 59.7 | 128         | 25.8 | 65         | 60.8 | 9     | 60  |
| BMI Total  | 583    | 48.6 | 495         | 41.2 | 107        | 9.0  | 15    | 1.2 |



**Figure-II:** Association between body mass index and severity of anemia

( $X^2=150.268$  with 9 degrees of freedom;  $P=0.000$ )

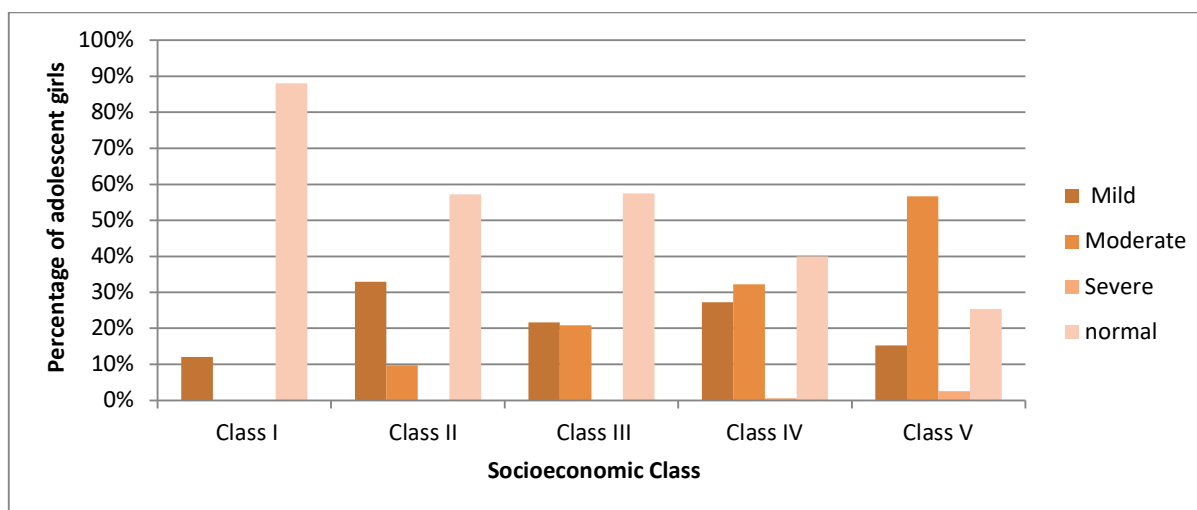
Class V (74.7%) and IV (60%) of socioeconomic status adolescent girls, were significantly anemic as compared to Class III (42.6%), Class II (42.8%) and Class I (12%) of socioeconomic status. [Table III] Out of socioeconomic Class V adolescent girls suffered significantly severe (2.6%), moderate (56.7%), and mild (15.3%) anemia. Anemia in adolescent girls was significantly reduced with rise in socioeconomic class.

[Figure III]

**Table III:** Association between socioeconomic class and anemia in adolescent girls.

( $\chi^2=118.696$  with 4 degrees of freedom;  $P=0.000$ )

|              | Socioeconomic class according to kuppuswami classification . |            |            |             |            |             |            |             |            |           |
|--------------|--|------------|------------|-------------|------------|-------------|------------|-------------|------------|-----------|
|              | Class I  |            | Class II   |             | Class III  |             | Class IV   |             | Class V    |           |
|              | No   | %          | No         | %           | No         | %           | No         | %           | No         | %         |
| Anemic       | 06   | 12         | 96         | 42.8        | 126        | 42.6        | 198        | 60          | 224        | 74.7      |
| Non anemic   | 44   | 88         | 128        | 57.2        | 170        | 57.4        | 132        | 40          | 76         | 25.3      |
| <b>Total</b> | <b>50</b>  | <b>4.2</b> | <b>224</b> | <b>18.7</b> | <b>296</b> | <b>24.6</b> | <b>330</b> | <b>27.5</b> | <b>300</b> | <b>25</b> |



**Figure-III:** Association between socioeconomic class and severity of anemia

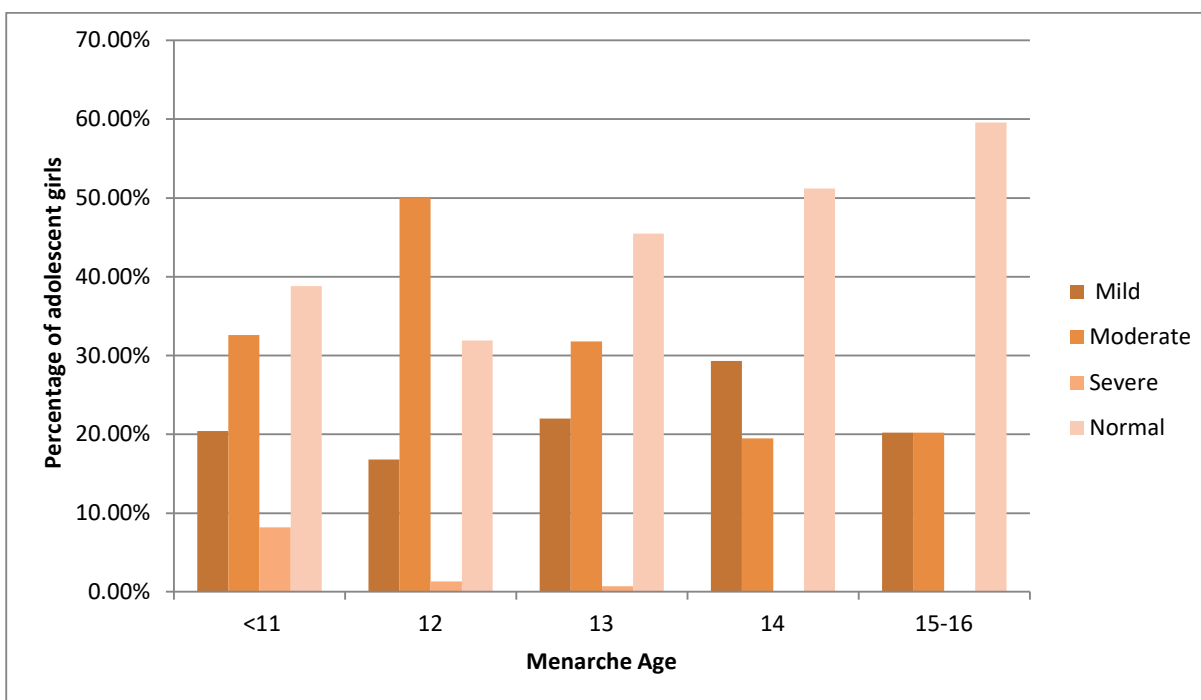
( $\chi^2=229.030$  with 12 degrees of freedom;  $P=0.000$ )

The commonest age at menarche in our study was 12-14 yrs, with maximum 422(35.2%) attained at 13yrs. The girls who attained menarche at  $\leq 11$  yrs, 12yrs and 13yrs had significant anemia 61.3%, 68.2% and 54.3% respectively. [Table IV] The girls who attained menarche at  $\leq 11$  yrs of age suffered significantly severe (8.2%), moderate (32.6%) and mild (20.4%) anemia. As menarche age increases the prevalence of anemia decreases. [Figure IV]

**Table IV:** Association between menarche age and anemia in adolescent girls.

( $\chi^2= 30.753$  with 4 degrees of freedom;  $P = 0.000$ )

| Menarche Age(yrs) | Anemic     |             | Non anemic |             | Total      |             |
|-------------------|------------|-------------|------------|-------------|------------|-------------|
|                   | No         | No          | %          | %           | No         | %           |
| $\leq 11$         | 30         | 49          | 4.0        | 61.3        | 19         | 38.7        |
| 12                | 150        | 220         | 18.4       | 68.2        | 70         | 31.8        |
| 13                | 230        | 422         | 35.2       | 54.5        | 192        | 45.5        |
| 14                | 200        | 410         | 34.1       | 48.8        | 210        | 51.2        |
| 15-16             | 40         | 99          | 8.3        | 40.4        | 59         | 59.6        |
| <b>Total</b>      | <b>650</b> | <b>1200</b> | <b>100</b> | <b>54.2</b> | <b>550</b> | <b>45.8</b> |



**Figure IV:** Association between menarche age and severity of anemia.  
( $\chi^2=112.482$  with 12 degrees of freedom;  $P=0.000$ )

## Discussion

Anemia symbolizes both poor nutrition and poor health. Adolescence is a crucial phase of growth in the life cycle of an individual. In girls middle adolescence growth happens earlier (12-15yrs) than in boys (13-16yrs). In the present study, prevalence of anemia in rural adolescent girls was reported to be 54.2%. Rawat et al [7], Kaur et al [8] and Kakkar et al [9] reported similar prevalence of anemia as 34.5%, 59.8% and 58.4% respectively in adolescent girls.

Deshpande et al [11] from Maharashtra, Sudhagandhi et al [16] from Tamil Nadu and Bharti et al [17] from Jharkhand reported prevalence of anemia as 60%, 67.8% and 99.9% respectively in adolescent girls. Peter et al [18] and Chitra B et al [19] observed prevalence of anemia as 77.9% and 81.7% respectively in rural adolescent girls. Goel S [20] observed low prevalence of anemia 13.3% in Shimla city.

Kakkar et al [9] reported prevalence of anemia 81% in early adolescence (10-13yrs) as compared to our study 13-14yrs (63.3%). Our study reported moderate anemia (30%) in adolescent girls. Similar results were reported by Rawat CMS et al [7], Deshpande et al [11] and Sudhagandhi et al [16] as 40.8%, 41.3% and 34.7% respectively, except Chitra B et al [19] reported severe

anemia 54.36%. In our study underweight adolescent girls were significantly anemic 74.2%. Deshpande et al [11] observed girls falling into thin and severely thin category had high prevalence of anemia. Kaur S [8] and Gupta et al [10] observed BMI did not contribute significantly with anemia. Pinhas-Hamiel O et al [21] found an association between anemia and obesity, due to upregulated hepcidin expression that hampers iron absorption. BMI is the most practical and widely used tool to ascertain an individual's body fat mass.

A very high percentage of adolescent girls from low socioeconomic status were found to suffer from anemia in the present study. Rawat et al observed anemia was higher in socioeconomic Class V (50%) and it significantly reduced with rise in socioeconomic status. Deshpande et al [11] and Peter et al [18] observed similar correlation between anemia and socioeconomic class. This may be because of better availability of high quality food with rise in socioeconomic status. Bharti et al [17] did not find significant effect of socioeconomic status alone on anemia.

The commonest age at menarche in our study was 13yrs (35.2%) and there was association between earlier menarche age and risk of anemia. This could be because

of hormonal changes which occur at the time of onset of menarche and blood loss during menstruation. Vasanthietal [22] found that anemia was higher in post-menarcheal girls than in pre-menarcheal girls of rural area. Kakkaretal [9] observed higher the age at menarche, there are more chances of anemia. Gupta etal [10] found no association between onset of menarche and anemia in adolescent girls.

Iron deficiency anemia and anemia are often used synonymously, as iron deficiency anemia constitutes the major anemia during adolescents. This is due to rapid pubertal growth with sharp increase in lean body mass, blood volume and red cell mass which increases iron requirements for myoglobin in muscles and hemoglobin in the blood. Iron requirement increases two to three folds from a preadolescent level of 0.7 to 0.9mg iron/day to as much as 1.40-3.27mg iron / day in adolescent girls [23]. In many developing countries, one half of all children and adolescents fail to achieve their full genetic growth potential due to the combined effects of inadequate nutrition and frequent illness. Moreover due to faulty dietary habits, ignorance and in country like India with multitude of social customs and beliefs cited against women, the prevalence of anemia amongst girls remain quiet high. As per WHO, if the prevalence of anemia is equal to or greater than 40%, it can be considered a severe public health problem otherwise prevalence in the range of 20% to 39% is to be considered as moderate one. [24] More effective methods need to be devised for community based hemoglobin testing. Iron supplementation programmes need to include nutrition education programmes. Health education and nutritional advise should be given to the adolescent girls at the time of menarche.

To conclude, prevalence of anemia in rural adolescent girls was 54.2%, with highest 63.3% in the 13-14yrs age group. 30% adolescent girls were moderately anemic. Underweight adolescent girls, girls from Class V and IV socioeconomic status and girls who attained menarche at earlier age were at risk of developing anemia. The governments anemia prevention and control programme should focus on rural adolescent girls.

Contributors: SK, DK: designed the study, collected and analysed the data and drafted the manuscript. AK: supervision of the work and analysed the data. AC: literature search and drafted the manuscript. AK will act as the guarantor. All authors approved the final version of manuscript.

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