

Iron Deficiency and Iron Deficiency Anemia in Adolescent Girls in Rural Upper Egypt

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SMOM, AMMH and SMS contributed to the conception and design of the study. Authors HAAA and SMOM designed the collection and acquisition of data. Authors SMOM, AMMH and HAAA contributed to the analysis of the data. All authors contributed to the interpretation of the data, drafting or revising of the manuscript, and final approval for publication.

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ABSTRACT

Background: Iron deficiency (ID) and iron deficiency anemia (IDA) in adolescents tends to increase with age due to acceleration of growth.

Objectives: This study aimed to determine the prevalence of ID and IDA in adolescent girls in rural Upper Egypt.

Methods: 912 girls in 5 different village preparatory schools situated in El-Minya governorate at Upper Egypt were enrolled in the study. Complete blood count and serum ferritin were done to determine the prevalence of ID and IDA among them.

Results: Our study revealed 39.9% of the girls were anemic, the prevalence of IDA was 30.2% and that of ID without anemia was 11.4%.

Conclusions: ID, with or without anemia is still a major health problem in adolescent girls living in rural Upper Egypt.

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Keywords: Adolescent girls; iron deficiency; iron deficiency anemia; Upper Egypt.

1. INTRODUCTION

Iron deficiency (ID) is in the top 20 risk factors for the global distribution of burden of disease [1] and the most common nutritional disorder and the leading cause of anemia in the world [2]. Iron deficiency anemia (IDA) represents a formidable health challenge in Egypt [3].

Girls in the period of late school age and early adolescence are prone to develop iron deficiency [4]. The lower total food intake or energy intake by adolescent girls compared to boys, combined with menstrual losses cause adolescent girls to be at greater risk of ID and IDA [2]. Moreover, the incidence of anemia tends to increase with age and corresponds to the highest acceleration of growth during adolescence [5]. IDA reduces cognitive functions and adversely affects learning and scholastic performance in school girls entering adolescence [6].

In this study, we aimed to determine the prevalence of iron deficiency and iron deficiency anemia in school- going adolescent girls in El-Minya governorate at Upper Egypt.

2. SUBJECTS AND METHODS

2.1 Subjects and Research Design

This descriptive cross sectional study was carried out in five preparatory schools for girls (from grade 7 to grade 9) in five different villages in El-Minia governorate at Upper Egypt. In the period from September 2014 to May 2015. From a total number of 1153 girls, 932 students aged between 12-17 years volunteered to participate in our study. Necessary permissions were taken from schools' authorities. The study was explained in details to the girls and written consents were taken from their legal guardians.

Participation in the screening program was voluntary, so, a selection bias may exist, but the large number of participation may overcome this bias.

The protocol of the study was approved by the Institutional Review Board and Medical Ethics Committee of Minia University hospitals.

Participant girls completed a questionnaire asking about medical and menstrual history as well as their dietary habits.

Regarding the dietary habits, we asked about the average number of iron rich meals per week (lean meat, liver, sea food, apple, green vegetables, fruits especially citrus fruits...) and average number of bad dietetic habits interfering with iron absorption per day as tea and coffee drinking within 30 minutes after a meal which are common habits in rural Egypt and also foods hindering iron absorption. Thus, we asked about number of times they were ingested per day.

Anthropometric Measures (weight, height) were taken. Wooden height scales were used for height measuring to the nearest 1 cm. Moreover, weight was measured using a scale with a sensitivity of 50 grams and a capacity of 150 kg and weight was measured using a scale with a sensitivity of 50 grams and a capacity of 150 kg. BMI was calculated by: $BMI = \text{weight (kg)} / \text{height (m}^2\text{)}$ [7]. BMI classification of the World Health Organization was applied [8].

2.2 Method of Screening

Screening was performed by: (1) Complete blood count (CBC) using automated blood counter (*Sysmex KX-21N*). (2) Serum ferritin assay by enzyme-linked immunosorbent assay (ELISA) (Ferritin Human ELISA Kit, ab108837, Abcam, Cambridge, USA) [9]. The assay was performed according to the manufacturer's instructions. Final serum ferritin values were expressed in nanogram per milliliter (ng/ml) (3) C-Reactive Protein (CRP) was analyzed by rapid latex-agglutination assay (CRP latex serology test kit, Omega diagnostics, Scotland, United Kingdom) [10] for the qualitative and semi-quantitative determination of CRP in human serum.

2.3 Sample Size

Assuming 35% prevalence of anemia [11], 10% relative error in the measured prevalence, a two tailed of 95% Confidence Interval, calculated minimum sample size came out to be 714. Assuming 10% non-response error, final targeted sample size was 800.

2.4 Sample Collection

About 4 ml of venous blood was withdrawn under complete aseptic technique. 1 ml was collected in EDTA coated tubes for CBC evaluation and 3 ml was collected in a plane tube for serum separation. The separated serum was stored at -

20°C for measurement of serum ferritin and CRP.

Anemia was diagnosed when Hb < 12 gm/dl [5] and ID when serum ferritin < 15 ng/ml [2]. If the mean corpuscular volume (MCV) was less than normal (< 80 fl) and serum ferritin was > 15 ng/ml, hemoglobin electrophoresis was done by methods of cellulose acetate and citrate agar to check for thalassemia minor. Girls with positive CRP were excluded.

The parents of the participant girls who revealed to be iron deficient or anemic (whatever the cause of anemia was) were contacted to ensure adequate treatment and further investigations when needed.

2.5 Statistical Methods

The collected data were statistically analyzed using statistical package for social sciences (SPSS) program for windows version 20. Continues results were presented as mean (SD) while qualitative data were presented by frequency distribution as percentage (%). Chi square test, was used to compare between proportions. The probability of error less than 0.05 was used as a cut off point for all significant tests.

3. RESULTS

From the 932 girls participated in our study, twenty girls were excluded due to positive CRP. So, 912 girls were included in the screening. Their demographic data were represented in Table 1.

Regarding their BMI, 486 (53.3%) were with normal BMI, 276 (30.3%) were under-weight, 113 (12.3%) were overweight and 37 (4.1%) were obese. History of menstruation was positive in 622 girls (68.2%).

We found 548 (60.1%) of studied girls were non-anemic, while 364 (39.9%) of them were anemic. Table 2 shows the degree of anemia and mean corpuscular volume of the 364 anemic girls. The difference between the mild, moderate and severe anemia in Table 2 is statistically significant (p<0.001).

444 (48.6%) of studied girls were non-anemic non-iron deficient, 104 (11.4%) of them were non-anemic iron deficient, 276 (30.2%) of them were anemic iron deficient and 88 (9.6%) of them anemic non-iron deficient (Fig. 1).

Table 1. Demographic data of the participant girls

Variable	Studied group (no=912)	
	Range	(mean ±SD)
Age (years)	12-17	(14.7±2)
Age of menarche (years)	12-15	(13.5±1.5)
Dietetic history		
IRF /week	0-4	(2.1±1.3)
FBIA /day	0-4	(1.9±0.9)
Weight (kg)	25-85	(46.95±11.8)
Height (cm)	130-166	(150.5±7.6)
Body mass index (BMI)	13.7-36.6	(21.2±4.4)
HR (beat/min)	70-99	(86.3±7.6)
Hb (gm/dl)	7.5-14	(11.9±1.97)

IRF/week: Iron rich food per week; FBIA /day: Food blocking iron absorption per day; HR: Heart rate; Hb: Hemoglobin

Table 2. Degree of anemia and mean corpuscular volume of the anemic girls

	Anemic girls (no =364) no (%)
Hemoglobin level:	
-Mild anemia (Hb 11-11.9 gm/dl)	326 (89.6%)
-Moderate anemia (Hb 8-10.9 gm/dl)	36 (9.9%)
-Severe anemia (Hb<8 gm/dl)	2 (0.5%)*
Mean corpuscular volume (MCV):	
-Microcytic anemia (MCV<80fl)	328 (90.1%)
-Normocytic anemia (MCV 80-96fl)	36 (9.9%)

Severity of anemia: according to WHO, 2011 [12]; Morphological diagnosis of anemia: according to Vajpayee et al. 2011 [13].

**Chi-square test, p value <0.001*

Fifty-two girls had a MCV less than normal (< 80 fl) and their serum ferritin was > 15 ng/ml, hemoglobin electrophoresis diagnosed 34 girls of them as having thalassemia minor, while 18 girls had normal hemoglobin electrophoresis, they were referred for further investigations. All the 52 girls had a Hb level < 12 gm/dl, consequently, they were included in the anemic non-iron deficient group.

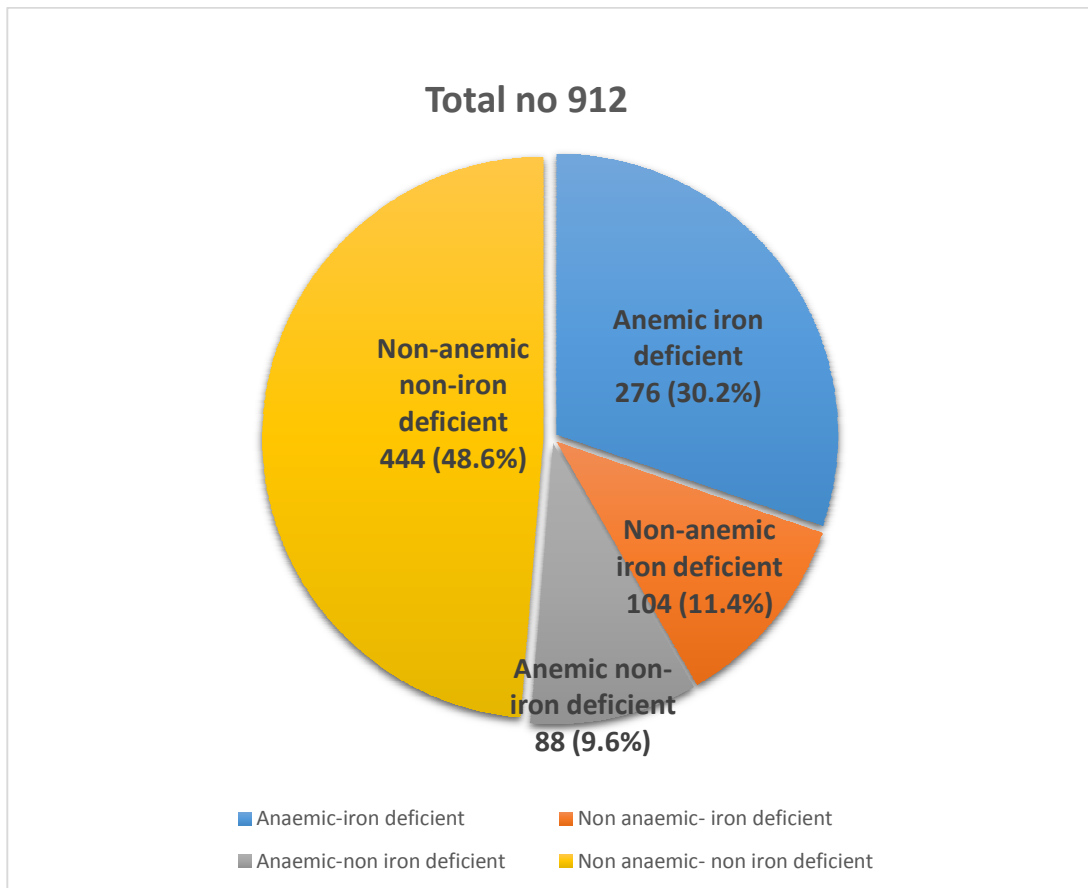


Fig. 1. Prevalence of iron deficiency and iron deficiency anaemia in studied girls

Non-anemic non-iron deficient: Hb>12 gm% & serum ferritin:>15 ng/ml; Non-anemic iron deficient:Hb>12 gm% & serum ferritin<15 ng/ml; Anaemic iron deficient:Hb<12 gm% & serum ferritin<15 ng/ml; Anaemic non-iron deficient: Hb<12 gm% & serum ferritin>15 ng/ml

4. DISCUSSION

The study found that 39.9% of the girls were anemic while 60.1% were not anemic. A national survey on adolescents in 21 Egyptian governorates in 1997 estimated that 46.6% of adolescents were anemic [14]. But this survey was before Egypt's Adolescent Anemia Prevention Program which started during the 1999-2000 school year which provides preventive health interventions to students regarding nutrition and health education [15]. In 2005, Egypt's Demographic Health Survey by the UN Children's Fund (UNICEF) elaborated that one quarter of the boys and one third of the girls were anemic [11]. Tawfik et al. in (2015) reported that 35.7% of adolescents were anemic [16]. The prevalence in our study was higher than those two studies, as they targeted both boys and girls, living in urban cities and rural villages, while our study targeted only adolescent girls in rural areas

where low socioeconomic level prevail. The lower total food intake compared to boys, combined with menstrual losses cause adolescent girls to be at greater risk of ID and IDA [2]. A study by Alaofè et al. stated that children from rural areas and lower social class children were significantly at higher risk for anemia especially IDA [17]. This may be due to lower-income households could have limited access to iron-rich foods and are more prone to parasitic infestations [18].

The prevalence of mild anemia was 89.6%, moderate anemia was 9.9% and 0.5% had severe anemia. In a study done in South Sinai by Yamamah et al. in (2015) on children aged 10.6±3.1 years, showed that 58.6% of studied anemic children had mild anemia, 41% had moderate anemia and <1% had severe anemia [19]. The high prevalence of mild anemia may be due to the application of Egypt's Adolescent

Anemia Prevention Program [15], after which the prevalence and severity of anemia has decreased in Egypt.

Our results showed that 90.1% of the anemic girls had microcytic anemia, 9.9% had normocytic anemia but there was no macrocytic anemia. The incidence of ID in this study was 11.4% and that of IDA was 30.2%.

53.3% girls were with normal BMI, 30.3% were under weight, 12.3% were over-weight and 4.1% were obese. Another study in (2014) on Egyptian girls aged between 11-17years, found that 28.2% were over-weight, 7.6% were obese and 9.9% were under-weight [20].

5. CONCLUSION

The prevalence of anemia among the adolescent girls was 39.9%, the prevalence of iron deficiency anemia was 30.2% and that of iron deficiency without anemia was 11.4%. Despite Egypt's Adolescent Anemia Prevention Program, ID and IDA are still health problems that need to be addressed to improve adolescent girls' health. This is of public health importance as it gives an opportunity for school-based interventions to improve adolescent girls' health.

We recommend screening girls with bad scholastic performance and bad memory for ID and IDA, and regular screening for ID in order to prevent IDA.

ETHICAL APPROVAL

The protocol of the study was approved by the Institutional Review Board and Medical Ethics Committee of Minia University hospitals.

Necessary permissions were taken from schools' authorities. The study was explained in details to the girls and written consents were taken from their legal guardians.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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