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Iron Status in Female Athletes Participating in Team Ball-Sports

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Abstract: Iron deficiency anemia is the most prevalent micronutrient deficiency in the world, affecting 20-50% of the world's population. It is estimated that 10 and 20% of male and female athletes are iron deficient, respectively. Iron deficiency has deleterious effects on the physical performance of athletes. It decreases aerobic capacity, increases heart rate and elongates the recovery time after exercise. In this cross-sectional study, 42 semi-professional female athletes who had been playing in basketball, volleyball and handball super league teams served as subjects. Data on socioeconomic and fertility status as well as the type of sport were obtained through a questionnaire. Nutritional data were gathered with a 3 day dietary recall. Total intake of calorie, iron, zinc, folate, vitamin C and B_{12} were also analyzed. In addition, ferritin and TIBC were measured and a CBC test was done for each subject. The results showed that the mean total calorie intake of women was 2049.79±735.12 kcal, where their iron intake was 22.33±9.24 mg day^{-1}. There was a significant difference between the iron intake of basketball and volleyball players ($p = 0.036$). Of our subjects, 33.33% had low ferritin levels (<30 ng mL^{-1}) and it was lowest in handball players. Higher than normal ferritin levels were seen in 12.5% of the subjects. We saw a significant difference in ferritin levels of basketball and handball players ($p = 0.047$). We conclude that the intake of calorie and iron is low in female athletes and therefore, their hematological indices such as ferritin level are below standard values.

Key words: Iron status, female athlete, nutrient intake

INTRODUCTION

Iron deficiency anemia is the most prevalent micronutrient deficiency in the world population (Beard and Stoltzfus, 2001). It occurs in developing countries at greater rates (Looker *et al*., 1997). The commonly used definition for anemia is the decrease in number and size of red blood cells or decreased amount of hemoglobin in red blood cells. Anemia inversely affects oxygen and carbon dioxide exchange between blood and tissue cells. Iron deficiency anemia is characterized by small (microcytic) erythrocytes and decreased level of hemoglobin in the circulation (Massey, 1992). Inadequate iron intake due to a poor diet, inefficient iron absorption, increased iron needs, increased iron loss and chronic inflammation are the main causes of iron deficiency anemia (Beard and Tobin, 2000).

There are evidences that show anemia occurs in professional athletes. The prevalence of iron deficiency in male and female athletes is reported to be 10 and 20%, respectively (Gross *et al*., 1994). Athletes doing intense exercise are at greater risks for iron deficiency (Spodaryk *et al*., 1985). Athletes may lose iron via several routes such as bleeding and sweating as well as menstrual cycle in female athletes. Erythrocyte destruction, exercise stress and decreased erythropoietin production may also cause anemia in athletes (Spodaryk *et al*., 1985; Weight *et al*., 1992). Iron deficiency is more prevalent in female athletes than in males (Beard and Tobin, 2000). Although, severe anemia is not that common, several studies reported that the depletion of iron stores is common among female athletes (Rownand, 1990).

Iron deficiency has deleterious effects on the physical performance of athletes. At the cellular level, reduced oxygen transport capacity and lower oxidation capacity are obvious consequences of iron depletion (Beard and Tobin, 2000). Physical activity, endurance activity and resistance to fatigue in athletes depend on many factors. One is the capacity of blood for carrying oxygen, which is basically determined by hemoglobin concentration (Faintuch, 1992). In all, iron deficiency in athletes decreases aerobic capacity, increases heart rate and elongates the recovery time after exercise (Rownand, 1990). The effects of iron deficiency on the physical performance of athletes and also the fact that iron status in female athletes is lower than the males, highlights the importance of evaluating iron status in female athletes.

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The aim of the present study is to determine the iron status in a group of semi-professional female athletes participating in team ball-sports, in Shiraz, Iran.

MATERIALS AND METHODS

This study was conducted between March and September 2006. In this cross-sectional study, 45 semi-professional female athletes who had been playing in basketball, volleyball and handball super league teams served as subjects. The subjects were chosen from two well-known stadiums: Hejab and 22-Bahman in Shiraz, Iran. Inclusion criteria was playing sport semi-professionally and not taking nutritional supplements. Three of the athletes were excluded because of taking nutritional supplements. The remaining 42 subjects were informed about the goals of the research project and gave informed consent. Data on socioeconomic and fertility status as well as the type of sport were obtained through a questionnaire. Nutritional data were gathered with a 3 day dietary recall. These 3 days were Saturday, Tuesday and Friday to represent the total weekly diet. Total energy intake (kcal), levels of iron (mg), zinc (mg), folate (μg), vitamin C (mg) and vitamin B_{12} (μg) intake in the subjects were also analyzed using the FDP software. These values were compared to the Recommended Daily Allowances (RDAs) for each nutrient (Gallagher, 2008). Then each subject was referred to the central laboratory of the Motahari clinic and a fasting blood sample was taken. In these samples, ferritin and TIBC were measured and a CBC test was done. These hematological indices were compared to the standard values (Lee and Nieman, 2007).

Statistical analysis: The one-way ANOVA test with Duncan procedure for multiple comparisons was performed to identify significant differences among the mean values of the variables measured. In order to compare the mean of each group with the standard or RDA, the one-sample t-test was performed. The p-values less than 0.05 were considered significant.

RESULTS

The subjects of this study were 42 semi-professional female athletes. Of these, 16 women (38%) were basketball players, 16 (38%) were volleyball players and 10 (23.8%) were handball players. The average age, weight and height of the female athletes were 23.61±4.35 years, 58.97±5.5 kg and 167.69±3.84 cm, respectively. Of these, 47.6% were students, 21.4% were homemakers and 31% had clerical posts. The rate of oligomenorrhea was 50% and it was maximum (47.61%) in basketball players. No amenorrhea was reported.

The results of dietary analysis showed that the mean calorie and iron intake of female athletes were 2049.79±735.12 kcal day^{-1} and 22.33±9.24 mg day^{-1}, respectively. The minimum intake of calorie and iron was seen in the basketball players. There was a significant difference between the iron intake of basketball and volleyball players ($p = 0.036$). The mean intakes of folate, zinc, vitamin B_{12} and iron were bellow the RDA in 100%, 100, 80 and 38% of female athletes, respectively. The mean intakes of calorie, iron, folate, zinc, vitamin B_{12} and C and their comparisons with the RDAs are shown in Table 1. The mean intake of calorie, vitamin B_{12}, folate and zinc differed from RDAs significantly in all sport groups and in general. There was no significant difference between the intake of vitamin C and the RDA. The differences between iron intake and the RDA was significant in volleyball players ($p<0.01$) and in all the athletes together ($p<0.01$), but it was not significant in basketball ($p = 0.41$) and handball players ($p = 0.1$).

The results of the hematological tests are shown in Table 2. The mean values of CBC tests, Hb and ferritin were within normal range, but the mean value of the TIBC was higher than normal. The Hb level was bellow the standard in 4.7% of the subjects. Of our subjects, 33.3% had low ferritin levels (<30 ng mL^{-1}) and 4.7% had depleted iron stores (ferritin <20 ng mL^{-1}) and it was lowest in handball players. Higher than normal ferritin levels were seen in 12.5% of the subjects. We saw a significant difference in ferritin levels of basketball and handball players ($p = 0.047$). We also compared the

Table 1: Nutrient intake of female athletes with respect to their sport type

	Basketball		Volleyball		Handball			Total	
Variables	Mean±SD	p-value*	Mean±SD	p-value*	Mean±SD	p-value*	p-value**	Mean±SD	p-value*
Calorie	1778.90±652.8	<0.001	2266.00±835.9	<0.001	2136.90±679.6	<0.001	0.173	2049.79±735.12	<0.001
Iron	18.33±5.51	0.41	26.61±10.84	<0.01	21.88±9.02	0.10	0.036	22.33±9.24	<0.01
Vitamin C	82.73±68.8	0.33	77.84±41.7	0.40	76.94±41.1	0.44	0.953	79.49±52.44	0.3
vitamin B_{12}	1.27±1.15	<0.001	1.31±1.1	<0.001	1.58±1.16	0.03	0.665	1.32±1.17	<0.001
Folate	66.57±44.54	<0.001	84.08±27.66	<0.001	80.09±32.25	<0.001	0.373	76.46±36.03	<0.001
zinc	2.43±2.15	<0.001	2.49±1.44	<0.001	2.95±1.59	<0.001	0.75	2.58±1.75	<0.001

*Comparisons with RDA. **Comparisons between groups

Table 2: Hematological indices of female athletes with respect to their sport type

Variables	Basketball	Volleyball	Handball	p-value**	Total Mean±SD	p-value*
	(Mean±SD)					
Hb	13.45±1.3	13.70±1.1	13.64±0.61	0.814	13.59±1.1	<0.001
HCT	41.33±3.02	41.66±2.85	41.66±1.6	0.93	41.53±2.6	0.10
MCV	82.97±7.4	82.87±6.5	81.38±14.2	0.909	82.48±8.9	0.04
MCH	27.05±3.02	27.27±2.7	27.87±2.02	0.755	27.33±2.68	0.22
MCHC	32.51±1.06	32.86±1.03	32.60±0.53	0.569	32.67±0.9	<0.001
RBC	4.99±0.41	5.05±0.42	4.89±0.29	0.636	4.9±0.3	<0.001
TIBC	416.40±40.25	436.8±31.32	419.50±28.72	0.222	424.9±34.9	<0.01
Semm Fe	69.75±26.6	63.93±20.4	63.10±23.6	0.718	65.95±23.34	<0.001
ferritin	60.7±35.1	41.26±23.2	35.79±13.3	0.047	47.39±28.3	<0.001

*Comparisons with standard values. **Comparisons between groups

hematological indices with standard values (Lee and Nieman, 2007). Significant differences were seen between standard values and observed values for Hb ($p<0.001$), MCV ($p = 0.04$), MCHC ($p<0.001$), RBC ($p<0.001$), TIBC ($p<0.01$), serum Fe ($p<0.001$) and ferritin ($p<0.001$).

DISCUSSION

Athletes, especially female athletes, are at risk of iron deficiency. It is estimated that 10 and 20% of male and female athletes are iron deficient, respectively (Gross *et al*., 1994). The present study assessed the socioeconomic, fertility, nutritional and hematological status of female athletes participating in team ball-sports. In present study, the rate of menstrual irregularity was 50% and no amenorrhea was reported. In contrast, other reported studies have noted lower rates of irregular menstruation (Jeanne *et al*., 2006; Beals, 2002) and higher rates of amenorrhea (Beals, 2002; Clement and Sawchuck, 1984). The small sample size in this study may be responsible for these observed differences.

During physical activity, pulsatile secretion of GnRH from hypothalamus changes and results in diminished production of FSH and LH. Low LH level, in turn, results in low estrogen levels (Goumenou *et al*., 2003; Warren and Perlroth, 2001). Leptin may play a role in athletes' amenorrhea too. Normal leptin level is an important factor in maintaining the menstrual cycle (Goumenou *et al*., 2003). Limited calorie intake during exercise may also be associated with menstrual disorders (Warren and Perlroth, 2001).

In our investigation, the intake of folate, B_{12} and zinc differed from the RDA significantly in all groups. There were significant differences between the RDA for iron and the iron intake of volleyball players and the mean of the whole group of players. Other similar studies reported higher B_{12} intake (Beals, 2002) and lower iron intake (Rowland and Kelleher, 1989; Faintuch, 1992) compared to present study. In present study, there was a significant difference between the calorie intake of the subjects and the recommended amounts. This is similar to the result of another study by Beals (2002) on female volleyball players. There is a positive association between iron and calorie intake (Gallagher, 2008). In present study, a significant difference was seen between the iron intake of basketball and volleyball players. This can be explained by differences in their calorie intake and association of calorie and iron intake. In present study, vitamin C intake of the subjects did not differ from the RDA significantly, but Beals (2002) reported a higher vitamin C intake in volleyball players. Vitamin C is the most potent enhancer of iron absorption. An imbalanced diet with inadequate vitamin C exacerbates iron deficiency (Gallagher, 2008). We should note that micronutrient intake of the subjects may be adequate according to the RDAs, but athletes need more energy than nonathletes and therefore their need to some micronutrients may increase too.

In present study, Hb level was bellow the standard in 4.7% of the subjects and it differed standard value significantly. Other studies reported higher (Clemet *et al*., 1987) and lower (Wijn *et al*., 1971) values. Bleeding due to increased body temperature, increased lactic acid, adrenalin, noradrenalin and free radical production may decrease hematological indices. Increased plasma volume and therefore blood dilution may be responsible for decreased Hb concentration too (Szygula, 1990). In present study, ferritin level was low in one third of female athletes and it was the lowest in handball players. There was a significant difference between the ferritin level of handball and basketball players. Present results are in consistency with the results of a study by Karamizrak *et al*. (1996) which showed that handball players had the lowest ferritin levels compared to other sport players. There was also a significant difference between the observed and the standard values of ferritin in all groups and in general. On the other hand, some of the subjects had higher than normal ferritin levels. Ferritin is an acute phase protein and may increase due to fever, infection and chronic inflammation (Litchford, 2008). Oxidative stress may also increase ferritin level (Magnusson *et al*., 1984).

We conclude that the intake of calorie and iron is low in female athletes; therefore their hematological indices such as ferritin level are under the standard values. We recommend that more attention be paid to the nutrient intake (especially calorie and micronutrient intake) of the female athletes.

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