ORIGINAL RESEARCH

Prevalence of Anemia Among Jazan University Students

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Purpose: Anemia is one of the most common disorders affecting the population in both low-income and developing countries. This study aimed to determine the prevalence of anemia and iron deficiency in apparently normal male and female students of Jazan University, Saudi Arabia.

Material and Methods: This cross-sectional study was conducted at the Faculty of Applied Medical Sciences, Jazan University, Gizan, Saudi Arabia. One hundred thirty-four (85 males and 49 females) healthy students with no outward signs of illness were recruited. A specific questionnaire related to sociodemographic and health characteristics was designed and validated. The collected samples were analyzed for complete blood count, serum iron, and serum ferritin.

Results: In the male group, 81 participants (95.3%) were nonanemic with normal hemoglobin (14.99 ± 1.11 g/dl), whereas only 4 males were anemic (hemoglobin <13.0 g/dl). On the other hand, anemia was more prevalent in female students, as 67.35% had hemoglobin values less than 12.0 g/dl. In addition, 26.54% of the anemic females had low serum iron and serum ferritin, indicating iron-deficiency anemia. Although the majority of male participants had normal hemoglobin levels, 37.6% of them had low mean cell volume (MCV), low mean cell hemoglobin (MCH), low mean cell hemoglobin concentration (MCHC), and high red blood cell (RBC) counts, suggesting thalassemia.

Conclusion: Anemia, in particular iron-deficiency anemia, was found to be highly prevalent in females, whereas more than one-third of the male participants might be carriers of alpha or beta thalassemia. Additionally, low dietary iron intake and irregular meal consumption could be two of the possible causes of anemia in the study population. Conducting this study on a large scale of male and female students from different faculties of Jazan University will provide in-depth details about the prevalence and types of anemia among them.

Keywords: anemia, iron deficiency, students, Jazan University

Introduction

Anemia is one of the most common human ailments.[1] It is estimated that around one-third of the world's population suffers from anemia.[2] It is also reported that in 50% of cases, anemia is due to iron deficiency. In the Middle East, the prevalence of iron deficiency is similar to that in developing countries, ranging from 25% to 35%, compared with 5–8% in developed countries.[3] Several factors contribute to the development of iron deficiency (ID) and iron-deficiency anemia (IDA). Any blood loss amounts to loss of iron from the body, which may lead to ID. Limited absorption of iron from the gut is another factor which predisposes a person to ID. Women during their reproductive period are prone to additional iron loss through menstruation,

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pregnancy, and lactation.[4] Milk, though a poor source of iron, has enough iron to predispose lactating mothers to developing IDA. During the period of rapid somatic growth, children are also at risk of developing IDA if their increased iron demand during this period is not met.[5]

Anemia is common in Saudi Arabia. Several studies have been conducted in urban areas of the country, especially in children, young females, and women of child-bearing age.[6–9] However, there is no data regarding the prevalence of anemia and ID in young males and females in the Jazan Area. This study aimed to determine the prevalence of anemia and ID in male and female students of Jazan University, Saudi Arabia.

Materials and Methods
Study Design
This cross-sectional study was conducted at the Faculty of Applied Medical Sciences, Jazan University, Gizan, Saudi Arabia. One hundred thirty-four (85 males and 49 females) healthy students with no outward signs of disease were recruited. A specific questionnaire was developed to inquire about sociodemographic and health characteristics (age, weight, height, marital status, menstrual cycle, the use of oral contraceptives, personal and family history of disease, type and intake of food). Body mass index (BMI) was calculated as previously described.[10]

Ethical Approval
The current study was approved by the Scientific Research Ethics Committee, Jazan University and was conducted in accordance with the Declaration of Helsinki.

Sample Size and Sample Collection
Sample size was calculated with G*Power 3.1.9.4 calculator power analysis with two sided exact one sample proportion case. The prevalence of anemia among female students reported by Al Hasnad et al[11] as 64%. The desired sample size at 5% level of significance, 80% power and the design effect of 0.112 is 134.

After informed written consent was obtained, venous blood was collected from all study participants into (i) a plain tube for serum iron and serum ferritin analysis and (ii) an Ethylenediaminetetraacetic acid (EDTA) anticoagulant tube for a complete blood count (CBC).

Complete Blood Count
A Sysmex XN–1000 Hematology Analyzer (Japan) was used to determine the CBC including red blood cells (RBC, x10^{12}/L), hemoglobin (Hb, g/dL), hematocrit (Hct, %), mean cell volume (MCV, fL), mean cell hemoglobin (MCH, pg), mean cell hemoglobin concentration (MCHC, g/dL), and red blood cell distribution width (RDW-CV and SD). A chemiluminescence Immunoassay system (China) using Maglumi 600 was used for the determination of serum ferritin. Serum iron was tested with a HumaStar 200 (Germany) chemistry analyzer.

Statistical Analysis
Statistical analysis of the data was performed using GraphPad Prism software, version 8.0 for Windows (GraphPad Software Inc., San Diego, CA, USA). Unless otherwise stated, results are presented as mean ± standard deviation (SD). Independent unpaired Student's t-tests were used for analysis of hematological parameters, serum iron, and ferritin. The chi-squared test was used for the correlation of nonparametric data, including demographic data analysis. For each test, differences were considered statistically significant if $P < 0.05$.

Results
Demographic and health characteristic data on the male and female participants in the current study are presented in Tables 1 and 2. Table 3 presents the mean values of red cell parameters, serum iron, and serum ferritin in the male and female groups. In the male group, the mean Hb of 81 males was 14.99 ± 1.11 g/dl (mean ± SD), representing 95.3% of the male participant population with normal Hb, while 4 males had a mean Hb of 12.69 ± 0.18 g/dl (mean ± SD) and were considered anemic, representing 4.7% (Figure 1A). In the female group, 16 females had normal Hb (>12.0 g/dl)

Table 1 Characteristic and Demographic Data of the Study Participants

Variables	Male (n = 85)		Female (n = 49)		P value
	Mean	SD	Mean	SD	
Age/year	25.1	7.1	23	4.9	0.07
Weight/kg	73.46	19.01	55.7	14.92	0.0001
Height/cm	169.56	4.42	155.1	5.37	0.0001
BMI	25.02	6.49	23.00	5.37	0.06

Abbreviation: SD, standard deviation.

Table 2 Health Characteristics and Lifestyle of the Participants

Variables		Male {n (%)}	Female {n (%)}	P value
Marital status	Single Married	70 (82.35) 15 (17.65)	32 (65.30) 17 (34.70)	0.04
Chronic disease	Yes No	9 (10.59) 76 (89.41)	9 (18.37) 40 (81.63)	0.186
Family history of chronic disease (mainly diabetes)	Yes No	11 (12.94) 74 (87.06)	21 (42.86) 28 (57.14)	0.000
Any surgery	Yes No	2 (2.35) 83 (97.65)	6 (12.24) 43 (87.76)	0.018
Blood transfusion	Yes No	1 (1.18) 84 (98.82)	0 (0) 49 (100)	0.451
Hospitalized	Yes No	2 (2.35) 83 (97.65)	3 (6.12) 46 (93.88)	0.256
Smoke	Yes No	25 (29.41) 60 (70.59)	1 (2.04) 48 (97.96)	0.000
Exercise	Yes No	30 (35.29) 55 (64.71)	8 (16.33) 41 (83.67)	0.022
Regular meals	Yes No	43 (50.59) 42 (49.41)	22 (44.90) 27 (55.10)	0.448
Red meat	Yes No (2 participant didn't answer)	74 (87.06) 9 (10.59)	32 (65.31) 17 (34.69)	0.001
Duration of menstrual cycle	Not regular (Heavy) Regular (Light)	– –	1 (2.04) 48 (97.96)	–
Oral contraceptive	Yes No	– –	2 (4.08) 47 (95.92)	–

representing 32.65%; on the other hand, 67.35% (n = 33) of the females were anemic (<12.0 g/dl) (Figure 1B).

In addition, Hb, Hct, MCV, MCH, MCHC, and ferritin were reduced in the anemic female population compared with the normal group, whereas, RDW was significantly higher in anemic females (18.77 ± 3.15 vs. 16.59 ± 1.99; P = 0.0006) (Table 3). The anemic male group also had low values of Hct, MCV, MCH, MCHC, serum iron, and ferritin compared with the normal male group, as shown in Table 3. However, only the red cell count, Hb, and RDW-CV showed statistically significant differences in the male group. In terms of severity, out of 33 anemic females, 78.8% (n = 26) were mildly anemic (Hb <12.0 g/dl), 15.1% (n = 5) were moderately anemic (Hb <10.0 g/dl), and 6.1% (n = 2) had severe anemia (Hb <8.0 g/dl).

Hematological data were further categorized based on the MCV parameter, and the normal male and female populations fell into two groups. In the male group, 31 subjects had low MCV as compared with the rest (n = 50), ie, 84.94 ± 5.36 vs. 74.48 ± 6.32; P < 0.0001 (Table 4). Additionally, RBC counts and RDW were found to be high in this group (n = 31; with low MCV) compared with the normal MCV group (5.50 ± 0.45 vs. 6.21 ± 0.61; P < 0.0001 and 16.00 ± 1.21 vs. 18.35 ± 2.21; P < 0.0001, respectively). MCH, MCHC, and ferritin were significantly lower in males with low MCV as compared with normal males with normal MCV. In females with normal Hb values, similar observations were noted, with MCV and MCH reaching significant differences (Table 4). In anemic females, three further subdivisions were made based upon MCV, i.e. >80 fl (n = 7), 70–80 fl (n = 13), and <70 fl (n = 13), as shown in Table 5. Lower MCV in a significant number of females correlates well with moderate anemia in this group. A review of the laboratory results and study questionnaire showed that 49.41% of males and 55.10% of females did not take regular meals. Moreover, 10.59% of males and 34.69% of females in the study population disclosed no red meat consumption. Chi-square test results correlating red meat and iron intake are shown in Table 6. A significant correlation of dietary iron intake with MCV and serum ferritin was observed, whereas other parameters failed to show a significant correlation with iron intake.

Discussion

Anemia is a public health burden in Saudi Arabia: the prevalence of anemia in women of childbearing age is around 30.2%, as reported by the WHO[11] and up to 37% of women in Riyadh, as reported by AlQuaiz et al.[12] Moreover, anemia is a health burden in the Gulf countries, where 30% of women aged 17–24 years[13] and 12.9% of males and 17.6% of females aged 11–19 years suffer from anemia.[14]

As the majority of previous studies conducted in the country were related to female participants, both children and women of childbearing age, this study was conducted to determine the frequency of anemia in both male and female students of Jazan University. The findings of this study showed that 95.3% (n = 81) of male students had normal Hb, while only 4.7% (n = 4) had anemia. Conversely, in the female group, 67.65% of participants had a low Hb concentration. A local study showed a prevalence of anemia ranging from 30.2% to 40%.[10]

Table 3 Red Blood Cell Parameters, Serum Iron and Serum Ferritin, of the Study Participants

Parameters	Male (85)			Female (49)		
	Normal (n = 81)	Anemic (n = 4)	P value	Normal (n = 16)	Anemic (n = 33)	P value
RBCs (×10^{12}/L)	5.78 ± 0.62	5.57 ± 1.18	0.560	4.81 ± 0.46	4.57 ± 1.34	0.1924
Hb(g/dl)	14.99 ± 1.11	12.69 ± 0.18	0.0001	12.90 ± 0.83	10.72 ± 1.34	0.0001
Hct (%)	46.34 ± 2.92	40.58 ± 1.12	0.0002	39.26 ± 2.15	33.49 ± 3.46	0.0001
MCV (fl)	80.81 ± 7.69	74.85 ± 13.26	0.159	82.14 ± 6.60	72.71 ± 8.81	0.0004
MCH (pg)	26.59 ± 3.73	23.50 ± 4.74	0.1133	27.04 ± 2.86	23.29 ± 3.41	0.0005
MCHC (g/dl)	32.22 ± 1.56	31.30 ± 1.27	0.1998	32.86 ± 1.21	31.92 ± 1.11	0.0001
RDW-CV (%)	16.89 ± 2.00	19.02 ± 3.13	0.0460	16.59 ± 1.99	19.77 ± 3.15	0.0006
RDW-SD (fl)	44.78 ± 6.69	43.02 ± 8.83	0.6152	44.93 ± 2.61	45.18 ± 4.21	0.8330
Serum iron (μg/dL)	105.7 ± 35.92	90.00 ± 20.00	0.0651	69.83 ± 35.46	50.31 ± 32.07	0.0665
Ferritin (μg/L)	70.62 ± 53.59	66.23 ± 53.33	0.0891	45.04 ± 46.01	15.99 ± 20.15	0.038

Abbreviations: RBC, red cell count; Hb, hemoglobin; Hct, hematocrit; MCV, mean cell volume; MCH, mean cell hemoglobin; MCHC, mean cell hemoglobin concentration; RDW-SD, red cell distribution width standard deviation; RDW-CV, red cell distribution width coefficient of variation.

IDA is the most common cause of anemia among all types of anemia affecting people in developed as well as developing countries and considered as the most prevalent micronutrient deficiency in the world.[15] In the current study, anemic females showed a wide range of serum iron and ferritin levels 50.31 ± 32.07 and 15.99 ± 20.15, respectively. When the anemic group was categorized further based upon the MCV, it was found that there were three groups as shown in Table 5. Those in group 3 (n = 13) with MCV less than 70 fl, markedly low levels of serum iron and ferritin were observed. These females were considered to have IDA, while in the group with MCV 70–80 fl, mildly low serum iron and ferritin were observed, and these females were considered as iron deficient (n = 13). Hence, it may be concluded that out of 49 females, 26.54% had ID, while

26.54% had IDA. These findings are consistent with other studies conducted in the same group of females in Saudi Arabia, i.e. (35.3%),[16] 38.3%,[17] and 41.6%.[18] However, they are discordant with other literature reports of the lowest prevalence of IDA in students of Tabuk University, i.e. 12.5%.[19] Another study showed that out of 64% of anemic female university students in Madina, 81% had IDA.[20] It is estimated that 40.5% of girls between 16 and 18 years of age suffer from IDA in the Arab region.[21] In the current study, ID could be partly attributed to irregular meals and a lack of red meat intake (heme iron) by the female group. In addition, 34.70% of female participants were married; hence, the over-all low level of iron could be explained by their increased iron requirements due to pregnancy and lactation. It should be noted that 49.41% of males and 55.10% of females
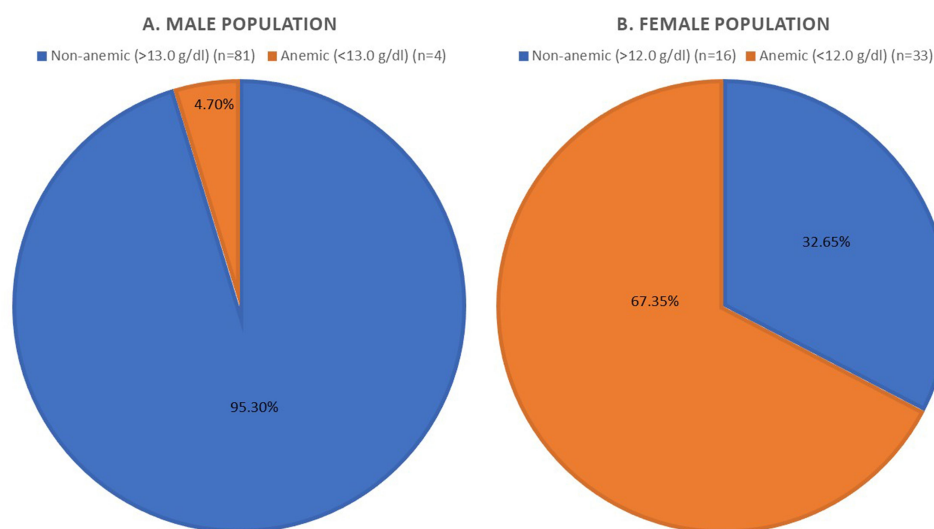

Figure 1 Percentage of anemia in the study population. Left (**A**) Percentage of anemia in the male population. Right (**B**) Percentage of anemia in the female population.

Table 4 Mean cell Volume (MCV) of Males and Females with Normal Hb Levels

Parameters	Male (81) Hb >13.0			Female (16) Hb>12.0		
	MCV >80 (n = 50)	MCV <80 (n = 31)	P value	MCV >80 (n = 10)	MCV <80 (n = 6)	P value
RBCs (×10¹²/L)	5.50 ± 0.45	6.21 ± 0.61	0.0001	4.645 ± 0.4263	5.07 ± 0.41	0.674
Hb (g/dl)	15.25 ± 1.05	14.59 ± 1.09	0.0022	13.119 ± 0.70	12.53 ± 0.95	0.1830
Hct (%)	46.60 ± 3.11	45.94 ± 2.69	0.164	39.6 ± 2.2588	38.68 ± 2.02	0.4289
MCV (fl)	84.94 ± 5.36	74.48 ± 6.32	0.0001	85.59 ± 4.77	76.4 ± 4.29	0.0017
MCH (pg)	27.82 ± 2.09	24.72 ± 4.81	0.0001	28.4 ± 2.43	24.76 ± 1.99	0.0082
MCHC (g/dl)	32.73 ± 0.77	31.44 ± 2.089	0.0001	33.14 ± 1.20	32.38 ± 1.15	0.2368
RDW-CV (%)	16.00 ± 1.21	18.35 ± 2.21	0.0001	15.83 ± 1.66	17.85 ± 1.98	0.045
RDW-SD (fl)	45.18 ± 6.67	44.17 ± 6.80	0.0001	45.689 ± 2.24	43.8 ± 2.91	0.1787
Serum iron (μg/dL)	116.67 ± 23.44	103.75 ± 37.90	0.582	79.6 ± 36.83	53.5 ± 28.58	0.1603
Ferritin (μg/l)	85.42 ± 65.61	52.69 ± 27.07	0.0146	45.4 ± 45.3	13.9 ± 6.36	0.01198

mentioned that they did not take regular meals, while 10.59% of males and 34.69% of females disclosed no red meat consumption. These factors could contribute to the development of anemia and ID in the long run. A review of the CBC report showed that both normal male and female groups had significant variation in their parameters, as shown in Table 4.

Table 5 Categorization of Anemic Females Based on Their MCV (n = 33)

Parameters	MCV >80 (n = 7)	MCV 70 - 80 (n = 13)	MCV <70 (n = 13)
RBCs (×10¹²/L)	4.29 ± 0.21	4.59 ± 0.25	4.86 ± 0.56
Hb (g/dl)	11.73 ± 0.15	11.20 ± 0.49	10.06 ± 1.35
Hct (%)	35.69 ± 0.68	34.75 ± 1.39	32.10 ± 3.91
MCV (fl)	83.29 ± 2.88	75.67 ± 2.11	66.09 ± 2.34
MCH (pg)	27.39 ± 1.34	24.40 ± 0.76	20.69 ± 1.05
MCHC (g/dl)	32.87 ± 0.60	32.22 ± 0.42	31.30 ± 0.87
RDW-CV (%)	17.03 ± 1.21	18.28 ± 1.44	22.06 ± 1.68
RDW-SD (fl)	47.40 ± 3.49	45.62 ± 3.51	44.90 ± 4.39
Serum iron (μg/dL)	60.00 ± 17.5	60.92 ± 40.54	18.01 ± 5.25
Ferritin (μg/l)	18.90 ± 11.8	21.01 ± 28.52	8.08 ± 5.41

Table 6 Correlation of Red Meat/Iron Intake with Red Cell and Iron Profile Parameters

Parameters	Red Meat/Iron Intake			P value
	Yes	No	Total	
Low hemoglobin	19	19	38	0.425
Low MCV	14	19	33	0.032
Low MCH	18	20	38	0.138
Low serum iron	12	16	28	0.098
Low ferritin	6	12	18	0.035

The division was established on the basis of red cell count and MCV. In both groups, those who had a MCV less than 80 fl with normal Hb had a significantly high red cell count, while low red cell indices were observed. These features are consistent with thalassemia (beta or alpha).[22,23] It should also be kept in mind that alpha and beta thalassemia are prevalent in this area.[24,25] As Hb electrophoresis was not carried out in this study, the authors could not make a definitive diagnosis of the thalassemia trait.

Conclusion

Form the above results, anemia, in particular IDA, was found to be highly prevalent in females, whereas more than one-third of male participants might be carriers for alpha or beta thalassemia. Conducting this study on a large scale of male and female students from different faculties of Jazan University will provide in-depth details about the prevalence and type of anemia among them. Consequently, well-organized nutritional and educational programs shall be considered by the university to improve the health of the enrolled students.

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Disclosure

The authors declare no conflicts of interest in this work.

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