Prevalence of anemia among school going adolescent girls in rural area of Pune, Maharashtra, India

Suman Bodat1*, Rakesh Bodat2, Prasanth Vinjamuri V. V. G.3, Anita Raj Rathore1

1Department of Community Medicine Government Medical College Pali, Ramaisya, Pali, Rajasthan, India
2Faculty of Information Technology, National Australian Institute of Technology, Melbourne, Australia
3Department of Product Certification, Bureau of Indian Standards, Government of India, Jaipur, Rajasthan, India

INTRODUCTION

Adolescent girls are at a risk of suffering from a multitude of nutritional problems like deficient calorie intake, Malnutrition, Nutritional Iron-deficiency anemia etc. Anemia is like the tip of an iceberg, as majority of anemic subjects are asymptomatic. An iron deficient diet, year after year, perpetuates an inter-generational cycle of anemia, anemic women giving birth to infants who are born with iron stores and grow to become anemic children. This situation is more acute in rural area due to their dietary habits, illiterate parents, socio-economic status, misconception about food, religions belief, menstruation and physical activity.

ABSTRACT

Background: Anemia is like the tip of an iceberg, as majority of anemic subjects are asymptomatic. Low iron diet for longer period perpetuates an inter-generational cycle of anemia, anemic women giving birth to anemic children. This situation is more acute in rural area due to their dietary habits, illiterate parents, socio-economic status, misconception about food, religions belief, menstruation and physical activity.

Methods: This descriptive cross-sectional study was conducted in rural field practice area of Rural Heal Training Centre (RHTC) under department of community medicine, Bharati Vidyapeeth Medical college Pune, Maharashtra, India. There are 11 villages under RHTC Lavale: Out of them one village viz. Pirangut village was randomly selected (by using random sampling method). This study was conducted in 2013. Total 740 senior secondary school girls studying in class 6th to 12th (10-19 age group) were included. Hb level was measured by Sahli’s hemoglobinometer. Chi square was used to test for association between qualitative variables, and p-value less than 0.05 was considered significant.

Results: The Hb level of girls reveal that majority 648 (87.6%) of them were anemic. It was found that 305 (47.06%) and 340 (52.48%) were suffering from mild and moderate anemia while 3 (0.46%) had severe anemia. The significant association was found with BMI for age.

Conclusions: Active measures to decrease the prevalence of anemia through educating these girls and their mothers, school diet supplementation, providing low cost diet.

Keywords: Adolescent girl, Anemia, Iron
METHODS
This descriptive cross-sectional study was conducted in rural field practice area of RHTC (Rural Heath Training Centre) under department of community medicine, Bharati Vidyapeeth Medical College, Pune, Maharashtra, India. There are eleven villages under RHTC Lavale: Out of them one village viz. Pirangut village was randomly selected. (by using random sampling method). Pirangut is a village in Mulshi taluka in Pune district in Maharashtra State. This study was conducted in 2013. This study was carried out in senior secondary school amongst girls studying in class 6th to 12th (10-19 age group). The minimum sample size was determined by the formula = 4 PQ/L.

Where p = 37.5% (prevalence of anemia among rural adolescent girls in 10-19 age group)

Q = 100-37.5 L= (3.6) (10% of 37.5)

= 4 × 37.5 × 62.5/3.6 × 3.6

= 9375/12.96 = 723 sample size.

Therefore, required sample size was 723. The strength of girls in the selected school was 740. So, all girls were included in this study.

Inclusion criteria
- All adolescent school going girls (10-19 age group) and resident of village were included.

Exclusion criteria
- All married adolescents’ girls in school.

The girls were selected according to WHO criteria for the adolescence that is 10-19 years (2005). The school authorities were contacted and explained about the study. After obtaining the permission from school authorities, interviews and Hb investigation dates were fixed for each class. A verbal consent of the adolescent girls was taken before administering the questionnaires and assured of confidentiality.

School records were used for getting accurate age information. The investigator distributed the pre-designed, pre-tested questionnaires (in local Marathi language). The girls were instructed on how to fill the questionnaires and explained about each question with help of female teacher and social workers. Questionnaires included socio demographic data, dietary intake (24 hours recall method) Menstrual history and menstrual problems, anemia, anthropometric examination was done. Weight, height and BMI were recorded. Anthropometric measurement was converted to BMI for age and percentile.

The height was taken barefooted in centimeter using standard measuring tape. A vertical tape fixed perpendicular to the ground on the wall was used as scale. This tape was non stretchable. It was fixed with transparent adhesive tape and care was taken to see that there was no fold or tilting to any side. Height was recorded to the nearest 1cm. The weight was measured in kilogram without shoes using a standard machine having precision of 0.5 kg. The body mass index 5 was calculated as weight (kg)/height (m²).

Percentile is the most commonly used indicator to assess the size and growth patterns of individual children. (2-20 years). The percentile indicates the relative position of the child BMI among children of the same sex and age. (CDC 2000) was used for BMI for age calculation. These consisted of estimation of haemoglobin by Sahli’s method. The results of the haemoglobin estimations were conveyed to the all the girls and anemic girls were informed about their current anemic status. Dietary intake was calculated by using 24 hours recall method.

Iron intake for Adolescent girls.10-12 age group = 18.9 mg/day, 13-15 age = 28 mg/day, 15-19 age = 29.9 mg/day. Anemia was classified as mild moderate and severe as per WHO classification.

As per the classification: mild anemia (10-12 gm/dl), moderate 7-10 gm/dl and severe <7 gm/dl respectively.

Statistical analysis
The data so collected was compiled in MS excel. The electronic record set as created above, was imported to SPSS 20.0 (Statistical Package for the Social Sciences). In case of attributes (i.e., qualitative variables) the frequency along with percent-frequency distributions were generated for quick understanding of the over-all status of girls. For quantitative variables under study, normally mean and standard deviation were calculated and analysed. Statistical significance of any association may be prevalent between two qualitative variables was tested using the popular Chi-square test. While testing of various hypothesis, statistical significance (i.e., rejection of null hypothesis and acceptance of research hypothesis) was considered at (p<0.05).

RESULTS
The 740 girls studying in class 6th to 12th (10-19 age group) in the senior secondary school located at Pirangut village were studied.

Sociodemographic characteristic
Table 1 indicates the distribution of adolescent girls by early and late adolescent phase. The ration of the early adolescent (10-14th years) and late adolescent (15-19 years) is nearly 50: 50. Majority of girls belonged to families with socio economic Group II (30.34%) and
Group III (30.13%) followed by Group I (17.82%). Majority 456 (61.6%) of girls were belonged to nuclear family than joint family 284 (38.3%). The mean height was 153.6 cm (SD 6.23) and mean weight was 43 kg (SD 8.48). In this present study overall 511 (69%) (5-85 percentile) girls were healthy weight, 183 (24.7) (<5 percentile) were underweight and 29 (3.9%) were overweight.

It has to be noted that none of girls reported to be a strict non-vegetarian. Hence, study classified the adolescent girls into those taking vegetarian and mixed diet as shown in Table 1. Majority 506 (68.3%) of adolescent girls were consuming mixed diet while only 234 (31.6%) were consuming vegetarian diet. Worm infestation is one of the contributing factors for anemia especially in rural area. However, it is interesting to note that only a very few 40 (5.4%) girls had the history of worm infestation in last six months.

In the present cross-sectional study anemic status of a girl was appropriately measured by the assessment of Hb level by Sahli’s hemoglobinometer in blood. According to the WHO criteria, the cut off level of the haemoglobin concentration in blood for the diagnosis of anemia is <12 gm/dl for adolescent girls. Out of 740 girls in the study, The Hb level of girls reveal that majority 648 (87.6%) of them were anemic, as shown in the Table 2. The mean haemoglobin was 9.8 mg/dl (SD 1.3). The 648 (87.6%) girls, who were anemic, were further classified by the degree of anemic. It was found that 305 (47.06%) and 340 (52.48%) were suffering from mild and moderate anemia while 3 (0.46%) had severe anemia respectively as in Table 3.

Socio economic status and anemia (n = 740)

In this study statistically indicates no significant association (p = 0.350 >0.05) was found between socio economic status and prevalence of anemia as shown in Table 4. Furthermore, irrespective of their socio-economic status; anemia was high in every group. This might be due because of all adolescent girls’ belonged to

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**Table 1: Socio-demographic characteristic of adolescent girl (n = 740).**

<table>
<thead>
<tr>
<th>Adolescent phase</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early adolescent (10-14 years)</td>
<td>355</td>
<td>48%</td>
</tr>
<tr>
<td>Late adolescent (15-19 years)</td>
<td>385</td>
<td>52%</td>
</tr>
<tr>
<td>Total (10-19 years)</td>
<td>740</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Table 2: Distribution of adolescent girl by their anemic status (n = 740).**

<table>
<thead>
<tr>
<th>Anemic status</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No anemia (≥12 gm/dl)</td>
<td>92</td>
<td>12.4%</td>
</tr>
<tr>
<td>Anemia (&lt;12 gm/dl)</td>
<td>648</td>
<td>87.6%</td>
</tr>
<tr>
<td>Total</td>
<td>740</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

**Table 3: Distribution of adolescent girl by degree of anemia (n = 648).**

<table>
<thead>
<tr>
<th>Anemic status</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild (10-12 gm/dl)</td>
<td>305</td>
<td>47.06%</td>
</tr>
<tr>
<td>Moderate (7-10 gm/dl)</td>
<td>340</td>
<td>52.48%</td>
</tr>
<tr>
<td>Severe (&lt;7 gm/dl)</td>
<td>3</td>
<td>0.46%</td>
</tr>
<tr>
<td>Total</td>
<td>648</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

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**Table 4: Distribution of girls according to socio economic status and prevalence of anemia (n = 740).**

<table>
<thead>
<tr>
<th>Socio-economic - status</th>
<th>Absent (%)</th>
<th>Present (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>13 (9.8%)</td>
<td>119 (90.2%)</td>
<td>132 (100.0%)</td>
</tr>
<tr>
<td>II</td>
<td>24 (10.5%)</td>
<td>204 (89.5%)</td>
<td>228 (100.0%)</td>
</tr>
<tr>
<td>III</td>
<td>32 (14.3%)</td>
<td>191 (85.7%)</td>
<td>223 (100.0%)</td>
</tr>
<tr>
<td>IV</td>
<td>16 (13.0%)</td>
<td>107 (87.0%)</td>
<td>123 (100.0%)</td>
</tr>
<tr>
<td>V</td>
<td>7 (20.6%)</td>
<td>27 (79.4%)</td>
<td>34 (100.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>92 (12.4%)</td>
<td>648 (87.6%)</td>
<td>740 (100.0%)</td>
</tr>
</tbody>
</table>

(\(\chi^2 = 4.438, df = 4, p = 0.350 >0.05\) NS.)
same area with similar cooking or eating practices and their culture beliefs related to food.

**BMI for age (percentile) and anemia status**

It is important to record that highest prevalence of anemia was 78(97.27%) among girls below BMI <5 percentile while lowest (82.4%) in obese girls. This study showed significant association between BMI for age and anemic status. (p = 0.000 <0.05) as shown in Table 5.

**Iron intake and anemia**

It was observed in this study that majority 450 (60.8%) of girls were consuming three meals/day while 259 (35%) were consuming two meals/day. Only few of them 31 (4.1%) were consuming four meals a day.

An analysis based on the study shows that daily iron intake various from 2-17 mg/day. The iron intake is alarming as almost all 622 (84.1%) of girls had iron intake of below <8 mg/day. This indicate that there is inadequate intake iron rich food in their daily diet as shown in Table 6.

**Age wise - distribution of girls according to their mean iron intake**

Further, age wise - distribution of girls according to their mean iron intake was done in Table 7 shows that girls every age group were taking below the RDA as per their age. The mean iron intake was 6.3 mg/dl±2.2 which not even a 25% of RDA (mg/day) values.

**Haemoglobin level and anemia status**

A scatter plot was plotted to determine if there is a linear relationship between the haemoglobin level and iron intake. The scatter plot of 740 study girl (10-19 years) between the variable haemoglobin level of blood and Iron intake (mg.) day is shown in Figure 1. This scatter plot indicates that there is a linear relationship between the variables “Hb level of blood” and “Iron intake (mg.) per day”.

**Table 5: BMI for age (percentile) and anemia status (n = 740).**

<table>
<thead>
<tr>
<th>BMI for age</th>
<th>Present (%)</th>
<th>Absent (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight (&lt; 5)</td>
<td>178 (97.27%)</td>
<td>5 (2.73%)</td>
<td>183 (100.0%)</td>
</tr>
<tr>
<td>Healthy weight (5-85)</td>
<td>431 (84.3%)</td>
<td>80 (15.7%)</td>
<td>511 (100.0%)</td>
</tr>
<tr>
<td>Overweight (85-95)</td>
<td>25 (86.2%)</td>
<td>4 (13.8%)</td>
<td>29 (100.0%)</td>
</tr>
<tr>
<td>Obese (&gt; 95th)</td>
<td>14 (82.4%)</td>
<td>3 (17.6%)</td>
<td>17 (100.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>648 (87.6%)</td>
<td>92 (12.4%)</td>
<td>740 (100.0%)</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 21.167, \text{df} = 3, p = 0.000 < 0.05 \text{ S.} \]

**Table 6: Distribution of girls (10-19 years) by daily iron intake (mg/day) (n = 740).**

<table>
<thead>
<tr>
<th>Daily iron intake (mg/day)</th>
<th>No. of girls</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 8 mg</td>
<td>622</td>
<td>84.1%</td>
</tr>
<tr>
<td>≥ 8 mg</td>
<td>118</td>
<td>15.9%</td>
</tr>
<tr>
<td>Total</td>
<td>740</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

**Table 7: Age wise - distribution of girls according to their mean iron intake (n = 740).**

<table>
<thead>
<tr>
<th>Age group</th>
<th>Recommended daily allowance (RDA) of iron (mg/day)</th>
<th>Mean iron intake±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-12</td>
<td>18.9</td>
<td>6.6±2.1</td>
</tr>
<tr>
<td>13-15</td>
<td>28</td>
<td>6.2±2.2</td>
</tr>
<tr>
<td>16-19</td>
<td>29.9</td>
<td>6.2±2.0</td>
</tr>
</tbody>
</table>

Since it is observed that a linear relationship exists between the two variables (Hb and iron intake), the regression analysis was performed to predict the Hb level of blood (i.e., anemic status of a girl) based on her daily intake of iron (mg.). The simple linear regression analysis using “Hb level” as dependent variable (Y) and “Iron intake (mg.) per day” as independent variable (X) establishes the following results:

- The correlation coefficient between “Hb level” and “Iron intake (mg) per day” is moderately positive (0.252)
- The linear equation (model) to predict the HB level of blood of a rural school going girl (10-19 years): \( Y = a + b \cdot X \). In this case, the values of a, b, X, and Y are as follows:

\( a = 8.872 \)
\( b = 0.155 \) (regression co-efficient of Y in X/slope of linear model)

\( X = \) Iron intake (mg.) per day (known value of independent variable)
\( Y = \) HB level (predicted value of dependent variable).

**Tea intake and anemia**

Dietary iron absorption from a meal is determined by iron status, heme- and non-heme-iron contents, and amounts
of various dietary factors that influence iron absorption like intake of tea.

Figure 1: This scatter plot indicates that there is a linear relationship between the variables Hb level and iron intake (mg) per day.

Table 8: Distribution of girls who consume tea and anemia status (n = 740).

<table>
<thead>
<tr>
<th>Tea cup/day</th>
<th>Anemia status</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present (%)</td>
<td>Absent (%)</td>
</tr>
<tr>
<td>Yes</td>
<td>580 (87.5%)</td>
<td>85 (12.7%)</td>
</tr>
<tr>
<td>No</td>
<td>68 (90.6%)</td>
<td>7 (9.3%)</td>
</tr>
<tr>
<td>Total</td>
<td>648 (87.5%)</td>
<td>92 (12.4%)</td>
</tr>
</tbody>
</table>

p = 0.39 >0.05 NS.

Table 8 reveals that the proportion of anemic girls 665 (89.8%) drink tea daily while and 75 (10.1%) girls do not drink tea. Study finding suggest that there is no statically significant association between tea intake and prevalence of anemia (p = 0.39 >0.05).

Worm infestation and anemia status

As mentioned earlier history of worm infestation was found among 40 (5.4%) in last six month, as shown in the Table 9. In the present study shows 40 (5.4%) girls had worm infestation out of which only 2 had no anemia, while 11 (27.1%) had mild 26 (65%) moderate and 1 (2.5%) severe anemia respectively.

Table 9: Distribution of girls by history of worm infestation in last 6 months and anemia (n = 740).

<table>
<thead>
<tr>
<th>Worm history (within 6 months)</th>
<th>Anemia</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present (%)</td>
<td>Absent (%)</td>
</tr>
<tr>
<td>Yes</td>
<td>38 (95.0%)</td>
<td>2 (5.0%)</td>
</tr>
<tr>
<td>No</td>
<td>610 (87.1%)</td>
<td>90 (12.9%)</td>
</tr>
<tr>
<td>Total</td>
<td>648 (87.6%)</td>
<td>92 (12.4%)</td>
</tr>
</tbody>
</table>

χ² = 2.146 df = 1 (0.143 >0.05) NS.

Table 9 shows that there is not much difference in the percentage of anemic girls between worm-infested (in last 6 months) girls (95.0 %) and non-worm-infested girls (87.1%). The statistical test for association found no statistically significant association between anemia and worm -infestation (p = 0.143 >0.05).

It is observed that out of 740 girls i.e. majority 622 (84.05%) of these girls attained menarche. It was found that prevalence of menstrual disorders was 228 (41.4%) amongst anemic girls while it was 32 (44.4%) among non-anemia girls. The chi-square test shows there is no significant association (p = 0.698 >0.05).

DISCUSSION

The ratio of the early adolescent (10-14th years) and late adolescent (15-19 years) is nearly 50:50. Majority of girls belonged to families with socio economic Group II (30.34%) and Group III (30.13%) followed by Group I (17.82%). Majority 456 (61.6%) of girls were belonged to nuclear family than joint family 284 (38.3%). The mean height was 153.6 cm (SD 6.23) and mean weight was 43 kg (SD 8.48). In this present study overall 511 (69%) (5-85 percentile) girls were healthy weight, 183 (24.7) (<5 percentile) were underweight and 29 (3.9%) were overweight. Majority 506 (68.3%) of adolescent girls were consuming mixed diet while only 234 (31.6%) were consuming vegetarian diet. A very few 40 (5.4%) girls had the history of worm infestation in last six month. Out of 740 girls, majority 648 (87.6%) of them were anemic. The mean hemoglobin was 9.8 mg/dl (SD 1.3). Thakar A et al, conducted a study among senior secondary adolescent girls (10-19) residing in Shimla city showed a similar high prevalence of anemia in 84.4% girl.11 Kaur S et al, found anemia among 59.8% rural adolescent girls.12 The varying degree of prevalence of anemia observed in different studied among adolescents girls may be because of the multi factorial etiology of anemia.13,14

Out of 648 (87.6%) anemic girls, it was found that 305 (47.06%) and 340 (52.48%) were suffering from mild and moderate anemia while 3 (0.46%) had severe anemia.
The prevalence of severe anemia was higher in a Hyderabad study where out of 1489 adolescent girls; 28.8% were mildly anemic, 35.2% moderately anemia, 34.1% were severely anemic while only 7.9% were found to be normal. Goyle A and Prakash S conducted a study to determine the iron status of adolescents girls (10-15 years) attending a government school in Jaipur city, Rajasthan. Of the 109 subject, 4 (3.7%) had normal level of haemoglobin, 34 (31.2%) suffered from mild deficiency and 71 (65.1%) suffered from the moderate deficiency.

Table 3, in this study statistically no significant association (p = 0.350 >0.05) was found between socio economic status and prevalence of anemia. Similarly, Siddharam SM et al, found that socioeconomic status were not significantly associated with anemia. However, Gawarika R et al, found in their study that the overall percent prevalence of anemia among the adolescent girls of weaker economic group was 96.5% and among of middle or higher middle income group was 65.18%. The prevalence of severe anemia among the adolescent girls of weaker group was 11.0% and among girls of middle or higher income group was 2.63%.

Daily iron intake is important determinant of anemia status. All the iron needed for the biological functions comes from diet. Iron deficiency also coexists with type of diet; strict vegetarian diet increases the risk of iron deficiency anemia.

Iron requirement for growth refers to the iron needed for expansion of blood volume and need for increase in lean body mass. The peak requirement for absorbed iron in girls reaches a maximum of approximately 1.5 mg/day during puberty and remains at about 1.3 mg/day after puberty to replace menstrual blood loss. The deficiency gets further aggravated by not eating high iron containing foods (such as meat) as well as poor bioavailability of iron due to food habits. In this study iron intake various from 2-17 mg/day. The mean iron intake was 6.3±2.2 mg/dl which not even a 25% of RDA (mg/day) (Table 6) Likewise Maliya CH et al, finding showed average iron intake was 13.2±2.5 mg/day was deficient by 48.2%.

Alaofè H et al, studied association between dietary iron intake and iron status in 100 adolescent girls aged 14-16 years from Benin. While 73% of adolescents met the recommendations for dietary iron intake, only 27% had estimated absorbable iron intake above the average requirement for absorbed iron.

Table 8, there is no statically significant association between tea intake and prevalence of anemia (p = 0.39 >0.05). Verma A et al, also pointed out in their study that anemia was significantly higher among those having the post meal habit of consuming tea/coffee (94.4%) (p <0.01). The statistical test for association found no statistically significant association between anemia and worm-infestation (p = 0.143 >0.05) as shows in Table 9. Kaur S et al, stated that 65 (10.3%) had history of worm infestation and they also found that worm infestation is strong predictor to anemia (OR = 5.45, CI = 2.55-11.62).

The chi-square test shows there is no significant association (p = 0.698 >0.05) between anemia status and menstruation disorder. Goel S et al, observed that 30 (53.6%) anemia females had menstrual problems like menorrhagia, polymenorrhea or irregular menstrual cycle as compared to 22 (6.6%) non anemia female (p <0.05).

**CONCLUSION**

In the present study overall prevalence of anemia was found to be high. Active interventions are required to decrease the prevalence of anemia through educating these adolescent girls and by providing free low-cost school diet supplementation and secondly, there is constant need to improve data collection on adolescent girls health especially; in rural India.

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**Conflict of interest: None declared**

**Ethical approval: The study was approved by the Institutional Ethics Committee**

**REFERENCES**


