Prevalence of iron deficiency and anemia in girls studying in high schools of Ilam city

Reza Shiri Haris[1], Bahram Rostami[2], Mohsen Mohsenzade[1], Negar Falahati[3], Mohamad Reza Hafezi Ahmadi[4], Enayat Anvari[*3]

1. Department of Hematology, Faculty of Paramedical Sciences, Ilam University of Medical Sciences, Ilam, Iran
2. Department of Hematology, Social Security Clinic, Social Security Organization, Ilam, Iran
3. Student's Research Committee, Ilam University of Medical Sciences, Ilam, Iran
4. Department of Pathology, Faculty of Medicine, Ilam University of Medical Sciences, Ilam, Iran

***Corresponding author:** Tel: +98 9361050933 Fax: +98 8432227120
Address: Department of Physiology, Faculty of Medicine, Ilam University of Medical Sciences, Ilam, Iran
E-mail: anvari_ph@yahoo.com
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Abstract

Introduction: Iron deficiency anemia (IDA) is the most common micronutrient deficiency in the world and almost a third of the world's population is involved with IDA. It could lead to serious disorders such as impairment of learning and mental focus. Reduction of iron resources of the body results in to an imbalance in the physiological functions. With regard to the role of iron in myelination of neurons and the effect on nerve conduction velocity, iron deficiency could lead to changes in sensory and behaviors responses. Given the importance of anemia and IDA in girls studying in Ilam high schools, this study aimed to determine the prevalence rate of anemia and IDA.

Materials and methods: Girls studying in Ilam high schools aged 16-18 years (n=210) were selected by random sampling design. Iron and total iron binding capacity (TIBC) was measured. Complete blood cells count and serum ferritin concentration also was assessed. Anemia and IDA was assessed in several methods. Iron depletion (Id) and Iron deficiency (ID) was checked too.

Results: According on the hematological and iron indices, 3.4% to 70.9% of subjects have anemia and iron deficiency. Severity distribution of anemia was categorized as mild (28.5%), moderate (1.4%) and sever (0%). Iron depletion and Iron deficiency was found for 45.2 and 4.3% of study participants respectively. The correlation of hemoglobin (Hb) with ferritin ($r=0.1$, $P= 0.15$) and TIBC ($r=-0.05$, $P= 0.4$) was not significant. Independent relationship of hemoglobin concentration with MCV, serum ferritin and TIBC were significant.

Conclusion: This study shows that the prevalence rate of anemia and IDA is high in girls studying in Ilam high schools. However, it is necessary that be given them proper nutrition program. In the long-term awareness of women's nutrition should be considered and should be taken to reform of their bad habits. Also, enrichment of food products with iron compounds should be considered as a national program. It should be checked also the role of economic status and parasitic diseases of participants in induction of ID and IDA.

Keywords: Anemia, Iron deficiency anemia, High schools girls

Introduction

Anemia is a disorder in which was reduced the volume of red blood cells or their number than healthy individuals (1). In the general health field is a major problem. Some research has shown that anemia could be a risk factor for infection (2-4). Nevertheless, weakness, loss of appetite and pallor are the clinical manifestations of

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anemia (5). Iron deficiency anemia (IDA) is a public health problem in all of the world, especially in developing countries (6) and more than half of school-age children are at risk of IDA (7). IDA is the most common micronutrient deficiency in the world and almost a third of the world's population is involved with IDA (8, 9). In fact, IDA is the most common form of anemia in teenagers (9). IDA could lead to serious disorders such as impairment of movement, speech, learning and mental focus (3). The negative effects of IDA on the cognitive function and physical development of children and on the work output of adults is the main concern (10). The prevention of IDA could lead to increased physical strength and reducing the infectious diseases (11). IDA is influenced by dietary habits, such as vegetarian diets and insufficient intake of animal sources (12).

Iron is an important bio metal for life, mainly due to its ability to accept and release of electrons and readily switching from ferrous (Fe2+) to ferric (Fe3+) ions. Transmission of electrons between iron and donor/recipient molecules causes to several vital functions in the body (13). Iron is also needed for growth of body tissues (11). Reduction of iron resources results in an imbalance in the body physiological functions including growth (2). If not eaten enough iron may disturb lymphocytes, gastrointestinal tract function, muscular and central nervous system (2-4). With regard to the role of iron in myelination of neurons and the effect on nerve conduction velocity, iron deficiency could lead to changes in sensory and behavioral responses (13).

Hemoglobin is necessary for oxygen transmission to the tissues, the electrons transport in the cells, making enzymes for use of energy production (6). Since it is made of iron, hemoglobin deficiency could lead to serious disorders (3). Reducing the volume and mass of red blood cells following of hemoglobin deficiency could lead to the reduction of oxygen transport capacity to the tissues, fatigue and loss of energy .(۵)

Women make up about half of the world's population. The country's future health is influenced by women's health. However, the sustainable development and welfare for all in the new century, without prioritizing women's health and nutrition is impossible (8, 9). Given the importance of prevention and control of anemia and IDA in girls studying in Ilam high schools, this study aimed to determine the prevalence rate of anemia and IDA on March 2015.

Materials and methods

Subjects and sampling. Girls studying in Ilam high schools, Iran aged 16-18 years (n=210) were evaluated on March 2015. Participants were selected by random sampling design; ten high schools were selected by cluster random sampling. At the second stage, high school girls were selected by stratified random sampling in each unit. Ethics Committee of Ilam University of Medical Sciences established the research protocol. Blood sampling were carried out by expert personnel. Five ml venous blood was taken from each subject to measuring of hematological parameters .

Laboratory analysis. Iron and total iron binding capacity (TIBC) was measured using an auto-analyzer (BT-3500, Biotecnica, USA-Italy). Complete blood cells count was done by KX-21-Hematology-Analyzer - Sysmex. Serum ferritin was measured by Chemiluminescence Immuno Assay (Monobind Company) .

Definition: Anemia was defined in several methods (6); on the base of Mentzer index [(MCV/RBC) <13], Ferritin <10, hematocrit< 40%, MCHC <30.6, MCHC <30.6, Fe <40 and TIBC >410. The severity of anemia was categorized as mild (10-12.3 g/dL), moderate (7-10 g/dL) and severe form (<7 g/dL). IDA was considered as; Transferrin saturation [(Fe/TIBC) × 100] <16%, ferritin<10 ng/ml. Iron depletion was defined as serum

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ferritin level of <20 ng/mL and iron deficiency as ferritin level of <12 ng/mL and transferrin saturation of <15% .

Statistical analysis

Hematological and iron indices were collected, analyzed, and reported as mean ± SEM. Correlations between hemoglobin with serum ferritin and TIBC were assessed by Pearson's correlation test. Independent relationship of hemoglobin concentration with MCV, serum ferritin and TIBC was evaluated by multiple regression analysis.

Results

All of the participants were girls and mean age of them was 16.8±0.2. Hematological and iron indices in girls studying in Ilam high schools were presented (Table 1). In this research were assessed anemia and IDA on the basis of different criteria (Table 2) (6). Severity distribution of anemia according on Hb <12.3 has shown (Table 3) .

The correlation of Hb with ferritin (r=0.1, P= 0.15) and TIBC (r=-0.05, P= 0.4) was done by Pearson Coefficient of Correlation. However, was shown any significant relationship in both of them.

Table 1. Hematological and iron indices in girls studying in Ilam high schools.

Variables	Minimum	Maximum	Mean ± SEM	Number
RBC (3×10^6/µm)	3.03	7.74	4.68±.03	210
Hb (gr/dl)	9.6	18.3	12.7±.07	210
Hct (%)	27.7	44.4	39.18±.16	210
MCV (fl)	62.7	96.5	84.23±.4	210
MCH (pg)	18.1	37.4	27.3±.19	210
MCHC (g/dl)	28.1	36.2	32.36±.98	210
Plt ($\times10^3$)	268	425	261±4	210
RDW	36.8	50.5	42.06±.14	175
Fe (µg/dl)	10	236	97.33±2.3	206
TIBC (µg/dl)	269	623	446±4	206
Ferritin (ng/ml)	1.38	220.5	29.71±1.88	208

RBC; red blood cells count, Hb; hemoglobin, Hct; hematocrit, MCV; mean corpuscular volume, MCH; mean corpuscular hemoglobin, MCHC; mean corpuscular hemoglobin concentrate, TIBC; total iron binding capacity, RDW; Red Cell Distribution Width, Plt; platelet count, Fe; iron.

Table 2. Number and percentage of subjects with anemia based on different hematological indices.

Variables	Status	Cases of anemia (number/percent)
Hb (gr/dl)	Hb (<12.3)	63 (30)
Hct (%)	Hct (<40%)	123(58.5)
MCHC (g/dl)	MCHC (<30.6)	21(10)
Fe (µg/dl)	Fe (<40)	7(3.4)
TIBC (µg/dl)	TIBC (>410)	146(70.9)
Ferritin (ng/ml)	Ferritin (<10)	45(21.6)
TS (%)	TS (%) (<16%)	21(10.2)
MI	MI<13	10(4.7)
IDA	IDA	53(25.4)

Hb; hemoglobin, Hct; hematocrit, MCHC; mean corpuscular hemoglobin concentrate, TS; Transferrin saturation (Fe/TIBC)×100, Fe; iron, TIBC; total iron binding capacity, MI; Mentzer index (MCV/RBC), IDA; iron deficiency anemia (ferritin<12 ng/ml).

Table 3. Prevalence of anemia in girls studying in Ilam high schools.

Severity of anemia (anemia was considered as Hb < 12.3)		
Mild (10 < Hb < 12.3)	Moderate (7 < Hb < 10)	Sever (Hb <7)
28.5%	1.4%	0%

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Iron depletion (serum ferritin level of <2320 ng/mL) was found in 45.2% of study participants. Iron deficiency (ferritin level of < 12 ng/mL and transferrin saturation of < 15%) also was found in 4.3% of study participants (15). Independent relationship of hemoglobin concentration with MCV, serum ferritin and TIBC has been shown in Table 4.

Table 4. Linear regression for hemoglobin concentration of girls studying in Ilam high schools, Iran.

Variables	B	β	t	P value
MCV	0.062	0.012	5.14	0.000
TIBC	0.000	-0.05	-7.2	0.000
Ferritin	0.004	0.1	1.43	0.000

MCV; mean corpuscular volume, TIBC; total iron binding capacity.

Discussion

The results of the present research which has been conducted in order to consideration of the prevalence rate of anemia and iron deficiency anemia (IDA) in 210 girls of high schools in Ilam City, Iran.

Some studies reported that several factors have influenced on anemia including educational level of girls and their parents, socioeconomic status, family size, status of menstruation, having a vegetarian diet, drinking tea before eating food, history of parasite infestation and use of iron supplement (16).

IDA is the most prevalent anemia, and usually comprises 50 percent cases of anemia and even though in some studies, 88.4% of cases had reported of deficiency anemia (17). In different regions of Iran, due to the differences in nutrition and food culture the prevalence rate of IDA has been different .

In this study, the lowest prevalence rate of anemia was 3.4% which was obtained by measuring the iron of serum (Fe<40µg/dl). Based on the assessment of the TIBC (TIBC>410µg/dl), the prevalence rate of anemia was 70.9% which was the highest percentage. These results cannot be compared to the past, because has not been done a study similar to this research in the city of Ilam on female students. However, similar studies were carried out in Iran have reported similar results on anemia. For example, in a survey that was conducted on the basis of hemoglobin, 24% of women of reproductive age were anemic (18). In our study the percent of anemia was 30% based on hemoglobin criteria (Hb <12.3). According to the study was done in Kerman (on 1993) 11.8% of women 15 to 45 years old had anemia (19). In other studies on the same basis in the North East of Iran was done by Dr. Sadeghi Pour and his colleagus, the prevalence rate of iron deficiency anemia was 36.6%. The prevalence of IDA in developing countries is more than developed countries, so that in one study was done in Senegal, rate of IDA was 36.6% (20). While in France, using hemoglobin index (<12.1), prevalence of IDA was 1.3 and 2.6 % in menopausal and premenopausal women respectively (21). Comparing these findings show that IDA is one of the major health problems in undeveloped and developing countries. This difference is due to sufficient iron intake by people in developed countries and high level of awareness of them (22). Based hematocrit index (Hct<40%), 58% of the subjects had IDA and in a similar study was conducted on women aged 15 to 45 years in Zanjan, 47.3% had anemia (6). Based MCHC criteria (MCHC<30.6), 10% of the subjects had IDA and while in study of women aged 15 to 45 years in Zanjan, percent of IDA was 14.5 % (6). In a research with the purpose of assessment of IDA (2008) in women in Ramsar and Tonekabon cities, it is mentioned that the prevalence rate of IDA was 21.3% (23). In another study, was done in Mashhad city the prevalence rate of IDA was 20.7%

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[24]. In a similar study in Yazd city, prevalence rate of IDA and anemia among high school girls has been reported that 9.3 and 13.5% respectively (25). Basically on this test, were determined moderate and severe cases of IDA and cannot show mild cases (6). These differences in results may be due to differences in social, economic and nutritional status.

In our study, there was no significant correlation between hemoglobin and serum ferritin show that iron status was not likely an important factor of anemia in the studied population. These data are in contrast to results of Hashismue et al. (26) who showed that a significant positive correlation between hemoglobin and serum ferritin in school children of the Aral Sea Region of Kasakhestan (r=0.275, p= 0.001). Also it differs from the data has been reported by Karimi et al. (27) who exhibited a significant positive correlation between hemoglobin and ferritin in pregnant women in Southern Iran (r= 0.76, p=0.01). One reason for this difference maybe children and pregnant women are more susceptible to deficiency of iron than adolescent girls.

Factors that affect hemoglobin concentration contain including MCV, TIBC, age, and body mass index (BMI). However, we did not check age, and BMI. Our study showed that significant relation of hemoglobin with MCV that is in the same line with the results of Hashismue et al. (26).

Dietary factors have been mentioned to be related with IDA. These factors are including low consumption of red meat, vegetables, cereals and fruits (28). Bateni et al. have mentioned inadequate intake from animal sources as the causes of iron deficiency (6). According to previous studies anemia was lower in children with good economic status. In similar studies, the prevalence of anemia declined as the economic situation was better. The possibility of providing food rich in iron, which is found in animal sources, is related to family income (7, 29). Since Ilam City is the least developed and with poor economic status people, it may be one of the reasons for the high prevalence of anemia among girls.

Approximately 10 to 20% of iron obtained by eating meat (heme iron) while 80 to 90% of non-heme iron obtained from vegetables, fruits, and cereals. However, absorption of non-heme iron is influenced of the iron status in subjects, the balance between inhibitory and excitatory factors affecting the absorption of the food, much more than iron from heme (30). According to the previous studies could be said that women sometimes consuming red meat and vegetables (less than twice a week from red meat and vegetables) were at risk of ID and IDA (31). Absorption of iron from plant sources is poor while the ability to absorb more, for animal sources of iron (32). Bateni et al. were reported iron deficiency due to inadequate intake from animal sources (6). Consumption of milk and dairy products was higher in children with anemia (32). Bonuck and colleagues, showed that high intake of milk and calcium has been associated with block of iron absorption and iron-deficiency anemia (33). In our study did not check nutritional status of girls. More research need to research on the dietary habits of girls in Ilam City, to be more clear the correlation of nutrition with anemia .

M Ramzi et al. (16) showed that parasite infestation was associated with anemia. This relationship has been emphasized also by Kaur et al. (34) in adolescent girls of Wardha. Leenstra et al. (35) showed that malaria and shistosomiasis were the major risk factors for anemia in young adolescent girls too. But we did not test participants for parasitic diseases that need to be reviewed.

Conclusion

This study shows that the prevalence of anemia is high in student's girls from Ilam, Iran. Due to the prevalence of iron deficiency anemia in high school students, it is necessary that be given them proper

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nutrition program. In the long-term awareness of women's nutrition should be considered and should be taken to reform of their bad habits. Enrichment of food products with iron compounds should be considered as a national program. It should be checked also the role of economic status and parasitic diseases of participants in ID and IDA.

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