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Epidemiological Study of Iron Deficiency Anemia Among Youth Female Athletes in Kuwait



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Abstract

Background: The prevalence of iron deficiency anemia is likely to be higher in athletic populations and groups, especially in younger female athletes, than in healthy sedentary individuals.

Aim: of this study is to determine the magnitude of this problem among athletes and identify their different dietary habits.

Subjects and Methods: Across sectional study was done. The sample included 150 female players from the female clubs in Kuwait where almost all types of sports activity are practiced at level of national competition. Using structured assisted questionnaire with laboratory investigations.

Results: Fifty five percent of anemic group were non-Kuwaiti, with a statistically significant difference. There was a statistically significant difference between the anemic, iron deficient and normal groups regarding the marital status and occupation, dietary pattern and habits as intake of tea and soft drinks. There were highly statistical significant differences between the three studied groups regarding blood hemoglobin (Hb), Mean corpuscular volume (MCV), Mean corpuscular hemoglobin (MCH), Mean corpuscular hemoglobin concentration (MCHC) and Serum ferritin.

Conclusion: A significant relation between dietary habits of female athlete. Also the logistic regression analysis reveals that increased number of soft drinks and tea drinks per day is significantly associated with high probability of having anemia. Women with increased consumption of soft drinks per day and those with high tea consumption per day are more than two times at higher risk of anemia (OR=2.34 and 2.17 respectively). On the other hand, Kuwaiti nationality, increased duration of practicing sport and increased frequency of eating breakfast in the last month subjects are significantly associated with lower probability of having anemia (OR=0.14, 0.74 and 0.17 respectively).

Keywords: Female Athletes; Iron Deficiency; Dietary Iron; Metabolism and Bioavailability; Stages of Iron Deficiency; Dietary Pattern and Habits; Predisposing Factors to Iron Deficiency Anemia

Introduction

Anemia is the most common disorder of the blood, affecting about quarter the people worldwide [1]. It is usually defined as a decrease in amount of red blood cells (RBCs) or hemoglobin in the blood [2,3]. Iron-deficiency anemia is the greatest common type of anemia. It happens when the body does not have enough iron. Iron deficiency is typically due to blood loss but may infrequently be due to poor absorption of iron. Pregnancy and childbirth consume a great deal of iron and thus can cause pregnancy-related anemia. Individuals who have had gastric bypass surgery for weight reduction or other reasons may also be iron deficient due to weak absorption [4]. Female athletes are considered to be at a greater risk of compromised iron status which may lead to iron deficiency (with or without anemia) due to negative iron balance contributed

by insufficient dietary iron intake, menstruation, increased iron losses associated with haemolysis, sweating, gastrointestinal bleeding and exercise induced acute inflammation [5,6]. Iron plays an important role in oxygen transport and fuel consumption [7]. Iron is crucial for the synthesis of hemoglobin and myoglobin, the proteins that carry oxygen to the blood and muscle, respectively. It is a vital component of the electron transport system that controls the energy release from cells. Iron is involved in DNA synthesis and red blood cell production. It acts as a promoter against harmful free-radical production [8]. But still wondering how exactly this mineral affects peak physical performance and when an athlete functions without adequate iron, less oxygen is transported to the muscles, maximal oxygen consumption (VO_{2max}) falls, and physical

performance is affected [9]. Moreover, too little iron may weaken immune and other physiological functions [10].

Iron deficiency is a progressive condition that develops through three stages: iron depletion, iron deficiency and iron deficiency anemia [11]. Iron deficiency is more common among physically active individuals compared with their sedentary counterpart. There are a few reasons why athletes are at a higher risk of experiencing iron deficiency compared to their non-athletic counterparts as higher requirements for iron use and increased risk of iron loss [12,13].

The aim of this study was to determine the magnitude of the iron deficiency and iron deficiency anemia among female Kuwaiti athletes and identify their different dietary habits.

Patients and Methods

A cross sectional study was done. Based on recent figure about the prevalence of iron deficiency anemia (IDA) among female athletes to be 10% [14]. The minimum sample size was calculated to be 139 ($N = Z^2 \times PQ/E^2 = (1.96)^2 \times 0.10 \times 0.97 / (0.05)^2 = 139$) out of the total 321 female athletes registered. The sample was increased to 150 players from the three female clubs in Kuwait (Aloyoun sport club, Salwa Alsabah sport club and Alfatat sport club) where almost all types of sports activity are practiced at level of national competition to increase accuracy of the results. Players fulfilling the inclusion criteria and accepted to participate were included. A random group of 150 female athletes were selected from a population of 321 using random systematic sampling technique.

Data were collected from the sample's athletes using a structured assisted questionnaire which included personal sociodemographic characteristics and history of following diet. In addition, dietary habits of the athletes, the components of

athletes' meals, as well as drinking tea, coffee and soft drinks. Smoking, medical history, family medical history (as diabetes and hypertension) and gynecological history were also included. Finally, a detailed description of the practiced sport. Physical examinations as anthropometric measurements (weight, height, waist circumference and calculating body mass index), medical examination which include blood pressure, signs of anemia, abdominal examination and blood investigations [15] (hemoglobin, MCV, MCH, MCHC and serum ferritin).

The collected data were summarized in terms of mean $\pm$ Standard Deviation (SD) and range for quantitative data and frequency and percentage for qualitative data. Comparisons between the different study groups were carried out using the Chisquare (χ^2) and Fisher's Exact Test (FET) to compare proportions as appropriate. The student t-test (t) was used to compare differences in the mean between two groups regarding normally distributed data. Stepwise logistic regression of being anemic conditioned on potential risk factors was carried out to identify significant factors and the results were expressed as Odd Ratio (OR) and 95% Confidence Interval (CI). Statistical significance was accepted at P value <0.05 (S). A P value <0.001 was considered highly significant (HS) while a P value >0.05 was considered nonsignificant. All statistical analyses were carried out using STATA/SE version 11.2 for Windows (STATA Corporation, College Station, Texas).

Results

The study revealed that (14.7%) of the subjects included had a low hemoglobin value and low serum ferritin that were classified as being iron deficiency anemia (IDA). (36.7%) had a normal hemoglobin value and low serum ferritin that were classified as being iron deficient (ID) while the rest of the participants were classified as being normal (48.7%) (Table 1).

Table 1: Prevalence of IDA, ID and being normal among studied groups.

Group (no.=150)	No.	%
*IDA (below normal Hb & below normal ferritin)	22	14.7
*ID (normal Hb & below normal ferritin)	55	36.7
Normal (normal Hb & normal ferritin)	73	48.7

IDA: Iron Deficiency Anemia

ID: Iron Deficient

Hb: blood hemoglobin

*This criteria according to German et al. [16].

Table 2: Comparing IDA, ID and normal groups according to sociodemographic characteristics.

Variable		IDA (no.=22)		ID (no.=55)		Normal (no.=73)		Chisquare Test	P
		No.	%	No.	%	No.	%		
Nationality	Kuwaiti	10	45.5	45	81.8	58	79.5	12.48	<0.05
	Non-Kuwaiti	12	54.6	10	18.2	15	20.6		
Age (years)	Mean $\pm$ SD	18.9 5 ± 3.41		18.8 ± 3.05		18.5 4 ± 2.86		F= 0.21	>0.05

Marital status	Single	17	77.3	50	90.9	70	95.9	FET	<0.05
	Married	5	22.7	5	9.1	3	4.1		
Educational level	Primary	1	4.6	0	0	0	0	FET	>0.05
	intermediate	4	18.2	3	5.5	3	4.1		
	Secondary	10	45.5	25	45.5	36	49.3		
	Diploma	5	22.7	9	16.4	17	23.3		
	University	2	9.1	18	32.7	17	23.3		
Occupation	Student	11	50	44	80	58	79.5	FET	<0.05
	No work	7	31.8	4	7.3	2	2.7		
	Employee	2	9.1	3	5.5	6	8.2		
	Technician	2	9.1	4	7.3	7	9.6		

F: Oneway Analysis of Variance (ANOVA)

P: Probability

Significant (P<0.05)

Non-significant (P>0.05)

FET: Fisher Exact Test

IDA: iron deficiency anemia

ID: iron deficiency

Regarding the sociodemographic characteristic, more than half of anemic (54.6%) were non-Kuwaiti. The majority of iron deficient (81.8%) and of normal (79.5%) were Kuwaiti with statistically significant difference (P<0.05). There was a statistically significant difference between the three groups regarding the marital state and occupation (P<0.05) for all. But insignificant difference regarding the mean age and the educational level (P>0.05) (Table 2).

Regarding the dietary pattern and habits between the three groups more than two thirds (68.2%) of the iron deficient anemic participants had two or less meals per day while more than half of iron deficient group (58.2%) compared to the majority of normal athletes (89%) consumed more than two meals per day. This difference is statistically significant (P<0.001) (Table 3).

Table 3: Comparing IDA, ID and normal groups regarding the dietary pattern and habits.

Variable		IDA (no.=22)		ID (no.=55)		Normal (no.=73)		Chisquare Test	P
		No.	%	No.	%	No.	%		
No. of meals/day	≤2	15	68.2	23	41.8	8	11	31.11	<0.001
	>2	7	31.8	32	58.2	65	89		
Breakfast in the last month	Never	11	50	14	25.5	7	9.6	25.73	<0.001
	Most of days	11	50	17	30.9	31	42.5		
	Always	0	0	24	43.6	35	48		
No. of soft drinks/day	0	3	13.6	16	29.1	37	51.4	20.92	<0.001
	1	4	18.2	22	40	17	23.6		
	≥2	15	68.2	17	30.9	19	26		
	Mean ± SD; (range)	2.23 ±1.57; (0-7)		1.16 ±1.05; (0-4)		0.92±1.26; (0-5)		F=9.44	<0.001
No. of tea drinks/day	0	10	45.5	32	58.2	44	61.1	15.64	<0.05
	1	2	9.1	8	14.6	21	29.2		
	≥2	10	45.5	15	27.3	8	11		
	Mean ± SD; (range)	1.32 ±1.43; (0-4)		0.71 ±0.92; (0-3)		0.49±0.67; (0-2)		F=7.11	<0.05
No. of coffee drinks/day	0	11	50	24	43.6	31	43.1	5.81	>0.05
	1	5	22.7	10	18.2	25	34.7		
	≥2	6	27.3	21	38.2	17	23.3		
	Mean ± SD; (range)	0.82 ±0.96; (0-3)		1.18 ±1.28; (0-4)		0.8±0.82; (0-3)		F=2.28	>0.05

Smoking	No	20	90.9	55	100	71	97.3	FET	>0.05
	Yes	0	0	0	0	1	1.4		
	Exsmoker	2	9.1	0	0	1	1.4		

P: Probability

Significant (P<0.05)

Highly Significant (P<0.001)

Non-significant (P>0.05)

FET: Fisher Exact Test

F: Oneway Analysis of Variance (ANOVA)

IDA: Iron Deficiency Anemia

ID: Iron Deficient

Table 3 also shows that exactly half (50%) of the IDA group never had breakfast and the other half had breakfast most of the days in last month. In the iron deficient and normal groups, the highest percentage for those who always had breakfast in the last month (43.6% and 48% respectively). This difference is statistically significant (P<0.001). There was a highly statistically significant difference regard the number of soft drinks (P<0.001) and tea cups consumed daily (P<0.05).

A highly statistical significant differences between the anemic, iron deficient and normal groups regarding blood hemoglobin (Hb),

Mean corpuscular volume (MCV), Mean corpuscular hemoglobin (MCH), Mean corpuscular hemoglobin concentration (MCHC) and Serum ferritin (P< 0.001 in all items). The mean hemoglobin (Hb) level among the IDA group was 11.07±0.63 gm/dl while it was 13.03±0.98 gm/dl among ID group and 13.41±0.78 gm/dl among normal group. Regard the mean serum ferritin level among IDA, ID and normal participants was 12.01±6.13 ng/ml, 18.87±6.04 ng/ml and 43.38±12.67 ng/ml respectively (Table 4). All participants of the anemic and non-anemic groups had normal CRP levels (CRP negative).

Table 4: Comparing IDA, ID and normal groups according to the different laboratory investigations.

Variable	IDA (no.=22)			ID (no.=55)			Normal (no.=73)			F	P
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range		
HB (gm/dl)	11.07	0.63	10-11.9	†13.03	0.98	12-15.3	†‡13.41	0.78	12-15.3	65.41	<0.001
MCV (fl)	74.7	5.2	67-88.5	†84.8	4.69	76.7-93.5	†86.05	3.4	78.7-94	63.27	<0.001
MCH (pg)	24.77	2.23	21.5-30	†30.05	7.95	24-86.4	†29.22	1.67	26.3-33.3	8.95	<0.001
MCHC (gm/l)	326.82	5.31	317-337	†335.87	7.92	313-351	†337.42	8.01	309-352	16.45	<0.001
Serum ferritin (ng/ml)	12.01	6.13	4-31.2	†18.87	6.04	9-29.8	†‡43.38	12.67	30-77	138.19	<0.001

P: Probability

Significant (P<0.05)

Highly Significant (P<0.001)

F: Oneway Analysis of Variance (ANOVA) † Significant differences compared to anemic group

‡ Significant differences compared to iron deficient group

Table 5: Logistic regression analysis for being anemic athletes conditioned on significant risk factors.

Variable (no.=150)	OR	95% CI	P
Nationality (Kuwaiti vs. non-Kuwaiti)	0.14	0.04 to 0.53	0.003
Duration of practicing sport (years)	0.74	0.58 to 0.96	0.02
Eating breakfast in the last month* (never/ most of days/ always)	0.17	0.06 to 0.48	0.001
No. of soft drinks/day	2.34	1.43 to 3.84	0.001
No. of tea drinks/day	2.17	1.23 to 3.84	0.008

* A continuous variable was used to indicate a trend

OR: Odd Ratio

95% CI: 95% Confidence Interval

Discussion

From the total female athletes aged (15-25), engaged in this research (36.7%) had ID, (14.7%) had ID anemia and (48.7%) were normal. No previous studies done on Kuwaiti athletes to determine the prevalence of ID or IDA, it is the first study done to determine the magnitude of this problem among athletes. In 2015, a study assessed the prevalence of anemia and iron deficiency of a nationally representative sample of the Kuwait population but not athletes, reported that ID and IDA are prevalent in Kuwait [16,17].

A significant percentage (54.6%) of anemic female athletes included in this study were non Kuwaiti ($P<0.001$). Similar work done in 2004 [18] reported that the race plays a role in developing iron deficiency anemia. A significant percentage (81.8%) of Kuwaiti participants had only iron deficient compared to non-Kuwaiti. Many studies documented that the incidence of iron deficiency without anemia is greater in female athletes [18-20]. Firstly, the Kuwaiti's habits of intake fast food and food that inhibits iron absorption as milk and milk products [17]. Secondary, the fact that iron absorption, which occurs mostly in the jejunum, is only 5 to 10 % of dietary intake in persons in homeostasis, in states of overload absorption decreases [19]. Also, Kuwaiti's food supply is widely available and highly subsidized. Excessive calories are widely consumed, as evidenced by the estimated 40% obesity rate for Kuwait and it is often poor in iron [20].

The marital state and occupation had a significant relation ($P<0.05$ each) and insignificant relation between the level of education ($P>0.05$) and the IDA, ID and normal groups. These factors reflect the psychological and the social state of the participant females which in turn affect their dietary habits and predisposing to ID and IDA. These results are in agreement with similar work done in 2004 [21] by Jolie reported a positive relation between anemia, education level and occupation. On the contrary, a study done in Kuwait [22] reported that the prevalence of anemia and ID did not differ by level of education or income. Also there was no significant relation between ID, IDA or normal and age of the participants ($P>0.05$). However, a study done in Bangladesh in 2005 showed that the prevalence of anemia varied by age and gender, but not socioeconomic status [23].

The study shows a significant good iron state and iron intake, assessed as the number of meals per day and the frequency of eating breakfast, in the non-anemic athletes ($P<0.001$) each. ID and IDA in the anemic group is due to the change of their dietary pattern, as there was insignificant difference between the three groups regarding the history of other diseases. Also, a significant difference between IDA and ID athletes and the non-anemic group, regarding consumption the non heme iron and hem iron inhibitors or enhancers. Many researches explained the prevalence of ID and IDA in sport individuals is due to dietary pattern [24-27].

The incidence of anemia is similar in anemic and non-anemic participants across all sports with insignificant difference between the two groups regarding the duration and time of practicing the sport. Supported by the work done by Haff and Triplett in 2015 [28]. On the contrary, other studies reported anemia more in runners and football players ("foot strike hemolysis") [29,30].

A highly statistical significant differences between the three groups regarding blood hemoglobin (Hb), MCV, MCH and MCHC ($P<0.001$) for all items indicating the presences of hypochromic microcytic anemia. Sport anemia that occurs in trained athletes, particularly in endurance sports because athletes have an increased total mass of red blood cells and hemoglobin in circulation relative to sedentary individuals. For defining anaemia, the cut off level of 120 g/L set by the World Health Organization 2004 [31] using Hb level in combination with erythrocyte indices (MCV, MCH and MCHC) [32].

Conclusion

IDA is more prevalent in non-Kuwaiti athletes that may be related to racial factors. ID and IDA are associated mainly with the dietary habits of the participants, the number of meals per day, the frequency of eating breakfast and type of food consumed.

Recommendations

Regular sessions of health education for athletic females about iron deficiency anemia, and factors enhancing and inhibiting it. The annual screening for all female athletes, using the traditional markers for ID and IDA; hemoglobin, MCV, MCH, MCHC, serum ferritin and TIBC.

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