# The prevalence of iron deficiency anaemia in female medical students in Tehran

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**ABSTRACT**

**Introduction: Female adolescents and adults are among the population groups who are most affected by iron deficiency. Thus, the aim of this study was to investigate the prevalence of iron deficiency and iron deficiency anaemia in female students aged 18 to 25 years old from the Tehran University of Medical Sciences, Iran.**

**Methods: 295 female university students participated in the study. The mean corpuscular volume (MCV) and haemoglobin (Hb), serum ferritin, serum iron and total iron binding capacity (TIBC) levels were measured. Iron deficiency anaemia was defined as a situation where Hb is less than 12 g/dL, MCV is less than 78 μm³, ferritin is less than 12 ng/ml or transferin saturation (TS) (iron/TIBC × 100) is less than 15 percent, Iron deficiency (ID) was defined as a situation where Hb is greater than or equal to 12 g/dL, MCV is greater than or equal to 74 μm³, ferritin is less than 12 ng/ml or TS is less than 15 percent.**

**Results: The complete data was available for 237 students. The prevalence of ID was 40.9 percent and that of IDA was 3.8 percent. Normal iron status was found in 49.8 percent of the subjects. The remaining (5.5 percent) had other kinds of anaemia or required confirmatory tests.**

**Conclusion: ID is common among 18 to 25-year-old Iranian female university students. Iron supplementation is thus required for the target group.**

**Keywords: adult females, iron deficiency, iron deficiency anaemia, medical students**

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## INTRODUCTION

Iron deficiency (ID) is the most widespread nutritional problem, and affects over two billion people.[1] It is a particularly common disorder among infants, preschool-aged children, young women and older people, but it can occur at all ages and in any region. A high demand for iron during rapid growth, pregnancy and lactation, accompanied by dietary deficiencies and menstrual blood loss, are the most common causes of iron deficiency in children and young women.

The first stage of ID involves the depletion of tissue iron stores. In the absence of inflammation, the level of serum ferritin, an iron-storage protein, has been shown to be a sensitive and reliable biomarker of the body iron store. This stage is characterised by serum ferritin levels that are below the normal range (< 12 ng/ml), without functional changes. The second stage begins when the negative balance persists. Laboratory findings in this stage include a reduction in serum iron and transferrin saturation (TS) levels (< 15%), and an increase in the free erythrocyte protoporphyrin level and the total iron binding capacity. At this stage, work capacity can be reduced. The third stage, iron deficiency anaemia (IDA), occurs when the iron stores are almost empty, leading to reduced erythropoiesis and red blood cells, which results in the development of anaemia (Hb level < 12 g/dl).[2,3] Anaemia is associated with a low work capacity, a poor pregnancy outcome, as well as lasting effects on learning and cognitive function, attention, behaviour, health and growth. Several studies have been conducted to evaluate the effects of IDA on psychomotor development and cognitive functions.[4,5]

Although nutritional deficiencies of folate and vitamin B12, infectious diseases, such as the human immunodeficiency virus, hookworm, malaria and other chronic diseases, may account for anaemia, according to the literature, more than 50% of cases of anaemia in young children and pregnant women in developing countries are related to iron deficiencies.[1,6] In the World Health Organization (WHO)/World Bank rankings, IDA is the third leading cause of disability-adjusted life years lost for females aged 15–44 years.[6,7]

The prevalence of ID and IDA is higher in less

**Table I. Indices of the iron status of the participants (n = 237).**

| Index | Mean | SD | 50th Percentile |
|---|---|---|---|
| Hb (g/dl) | 13.7 | 1 | 13.8 |
| MCV (µm$^3$) | 88 | 5.1 | 84 |
| Ferritin (ng/ml) | 27.7 | 25.6 | 19 |
| Serum iron (µg/dl) | 83 | 41 | 81 |
| TIBC (µg/dl) | 437 | 70 | 429 |
| TS (%) | 19.8 | 10 | 19.3 |

Hb: haemoglobin; MCV: mean corpuscular volumes; TIBC: total iron binding capacity; TS: transferin saturation

**Table II. Indices of the iron status in the normal, ID and IDA groups (n = 224).**

| Index | Mean ± SD | | |
|---|---|---|---|
| | Normal (n = 118) | ID (n = 97) | IDA (n = 9) |
| Hb (g/dl) | 13.96 ± 0.68 | 13.96 ± 0.68 | 11 ± 0.9 |
| MCV (µm$^3$) | 84.9 ± 3.48 | 84 ± 3.1 | 67.2 ± 6.7 |
| Ferritin (ng/ml) | 38.8 ± 25.9 | 6.6 ± 2.96 | 3.4 ± 1.3 |
| Serum iron (µg/dl) | 102 ± 33.8 | 44.4 ± 13.2 | 14.5 ± 6.4 |
| TIBC (µg/dl) | 403 ± 51.4 | 495 ± 57.9 | 511 ± 87 |
| TS (%) | 25.5 ± 8.0 | 9.0 ± 2.8 | 3.0 ± 2.0 |

Hb: haemoglobin; MCV: mean corpuscular volumes; TIBC: total iron binding capacity; TS: transferin saturation

developed countries as compared to developed countries. In South Africa, 5.1% of children aged zero to four years and 9%–12% of pregnant women are estimated to have IDA, and about 7.3% of perinatal deaths and 4.9% of maternal deaths are related to IDA.[1] In their study, Seaverson et al found that 7.2% of Hispanic women and 2.3% of non-Hispanic white older adults had IDA.[8] The literature has shown that the rates of ID among adolescent girls in America, China and India are 8.7%, 11.3% and 27.5%, respectively.[5,9]

Although the diagnosis of ID is relatively simple, it may go unnoticed for a long time due to its nonspecific clinical signs. The most common signs of ID include paleness, anorexia, apathy, irritability, reduced attention span and psychomotor deficiencies. As female adolescents and adults are among the population groups who are most affected by it, the present study was conducted to determine the prevalence of ID and IDA in female Iranian medical students.

## METHODS

This was a cross-sectional study of the prevalence of IDA in Iranian females aged 18–25 years old. From October 2005 to October 2006, 295 female students from the Tehran University of Medical Sciences, Iran, were recruited for the study. Written informed consent was obtained from all the participants prior to enrolment. The study protocol was approved by the Institutional Review Board of the university. A detailed physical examination was conducted on all the participants. Blood samples were obtained. Serum iron and total iron binding capacity levels were measured using a commercially available kit (Hitachi 704, Hitachi Ltd, Tokyo, Japan). The haemoglobin (Hb) and mean corpuscular volumes (MCV) were analysed on the cell counter (Sysmex K-1000, TOA Medical Electronics Co Ltd, Kobe, Japan). The concentration levels of serum ferritin were measured using radio-immunoassay.

The criteria for IDA were Hb < 12 g/dL, MCV < 78 µm$^3$, ferritin < 12 ng/ml or TS < 15%, and those for ID were Hb ≥ 12 g/dL, MCV ≥ 74 µm$^3$, ferritin < 12 ng/ml or TS < 15%. One participant was excluded from the study because of thalassaemia major, and 237 completed laboratory test results were received. Seven of these participants exhibited thalassaemia minor and six required confirmatory tests, and were thus not included in the study groups. The remaining participants were categorised into one of the following three groups: Group 1 – iron sufficient and not anaemic (normal); Group 2 – iron-deficient; and Group 3 – iron-deficiency anaemia.

The statistical analysis was performed using the Statistical Package for the Social Sciences version 13 (SPSS Inc, Chicago, IL, USA). The student's *t*-test for continuous variables was used to compare the differences between the groups. A p-value of < 0.05 was considered to be statistically significant.

## RESULTS

A total of 295 individuals participated in the study, out of which 237 were included in the final analysis. Their ages ranged from 18 to 25 years, with a mean age of 19.8 years. Table I shows the indices of the iron status of the participants. Among the 224 participants who were categorised into the study groups, 118 (52.7%) had a normal iron status (Group 1), nine (4.0%) suffered from IDA (Group 3) and 97 (43.3%) had ID without anaemia (Group 2). Table II shows the indices of the iron status in the three groups. There were a significant differences in terms of the ferritin, iron and TS levels between the ID and normal groups (p < 0.00005). Considerable differences were also found for all the indices between the ID and IDA groups (p < 0.00005). The indices of the iron status were significantly different between the normal and IDA groups (p < 0.00005).

## DISCUSSION

ID is the most common cause of anaemia worldwide. It frequently occurs due to inadequate iron intake, chronic blood loss or disease, malabsorption, or a combination of all these factors. It affects one's development, growth and resistance to infections, and is associated with mortality among children younger than two years old.[10] IDA is distributed universally; the most affected population groups are infants aged between four and 24 months old, school-age children, female adolescents, pregnant women and nurturing mothers.[10]

ID usually develops in a sequential manner over a period of negative iron balance, such as periods of blood loss and/or prolonged iron-deficient diet, accelerated growth in children and adolescents as well as during pregnancy and lactation.[11,12] These stages include the iron-depletion phase, iron-deficient erythropoiesis and IDA. IDA affects 43% of preschool children all over the world, especially in developing countries, where its prevalence rate is four times higher than in industrialised countries.[11] Oelofse et al found the prevalence of ID among preschoolers in rural KwaZulu-Natal to be 19.8%, and that 18.9% of mothers were iron deficient but not necessarily anaemic.[13] Mayet et al found that 42% of males and 53% of females aged 6–74 years in a rural setting in KwaZulu-Natal were anaemic, largely as a result of low iron intake.[14]

In this study, the prevalence rates of ID and IDA in female university students aged 18–25 years were 40.9% and 3.8%, respectively. A study by Thankachan et al showed that the prevalence rates of anaemia and ID were 39% and 62%, respectively, in young women of low socioeconomic status in Bangalore, India. The majority of these anaemic women were iron deficient, and the primary factors responsible for this high prevalence rate in this population were inadequate intake of dietary iron, poor bioavailability and a concurrent inadequate intake of dietary micronutrients.[15] Another study of 452 healthy pregnant women was conducted in Ghana to determine the prevalence of ID and anaemia among pregnant Ghanaian women from urban areas. The data indicated that anaemia (Hb < 11 g/dL) was present in 144 (34%), ID (ferritin ≤ 16 ng/ ml) in 69 (16%), and IDA in 32 (7.5%) of the study subjects.[16]

In one study conducted in the south of Iran, the prevalence rate of ID and IDA in children aged four to 24 months were 31.7% and 26.2%, respectively.[17] In another study in Western Iran, ID was found in 23.7% of girls aged 14–20 years old,[18] which is much lower than the rate found in the current study. This may be due to the differences in nutritional habits in that area. In a study conducted by Gholamreza in the south-eastern part of the Caspian Sea in Iran, the prevalence rates of ID and IDA were 35.6% and 13.5%, respectively, in village women aged 18–35 years old.[19]

The diagnostic criteria for anaemia in IDA varies between studies. WHO definitions for anaemia are based on age, gender and pregnancy status as follows: for children six months to five years of age, anaemia is defined as Hb level < 11 g/dL; for children five to 11 years of age, it is Hb < 11.5 g/dL; for adult male, it is defined as Hb < 13 g/dL; for non-pregnant female, it is Hb < 12 g/dL; and for pregnant female, it is defined as Hb < 11 g/dL.[6,20] A Hb concentration level of < 12 g/dL was used in this study to define anaemia.

Menstruating women are a particularly important healthy population, and IDA occurs in 5%–10% of this population.[21] The subjects of this study were in the age group in which menstrual loss, pregnancy and breastfeeding are usually responsible for anaemia, so an IDA prevention program may be a useful intervention. The emphasis should be placed on pre-pregnancy programs in order to increase the womens' body iron stores. The significant goal of this type of interventions is to maintain maternal and neonatal health. The results of this study indicate that iron supplementation is required for the target group.

Further research is recommended to identify the specific risk factors for ID and IDA. It may be helpful to implement measures to improve nutritional knowledge and awareness among mothers and health workers. Finally, nutrition education and intervention programs should address ID with a focus on both the dietary quantity and the quality of the micronutrient composition. All of these interventions must be monitored for effectiveness.

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