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Epidemiological correlates of nutritional anaemia among adolescent girls

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Abstract
Background: Adolescents are vulnerable to anaemia particularly in developing countries because of increased iron requirements related to rapid growth. Inadequate nutrition during adolescence depicts serious consequences throughout the reproductive years of life and beyond. Socio-economic gradients, dietary habits, parental illiteracy, behavioural changes etc., are likely to influence the haemoglobin profile of adolescents.
Objectives: The objective of the study was to assess the anthropometric, socio-economic and haemoglobin (Hb) profile of adolescent girls and to study the correlation between haemoglobin profile and socio-economic status of the subjects.
Methods and Materials: In the present study, a total number of 1300 school going adolescent girls from the age group of 13-17 years were randomly selected for the study from Puttaparthi Mandal, Anantapur District, Andhra Pradesh. A pre-designed and pre-tested questionnaire was used to collect the data regarding anthropometric, socio-economic and haemoglobin profile of the selected subjects. The data analysis was carried out using the Statistical Package for Social Sciences (SPSS) Software.
Results: In the present study, about 31 per cent of the subjects were suffering from mild anaemia, followed by 6 per cent (moderate anaemia) and 3 per cent (severe anaemia). A highly significant (p<0.01), positive correlation of haemoglobin with BMI strata was observed among the subjects with severe thinness and overweight category. The prevalence rates of anaemia among the subjects were found to be significantly associated with type of family, family income, parents' education, religion, menstrual bleeding, history of worms infestation and dietary practices.
Conclusions: The anaemic adolescent girls grow into adult women with compromised growth, physiological and cognitive development. The overall prevalence rate of anaemia among adolescent girls suggests an urgent necessity for improving their overall nutritional status by implementation of multi-sectorial community based programme such as nutrition education awareness, anaemia prophylaxis and poverty alleviation programme.

Keywords: anaemia, haemoglobin, adolescent girls and socio-economic gradients

1. Introduction
Anaemia is one of the most common haematological abnormalities commonly found among adolescents, especially girls. Globally, anaemia affects 1.62 billion people with about 69.4 million adolescents, 56 million pregnant women, and 468 million non-pregnant women are estimated to be anaemic. Adolescent girls form a crucial vulnerable segment of the population and 240 million (20 per cent) of the world's adolescents live in India and about 115 million (48 per cent) Indian adolescents are girls (UNICEF, 2016) [9].
Adolescents are vulnerable to anaemia particularly in developing countries because of increased iron requirements related to rapid growth. In a family with limited resources, the female child is more likely to be neglected. The anaemic adolescent girls grow into adult women with compromised growth, physiological and cognitive development, which further declines the work performance and even contributes to adverse outcomes in pregnancy.
During adolescence, iron requirements increases drastically as a result of the expansion of the total blood volume, the increase in the lean body mass and the onset of menses in young females. Inadequate nutrition during adolescence depicts serious consequences throughout the reproductive years of life and beyond.
The present study was conducted to study was to assess the anthropometric, socio-economic and haemoglobin (Hb) profile of adolescent girls and to study the correlation between haemoglobin profile and socio-economic status of the subjects.

2. Material and methods
A cross-sectional study was carried out in 10 different schools of Puttaparthi Mandal, Anantapur District, Andhra Pradesh. A total number of 1300 adolescent girls from the age group of 13-17 years were randomly selected for the study. The participants and parents were informed about the study and written consent was obtained from the parents and guardians of the participants. A pre-designed and pre-tested questionnaire was used to collect the data regarding anthropometric, socio-economic and haemoglobin profile. The BMI was calculated using the following formula.

$$\textbf{BMI} = \frac{\text{Weight (kg)}}{\text{Height}^2\ (\text{m}^2)}$$

The selected adolescent girls were assessed for their haemoglobin profile using Sahli's Haemoglobinometer. The data analysis was carried out using the Statistical Package for Social Sciences (SPSS) Software. The relationship between haemoglobin profile (Hb) and socio-economic status was examined by calculating Pearson's Correlation Coefficient and Regression Analysis.

3. Results

In the present study of 1300 adolescent girls, 301 (23.2 per cent) belonged to 13 years, 260 (20 per cent) belonged to 14 years, 220 (17 per cent) belonged to 15 years, 249 (19 per cent) belonged to 16 years and 270 (20.8 per cent) belonged to 17 years of age. Table 1 represents age wise distribution of the subjects.

Table 1: Age-wise distribution of the subjects

S. No.	Age	N	%
1.	13 years	301	23.2
2.	14 years	260	20
3.	15 years	220	17
4.	16 years	249	19
5.	17 years	270	20.8
Total		1300	100

The mean weight and height of the subjects was collected using weighing balance and height measurement rods and further BMI was calculated. Among 13 and 14 years age group, the mean weight was found to be lower, when compared with ICMR standards. Table 2 shows mean weight, height and BMI of the subjects according to their age. The mean BMI of 16 and 17 years age group was found to be higher than normal when compared with other age groups

Table 2: Mean weight and height of the subjects according to their age

Measurements	Age of the subjects					*p* value
	13 Years (N=271)	14 Years (N=263)	15 Years (N=251)	16 Years (N=255)	17 Years (N=260)	
	mean ± SD*	Mean ± SD*	Mean ± SD*	Mean ± SD*	Mean ± SD*	
WEIGHT (kg)	31.2 ±3.25	35.4 ± 2.8	40.5 ± 1.9	49.8 ± 1.34	58.5 ± 4.73	0.000*
Height (cm)	132.2 ± 2.88	139.8 ± 2.76	142.5 ± 3.7	146.9 ± 3.45	149.2 ± 4.53	0.000*
Body mass index (BMI) [kg/m^2]	17.9 ± 1.36	18.2 ± 1.33	20.0 ± 1.16	23.18 ± 1.61	26.44 ± 2.36	0.000*

Values are mean ± SD of number of subjects under each group. *Significant at p <0.01 level.

As per WHO criteria for diagnosis and classification of anaemia (table 3), majority of the subjects (60 per cent) were found to be normal (figure 1), followed by mild anaemia (31 per cent), moderate anaemia (6 per cent) and severe anaemia (6 per cent).

Among all the age groups, severe anaemia (6.3 per cent) and moderate anaemia (13.3 per cent) were found to be highest among 13 years age group. Majority of the subjects (37.6 per cent) from 14 years age group fell under mild anaemia category.

Table 3: Prevalence of anaemia among the subjects

SNO	WHO Criteria Haemoglobin (gm/dl)	Grading of anaemia	Age of the respondents											
			13 Years		14 Years		15 Years		16 Years		17 Years		Total	
			N	%	N	%	N	%	N	%	N	%	N	%
1.	≤ 6.9 gm/dl	Severe Anemia	17	6.3	6	2.3	7	2.8	3	1.2	6	2.3	39	3
2.	7 – 9.9 gm/dl	Moderate Anemia	36	13.3	21	8	9	3.6	7	2.7	5	2	78	6
3.	10 - 11.9 gm/dl	Mild Anemia	94	34.7	99	37.6	63	25.1	81	31.8	65	25	402	31
4.	>12 gm/dl	Normal	124	45.7	137	52.1	172	68.5	164	64.3	184	70.7	781	60
		Total	271	100	263	100	251	100	255	100	260	100	1300	100

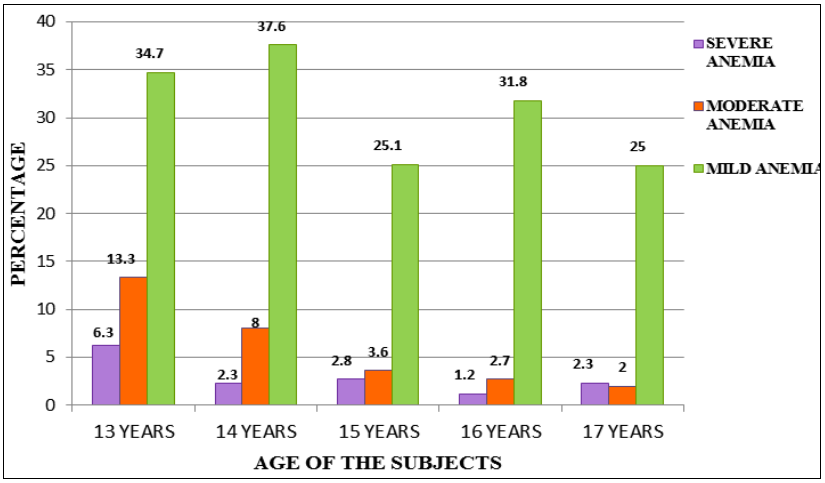

Fig 1: Prevalence of Anaemia among the Subjects

A highly significant (p<0.01), positive correlation of haemoglobin with BMI strata was observed among the subjects with severe thinness and overweight category (table 4). A positive correlation was observed more clearly through the scatter plot (figure 2).

Table 4: Correlation of haemoglobin with bmi grades of the subjects (n=1300)

SNO	BMI for age (WHO z- score)	r	Significance (*p*)
1.	Severe Thinness	0.55	0.007**
2.	Thinness	0.96	0.042*
3.	Normal	0.87	0.026*
4.	Overweight	0.92	0.003**
5.	Obesity	0.19	0.013*

BMI Body Mass Index; R: Correlation oefficient *Significance at 1 % <0.01); *Significance at 5 % (p<0.05) NS: Not significant

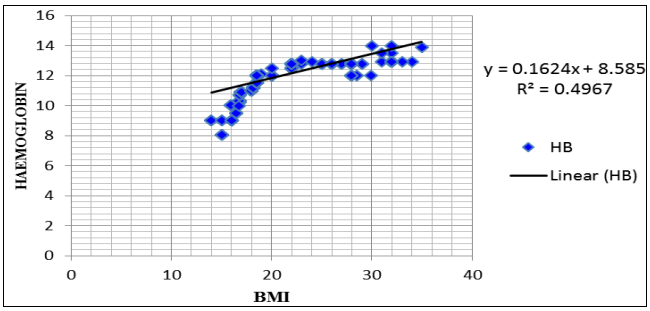

Fig 2: Correlation of BMI with Haemoglobin in subjects

Table 5 depicts the prevalence of anaemia as per socio-economic determinants. In the present study, the prevalence of anaemia was found to be significantly (p<0.01) higher among the subjects belonging to nuclear family when compared with the subjects from joint family. The prevalence rates of mild = anaemia was found to be significantly (p<0.01) higher among the subjects (61.2 per cent) belonging to economically weaker section when compared with the subjects from low income group (43.7 per cent), middle income group (24.5 per cent) and high income group (22.6 percent).

A significant (*p*<0.01) higher proportion of the subjects (64.6 percent) belonging to illiterate fathers' were suffering from mild anaemia; about 16.9 and 7.7 per cent of the subjects were suffering from moderate and severe anaemia, respectively. Similarly. The prevalence rates of mild anaemia was found to be significantly (p<0.01) higher among the subjects (64.4 per cent) belonging to illiterate mothers' when compared with the subjects from mothers' who were educated above primary to graduated.

The prevalence rate of overall anaemia was found to be significantly (p<0.01) higher among the subjects (43.2 per cent) belonging to Hindu religion when compared with the subjects from Christian (41.2 percent) and Muslim (4.26 per cent) religion.

Table 5: Prevalence of anaemia among adolescents as per socio-economic determinants

	Variables	No. of subjects (%)				Total N	Chi square, P value
		Severe Anaemia	Moderate Anaemia	Mild Anaemia	Normal		
1.	Type Of Family						
	Nuclear Family	30 (3.1)	68 (7)	339 (35)	532 (54.9)	969	χ^2 =16.52 p = 0.012
	Joint Family	9 (2.7)	10 (3)	63 (19)	249 (75.2)	331	
	Total	39	78	402	781	1300	
2.	Family Income						
	< 2500 (Economically Weaker Section)	9 (9.2)	20 (20.4)	60 (61.2)	9 (9.2)	98	
	2501 – 5500 (Low Income Group)	20 (7.6)	48 (18.3)	115 (43.7)	80 (30)	263	χ^2 =32.07 p = 0.0001
	5501 – 10,000 (Middle Income Group)	10 (1.3)	10 (1.28)	191 (24.5)	569 (73)	780	
	>10,001 (High Income Group)	-	-	36 (22.6)	123 (77)	159	
	Total	39	78	402	781	1300	
3.	Fathers education						
	Illiterate	5 (7.7)	11 (16.9)	42 (64.6)	7 (11)	65	
	Upto primary	5 (5.7)	14 (15.9)	42 (47.7)	27 (31)	88	
	Upto secondary	28 (4.3)	49 (7.54)	263 (40.5)	310 (48)	650	χ^2 =23.04 p = 0.026
	Higher secondary	1 (0.3)	3 (1.01)	44 (14.8)	250 (84)	298	
	Graduation & above	-	1 (0.5)	11 (5.53)	187 (94)	199	
	Total	39	78	402	781	1300	
4.	Mothers education						
	Illiterate	31 (7.9)	50 (13)	251 (64.4)	58 (14.9)	390	
	Upto primary	7 (1)	23 (3.3)	130 (18.5)	541 (77.2)	701	
	Upto secondary	1 (0.6)	4 (2.5)	17 (10.7)	137 (86.2)	159	χ^2 =12.24 p = 0.0001
	Higher secondary	-	1 (2.9)	3 (8.57)	31 (88.6)	35	
	Graduation & above	-	-	1 (6.67)	14 (93.3)	15	
	Total	39	78	402	781	1300	
5.	Religion						
	Hindu	39 (4.1)	74 (7.7)	301 (31.4)	546 (56.9)	960	χ^2 =101.5 p = 0.016
	Christian	-	3 (1.2)	98 (40)	144 (58.8)	245	
	MUSLIM	-	1 (1.1)	3 (3.16)	91 (95.8)	95	
	Total	39	78	402	781	1300	

Table 6: Menstrual history, history of worms infestation and nutritional factors among adolescent girls in relation to anaemia

	Variables	No. Of subjects (%)				Total N	Chi square, P value
		severe anaemia	Moderate anaemia	Mild Anaemia	Normal		
1.	Status Of Menarche						
	Attained	39 (3)	78 (6)	400 (30.9)	778 (60.1)	1295	χ^2 =41.36 p = 0.027
	Not attained	-	-	2 (40)	3 (60)	5	
	total	39	78	402	781	1300	
2.	duration of menstrual bleeding						
	1-3 days	-	7 (1.9)	6 (1.6)	351 (96.4)	364	χ^2 =37.05 p = 0.019
	4-5 days	9 (1.9)	27 (5.6)	250 (42)	242 (50.6)	478	
	> 5 days	30 (6.6)	44 (9.6)	146 (43)	188 (41)	458	
	total	39	78	402	781	1300	
3.	amount of blood loss during menses						
	Excessive	10 (3.2)	25 (8)	127 (40.7)	150 (48.1)	312	χ^2 =71.25 p = 0.0001
	Normal	29 (2.9)	53 (5.4)	275 (27.8)	631 (63.9)	988	
	total	39	78	402	781	1300	
4.	history of worms infestation						
	Present	31 (20)	59 (39)	62 (40.5)	1 (0.7)	153	χ^2 =11.06 p = 0.037
	Absent	8 (0.7)	19 (1.7)	340 (29.6)	780 (68)	1147	
	total	39	78	402	781	1300	
5.	dietary habits						
	Vegetarian	37 (6.4)	71 (12)	276 (48)	193 (33.4)	577	χ^2 =32.91 p =0.0001
	Non-vegetarian	-	2 (0.3)	100 (17)	500 (83.1)	602	
	Ovo-vegetarian	2 (1.7)	5 (4.1)	26 (21)	88 (72.7)	121	
	Total	39	78	402	781	1300	

Table 6 shows menstrual history, history of worms infestation and nutritional factors among adolescent girls in relation to anaemia. The prevalence rate of overall anaemia was found to be significantly (p<0.01) higher among the subjects (59.2 per cent), who were getting menstrual bleeding of more than 5 days when compared with the subjects, where the duration of menstrual bleeding was between 4 to 5 days (49.5 per cent subjects) and 1 to 3 days (3.5 per cent subjects).

A significant (p<0.01) higher proportion of the subjects (40.7 per cent), who were getting excessive blood loss during menses fell under mild anaemia category when compared with the subjects (27.8 per cent) with normal blood loss during menses. Adolescents with the history of worms infestation and vegetarian diet consumption showed significantly (p<0.05) higher prevalence of overall anaemia when compared with the subjects with no worn infestation and consuming non-vegetarian diet, respectively.

4. Discussion

In the present study, about 31 per cent of the subjects were suffering from mild anaemia, followed by moderate anaemia (6 per cent) and severe anaemia (3 per cent). Findings of the present study are in concurrence with the study conducted by Soman *et al*., (2017) [7], which revealed that the prevalence rates of mild anaemia (57.4 per cent) was found to be highest among the subjects, followed by moderate malnutrition (4.2 per cent). Another study conducted by Jayant and Jayshree (2017) [2], revealed that the overall prevalence of mild and moderate anaemia were found to be 73.3 per cent and 16.6 per cent, respectively, which is relatively higher when compared with the present study.

A study revealed relatively higher prevalence rates of anaemia when compared with the present study, about 54.2 per cent of adolescent girls were suffering from nutritional anaemia (Kavthekar *et al*., (2016) [4]. A cross-sectional study conducted by Devi *et al*., (2015) [1] revealed that the overall prevalence of anaemia was found to be 73 per cent among adolescent girls, which is relatively higher when compared with the present study.

In the present study, a highly significant (p<0.01), positive correlation of haemoglobin with BMI strata was observed among the subjects with severe thinness and overweight category. Findings of the present study are in concurrence with the study conducted by Kaur *et al*., (2015) [3], which revealed a positive correlation haemoglobin with BMI strata among subjects with severe thinness.

In the present study, the prevalence rates of anaemia among the subjects were significantly (p<0.01) associated with type of family, family income, parents' education, religion, menstrual bleeding, history of worms infestation and dietary practices. Findings have shown a significant (p<0.01) positive association of anaemia with Body Mass Index (BMI) socioeconomic gradients, dietary pattern, worms' infestation, menstrual bleeding and personal hygiene practices (Patel *et al*., 2017; Siva *et al*., 2016; Srivastava *et al*., 2016) [5, 6, 8]. A cross-sectional study conducted by Siva *et al*., (2016) [6] revealed the prevalence rate of overall anaemia among adolescent girls (21 per cent), which is relatively lower when compared with the present study. Similar results were obtained in a study conducted by Patel *et al*., (2017) [5], about 36 per cent of adolescent girls were suffering from anaemia.

5. Conclusion

In this study, it is concluded that the overall prevalence of mild, moderate and severe anaemia among adolescent girls were found to be 31, 6 and 3 per cent, respectively. A highly significant (p<0.01), positive correlation of haemoglobin with BMI strata was observed among the subjects with severe thinness and overweight category. The prevalence rates of anaemia among the subjects were found to be significantly associated with type of family, family income, parents' education, religion, menstrual bleeding, history of worms infestation and dietary practices.

6. Recommendations

The overall prevalence rate of anaemia among adolescent girls suggests a need an urgent necessity for improving their

overall nutritional status. Recommended strategies are as follows:

- Development of intensive nutrition education programme.
- Implementation of iron and folic acid supplementation programme to eradicate anaemia.
- Incorporating poverty alleviation programmes in order to improve socio-economic status.
- Implementation of hygiene and sanitation programme.
- Prevention of worms' infestation by incorporating deworming tablets in their schedules.

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