

Short Research Article

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

Running title: ID and IDA in adolescent Egyptian girls

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.

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 hospital.

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].

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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 collection

About 4ml of venous blood was withdrawn under complete aseptic technique. 1ml was collected in EDTA coated tubes for CBC evaluation and 3ml 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 $Hb < 12 \text{ gm/dl}$ [5] and ID when serum ferritin $< 15 \text{ ng/ml}$ [2]. If the mean corpuscular volume (MCV) was less than normal ($< 80 \text{ fl}$) and serum ferritin was $> 15 \text{ ng/ml}$, hemoglobin electrophoresis was done by methods of cellulose

73 acetate and citrate agar to check for thalassemia minor. Girls with positive CRP were
74 excluded.

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

78 2.4 Statistical methods

79 The collected data were statistically analyzed using statistical package for social sciences
80 (SPSS) program for windows version 20. Quantitative results were presented as mean (SD)
81 while qualitative data were presented by frequency distribution as percentage (%).

82 3. Results

83 From the 932 girls participated in our study, twenty girls were excluded due to
84 positive CRP. So, 912 girls were included in the screening. Their demographic data were
85 represented in table (I).

86 **Table (I): Demographic data of the participant girls.**

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Variable	Studied group (no=912)	
	Range	(mean $\pm$ SD)
Age (years):	12-17	(14.7 $\pm$ 2)
Age of menarche (years)	12-15	(13.5 $\pm$ 1.5)
Dietetic history		
IRF /week	0-4	(2.1 $\pm$ 1.3)
FBIA /day	0-4	(1.9 $\pm$ 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)

88 IRF/week: iron rich food per week; FBIA /day: Food blocking iron absorption per day; HR:
 89 heart rate; Hb: hemoglobin.

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

93 We found 548 (60.1%) of studied girls were non-anemic, while 364 (39.9%) of them
 94 were anemic. Table (II) shows the degree of anemia and mean corpuscular volume of the 364
 95 anemic girls.

96 **Table (II): Degree of anemia and mean corpuscular volume of the anemic girls.**

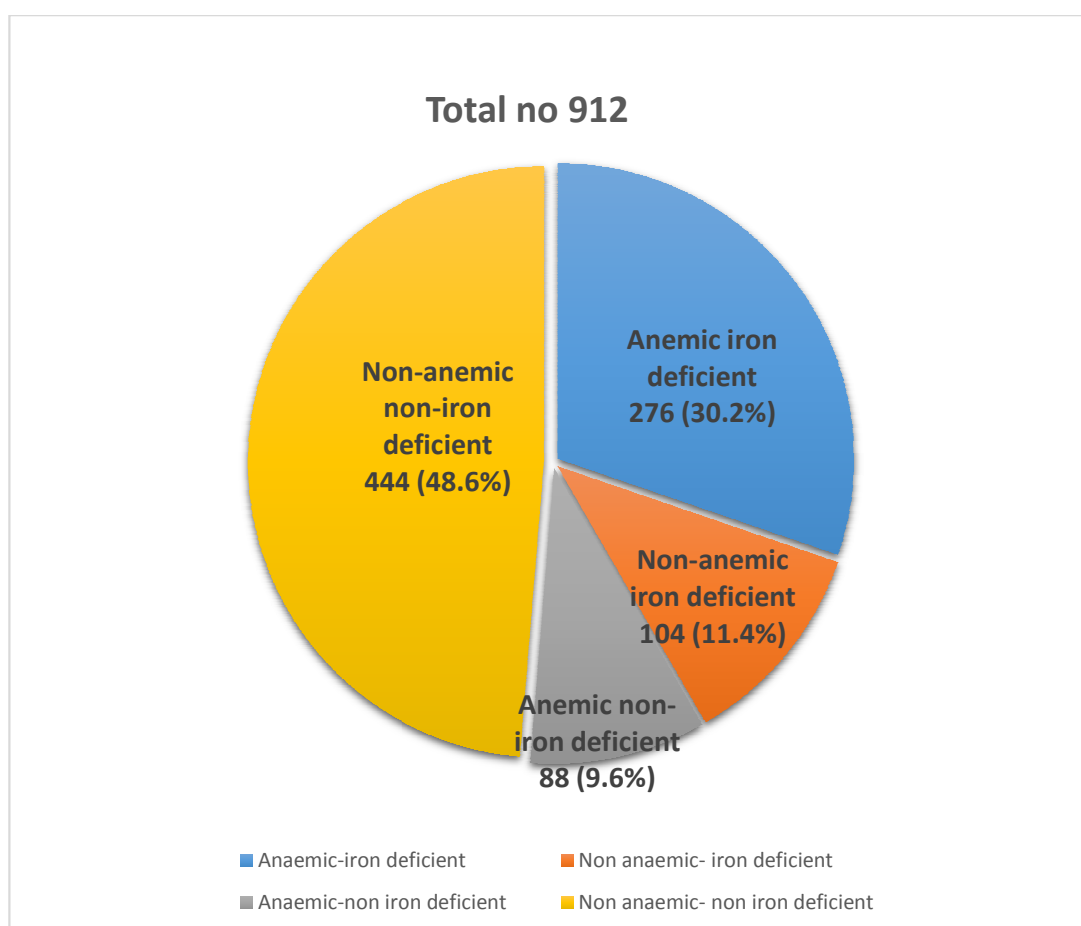
	Anemic girls (no =364)
	no (%)
**Hemoglobin level:	
- Mild anemia (Hb11-11.9gm/dl)	326 (89.6%)
- Moderate anemia (Hb 8-10.9gm/dl)	36 (9.9%)
- Severe anemia (Hb<8gm/dl)	2 (0.5%)

**Mean corpuscular volume (MCV):	
- Microcytic anemia (MCV<80fl)	328 (90.1%)
- Normocytic anemia (MCV 80-96fl)	36 (9.9%)

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98 Severity of anemia: according to WHO, 2011 [11]; Morphological diagnosis of anemia: according to
99 Vajpayee et al., 2011 [12].

100 444 (48.6%) of studied girls were non-anemic non-iron deficient, 104 (11.4%) of
101 them were non-anemic iron deficient, 276 (30.2%) of them were anemic iron deficient and 88
102 (9.6%) of them anemic non-iron deficient (fig. 1).



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

Figure (1): Prevalence of iron deficiency and iron deficiency anaemia in studied girls.

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.

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 [13]. 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 [14]. 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 [15]. 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 [14], 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 overweight 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.

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