Prevalence of anemia and iron deficiency in adolescent school girls of Dharan, Nepal

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ABSTRACT

Background: The prevalence of anemia in adolescence girls are said to be 42 to 60% in Nepal. Iron deficiency results from prolonged deficit of iron in diet or increased need for iron during a period of intense growth like adolescence. However, the terms anemia, iron deficiency, and iron deficiency anemia are used interchangeably. **Aims and Objective:** We aimed to find out the prevalence of anemia and iron deficiency in adolescent school girls of Dharan, Nepal by measuring hemoglobin and serum ferritin levels. **Materials and Methods:** This cross-sectional study was done in higher secondary schools, including government and private schools, of Dharan conducted by the Department of Basic and Clinical Physiology, B. P. Koirala Institute of Health Sciences, Dharan, Nepal. A total of 150 adolescent school girls of Dharan was selected by systemic random sampling method. Hemoglobin and ferritin levels were analyzed by cyanmethemoglobin method and immunoturbidimetric assay respectively. Descriptive statistics, paired t-test and chi-square test were used. **Results:** Anemic girls were 33.33% (n = 50/150). Anemia with iron deficiency was identified in 17.33% girls (n = 26/50) and anemia with normal iron level was in 16% girls (n = 24/50). Normal hemoglobin level with iron deficiency was identified in 9% (n = 14/100) girls and normal hemoglobin with normal ferritin level was in 57% (n = 86/100) girls. **Conclusions:** Prevalence of anemia was less in the adolescent school girls of Dharan, Nepal, than the earlier documented reports in which only half the anemic adolescent girls were iron deficient; suggesting that the remaining other anemic girls had other causes of anemia.

Key words: Anemia, Adolescent, Iron deficiency, Prevalence

INTRODUCTION

The prevalence of anemia among adolescent girls' in Nepal is 42 to 60.0%.[1-3] Iron deficiency anemia is severe form of iron deficiency. Presence of insufficient iron supply for the optimal physiological production and function of iron dependent cells is considered iron deficiency.[4] Generally, it results from a prolonged deficit of iron in the diet or increased need for iron during a period of intense growth like infancy, adolescence and pregnancy.[5] Adolescence is a transition phase of life from childhood to adulthood. This phase of life is vulnerable to nutritional deficiency due to the increased nutritional demands for growth and development.[6] In a developing country like Nepal, young girls are at high risk for the development of iron deficiency anemia because of gender discrimination and their socio-economic status.

In the context of Nepal, most of the studies have identified iron deficiency anemia only based on hemoglobin level. The terms anemia, iron deficiency, and iron deficiency anemia are used interchangeably. The characteristics of iron deficiency anemia is not only low hemoglobin and hematocrit levels but also decreased iron store, low serum iron level and decreased transferrin saturation.[7] With the feasible resources, we aimed to study the prevalence of

anemia and iron deficiency in adolescent school girls of Dharan, sub-metropolitan city, eastern part of Nepal by measuring hemoglobin and serum ferritin levels.

MATERIALS AND METHODS

This cross-sectional study was conducted in schools of Dharan from June 2014 to December 2014 after the ethical approval from the Institutional Review Committee. We did systematic random sampling method to select our subjects. There are 17 higher secondary schools in Dharan municipality. From these 17 schools, eight are government and nine are private higher secondary schools. From them, we had selected four schools, two government and two private schools, using population proportion sampling technique, which covered 25% of the total schools. After taking informed and written consent from the school principles of each four schools, we checked the registration list and got the total number of adolescent girls (11-19 years) studying in each school. Then, we selected 66% adolescent girls from the two government schools (n=100/1450) and 34% adolescent girls from the two private schools (n=50/650). The objectives, procedure and benefits of the study were explained to the participating 150 adolescent girls to their satisfaction. Informed and written consent was also taken from their parents.

Height, weight and BMI of each selected girls were measured in their school. Their history was taken if they had/have any systemic diseases. Then, 5 ml blood sample of these girls were collected from the cubital vein. It was placed into EDTA and heparinized tubes for hemoglobin and serum ferritin analysis respectively. Collected tubes were kept in a portable ice-box maintaining the temperature at 4°C. Then, it was sent to the biochemistry and pathology laboratories of B. P. Koirala Institute of Health Sciences, Dharan Nepal for their analysis. Hemoglobin was analyzed by cyanmethemoglobin methodand ferritin was analyzed by Tina-quant Ferritin Gen 3 Roche/Hitachi cobas c system which works on agglutination principle with enhancement of the reaction by latex.

We considered anemia when hemoglobin level was less than 12 g/dL and depletion of iron stores when serum ferritin was less than 15 µg/L as per the WHO cut-off value. [5]Likewise, we classified anemia as mild, moderate and severe when hemoglobin level was 11 to 11.9 gm/dL, 8 to 10.9 g/dL and less than 8 gm/dl respectively as per the WHO cut-off value. [8]The result obtained was shared with the participants. Then, appropriate advice was given to those having hemoglobin and ferritin values below normal levels. Descriptive statistics was used to describe the frequency of hemoglobin and ferritin level; paired t test

was used to compare the data showing normal distribution and Chi Square test was used to compare the categorical variables of anemic and non-anemic adolescent school girls. A p-value of < 0.05 was considered statistically significant.

RESULTS

We had screened 150 adolescent school girls for anemia and iron store level. From these adolescent girls, 66.66% (n=100) and 33.3% (n=50) girls were enrolled in our study from the two government schools and two private schools respectively (Table 1).

From the total 150 adolescent school girls, 33.33% (n=50) girls were anemic and the remaining 66.67% (n=100) girls were not anemic (Table 1). The frequency of anemia in the government and private sector higher secondary schools were similar (p= 0.52) (Table 2).

The mean age (years), height (m), weight (kg) and BMI (Kg/m^2) of total adolescent girls are shown in Table 3. These general characteristics of anemic and non-anemic adolescent girls were similar but there was a significant decrease of hemoglobin and ferritin levels in anemic girls compared to non-anemic girls (Hb level, anemic girls = 11.10±0.92 Vs. non-anemic girls= 12.90 ± 0.68, p= <0.001; ferritin level, anemic girls = 21.85 ± 17.80 Vs. non-anemic girls= 35.8 ± 20.98 µg/L, p=<0.001) (Table 4).

From the 150 adolescent girls, 17.33% (n=26/150) girls were identified anemic with iron deficiency (Hb<12 and ferritin <15 µg/L), 16 % (n=24/150) girls were anemic with normal iron level (Hb<12 and ferritin >15 µg/L), 9.33% (n=14/150) girls were iron deficient without anemia (Hb>12 and ferritin <15 µg/L) and 57.33% (n=86/150) girls were identified with normal hemoglobin and ferritin levels (Hb>12 gm/dl and ferritin >15 µg/L) (Table 5).

Table 1: School distribution and screening of anemia of adolescent girls, Dharan

Characteristics	Categories	Number of adolescent school girls (%)
Higher secondary schools	Government school	50 (33.3)
	Government school	50 (33.3)
	Private school	33 (22.0)
	Private school	17 (11.3)
Adolescent school girls	Anemic	50 (33.33)
	Non-anemic	100 (66.67)

Table 2: Frequency of anemic and non-anemic adolescent girls from the government and private sectors higher secondary schools

Characteristics	Category	Adolescent school girls		p value
		Anemic (%)	Non-anemic (%)	
Higher secondary schools	Government school	19 (38.0)	31 (62.0)	0.52
	Government school	19 (38.0)	31 (62.0)	
	Private school	8 (24.2)	25 (72.7)	
	Private school	4 (23.0)	13 (76.5)	
Total		50 (33.33)	100 (66.67)	

Table 3: General characteristics of adolescent school girls, Dharan

Variables	Mean±SD	Minimum	Maximum
Age (years)	14.30±1.41	11	18
Height (m)	1.53±0.06	1.4	1.8
Weight (kg)	46.22±7.82	29	70
BMI (kg/m^2)	19.39±3.19	13.77	29.51

Table 4: Comparison of general characteristics, hemoglobin and ferritin level of anemic and non-anemic school girls, Dharan

Variables	Categories	Mean±SD	p value
Age (years)	Non-anemic (n=100)	14.41±1.39	0.19
	Anemic (n=50)	14.08±1.45	
Height (m)	Non-anemic (n=100)	1.534±0.07	0.88
	Anemic (n=50)	1.54±0.05	
Weight (kg)	Non-anemic (n=100)	45.82±7.82	0.37
	Anemic (n=50)	47.04±7.92	
BMI (kg/m^2)	Non-Anemic (n=100)	19.44±2.93	0.35
	Anemic (n=50)	19.93±3.27	
Hb (gm/dL)	Non-Anemic (n=100)	12.9±0.68	<0.001
	Anemic (n=50)	11.10±0.92	
Ferritin (µg/L)	Non-Anemic (n=100)	35.80±20.98	<0.001
	Anemic (n=50)	21.85±17.80	

Table 5: Iron store level in anemic and non-anemic adolescent school girls, Dharan

	Hemoglobin level				Total	
	Anemic (Hb<12 gm/dL)		Non-Anemic (Hb>12gm/dL)			
	n	(%)	n	(%)	n	(%)
Ferritin level (15-150µg/L)						
Decreased iron store	26	17.33	14	9.33	37	24.66
Normal iron store	24	16	86	57.33	113	75.33
Total	50	33.33	100	66.66	150	100

From the 50 anemic adolescent school girls, 72% (n=36/50) had mild anemia (Hb= 11-11.9 gm/dl), 26% (n=13/50) had moderate anemia (Hb= 8-10.9 gm/dl) and 2% (n=1/50) had severe anemia (<8) (Table 6).

In mild anemic adolescent girls, 32% (n= 16/50) girls had decreased and 40% (n=20/50) girls had normal ferritin

Table 6: Severity of anemia of anemic adolescent school girls, Dharan

Hemoglobin level	Anemic adolescent school girls	
	severity of anemia	n (%)
11-11.9 gm/dl	Mild anemia	36 (72)
8-10.9 gm/dl	Moderate anemia	13 (26)
<8 gm/dl	Severe anemia	1 (2)
Total		50 (100)

Table 7: Iron store level according to the severity of anemia of anemic adolescent school girls, Dharan

	Ferritin level (15-150µg/L)				Total	
	Decreased		Normal			
	n	(%)	n	(%)	n	(%)
Severity of anemia* of anemic adolescent girls (Hb, gm/dL)						
Mild	16	32	20	40	36	72
Moderate	9	18	4	8	13	26
Severe	1	2	-	-	1	2
Total	26	52	24	48	50	100

*Hb level: Mild anemia=11-11.9 gm/dl, Moderate anemia=8-10.9 gm/dl, Severe= <8 gm/dl

level. In moderate adolescent anemic girls, 18%(n=9/50) girls had decreased and 8% (n=4/50) girls had normal ferritin level. In 2% (n= 1/50) severe anemic adolescent girl had decreased ferritin level (Table 7).

DISCUSSION

We had investigated the prevalence of anemia and iron deficiency in adolescent local school girls of Dharan, Nepal. We found that the prevalence of anemia in this area of adolescent school girls was only 33.33% in which 72% had mild, 26% had moderate and 2% had severe anemia. Similar to ours, Gupta et al has reported the prevalence of anemia in adolescent girls of rural area of central Kathmandu is 35.3%.[9] Other studies mostly done in various parts of eastern region of Nepal, however, have shown higher prevalence than ours: Sinha et al 56.3% (retrospective hospital based study, Biratnagar),[10] Baral and Onta 65.6% (rural and urban area of Morang district).[11]

The possibility of this difference could be that we had studied in school-based population of Dharan while other had studied in different setting. The Survival for Women and Children (SWACH) Foundation study of India has demonstrated that prevalence of anemia is higher in non-school going girls as compared to school going girls. This may be due to ignorance about the nutritional needs, as well as the socio-economic background of non-school going girls.[12] Likewise, Kanodia et al had found the prevalence of adolescent girls of government school of Dharan was 51.3% which is more than our studies.[13] We have studied in both the government and private higher secondary schools in contrast to Kanodia et al. We found no difference in the frequency of anemia in between these government and private schools. In private school girls, the possibility may not be due to poor socio-economic condition but due to body image, craze for trendy foods, peer influence, media and association of food with famous people have great influence in their nutritional status.[12]

Serum ferritin level reflects status of iron store in the body. We found that in mild anemic girls, 32% had iron deficiency and 40% had normal iron store. In moderate anemic girls, 18% had iron deficiency and 8% had normal iron store. In 2% severe anemic girls had iron deficiency. Overall, 52% girls had iron deficiency anemia and 48% anemic girls had normal iron store level. Study done by Chandya RK et al in women of reproductive age of Bhaktapur, Nepal, found that the prevalence of anemia and iron deficiency anemia was only 12% and 6% respectively.[7] Similar to our finding in adolescent girls, they have reported anemia with normal iron store level in 47% women of reproductive age. In this condition, they have found increased serum transferrin receptor level. The level of serum transferrin receptor reflects the intensity of red blood cell formation and the demand for iron. When the supply of iron to the tissues gradually declines, expression of transferrin receptor on the cell membrane increases.[14] This hyperproliferative production of red blood cells may leads to other micronutrient deficiencies like folate, vitamin A and vitamin B12.[15-17] Anemia with normal iron store level can be associated with infectious diseases like malaria, intestinal parasitic infestations and chronic infections.[17]

In non-anemic adolescent girls, we found that 9% girls had iron deficiency. This condition is called iron-deficient erythropoiesis, in which there is depleted iron stores and elevated transferrin receptor but normal hemoglobin level.[7] It may be due to hyperproliferative erythropoiesis caused by other reasons or it may occur before iron stores are completely depleted. Both conditions lead to insufficient iron supply to the bone marrow.[18, 7]

Ferritin is a better indicator for detecting iron deficiency when measured in the absence of infection.[8] Serum ferritin, along with soluble transferrin receptor, is a better indicator to measure the iron status of populations in areas where inflammation is not prevalent.[19]

Because of resource constraint, we have analyzed only serum ferritin level to assess the iron store level in adolescent girls. Most of the studies regarding the prevalence of iron deficiency anemia done in Nepal is based on the concentration of hemoglobin level only. Measuring only hemoglobin level as a proxy for iron deficiency and iron deficiency anemia underestimates other causes of anemia.[7]

To conclude we found that the prevalence of anemia was less in the adolescent school girls of Dharan, Nepal, than the earlier documented reports, in which only half the anemic girls were iron deficient and remaining half had normal iron store level. Among anemia, prevalence of mild anemia was highest in which almost half of these anemic girls had iron deficient. This finding suggest that only half of these anemic girls had iron deficiency anemia and remaining other half could have other causes of anemia. It also gives indication that the terms anemia and iron-deficiency anemia cannot be use interchangeably. Normal hemoglobin did not exclude iron deficiency as 9% non-anemic girls had decreased ferritin level.

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NL- Concept and design of the study, data collection, statistical analysis and interpretation, manuscript preparation, critical revision of the manuscript;
DT- Design of the study, review of the study and helped in preparing first draft of the manuscript; **BKLD-** Design of the study, interpretation of the result and critical revision of the manuscript; **LBC-** Data collection, review of literature and helped in preparing first draft of manuscript; **AP-** Data collection and interpretation of the result; **DB-** Design of the study and statistical analysis.

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