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Prevalence of Anemia and Associated Risk Factors Among Non-Pregnant Women in Riyadh, Saudi Arabia: A Cross-Sectional Study

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Background: Iron deficiency is known to be the most common nutritional disorder. About 30% of the world's population is iron deficient (ID). Women are more likely to be exposed to anemia than men, which is an epidemic public health problem.
Objective: A cross-sectional study was carried out to investigate the prevalence of anemia and associated risk factors among non-pregnant women in Riyadh, Saudi Arabia.
Methods: Non-pregnant women (n = 250) aged 20–65 years were involved in this study. Sociodemographic, nutritional status, menstrual history, anthropometric and haematological properties were calculated. Anaemia proxies including haemoglobin (HB), serum ferritin (IDA), Haematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were determined as well as BMI.
Results: The respondents were varied according to demographic factors and according to anemia proxies, the majority of them suffered from anemia. The Student's *t*-test analysis showed that the average daily food intake was lower than that of the dietary requirement intake (DRI). Correlation and logistic regression analysis between sociodemographic factors and anemia proxies revealed that most of such factors significantly and negatively affected anemia proxies. Moreover, the correlation of daily food intake and anemia proxies showed that the nutrients responsible for the improvement of anemia proxies were not taken in sufficient amount as indicated by a significant and positive correlation.
Conclusion: In conclusion, various factors including demographic factors, daily food intake appeared to be associated with anemia proxies, which are the most important risk factor for anemia among non-pregnant women in Riyadh, Saudi Arabia.
Keywords: anemia, nutrient deficiency, dietary intake, hemoglobin, anthropometric

Introduction

Anemia was reported to affect 2.2 billion people worldwide at a rate of 33%.[1] It is defined as the state at which hemoglobin (Hb) and haematocrit (Hct) levels fall under indicated referenced cut-off points depending on age, gender and altitude. Over 30% of women and >50% of pregnant women worldwide are suffering from anemia.[2] In developing countries, anemia leads to one of the major public health problems because it can happen at all stages of life. More than one-third of people in the Middle East have anemia due to either iron deficiency (ID) or a combinations of other factors, the majority of which are women.[3] In particular, anemia (Hb < 12 g/dl) was observed in 40% of Saudi women aged 15 to 49 years.[4]

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Moreover, IDA is recognized as a condition in which the blood contains inadequate iron to maintain the regular physiological functions of body tissues, such as muscles, bones, and the brain. IDA may occur in the absence of anemia if it has insufficiently persisted or if it is insufficiently severe to cause Hb to drop below specified sex and age thresholds.[2] Iron deficiency anemia (IDA) is prevalent among teenagers in the Kingdom of Saudi Arabia (KSA) because of iron deficiency in the diet and scarcity of awareness regarding balanced nutrition and iron-rich food.[5] IDA is one of the most proliferating types of under-nutrition. About 50% of anemia cases worldwide are considered caused by iron deficiency, which results in annual mortality of 841,000.[6] The prevalence of anemia was associated with haemoglobinopathies (normocytic normochromic anemia), Fe deficiency (microcytic hypochromic anemia) as well as B12/folic acid deficiency (megaloblastic anemia). However, ID is the most significant factor in nutritional anemia.[7] Low iron intake and unbalanced diet combined with blood loss due to menstrual cycle put young Mexican women of normal weight and those suffered from obesity at risk of developing IDA.[8]

Nutritional deficiency can include the deficiency of calories, proteins, vitamins, iron, and other nutrients. The contributing factors of IDA in developing countries include poor intake of dietary iron (low consumption of red meat), and an increased iron requirement for reproduction, low bioavailability of dietary iron (non-heme iron in the cereal-based diet and black tea taken with meals), and iron loss due to parasitic infections.[9] Also, a link between ID and obesity was reported. Tijerina-Sáenz et al,[8] proposed a multifactorial etiology comprising inadequate iron bioavailability relative to body weight and weakening in iron absorption as reported in subjects with extra adiposity. In addition to nutritional and health status, several scholars reported associations between anemia and biological, socioeconomic, ecological, educational, behavioral, and political factors.[10–13] The shortage of data and studies that estimate the prevalence of anemia and micronutrient deficiency and their impacts on healthy women is notable. Therefore, the present study aimed to assess anemia proxies, which lead to the prevalence of anemia and associated risk factors among non-pregnant women in Riyadh, Saudi Arabia.

Materials and Methods

Design and Sampling Method

A cross-sectional study was carried out in King Saud Medical City and King Fahad Medical City, Riyadh, Saudi Arabia, during the spring semester of 2018. A total of 250 women with ages ranging from 20 to 65 years old were involved in this study, after signing a form according to the Helsinki Declaration. The respondents did not include pregnant as indicated by pregnancy test performed at the hospital and did not use any mineral or vitamin supplementation, as well as subjects with a history of any form of cancer, were excluded.

Data Collection

A structural questionnaire and anthropometric measurements were used for data collection. All participants were provided with a written informed consent in their native language before enrollment. The questionnaire was designed to study sociodemographic factors and daily food intake. Before answering the questionnaire, respondents were given an idea about the study and instructed on how to truthfully complete the questionnaire. The nutrients of the respondents' dietary intake were recorded using the ESHA Program (Elizabeth Stewart Hands and Associates Program) after recording daily food intake of respondents. Fortunately, the respondents are mature enough to communicate well with the data collector. Moreover, the data provided are reliable and the respondents provided good and reliable information. The data collected were reviewed and approved by professionals in this field. According to the ESHA Program menu, a code was given to each type of food. In the case of mixed and cooked food, contents are provided separately. The 24-hour recall food intake data (average of 3 measurements) for each respondent to the ESHA food processor program was entered. Thereafter, the software analyzes the food and gives a percentage of all nutrients including calories that have been taken by the respondents and then compares with the dietary requirement intake (DRI) reported by WHO/FAO dietary guidelines prepared for different populations.

Biochemical Analysis

After 12-hour fasting, blood samples were taken by an expert in the hospital. Thereafter, plasma samples were separated by centrifugation for 20 min at 2000×g. Separated plasma was kept at −70°C for further use. Ferritin was assessed by a two-site immunoradiometric assay[14] and by a cobas® 6000 analyzer, Siemens (Erlangen, Germany) using Roche assay. Plasma iron was analyzed by the use of Dimension® RxL Max® Integrated Chemistry System (Siemens, Erlangen, Germany). Hb and hematocrit (Hct) levels were determined by CELL-DYN Ruby Hematology System (Abbott, USA).

Normal Hb range is generally defined as 11.6 to 15 grams (g) of Hb per deciliter (dL) of blood. Anemia is classified as; mild = 10.0–10.9 g/dl, moderate = 7.0–9.9 g/dl, and severe = <7.0 g/dl according to WHO cutoff points for anemia based on Hb concentration,[15] whereas normal levels of Hct are between 35.5 and 44.9% percent in general. According to the WHO guidelines, female who measured Hb <12.0 g/dl, serum ferritin <15 µg/L, serum iron <10 µmol/L, and TIBC ≥68 µmol/L were defined as IDA. Normal iron level is 60–170 micrograms per deciliter (µcg/dL).

Body Mass Index (BMI) Determination

BMI was calculated as a ratio of weight in kg to height in m^2 and classified according to the indices of the WHO.[16] According to the WHO classification the BMI categories include: <18.5= underweight; 18.5–24.9= normal; ≥25.0= overweight; 25.0–29.9= pre-obese; 30.0–34.9= obese G1; 35.0–39.9= obese G2; ≥40.0= obese G3.

Data Analysis

The statistical package for social sciences (SPSS Inc., Chicago, IL, USA) version 20 was used for the analysis of the data. The results were expressed as means. The comparison of means between nutrients intake (24-hour recall) and DRI was done using the Student's *t*-test. Correlation between anemia proxies and sociodemographic characteristics or food intake was tested using Spearman correlation coefficients and logistic regression analysis.

Ethical Consideration

The study was approved by the ethical review committee of King Saud Medical City (IRB registration number with KACST, KSA: H-01-R-012; IRB Log number: HRC-27-Aug15-01) and King Fahad Medical City (IRB registration number with KACST, KSA: H-01-R-053; Ref. number 15–02E), Riyadh, Saudi Arabia. All participants were provided with written informed consent in their native language before enrollment. Participants were informed of the general-purpose, and benefits of the study. All participants signed a consent form in accordance with the declaration of Helsinki.

Results

Sociodemographic and Lifestyle Characteristics

Table 1 shows the frequency distribution of sociodemographic factors and lifestyle characteristics of study subjects (n = 250). Almost half of the respondents (50.4%) with an age ranged from 40 to 49 years visited the hospital followed by those with age >50 years and those with age ranged from 20 to 39 years. It has been observed that most of the hospital visitors are between the ages of 40 to 49 years old. The level of a monthly income of the family respondents was found to be medium (≤1000 USD) and a low percentage had a high income (>1000 USD).

Table 1 Frequency Distribution of Sociodemographics and Lifestyle Characteristics of Study Subjects (n = 250)

Characteristics	Variables	Subjects	
		F	(%)
Age group	<29	14	5.6
	30–39	52	20.8
	40–49	126	50.4
	>50 Years	58	23.2
Family income	1000 USD or less	132	52.8
	More than 1000 USD	118	47.2
Education level	High school or less	155	62
	College or more	95	38
Marital status	Married	175	70
	Unmarried	75	30
Work status	Yes	90	36
	Never	160	64
Menstruation	Yes	177	70.8
	No	73	29.2
Frequency of menstrual cycle	Regular	202	80.8
	Irregular	48	19.2
Duration of menstruation	< 7 days	47	18.8
	≥ 7 days	132	52.8
Breastfeeding	Non	71	28.4
	No	207	82.8
	Yes	43	17.2
Number of kids	< 4	74	29.6
	≥ 4	176	70.4

Abbreviation: F, frequency.

The educational level of the respondents was low, and the majority has a high school certificate or less followed by those who have university education which represents a very low percentage. The percentage of married respondents was higher than those unmarried. Most of the respondents dislike to work (64%) compared to those who had a job (36%). About 80.8% of respondents reported regular menstrual cycle, while 19.2% had an irregular cycle and 28.4% had reached the age of menopause. The average duration of menstruation was one week or more in two-thirds of respondents and less than a week for the others. It was found that only 17.2% of the respondents breastfed their children, this is equal to 20.33% of women of childbearing age, while 82.8 did not breastfeed their children. The majority of the respondents (70.4%) had an average number of children ≥4 and 29.6% had less than 4 kids. This reflects the Saudi culture that favored large families.

Average Daily Intake of Respondents

The respondents' nutritional status was investigated by assessing their daily food intake (nutrients). The daily average amount of food taken by the respondents was determined using the ESHA program to give the average composition (calories, protein, carbohydrates, dietary fiber, total fat, saturated fat, unsaturated fat, cholesterol, vitamins, folate, and minerals). Then the mean of each constituent was compared to the mean of dietary requirement intake (DRI) by using the *t*-test.

Table 2 shows the average intake of nutrients for respondents compared to that of dietary reference intake (DRI). The results showed that the average intake of calories (902.54 kcal) and carbohydrates (89.28 g) of respondents were significantly ($P \leq 0.01$) lower than that of the DRI. The amount of unsaturated fat (23.47 g) was significantly ($P \leq 0.01$) lower than that of the DRI, while the amount of saturated fat (19.95 g) was significantly ($P \leq 0.01$) higher. Cholesterol, fiber, and vitamins were significantly ($P \leq 0.01$) lower than that of the DRI. The average intake of all minerals except Na was significantly ($P \leq 0.01$) lower than that of the DRI. The decrease in consumption of iron may be due to low intake of proteins while low consumption of fruits and vegetables by the respondents is the main factor that lowered the intake of some vitamins and minerals.

Table 2 Average Daily Intake of Nutrients (24-h Recall) in Relation to the Dietary Requirement Intake (DRI) for Respondents Using the *t*-Test

Nutrients	Mean Intake	DRI	Mean Difference	t-Test
Calories	902.54	1223.4	−320.86	**
Carbohydrates (g)	89.28	100.00	−10.72	**
Protein (g)	42.78	42.38	0.4	NS
Fat (g)	41.59a	33.98	7.61	**
SFA	19.95a	13.59	6.36	**
USFA	23.47a	40.78	−17.31	**
Cholesterol (mg)	232.72	300.00	−67.28	**
Fiber (g)	12.25	25.00	−12.75	**
Vit. A (µg)	214.57	500.00	−285.43	**
Vit. C (mg)	15.86	60.00	−44.14	**
Vit. E (mg)	1.97	12.00	−10.03	**
Vit. D (µg)	305.55	600.00	−294.45	**
Folic acid (µg)	107.81	350.00	−242.19	**
Vit. B12 (µg)	0.80	2.00	−1.2	NS
Niacin (mg)	3.09	14.00	−10.91	**
Vit. B6 (mg)	0.28	1.30	−1.02	NS
Riboflavin (mg)	0.28	1.10	−0.82	NS
Iron (mg)	2.28	8.10	−5.82	**
Na (mg)	4.75	1.50	3.25	*
Ca (mg)	401.17	800.00	−398.83	**
P (mg)	249.27	580.00	−330.73	**
K (mg)	2.66	4.70	−2.04	NS
Zn (mg)	2.10	6.80	−4.7	**
Cr (µg)	3.20	25.00	−21.8	**
Mg (mg)	62.78	320.00	−257.22	**

Notes: **$P \leq 0.01$; *$P \leq 0.05$; difference: mean – DRI.
Abbreviations: DRI, dietary recommended intake; NS, not significant; SFA, saturated fatty acids; USFA, unsaturated fatty acids.

Biochemical and Anthropometric Characteristics

Table 3 shows the frequency distribution of anemia proxies and BMI of the respondents under investigation. The data collected showed that 28.40% of the respondents had low hemoglobin (Hb) level while 68.40 had sufficient Hb and 3.20% had a high level. Ferritin is one of the factors that causes anemia. Among the respondents, 36% suffered from low ferritin level (iron depletion), 55.20% had a moderate level and only 8.80% had high level. Hematocrit (Hct) percent varied between respondents with 28% had a lower level and 72% had a higher level than the normal. The analysis of red blood cells showed that 1.20% had a smaller number of blood cells (microcytic) than normal, 88.40% had the normal numbers and 10.40% had a higher level than the normal (macrocytic).

The average size of the red blood cells measured as mean corpuscular volume (MCV) showed that 31.60% were microcytic, 67.60% were non-microcytic and only 0.80% were observed to be macrocytic. The average amount of the protein (hemoglobin) in red blood cells which carries oxygen around the body as mean corpuscular hemoglobin (MCH) showed that 46.60% had a lower level than the normal, 46.80% had a normal level and 3.60% had a higher level than the normal. The average concentration of hemoglobin inside a single red blood cell measured as mean corpuscular hemoglobin concentration (MCHC) showed that 45.20% of the respondents had a lower level than the normal, 52.40% had a normal level and 0nly 2.40% had a higher level than the normal. Furthermore, BMI was determined and the results are

Table 3 Frequency Distribution of Anaemia Proxies and BMI of the Respondents

Anemia Proxy	Proxies Classification	Subjects	
		F	%
Hb			
Severe	<7 g/dl	2	0.80
Moderate	7–10 g/dl	25	10.0
Mild	10–11.6 g/dl	44	17.60
Sufficient	11.6–15 g/dl	171	68.40
High	Hb >15 g/dl	8	3.20
Total		250	100
Ferritin			
iron depletion	<15 µg/L	90	36.00
Moderate	15–100 µg/L	138	55.20
High	>100 µg/L	22	8.80
Total		250	100
Hct			
Low	<36%	70	28.00
Normal	>36%	180	72.00
Total		250	100
RBC			
Low	<3.8	3	1.20
Normal	3.8–5.2	221	88.40
High	>5.2	26	10.40
Total		250	100
MCV			
Low	< 80 fl	79	31.60
Normal	80–94 fl	169	67.60
High	≥95 fl	2	0.80
Total		250	100
MCH			
Low	<27 pg	124	49.60
Normal	(27–31 pg	117	46.80
High	>31 pg	9	3.60
Total		250	100
MCHC			
Low	<32 g/dl	113	45.20
Normal	32–36 g/dl	131	52.40
High	>36 g/dl	6	2.40
Total		250	100
BMI			
Underweight	<18.5	7	2.8
Normal	18.5–24.9	52	20.9
Overweight	≥25.0	53	21.2
Obese G1	30.0–34.9	71	28.5
Obese G2	35.0–39.9	44	17.7
Obese G3	≥ 40.0	23	9.2
Total		250	100

Note: Chi-Square (P = 0.0) for each parameter.
Abbreviations: F, frequency; Hb, hemoglobin; Hct, hematocrit; RBC, red blood count; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; BMI, body mass index.

shown in Table 2. According to BMI classification, the study results showed that 2.80% of the respondents are observed to be underweight, 20.90% have a normal BMI, and 21.20% are overweight, while 28.50, 17.7, and 9.2% suffered from obesity G1, G2, and G3, respectively.

Data of Table 4 showed that among each sub-group the anemic respondents were within the age of 30–39 years (34.62%) and those with low income (30.3%) and educational (29.68%) levels. Moreover, married (28.57%) and working (30%) respondents relative to those who were involved in work had been greatly subjected to anemia. Respondents with menstruation (36.16%), especially those with regular menstruation (45.05%), as well as those with prolonged menstruation (35.61%) were observed to be anemic. The respondents who breastfeed their kids (46.51%) or have <4 kids (35.14%) were observed to suffer from anemia. It has been observed that within anemic respondents 57.14% were underweight followed by obese G1 (35.21%) and obese G3 (34.78%). The majority of non-anemic respondents were suffered from overweight and obesity.

Risk Factors Associated with Anemia

To investigate the risk factors associated with anemia of the respondents, Spearman correlation coefficients and logistic regression analysis between the respondents' sociodemographic and anemia proxies were calculated. As shown in Table 5, Spearman correlation coefficients and logistic regression analysis between the respondents' sociodemographic and anemia proxies, in general, showed that the anemia proxies including hemoglobin (Hb) level whether severe, moderate or mild, ferritin whether low, moderate or high, low Hct, low MCV, and low MCHC were significantly ($P \leq 0.05$ or $P \leq 0.01$) and negatively related to age, work status, menstrual cycle, breastfeeding and the number of kids which indicated that such anemia proxies decrease with these factors as indicated by Spearman correlation and strengthened by logistic regression analysis (Odd ratio and 95% CI). Therefore, lower values of anemia proxies were observed among respondents aged 30–49 years while those of years, ≥50 expected to reach the menopause stage.

Family income, educational level and marital status as independent variables were significantly and positively correlated with anemia proxies. According to the data, it was observed that the majority of the demographic factors of the respondents were considered risk factors and

Table 4 Frequency Distribution of Anaemic and Non-Anaemic Respondents According to Sociodemographic and BMI Data

Variables		Anaemic		Non-Anemic				Total
				Sufficient		High		
		N	%	N	%	N	%	
Age Groups	<29	3	21.43	10	71.43	1	7.14	14
	30–39 years	18	34.62	29	55.77	5	9.61	52
	40–49 years	40	31.75	84	66.67	2	1.59	126
	≥50 years	10	17.24	40	68.97	8	13.81	58
Family Income	≤1000 USD	40	30.30	87	65.91	5	3.79	132
	>1000 USD	31	26.27	78	66.10	9	7.63	118
Education Level	High school or less	46	29.68	102	65.81	7	4.52	155
	College or more	25	26.32	65	68.42	5	5.26	95
Marital Status	Married	50	28.57	116	66.29	9	5.14	175
	Unmarried	21	28	49	65.33	5	6.67	75
Work Status	Yes	27	30	60	66.67	3	3.33	90
	Never	44	27.5	109	68.12	7	4.37	160
Menstruation	Yes	64	36.16	107	60.45	6	3.39	177
	No	20	27.40	49	67.12	4	5.48	73
Frequency of menstruation	Regular	91	45.05	106	52.47	5	2.47	202
	Irregular	16	33.33	31	64.58	1	2.08	48
Duration of menstruation	<7 days	13	27.66	30	63.83	4	8.51	47
	≥7 days	47	35.61	80	60.61	5	3.79	132
	No menstruation	11	15.49	58	81.69	2	2.82	71
Breastfeeding	No	51	24.64	141	68.12	15	7.25	207
	Yes	20	46.51	14	32.56	9	20.91	43
Number of kids	Less than 4	26	35.14	40	54.05	8	10.8	74
	4 and more	45	25.57	114	64.77	17	9.66	176
BMI	Underweight	4	57.14	3	42.86	0	0	7
	Normal	14	26.92	36	69.23	2	3.85	52
	Overweight	11	20.75	42	79.24	0	0	53
	Obese G1	25	35.21	46	64.79	0	0	71
	Obese G2	10	22.73	29	65.91	5	11.41	44
	Obese G3	8	34.78	14	60.87	1	4.35	23

Abbreviation: N, number of respondents.

significantly associated with anemia proxies. Also, the anemia proxies especially low hemoglobin and MCV was more common among those with menstrual cycles and breastfeeding. However, the prevalence of anemia was high in menstruated respondents and those with regular menstrual cycles compared to those with irregular cycles. Moreover, Spearman correlation coefficients and logistic regression analysis between the respondents' daily food intake, anemia proxies, and BMI were calculated (Table 6). The results showed that most independent variables were positively or negatively correlated with the dependent variables, but the strength of correlation varied among the variables, nutrient intake was significantly ($P \leq 0.05$ or $P \leq 0.01$) and positively correlated with all anemia proxies and BMI. In all groups, an increase in the intake of nutrients, significantly ($P \leq 0.01$ or $P \leq 0.05$) increased the level of anemia proxies as well as the BMI. However, respondents' intake of such nutrients was found to be very low and therefore, their anemia proxies were low as indicated in Table 2. Other nutrient intake was either positively or negatively correlated with anemia proxies and BMI, but the correlations were not significant.

Table 5 Spearman Correlation and Multiple Logistic Regression Between Sociodemographic Data and Anaemia Proxies of Respondents (n = 250)

Independent Variables/ Dependent Variables	Sociodemographic Factors															
	Age	OR (95% CI)	Family Income	OR (95% CI)	Education Level	OR (95% CI))	Marital Status	OR (95% CI))	Work Status	OR (95% CI))	Menstrual Cycle	OR (95% CI)	Breast Feeding	OR (95% CI)	Number of Kids	OR (95% CI)
Hb																
Severe	−0.103*	0.52 (0.30–0.91)	0.872	1.82 (0.7–1.9)	0.359**	1.41 (0.7–1.5)	0.552*	1.65 (1.1–1.8)	−0.110*	0.62 (0.3–0.7)	−0.289*	0.54 (0.4–0.7)	−0.26**	0.43 (0.3–0.7)	−0.29**	0.52 (0.7–1.2)
Moderate	−0.402*	0.80 (0.51–1.23)	0.273*	1.26 (0.92–1.4)	0.465*	1.56 (0.8–1.9)	0.219**	1.32 (0.6–1.4)	−0.295*	0.71 (0.5–1.2)	−0.260*	0.61 (0.3–1.1)	−0.326*	0.90 (0.5–1.1)	−0.162*	0.41 (0.3–0.6)
Mild	−0.03**	0.23 (0.16–0.62)	0.020**	1.07 (0.8–1.1)	0.027**	1.03 (0.2–1.1)	0.088*	1.04 (0.4–1.2)	−0.015*	0.20 (0.1–0.6)	−0.205**	0.83 (0.6–0.9)	−0.03**	0.23 (0.1–0.4)	−0.088*	0.37 (0.1–1.1)
Sufficient	−0.127	0.71 (0.61–1.59)	0.085	1.03 (0.5–1.3)	0.016*	1.05 (0.7–1.2)	0.128	1.24 (1.2–1.4)	−0.213**	0.53 (0.4–1.4)	−0.055	0.23 (0.2–0.6)	−0.02*	0.31 (0.2–0.8)	−0.095*	0.31 (0.2–0.7)
High level	−0.64*	0.93 (0.73–1.63)	0.866**	1.9 (1.6–1.97)	0.009**	1.01 (0.4–1.3)	0.121*	1.23 (0.7–1.5)	−0.349	0.8 (0.6–1.3)	−0.019**	0.70 (0.6–1.4)	−0.274*	0.84 (0.7–1.3)	−0.14**	0.82 (0.6–1.4)
Ferritin																
Low	−0.144*	0.77 (0.63–1.91)	0.050*	1.12 (1.1–1.5)	0.121*	1.36 (1.2–2.1)	0.081*	1.02 (0.7–1.3)	−0.161	0.61 (0.5–0.9)	−0.082*	0.63 (0.3–0.7)	−0.12**	0.70 (0.3–1.4)	−0.149*	0.51 (0.1–0.7)
Moderate	−0.15**	0.81 (0.67–1.78)	0.060	1.01 (1.0–1.2)	0.072	1.04 (0.9–1.2)	0.105**	1.47 (1.1–1.6)	−0.278**	0.74 (0.8–1.3)	−0.080	0.72 (0.1–1.4)	−0.998	0.98 (0.5–1.6)	−0.222	0.74 (0.6–0.9)
High	−0.28**	0.87 (0.74–0.97)	0.164**	1.85 (1.4–0.9)	−0.081**	0.44 (0.2–0.8)	−0.520*	0.77 (0.3–0.8)	0.068	1.07 (0.7–1.2)	0.293*	1.51 (1.3–2.3)	0.02**	1.07 (0.8–1.3)	0.92**	2.0 (1.4–2.5)
Hct																
Low	−0.26*	0.76 (0.70–0.88)	0.289*	1.35 (1.1–1.5)	0.277*	1.52 (1.3–2.2)	0.403**	1.39 (0.8–2.3)	−0.17*	0.68 (0.4–1.1)	−0.041*	0.61 (0.4–1.6)	−0.31**	0.73 (0.4–0.9)	−0.03**	0.45 (0.3–0.7)
High	0.069**	1.12 (1.30–1.54)	−0. 383*	0.79 (0.6–1.4)	−0.252	0.67 (0.60–0.9)	−0.180**	0.64 (0.6–1.4)	0.015	1.08 (0.92–1.4)	−0.045**	0.49 (0.3–0.6)	0.213*	1.4 (1.2–1.7)	0.320*	1.54 (1.1–1.6).
RBC																
Low	−0.17	0.79 (0.55–0.96)	0.140**	1.24 (1.2–1.7)	0.131*	1.16 (0.7–1.4)	0.071*	1.07 (0.7–1.2)	−0.031	0.72 (0.6–0.9)	−0.02	0.32 (0.2–0.5)	−0.08	0.71 (0.4–0.8)	−0.19	0.42 (0.1–0.8)

(*Continued*)

Table 5 (Continued).

Independent Variables/ Dependent Variables	Sociodemographic Factors															
	Age	OR (95% CI)	Family Income	OR (95% CI)	Education Level	OR (95% CI))	Marital Status	OR (95% CI))	Work Status	OR (95% CI))	Menstrual Cycle	OR (95% CI)	Breast Feeding	OR (95% CI)	Number of Kids	OR (95% CI)
Normal	−0.047*	0.09 (0.11–0.34)	0.069	1.03 (0.7–1.2)	0.044**	1.08 (0.6–1.3)	0.006	1.02 (0.5–1.3)	0.056	1.37 (1.4–1.6)	0.010*	1.07 (0.9–1.3)	0.053*	1.3 (1.1–1.6)	0.016*	1.06 (1.0–1.1)
High	−0.825	0.92 (0.93–1.22)	0.308*	1.51 (1.1–1.8)	0.42	1.76 (1.5–2.5)	0.017*	1.05 (0.7–1.1)	−0.27	0.86 (0.8–1.5)	−0.113**	0.73 (0.6–1.4)	−0.321	0.86 (0.8–1.2)	−0.073*	0.78 (0.5–0.9)
MCV																
Low	−0.07**	0.18 (0.16–0.54)	0.419*	1.57 (1.4–1.6)	0.462	1.79 (0.9–1.8)	0.179**	1.48 (0.9–1.7)	−0.15	0.59 (0.6–1.7)	−0.053	0.51 (0.3–0.8)	−0.08	0.63 (0.4–1.4)	−0.05**	0.35 (0.2–0.6)
Normal	−0.274*	0.74 (0.67–0.1.3)	0.244	1.17 (0.8–1.2)	0.998**	2.1 (1.6–2.7)	0.296*	1.18 (0.7–1.4)	0.032	1.09 (0.7–1.3)	0.0593**	1.22 (0.9–1.7)	0.29**	1.37 (1.0–2.1)	0.62*	1.80 (1.2–2.2)
High	−0.055*	0.13 (0.07–0.73)	0.039*	1.22 (1.1–1.3)	0.034*	1.04 (1.0–1.3)	0.059*	1.04 (0.4–1.3)	−0.013	0.85 (0.5–91)	−0.002	0.81 (0.4–1.2)	−0.203*	0.87 (0.6–1.1)	−0.523	0.91 (0.5–1.4)
MCH																
Low	−0.044	0.07 (0.02–0.0.1)	0.092**	1.03 (0.4–1.1)	0.127*	1.23 (0.6–1.4)	0.424*	1.56 (1.2–1.6)	−0.060	0.54 (0.2–87)	−0.154	0.75 (0.6–1.3)	−0.145*	0.64 (0.4–1.4)	−0.47**	0.78 (0.4–0.9)
Normal	−0.12**	0.54 (0.30–0.76)	0.034**	1.08 (0.6–1.4)	0.597	1.66 (1.2–1.8)	0.16	0.44 (0.2–0.5)	−0.088	0.39 (0.2–1.1)	−0.603**	0.82 (0.5–1.2)	−0.32**	0.49 (0.2–1.2)	−0.11**	0.53 (0.1–0.7)
High	−0.48*	0.78 (0.60–1.33)	0.145*	1.3 (1.1–1.7)	0.116**	1.07 (0.8–1.2)	0.0073**	1.01 (0.6–1.2)	−0.035	0.40 (0.3–0.7)	−0.281**	0.64 (0.5–1.6)	−0.248	0.54 (0.3–1.5)	−0.61**	0.8 (0.3–1.6)
MCHC																
Low	−0.69**	0.97 (0.91–1.27)	0.189**	1.5 (1.0–1.6)	−0.132*	0.74 (0.6–0.9)	0.564**	1.62 (0.2–1.7)	−0.135*	0.70 (0.6–1.6)	−0.146*	0.33 (0.2–0.6)	−0.54**	0.79 (0.6–1.2)	−0.123	0.53 (0.3–0.8)
Normal	−0.21	0.45 (0.34–0.78)	0.065	1.06 (0.6–1.3)	0.059	1.07 (0.8–1.4)	0.125	1.25 (1.2–1.4)	−0.505**	0.89 (0.7–1.4)	−0.130*	0.5 (0.3–0.7)	−0.260	0.52 (0.4–1.4)	−0.25**	0.42 (0.2–0.7)
High	−0.76**	0.88 (0.72–1.07)	0.164**	1.3 (0.9–1.40)	0.607**	1.8 (1.5–2.4)	0.794**	1.76 (1.5–2.1)	−0.280**	0.45 (0.2–0.7)	−0.670**	0.83 (0.6–1.2)	−0.273*	0.81 (0.3–1.1)	−0.34**	0.61 (0.5–1.3)

Notes: **P ≤ 0.01; *P ≤ 0.05.
Abbreviations: OR, odds ratio; CI, confidence interval.

Table 6 Spearman Correlation and Multiple Logistic Regression Between Food Intake and Anaemia Proxies and Body Mass Index (BMI) of Respondents (n = 250)

Independent Variables/ Dependent Variables	Anaemia Proxies													
	Hb (g/dl)	OR (95% CI)	RBC/ mm^3	OR (95% CI)	Ferritin (µg/L)	OR (95% CI)	Iron (µg/L)	OR (95% CI)	MCV (fl)	OR (95% CI)	MCH (pg)	OR (95% CI)	BMI	OR (95% CI)
Calories	0.01*	1.26 (0.30–1.91)	0.015**	1.54 (1.29–1.69)	0.075*	1.30 (0.96–1.39)	0.022*	1.15 (0.70–1.21)	0.053	1.18 (0.71–1.32)	0.057*	1.27 (1.25–1.33)	0.113**	1.70 (1.20–1.94)
Carbs (g)	0.046	1.42 (1.32–1.87)	0.063*	1.68 (1.65–1.74)	0.003	1.09 (1.0–1.21)	0.026	1.19 (0.80–1.30)	0.022**	1.34 (1.01–1.45)	0.013	1.04 (0.92–1.12)	0.030*	1.43 (1.05–1.58)
Protein (g)	0.034**	1.65 (0.90–2.01)	0.035	1.37 (0.97–1.59)	0.069*	1.07 (0.93–1.38)	0.036	1.27 (1.05–1.47)	0.026	1.23 (1.1–1.50)	0.042	1.38 (0.87–1.45)	0.007	–
Fat (g)	0.019*	1.12 (0.86–1.77)	0.026	1.28 (0.88–1.36)	0.065**	1.40 (1.20–1.83)	0.003	1.03 (0.83–1.12)	0.027	1.15 (0.90–1.31)	0.045*	1.44 (0.93–1.55)	0.032**	1.52 (0.83–1.60)
SFA	0.073	1.32 (1.10–1.62)	−0.087*	0.68 (0.23–0.93)	−0.014	0.26 (0.10–0.52)	0.021	1.08 (0.72–1.24)	0.056	1.40 (0.82–1.66)	0.05	1.51 (1.23–1.83)	0.129*	1.61 (0.97–2.01)
USFA	0.036	1.07 (0.98–1.20)	0.006	–	−0.010	–	0.005	–	0.056	1.40 (0.62–1.80)	0.009	–	0.005	–
Cholesterol (mg)	0.053**	1.71 (1.34–1.92)	−0.002	0.45 (0.30–1.27)	0.039**	1.56 (1.16–1.75)	0.006	1.15 (0.94–1.33)	0.019*	1.34 (0.57–1.40)	0.007	1.02 (0.66–1.34)	0.015*	1.41 (1.20–1.67)
Fiber (g)	0.131*	1.85 (1.50–2.04)	0.141*	1.62 (1.32–1.80)	0.07	1.05 (0.94–1.20)	0.132*	1.59 (1.40–1.99)	0.066	1.52 (1.32–1.98)	0.084*	1.58 (0.86–1.78)	0.019	1.03 (0.64–1.34)
Vit. A (µg)	0.125*	1.79 (1.20–1.98)	0.112	1.55 (0.87–1.68)	0.022*	1.36 (0.87–1.62)	0.074	1.18 (1.06–1.28)	0.036*	1.22 (0.87–1.47)	0.034	1.06 (0.70–1.22)	0.037*	1.38 (0.85–1.41)
Vit. C (mg)	0.009**	1.52 (0.77–1.83)	0.015	1.43 (1.19–1.50)	0.082*	1.40 (0.76–1.69)	0.049	1.33 (0.93–1.54)	0.06	1.03 (0.91–1.20)	0.025	1.11 (0.56–1.47)	0.023*	1.25 (0.77–1.36)
Vit. E (mg)	0.007	–	0.012	–	0.075	1.16 (0.36–1.23)	0.04	–	0.061	–	0.027	1.09 (0.76–1.51)	0.012	–
Vit. D (µg)	0.030**	1.56 (1.42–1.76)	0.019	1.03 (0.24–1.13)	0.044*	1.38 (0.44–1.56)	0.063	1.04 (1.0–1.36)	0.010**	1.43 (0.97–1.68)	0.093*	1.45 (1.20–1.78)	0.088*	1.57 (1.20–1.80)
Ca (mg)	0.010	–	0.01*	1.34 (0.86–1.54)	0.035*	1.42 (0.39–1.51)	0.14**	1.61 (0.94–1.89)	0.090	–	0.045	1.02 (0.16–1.39)	0.042**	1.68 (0.96–1.92)

(*Continued*)

Table 6 (Continued).

Independent Variables/ Dependent Variables	Anaemia Proxies													
	Hb (g/dl)	**OR (95% CI)**	**RBC/ mm^3**	**OR (95% CI)**	**Ferritin (µg/L)**	**OR (95% CI)**	**Iron (µg/L)**	**OR (95% CI)**	**MCV (fl)**	**OR (95% CI)**	**MCH (pg)**	**OR (95% CI)**	**BMI**	**OR (95% CI)**
P (mg)	0.086*	1.33 (0,69–1.43)	0.038	1.44 (0.73–1.64)	0.020	–	0.039*	1.44 (0.80–1.67)	0.020	–	0.076	1.18 (0.93–1.35)	0.070	–
Folate (µg)	0.032	1.08 (0.36–1.24)	0.035**	1.55 (0.98–1.93)	0.039*	1.49 (0.92–1.83)	0.031*	1.39 (1.29–1.43)	0.026	1.09 (0.67–1.25)	0.074	1.07 (0.64–1.24)	0.063	1.04 (0.80–1.20)
Vit. B12 (µg)	0.057*	1.26 (0.83–1.44)	0.028	1.25 (0.55–1.34)	0.046	1.07 (0.76–1.26)	0.005	–	0.000	–	0.071	1.05 (0.72–1.22)	0.032*	1.49 (0.94–1.76)
Niacin (mg)	0.011	–	0.030*	1.38 (0.69–1.48)	0.113*	1.57 (1.07–1.78)	0.016	–	0.058*	1.48 (1.08–1.86)	0.091	1.29 (1.03–1.43)	0.103**	1.57 (1.23–1.82)
Vit. B6 (mg)	−0.014	–	0.005	–	−0.095	0.17 (0.12–0.63)	0.021	1.033 (0.62–1.52)	0.036	1.11 (0.20–1.28)	0.079	1.13 (0.57–1.50)	0.093*	1.38 (0.82–1.44)
Iron mg	0.078*	1.36 (1.32–1.56)	0.024*	1.31 (0.78–1.53)	0.071	1.04 (0.57–1.34)	0.54**	1.83 (0.93–2.30)	0.031*	1.36 (0.95–1.56)	0.065*	1.46 (0.81–1.64)	0.087**	1.41 (0.69–1.85)
Na (mg)	0.055*	1.29 (0.88–1.38)	0.012	–	0.050	–	0.033*	1.37 (0.72–1.45)	0.038	1.14 (0.52–1.24)	0.027	1.22 (0.78–1.40)	0.004	–
K (mg))	0.081*	1.34 (0.67–1.47)	0.051**	1.46 (1.25–1.78)	0.018*	1.26 (1.12–1.46)	0.025	–	0.010	–	0.087**	1.63 (1.17–1.72)	0.028*	1.27 (0.63–1.43)
Zn (mg)	0.084*	1.24 (0.70–1.45)	0.048	1.07 (0.47–1.43)	0.062**	1.46 (0.90–2.06)	0.019*	1.42 (0.84–1.78)	0.094	1.32 (0.87–1.46)	0.001	–	0.056*	1.29 (1.17–1.35)
Cr (µg)	0.010	–	0.013*	1.31 (0.88–1.52)	0.078	–	0.029	1.15 (1.02–1.32)	0.026**	1.52 (0.98–1.98)	0.092*	1.57 (0.86–1.73)	0.097*	1.39 (0.64–1.54)
Mg (mg)	0.081**	1.53 (1.10–1.96)	0.075	–	0.097*	1.43 (1.21–1.76)	0.048*	1.38 (0.91–1.72)	0.084	–	0.048	1.04 (0.93–1.20)	0.016*	1.37 (0.73–1.46)

Notes: **P ≤ 0.01; *P ≤ 0.05.
Abbreviations: OR, odds ratio; CI, confidence interval.

Discussion

The current study aimed to investigate anemia proxies and associated risk factors in non-pregnant women in Riyadh city, Kingdom of Saudi Arabia. The results showed that the majority of the respondents with age 40 to 49 years had medium or low income, low level of education, dislike working, menstruated with regular cycle (<7 days), with ≤4 kids, and did not breastfeed the kids. Most of the respondents' demographic factors are expected to harm nutritional as well as health status. Educated mothers make better use of health services and provide better childcare including breastfeeding. The level of the monthly income of the families' respondents was found to be an important factor for the respondents' nutritional status.

The decrease in the intake of iron and other elements could be due to low intakes of proteins, fruits and vegetables as reported is believed to be the major factor that lowered the level of vitamins and minerals.[17] Overall, the results obtained for the respondents indicated that all groups took less food of high carbohydrates, unsaturated fat, and protein and their food intake was insufficient in vitamins and minerals. The results also indicated that most of the respondents had bad food habits. AlQuaiz et al,[4] reported that the infrequent intake of meat was associated with the increased risk of anemia according to the results of dietary intake and diversity.

The results revealed that the participants are severely suffering from the deficiency of all nutrients compared to the recommended dietary intake. Anemia proxies expected to be low and the respondents' will be under risk of anemia due to bad lifestyle that adversely affected their eating habits. Although the respondents enjoy a reasonable level of income and education, the majority of them were found to be anemic based on many parameters including the lower level of Hb, ferritin, Hct, MCV, MHC and MCHC than the recommended level. The anemia proxies were observed to fell below the cutoff points for anemia, which could be attributed to low nutrients intake especially iron, as well as regular menstruation that lasts for a long time. This finding is in contrast with those of Saranaz and Hossein[18] who focused on non-pregnant women aged 15 to 45 years. However, these findings were comparable with those of women at the university level in Saudi Arabia and women of reproductive age in Turkey.[19,20] Similar results of Hb, MCH, and MCV were observed in women of child-bearing age in Riyadh but lower in terms of MCHC.[4]

The results of the present study showed that the reduction in anemia proxies that lead to the prevalence of anemia differs from those of previous studies conducted in countries like Egypt,[21] Uganda,[22] and Ethiopia.[23] This variation could be due to variation in the cultural, social, and economic differences as well as differences in nutritional habits, common diseases, health status, and education. According to our data, the reduction in anemia proxy levels and the prevalence of anemia whether low hemoglobin or iron among respondents could be due to insufficient nutrient intake as well as physiological and pathological factors.[18] The average daily intake of nutrients was significantly lower than the DRI especially those had great influence on anemia proxies. The physiological factors that affect anemia are related to the intake and need for iron. The need for iron increases in women because of the menstrual cycle as well as how long it takes. The study observed that respondents received less food due to bad habits. Therefore, the intake of iron is less and the prevalence of anemia is more expected.

The study showed that the prevalence of anemia was increased with age, menstruation especially those of regular and prolong cycle, breastfeeding, increased number of kids and BMI. The study observed that the percentage of underweight respondents who suffered from anemia was lower than those of overweight or with obesity G1. The study observed that anemic women were either overweight or obese, whereas those of underweight were normal. The results suggest that anemia is positively related to obesity because anemia was increased with the increase in obesity. Therefore, the authors suggested that obesity could be one of the factors that influence the prevalence and development of anemia. It has been reported that women with anemia reached 40.8% of the participants in normal BMI range, 8.45% were underweight, and 50.7% were overweight.[16] Likewise, Kim and Lee[24] noted that women with anemia displayed lower anthropometric values compared with non-anemic participants. In contrast to our results, Gautam et al[25] found that low risk of developing anemia among those of high BMI compared to those of low BMI.

To determine the risk factors that associated with anemia, we explored the correlation and logistic regression of sociodemographic characteristics and daily food intake with anemia proxies of the respondents. According to iron deficiency anemia proxies such as low hemoglobin, low serum iron, a low serum ferritin, low transferrin saturation, and high total iron-binding capacity, the analyses showed that such proxies decreased significantly with age, working status, menstrual cycle especially regular and prolong cycle, education, and breastfeeding. Also, the analysis showed that the proxies decreased (anemic cases) significantly with the decrease in nutrient intake especially intake of iron by respondents. Moreover, anemia proxies' levels significantly increased with an increase in monthly income and decreased number of kids. Generally, the results showed that anemia proxies' levels were significantly affected by demographic factors as well as nutrient intake especially insufficient intake of iron or food rich in iron. Such factors were observed to be responsible for severe anemia of the respondents. Ganapathi and Kumar[26] reported that sociodemographic, obstetric, dietary, menstrual, behavioral, contraceptive, and ecological factors were related to anemia for women of reproductive age. Moreover, the prevalence of anemia among women with high levels of economic income was low. This finding is in accordance with the World Bank report on anemia in women, that is, the prevalence of anemia decreases with the increase in income across regions or countries.

Specifically, the prevalence of anemia among people in poor regions is twofold compared with their rich counterparts in numerous countries.[27] The result is in line with that of AlQuaiz et al,[4] who found that women with five or more children were nearly twice at risk of developing anemia. Women with higher education levels had a significantly high average quantity of hemoglobin in a red blood cell. Similar findings were reported by Aikawa et al,[28] Rasheed et al,[29] Habib et al.[30] Illiteracy in women was six times more likely to promote anemia compared with women who achieved secondary and higher educational levels.[31] According to the Pearson correlation and logistic regression analyses, the potential demographic risk factors associated with low anemia proxies in respondents include age, work status, menstrual cycle, breastfeeding and number of kids as well as insufficient intake of nutrients.

Conclusion

The respondents under investigation were varied according to demographic factors. Their intake of nutrients was lower than the recommended dietary intake. The majority of them had low levels of anemia proxies. The educational level, increased blood loss due to menstruation, lack of breastfeeding, work status, and the number of kids were directly and strongly correlated to anemia proxies among Saudi women. The results showed that the demographic factors, obesity, and nutritional inadequacy of micronutrients such as iron, folic acid, and vitamins B12, C, and D are the most important factors that influence anemia proxies and leading to the prevalence of anemia in respondents. Therefore, conducting additional studies and establishing appropriate intervention strategies to improve the nutritional status, reduce obesity, and increase the intake of food that contains adequate quantities of micronutrients, particularly iron intake.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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