

Iron Profile and Prevalence of Iron Deficiency in Hong Kong Adolescent Athletes

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Abstract

Adolescent athletes are at high risk of iron deficiency due to excessive iron demands from physical training and rapid growth during adolescence. This may affect normal growth and exercise performance. The present study investigated the iron status of Hong Kong adolescent athletes and compared the prevalence of iron depletion and iron deficiency anemia between genders. 290 adolescent athletes (132 Females and 158 Males, aged 9-17 years) engaging in various sports were studied. Screening of iron stores status included complete blood count and levels of serum iron, serum ferritin, transferrin, transferrin saturation and total iron binding capacity. Iron depletion, defined by ferritin level below 45ng/ml for male and below 35ng/ml for female, was found in 20.3% of male athletes and 25% of female athletes. Iron-deficient erythropoiesis and iron deficiency anemia were found in 2.3% and 1.5% of females respectively. No significant difference was found between genders regarding iron depletion, iron-deficient erythropoiesis and iron deficiency anemia. All youth athletes should be educated regarding an iron-rich diet and their iron status should be monitored regularly to ensure adequate iron store for sport training and normal growth during adolescence.

Introduction

Iron is essential for oxygen delivery and energy production during exercise. Iron deficiency anemia (IDA) decreases physical work capacity and iron depletion, a condition much more prevalent than IDA, may already limit exercise performance [1].

Athletes engaged in strenuous physical trainings have a greater tendency toward iron deficiency with or without anemia, particularly females and adolescents [2-3]. During puberty, the cumulative effects from biological demands of growth and development and physiological demands of various sports impose a significant iron cost on adolescent athletes. Highly active adolescent athletes are at high risk for developing iron deficiency, which may retard normal growth and maturation processes, as well as exercise performance [4]. Although many previous studies investigated prevalence of iron depletion in female athletes [5-7], young male athletes are also prone to iron deficiency during growth spurt period. A study on iron status of young male gymnasts, swimmers and tennis players reported a high prevalence of iron depletion (20-36%) [5]. Another study stated that iron depletion was found in 19% of adolescent male basketball players [6].

The purposes of this study were to investigate the complete blood count (CBC) and iron profile of Hong Kong adolescent athletes engaged in various sports and to compare the prevalence of iron depletion, iron deficient erythropoiesis (IDE) and IDA between genders.

Methodology

Data were collected from 290 Hong Kong Sports Institute (HKSI) adolescent athletes, aged 9 to 17 years, as part of annual medical screening. Subjects were 132 females (mean age: 14.89 ± 1.76 years) and 158 males (mean age: 15.46 ± 1.73 years) from 17 sports, namely athletics, badminton, billiard sports, cycling, diving, fencing, gymnastics, karatedo, rowing, squash, swimming, table tennis, tennis, tenpin bowling, triathlon, windsurfing and wushu.

Screening of iron stores status included CBC, serum iron, serum ferritin (SF), transferrin, transferrin saturation and total iron binding capacity (TIBC). Three stages of iron depletion have been identified. Iron depletion was defined as SF level below 45ng/ml for male and below 35ng/ml for female [8]. The definition of IDE was SF level below 12ng/ml and transferrin saturation below 16% for both male and female [6,9]. IDA was defined by hemoglobin (Hb) level below 13g/dL for male and below 12g/dL for female, plus the criteria of IDE [9]. All statistical analyses were performed using PASW Statistics 17 (SPSS Inc., Chicago, Ill., USA).

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Results

Table 1 states the CBC and iron profile of the subjects. Significant difference in mean CBC measurements was found between genders. Females had significantly lower levels of SF ($p < .001$), serum iron ($p < .001$), and Hb ($p < .001$) when compared with males. High prevalence of iron depletion was found in both male (20.3%) and female (25%) adolescent athletes (Figure 1). IDE and IDA were found in 2.3% and 1.5% of females respectively, but not in males. However, there is no significant difference between genders regarding the prevalence of iron depletion ($p = .334$), IDE ($p = .093$), and IDA ($p = .206$).

Table 1. Mean values of CBC and iron store measurements

	Female (N=132)	Male (N=158)
Hemoglobin (g/dL)**	13.28 ± 0.90	14.46 ± 1.08
Hematocrit (%)**	40.10 ± 2.38	43.12 ± 3.03
MCV (fL)**	86.74 ± 6.35	83.73 ± 7.57
MCHC (g/dL)**	33.11 ± 0.77	33.46 ± 0.94
Serum ferritin (ng/ml)**	63.74 ± 44.37	88.90 ± 50.15
Serum iron (µg/dL)**	73.97 ± 29.83	87.74 ± 29.49
Transferrin (mg/dL)	260.15 ± 37.55	252.80 ± 32.41
TIBC (µg/dL)	330.39 ± 47.69	321.06 ± 41.17
Transferrin saturation (%)**	22.80 ± 9.55	27.68 ± 9.82

Note. Data presented as mean ± SD. MCV: Mean Corpuscular Volume; MCHC: Mean Corpuscular Hemoglobin Concentration. Significant difference between males and females: * $p < .01$, ** $p < .001$.

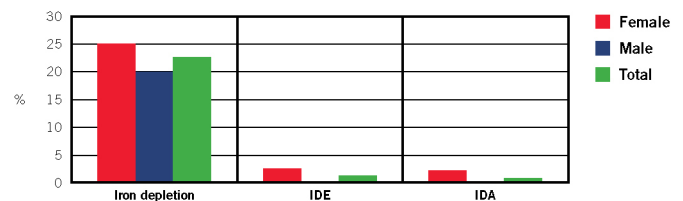


Figure 1. Percentage of adolescent athletes with iron depletion, iron-deficient erythropoiesis (IDE), and iron deficiency anemia (IDA)

Discussion

In this study, the prevalence of iron depletion was 20.3% and 25% in male and female adolescent athletes respectively, which is coherent with previous studies [5-6] (Figure 1). Excessive demands on body iron stores may lead to high prevalence of iron depletion in adolescent athletes, as a result of rapid growth and sport training. During growth spurt period, greater iron requirement is needed for adolescents due to hormonal changes and increase in body mass, Hb concentration, and total blood volume [4,10-11]. Moreover, intensive physical training that stimulates muscle tissue development further decreases body iron stores [12]. The risk of developing iron deficiency is higher in girls because of additional iron loss in menses [13]. The difference in dietary habit between genders may also affect the dietary absorption of iron. Willows *et al.* [14] suggested that adolescent males usually intake more animal foods (meat, fish and poultry) with heme iron, whereas the diets of adolescent females maybe higher in nonheme iron, which is less readily absorbed in the body.

Adolescent athletes are susceptible to developing iron deficiency even at recommended iron intake [5,15]. These athletes, usually without adequate nutrition knowledge, should be educated on how to make proper food choices for increasing dietary iron intake and iron bioavailability. Iron deficiency may impair performance in young athletes and thus monitoring of iron stores in adolescent athletes for both genders is of great importance so as to ensure adequate iron store for normal growth and sport training during the growth period.

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