Evaluation of Iron Status of College going Adolescent girls

[1]Helen.C, ResearchScholar, Mother Teresa Women's University, Kodaikanal
[2]Dr.R.Jagan Mohan, Professor& Head, Dept. of Food Product Development, IIFPT, Thanjavur.

Abstract :

Anaemia is a serious and widespread public health problem which is disproportionately high among adolescent girls. The scale and magnitude of the problem affects the quality of life, both physiologically and socioeconomically, require the urgent adoption of known and effective measures. The main cause of anaemia is dietary iron deficiency. Other causes of anaemia include other micronutrient deficiencies, acute and chronic infections, and inherited or acquired disorders. Its prevalence was very high among adolescent girls. Anaemia, characterized by decreased levels of haemoglobin and tissue iron contents, is known to lead to several functional abnormalities with health consequences like impaired maximal work capacity, decreased immunological competence, behavioural abnormalities and reduced learning ability. In this context to plan effective interventions to combat both iron deficiency and anaemia there is an urgent need to have better information on the iron status of adolescent girls. This will enable the right interventions to be chosen in the first place and then, once programmes are in place, to have the right indicators to monitor their impact. The present study was an attempt to evaluate the iron status of adolescent girls and to find out the prevalence of anaemia, iron deficiency anaemia, iron deficiency and iron depletion among adolescent girls. A total of 621 adolescent girls aged 17-19 years studying in a women's college at Madurai were participated in the study. Haemoglobin level was assessed for all the girls using cyanmethaemoglobin method and iron indicators like serum ferritin, serum iron and total iron binding capacity were assessed for a sub sample of 110 adolescent girls. Results revealed that the overall prevalence of anaemia in adolescent girls was found to be 82.8%, which is of severe public health problem. About 31.7%, 47.1% and 3.8% of the girls suffered from mild, moderate and severe anaemia respectively. Regarding the iron indicators 60% and 69% of the adolescent girls were deficit in serum ferritin and serum iron respectively which shows that majority of the girls had depleted iron stores. Around 44.5% of the girls had higher total iron binding capacity which indicates iron deficiency. Findings also revealed that about 30 adolescent girls had sufficient iron store and 10.9% of the girls had depleted iron stores. If this iron depletion is not corrected, it may indeed progress to iron deficiency. Results showed that the prevalence of iron deficiency among adolescent girls was 31% and 28.1% of the adolescent girls had iron deficiency anaemia. Thus the study confirms that adolescent girls constitute a group at risk of anaemia, iron deficiency and iron deficiency anaemia. Therefore specific attention should be given to them during adolescence to ensure that their dietary intake of iron is adequate to their requirements and thereby maintaining optimum health and wellbeing.

Key Words: Anaemia, Iron deficiency, Adolescent girls, Iron indicators.

1. INTRODUCTION

Anaemia is defined by World Health Organization (WHO) as low blood haemoglobin concentration, <12 gm/dl, and has been regarded as public health problem in both developed and developing countries (1). The prevalence of anaemia is disproportionately high in the developing countries, due to poverty, inadequate diet, worm infestations, pregnancy/lactation and poor access to the health services (2). In particular, a persistently high level of anaemia among women in India (53% of all women have anaemia as per the National Family Health Survey 2015–2016) is of great concern, and the 2017 National Health Policy tabled by the Ministry of Health and Family Welfare, Government of India, acknowledges this high burden (3).

The most reliable indicator of anaemia at the population level is blood haemoglobin concentration, but this alone does not determine the cause of anaemia. Anaemia may result from a number of causes, with the most significant contributor being iron deficiency (4). Approximately 50% of cases of anaemia are considered to be due to iron deficiency, but the proportion probably varies among population groups and in different areas, according to the local conditions. Other causes of anaemia include other micronutrient deficiencies (e.g. folate, riboflavin, vitamins A and B12), acute and chronic infections (e.g. malaria, cancer, tuberculosis and HIV), and inherited or acquired disorders that affect haemoglobin synthesis, red blood cell production or red blood cell survival (e.g. haemoglobinopathies). Anaemia resulting from iron deficiency adversely affects cognitive and motor development, causes fatigue and low productivity (5).

Even though iron deficiency anemia can possibly occur at all stages of the life, it is more prevalent among pregnant women, young children, and adolescents. Adolescent girls, the future mothers are at increased risk of developing iron deficiency because of regular blood loss during menstruation. Periods of high growth and development during adolescence incur significant additional iron needs. The other causes of anemia are insufficient iron in diet, malaria, intestinal worms, and HIV/AIDS. Chronic anemia may result in reduced scholastic performance in adolescents (6). Iron deficiency anaemia in adolescent girls not only affects the present health status of girls but also has deleterious effects in future pregnancy, that puts the women at three times greater risk of delivering low birth weight and nine times higher risk of perinatal mortality, thus contributing significantly for increased infant mortality rate and 30 % maternal deaths (7). This phase of life is also important due to the ever-increasing evidence that the control of anaemia in pregnant women can be more easily achieved if a satisfactory iron status can be ensured during adolescence.

To plan effective interventions to combat anaemia, iron deficiency anaemia and iron deficiency among adolescent girls there is an urgent need to have better information on the iron status of adolescent girls. This will enable the right interventions to be chosen in the first place and then, once programmes are in place, to have the right indicators to monitor their impact. Therefore assessing the iron status of adolescent girls provides an opportunity to understand and intervene at a point in the life cycle before potential problems become serious in later life. The objectives of the present study were therefore: (i) to assess the

iron status of adolescent girls; and (ii) to examine the prevalence of anaemia, iron deficiency anaemia and iron deficiency among adolescent girls. This study is significant since data on the iron status of adolescent girls is rare. The findings of this study will help in identifying the quantum of this problem and planning interventions to combat iron deficiency with or without anaemia which in turn ensure safe motherhood in future.

2. MATERIALS AND METHODS

2.1 Study Design and Sample Selection

The present study is a cross-sectional study carried out in a women's college at Madurai. Permission for the study was obtained from the college authorities prior to commencement of the study. Simple random sampling was used to select the adolescent girls. A total of 621 adolescent girls belonging to the age group 17 – 19 years were participated in the study.

2.2 Ethical Considerations

The study was approved by the institutional ethical committee (MMHRC-IEC) and written consent for participation in the study was obtained from the parents of the adolescent girls.

2.3 Haematological Analysis

Finger prick blood samples were obtained from 621 adolescent girls and were used to measure haemoglobin using cyanmethaemoglobin method. To obtain serum for the determination of parameters of iron status, blood sample (5 ml) was drawn from each adolescent girls of the subsample (110) and allowed to coagulate at room temperature. The coagulated blood was centrifuged and the serum was divided into aliquots for the measurement of serum ferritin, serum iron and total iron-binding capacity (TIBC) using standard methods (8).

2.4 Anaemia and Iron status classification

For interpretation of anemia (9), cut-off point for hemoglobin level taken was < 12g/dl. The severity of anemia was graded as Mild (10-12g/dl), Moderate (7-10gm/dl) and Severe (<7gm/dl).

The ironnutriture can be classified into three stages: iron depletion, iron deficiency and iron deficiency anaemia. During the depletion phase, iron stores are exhausted; however, decrease of serum iron or haemoglobin is not present. Iron deficiency occurs as iron stores decline and a decrease in transport iron is present. Anaemia and hypochromia are still not detectable. Iron deficiency anaemia occurs as the synthesis of iron-containing proteins, such as haemoglobin becomes compromised to the point at which values fall below a specified cut-off value. The adolescent girls were categorized as iron deficient if they presented low serum ferritin, low serum iron and high total iron binding capacity; iron deficiency anaemia if they were iron deficient and had haemoglobin less than 12g/dL (10). The cut off values for iron status indicators are presented in Table 1 and the classification of iron status are given in Table 2.

Table - 1
Cut off values for Iron Status Indicators

Iron Status Indicators	Values
Haemoglobin	< 12 g/dL
Serum Ferritin	<15µg/L
Serum Iron	< 60 µg/dL
Total iron binding capacity	>410 µg/dL

Table – 2
Classification of Iron Status

Classification of Iron status	Values of Iron Indicators			
	Haemoglobin	Serum Iron	Serum Ferritin	Total Iron Binding Capacity
Iron Sufficiency	12 g/dL	60 µg/dL	15µ/L	250 - 410 µ/dL
Iron Depletion	12 g/dL	60 µg/dL	<15µ/L	250 - 410 µ/dL
Iron Deficiency	12 g/dL	< 60 µg/dL	<15µ/L	>410 µ/dL
Iron Deficiency Anaemia	< 12 g/dL	< 60 µg/dL	<15µ/L	>410 µ/dL
Anaemia	< 12 g/dL	decreased	decreased/ increased (Chronic diseases)	decreased

2.5 Statistical Analysis

The collected data was analyzed statistically using Statistical Package for Social Sciences Version 16.0 for Windows. Chi-Squared test (X2) was used to determine significant differences between the categorical variables (P<0.05).

3. RESULTS AND DISCUSSION

3.1 Prevalence of anaemia

Overall prevalence of anaemia in adolescent girls was found to be 82.8%, which is of severe public health problem according to WHO (11). Numerous studies have been done to find out the prevalence of anaemia in adolescent girls in different parts of India like Vadodara (12), Nagpur (Urban area) (13), Tamil Nadu (14) and Lucknow (15) which was found to be 75%, 35.1%, 44.8% and 56% respectively.

The mean haemoglobin level of adolescent girls (17-19 years) was 9.11 ± 1.42g/dl implying that a majority of the subjects suffered from a moderate degree of anaemia. Of the 621 subjects, 107 (17.2%) had normal levels of haemoglobin, 197 (31.7%) suffered from mild anaemia, 293 (47.1%) suffered from moderate anaemia and 24 (3.8%) suffered from severe anaemia (Table 3).

Table - 3
Distribution of study participants in relation to the severity of anaemia

Degree of anaemia	Mean Hb g/dL	Study Participants (n=621)		F value
		Number	Percentage	
Normal	12.2 ± 0.26	107	17.2	1454.118**
Mild anaemia	10.9±0.51	197	31.7	
Moderate anaemia	8.6± 0.70	293	47.1	
Severe anaemia	6.5± 0.39	24	3.8	

** Significant at 1% level

Considering the data age-wise, high percentages of subjects suffering from mild anaemia were from the age groups of 18 years. High percentages of subjects suffering from moderate anaemia were from the age group of 17 years (Table 4). However, in each age category, the mean hemoglobin level was below the cut-off point of 12g/dl.

Table - 4
Age wise distribution of anaemic adolescents (n=621)

Age group (years)	Normal		Severity of Anaemia						Chi square	P Value
	No	%	Mild		Moderate		Severe			
			No	%	No	%	No	%		
17	50	16.3	85	27.7	157	51.1	15	4.9	11.53 df (6)	P<0.073 *S
18	45	16.5	98	36.0	120	44.1	9	3.3		
19	12	28.6	14	33.3	16	38.1	0	0		

Significant at P<0.05

3.2 Indicators of Iron Status

Serum Ferritin

Serum ferritin is a measure of the amount of iron in body stores if there is no concurrent infection: when the concentration is ≥15 µg/L iron stores are present; when the concentration is low (<15 µg/L) then iron stores are depleted. When infection is present the concentration of ferritin may increase even if iron stores are low; this means that it can be difficult to interpret the concentration of ferritin in situations in which infectious diseases are common (16).

Table - 5
Serum Ferritin levels of adolescent girls

Age group (in years)	Serum Ferritin (n=110)				
	Mean Values µg/dL	Normal (n=44) (≥15µ/L)		Deficient (n=66) (<15µ/L)	
		No	%	No	%
17 (n=38)	12.06 ± 1.28	18	47.4	20	52.6
18 (n=40)	13.01 ± 0.78	14	35	26	65
19 (n=32)	13.67 ± 1.61	12	37.5	20	62.5
Total		**44**	**40**	**66**	**60**

Table 5 depicts the mean values of serum ferritin which ranges from 12.06 ± 1.28 to 13.67 ± 1.61 µg/dL indicating low iron stores among adolescent girls. Among the adolescent girls 44 girls (40%) had normal serum ferritin levels whereas 64 girls (60%) had low levels. This shows that majority of the girls had depleted iron stores which may also lead to iron deficiency.

Serum Iron

Serum iron is the amount of circulating iron that bound to transferrin. The mean serum iron levels of the adolescent girls are presented in Table 6.

Table - 6
Serum Iron levels of adolescent girls

Age group (in years)	Serum Iron (n=110)				
	Mean Values µg/dL	Normal (60 µg/dL)		Deficient (< 60 µg/dL)	
		No	%	No	%
17 (n=38)	29.92 ± 2.67	15	39.5	23	60.5
18 (n=40)	34.83 ± 4.83	10	25	30	75
19 (n=32)	31.83 ± 5.91	9	28.2	23	71.8
Total		34	30.9	76	69.1

The mean serum iron of the adolescent girls was ranged from 29.92 to 34.83 µg/dLwhich was much less than the normal value. About 31% of the subjects had normal levels while the rest (69%) had low levels of serum iron (Table 6). These findings are in par with results of study carried out among the adolescent girls of Jaipur city (17).

Total Iron Binding Capacity

Total iron-binding capacity (TIBC) measures the total amount of iron that can be bound by proteins in the blood. Since transferrin is the primary iron-binding protein, the TIBC test is a good indirect measurement of transferrin availability (16).

Table - 7
Total Iron Binding Capacity of adolescent girls

Age group (in years)	Total Iron Binding Capacity (n=110)				
	Mean Values µg/dL	Normal (250 - 410 µ/dL)		Higher (>410 µ/dL)	
		No	%	No	%
17 (n=38)	426.7 ± 12.34	20	52.6	18	47.4
18 (n=40)	365.7 ± 34.04	19	47.5	21	52.5
19 (n=32)	318.3 ± 45.64	22	68.8	10	31.2
Total		61	55.5	49	44.5

Results (Table 7) showed that the mean total iron binding capacity was ranged from 318.3 ± 45.64 to 426.7 ± 12.34 µg/dL. Considering the cutoff level of 250 - 410 µ/dL, about 55.5% of the subjects had normal but near the higher range while 44.5% had higher levels.

3.3 Prevalence of Iron deficiency and Iron deficiency anaemia

Table – 8
Iron Status of Adolescent girls

Classification of Iron status	Adolescent girls (n=110)	
	No	%
Iron Sufficiency	33	30
Iron Depletion	12	10.9
Iron Deficiency	34	31
Iron Deficiency Anaemia	31	28.1

As shown in the Table 8, about 30 % of the adolescent girls had sufficient iron store and 10.9% of the girls had depleted iron stores. If this iron depletion is not corrected, it may indeed progress to iron deficiency. The findings also revealed that the prevalence of iron deficiency among adolescent girls was 31%. WHO (2007) stated that iron deficiency anaemia is generally considered to account for about 50% of the anaemia. In the present study about 28.1% of the adolescent girls had iron deficiency anaemia. Iron stores of the adolescent girls remain low during the whole pubertal period. This is because, in addition to the rapid growth, the loss of iron with menstruation contributes to the low iron stores. In previous studies, it was observed that the growth spurt associated with menstrual status, blood loss and a low iron intake may have adverse effects on iron stores in adolescent girls (18).

4. Conclusion

In conclusion, the present study stated that the prevalence of anaemia is a significant public health problem. This is supported by the findings of the present study where 82.8% of the adolescent girls had anemia. The prevalence of iron depletion, iron deficiency and iron deficiency anaemia highlighted higher risk for adolescent girls. Therefore, specific attention should be given to them during adolescence to ensure that their dietary intake of iron is adequate to their requirements. The findings also emphases the potential importance of routine monitoring and screening for iron deficiency at several time points during adolescence for timely commencement of iron treatment for maintaining optimal health of adolescent girls.

REFERENCES

1. World Health Organization. (2015). The global prevalence of anaemia in 2011. World Health Organization. Geneva. 1-2.
2. Shilpa S. Biradar, Somashekar P. Biradar, A.C. Alatagi, A.S. Wantamutte, P.R. Malur, (2012). Prevalence of Anaemia among adolescent girls – A One year cross – sectional study. Journal of Clinical and Diagnostic Research. 6(3):372-377.
3. National Health Policy. (2017). Ministry of Health and Family Welfare, Government of India; New Delhi.
4. Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F et al. (2013). Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis of population-representative data. Lancet Glob Health. 1:E16–E25.
5. Balarajan Y, Ramakrishnan U, Ozaltin E, Shankar AH, Subramanian SV. (2011). Anaemia in low-income and middle-income countries. Lancet.;378:2123–35.
6. Saratha A, Singh Z, Datta SS, Boratne AV, Senthilvel V and Joice S. (2010). Prevalence of Anaemia among Young Adult Female Students in a Medical Teaching Institution in Pondicherry. Indian Journal of Maternal and Child Health. 12 (4).
7. Kaur S, Deshmukh PR, Garg BS. (2006). Epidemiological correlates of nutritional anaemia in adolescent girls of rural Wardha. Indian Journal of Community Medicine; 31:255-58.
8. N. Raghuramulu, K. Madhavan Nair, S. KalyanaSundaram. (2003). A Manual of Laboratory Techniques, NIN, Hyderabad. 140–146, 177.
9. DeMaeyer EM, Dallman P, Gurney JM, Halberg L, Sood SK, Srikantia SG. (1989). Preventing and controlling iron deficiency anemia through primary health care. World Health Organization, Geneva; 8-9.
10. HalimatouAlaofe, John Zee, Romain Dossa3 and Huguette Turgeon O'Brien. (2008). Iron status of adolescent girls from two boarding schools in southern Benin, Public Health Nutrition. 11(7). 737–746.
11. Nutritional anaemias: tools for effective prevention and control. (2017). World Health Organization. Geneva. 7-10.
12. Kotecha PV, Nirupam S, Karkar PD. (2009). Adolescent girls' anaemia control programme, Gujarat, India. Indian Journal of Medical Research. 130:584-89.
13. Chaudhary SM, Dhage VR. (2008). A study of anaemia among adolescent females in the urban area of Nagpur-Indian Journal of Community Medicine. 33(4):243-45.
14. Rajaratnam J, Abel R, Asokan JS, Jonathan P. (2000). Prevalence of anaemia among the adolescent girls of rural Tamil Nadu. Indian Paediatrics. 37:532-36.
15. Singh J, Singh JV, Srivastava AK, Suryakant. (2006). Health status of the adolescent girls in the slums of Lucknow. Indian J Community Med.31(2):102-03.
16. Assessing the Iron status of populations second edition. (2007). World Health Organization. Geneva. 5-8.
17. GoyleA& Prakash S. (2009). Iron Status of Adolescent Girls (10-15 years) Attending a Government School in Jaipur City, Rajasthan, India, Malaysian Journal of Nutrition, 15(1): 205 – 211.
18. M Ferrari, L Mistura, E Patterson, M. (2011). Evaluation of iron status in European adolescents through biochemical iron indicators: the HELENA Study, European Journal of Clinical Nutrition. 65, 340–349.