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# Food Iron Supplementation and its Impact on Biochemical and Physical Fitness components of Selected Sports Persons

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## Abstract

Nutrition has an important effect on the endurance capacity and performance of sports persons. Nutritional supplements have been widely used all over the world by sports persons as it is difficult to obtain a sufficient level of nutrients from a normal diet. The objective of the study was to contribute to the scientific basis for the value of iron in sports performance. The subjects were selected by purposive random sampling technique. An interview schedule was formulated to collect base line information. Rice mix was enriched with iron and supplemented to the sports persons for a period of 90 days. The mean blood hemoglobin, mean serum iron and the transfer in saturation significantly ($p<0.05$) increased on supplementation. There was a significant ($p<0.05$) improvement in 12 minute run test after supplementation. The study concludes supplementation of iron rich foods definitely improved the biochemical and physical fitness components of the sports persons. This in turn helps to improve their endurance and performance.

**Keywords:** Biochemical Parameters, Diet Practices, Food Iron, Physical Fitness, Sports Person, Supplementation

## 1. Introduction

A sport is defined as a physical activity involving structured and competitive situations, governed by rules[1]. Sports Nutrition is an emerging field, which by itself shows the interest of athletes and coaches towards good nutrition. Scheduling what should be eaten before, during and after exercise is important. A healthy diet will increase the energy and endurance, reduce fatigue and maximize the fitness gains. After exercise, the body needs enough nutrients for repair and recovery. Endurance athletes require different types and amounts of fluid and fuel than athletes in power or team sports do. Eating a well balanced, healthy diet does not guarantee success, but poor eating habits can literally stop or at least slow down the process. The foods and fluids that are consumed on a daily basis provide the fuel and nutrients that the body needs to perform day after day. The foods chosen to eat from day to day must also taste good and be satisfying. The key is to follow an eating style that fulfils both these needs-high performance nutritional foods that fuel the body (foods that are needed) and foods that feed the mind (foods that are required)[2].

Nutrition has an important effect on the endurance capacity and performance of athletes. However the legitimate role of nutrition is poorly understood by athletes and coaches alike. Iron is a critical micronutrient for athletes because iron deficiency anemia decreases

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endurance. Reviews suggest that iron deficiency has a negative effect on the physical activity and performance of athletes. Studies conducted by various researchers confirm that inclusion of iron rich foods and iron supplements will retain the exercise performance of athletes.

The role of heme and nonheme iron in biological function and work performance has been elucidated through human and animal experiments[3,4]. Lack of hemoglobin iron can alter physical work performance via a decrease in oxygen transport to exercising muscle. Maximal oxygen uptake ($VO_2$max) is determined primarily by the oxygen-carrying capacity of the blood and is correlated with the degree of anemia. Therefore the present study was designed with the objective to study the impact of iron supplementation on health and performance of sports persons.

## 2. Materials and Methods

Ethical clearance was got from the Human Ethics Committee of PSG Institute of Medical Sciences and Research, Coimbatore, Tamil Nadu. Experimental research design was adopted in this study. The subjects were selected by purposive random sampling technique. Base line data was collected from 15 sports persons of SRMV Maruthi College of physical education using an interview schedule.

**Table 1.** Iron rich rice mix powder

| Sl No. | Ingredients | Quantity (g) |
|---|---|---|
| 1 | Curry leaves powder | 50 |
| 2 | Manathakkali powder | 40 |
| 3 | Mango Powder | 10 |
| 4 | Chilli Powder | 5 |
| 5 | Cumin Seed Powder | 5 |
| 6 | Asafoetida Powder | 5 |

Iron Rich Rice Mix Powder (Table 1) was prepared with curry leaves (Murrayakoenigii) and manathakkali leaves (Solanum nigrum) which was powdered and mixed with other flavouring ingredients. This powder is then mixed with hot cooked rice, with a teaspoon of ghee and consumed. Since it was necessary to provide 1/3 of the daily iron requirement (Male - 5.6 mg, Female - 7mg) through the supplement, the investigator calculated the amount of iron present in each ingredient of the formula and arrived at the amount of the formula that has to be supplemented per day. The supplement was supplemented to the selected sports persons for a period of 90 days.

The bio-chemical parameters namely blood haemoglobin (cyanmenthmoglobin method), serum iron (Bathopheninthroline Method), TIBC level (spectrophotometer method) and transfer in saturation (Factorial method) were analysed and physical fitness tests (Pull-ups, Bent Knee Sit-ups, Sit and Reach Test and 12 minutes running) were conducted on the sports persons before and after supplementation.

The results were analyzed using SPSS version 17. Paired 't' test were used to assess the impact of supplementation.

## 3. Results and Discussion

### 3.1 General Information

All the selected sports persons were males and were between twenty to thirty five years of age. Sixty seven percent of them belonged to families whose monthly income was less than Rs. 15,000/- and thirty percent of families were earning more than Rs. 20,000/- as monthly income.

Finding out the economic level of the sports person determines the amount of money spent on food and thereby, their nutritional and health status. In the present study, since the monthly income of majority of sports person is low, the amount spent on food especially on the good nutritious ones and the intake of vital nutrients is also likely to be low which have an impact on their nutritional status.

Individuals lower in Socioeconomic Status (SES) have poorer health than individuals higher in SES. The findings consistently show that the higher the SES, the more the involvement in sport and physical activity. Socioeconomic Status (SES), has a profound influence on sport and physical activity. Previous findings show that living in low SES areas is predictive of low levels of participation in sport and physical activity[5-15].

Only male participants took part in the present study. The relationship between femininity and physical exercise was well studied by historians[16]. Findings[17] also opined that women athletes continue to be depicted in traditional roles that reaffirm their femininity.

## 3.2 Dietary Practices

Two of the sports persons (Table 2) were ova vegetarians, 12 were non vegetarians and only one was vegetarian. Two of the selected sports persons were consuming only two meals per day, due to monotony of food served in the hostel. A substantial percentage (80 percent) of the selected sports persons consumed three meals per day. About 13 percent skipped breakfast most of the days, the reason being lack of time.

**Table 2.** Dietary practices of sports persons

| Sl. No. | Nutritional Information | No. | Percent |
|---|---|---|---|
| 1 | **Dietary Pattern** | | |
| | Vegetarian | 01 | 07 |
| | Non Vegetarian | 12 | 80 |
| | Ova Vegetarian | 02 | 13 |
| 2 | **Meal Frequency** | | |
| | 2 | 02 | 13 |
| | 3 | 12 | 80 |
| | 4 | 01 | 07 |
| 3 | **Type of Meal Skipped** | | |
| | No | 12 | 80 |
| | **Yes** | 02 | 13 |
| | Breakfast | 01 | 07 |
| | Lunch | | |
| 4 | **Type of Food Supplement** | | |
| | No | 05 | 33 |
| | Homemade Health Mix | 04 | 27 |
| | Commercial Health Products Others | 05 | 33 |
| | | 01 | 07 |
| 5 | **Nutrient Supplements** | | |
| | No | 10 | 67 |
| | Multi Vitamin Tablets | 02 | 13 |
| | Calcium Tablets | 01 | 07 |
| | Iron Tablets | 02 | 13 |
| 6 | **Water consumption during event** | | |
| | No | 02 | 13 |
| | Sips of water | 07 | 47 |
| | 100ml | 03 | 20 |
| | 200ml | 03 | 20 |
| 7 | **Consumption of Ergogenic foods** | | |
| | No | 08 | 53 |
| | Red Bull | 01 | 07 |
| | Dark Chocolate | 03 | 20 |
| | Coffee | 03 | 20 |
| 8 | **Consumption of Rehydration drink** | | |
| | No | 03 | 20 |
| | Glucose D | 07 | 47 |
| | Gatrade | 01 | 07 |
| | Electrol powder | 04 | 26 |

Ten sports persons were consuming food supplements. Of them five were consuming commercial food supplements of reputed brands as they were being endorsed by international sports men (marketing strategies employed by manufacturers), and also due to convenience. Only four of the sports persons were consuming homemade health mix due to the personal care given by their parents.

During sports event, almost 90 percent of the sports persons were consuming plain water. The common ergogenic foods consumed by the sports persons (20%) were dark chocolate and coffee. In the present study, nearly half of selected sports persons have turned to ergogenic aids in the hope of achieving an edge over their opponents.

It is heartening to observe that the selected sports persons had good hydration practices. Eighty percent of the sports person were consuming rehydration drinks during sports events, of which glucose was consumed by 47 percent and 26 percent consumed ORS solution. The popular branded formula was consumed by one of the selected sports persons.

### *3.2.1 Dietary Pattern*

In India due to the various reasons the dietary habits vary amongst different populations. About 85 per cent of sports women following vegetarian diet in a study[18]. In contrary, majority of the participants of the present study were non vegetarians.

A vegetarian diet per se is not associated with improved aerobic endurance performance[19]. A varied and well-planned vegetarian diet is compatible with successful athletic endeavor. Nutrient intake, haemoglobin level and endurance time were better in non-vegetarians than lacto, ovolacto vegetarians[20].

Vegetarian athletes had low energy intake with low levels of vitamins and minerals[21] such as B-complex, calcium, iron, and zinc[22,23]. Since majority of the selected participants of the present study were non vegetarians, they are less likely to develop any vitamin and mineral deficiency.

### *3.2.2 Meal Frequency*

The results of the present study goes in accordance with observations where on an average the frequency of meals consumed by selected athletes were 3 meals per day[24].

Most research fails to support the effectiveness of increased meal frequency on the thermic effect of food, resting metabolic rate, and total energy expenditure. However, in the present study, only one subject was consuming 4 meals a day.

### *3.2.3 Type of Meal Skipped*

Habitual breakfast consumption is associated with healthy Body Mass Index and higher Physical Activity levels in schoolchildren. In boys, regularly eating breakfast is also associated with higher levels of Cardio Respiratory Fitness[25].

Skipping breakfast could have a causal effect and actually lead to apathy and lethargy and therefore reduced Physical Activity throughout the day[26–28].

About 20 per cent skipped either breakfast or lunch. These participants are more likely to develop symptoms of apathy and lethargy with reduced physical activity.

### *3.2.4 Consumption of Supplements*

Dietary supplements should only be supplements to the diet and not replacements for a good diet, as they help to optimize performance[29]. In the present study, only five participants did not have supplements to improve their health and performance.

Vitamin deficiencies can certainly impair exercise performance as it leads to a significant decrease in VO2max and anaerobic threshold in less than four weeks[30,31].

Multivitamin/mineral supplements are unnecessary for athletes or other physically active individuals who are on a well-balanced diet with adequate calories. Several studies reported no significant effects on both laboratory and sport-specific tests of physical performance[32,33]. One of the most comprehensive studies[34] from the Australian Institute of Sport reported no significant effect of supplementation of vitamins/minerals on physical performance of athletes when compared to whose vitamin and mineral RDA were met by regular diet.

Only five of the selected participants had nutrient supplement in the form of tablets. However, a well balanced diet will meet the vitamin and mineral requirement and there is no need for any supplement.

### *3.2.5 Hydration*

Exercise performance is impaired when an individual is dehydrated by as little as 2% of body weight and losses in excess of 5% can decrease the capacity for work by about 30%[35–37].

Ensuring adequate hydration includes initiating exercise in a euhydrated state and matching fluid intake to sweat rate during exercise[38]. Proper hydration during exercise will influence cardiovascular function, thermoregulatory function, muscle functioning, fluid volume status, and exercise performance[39].

In the present study, majority of the participants had good hydration habit during event.

### *3.2.6 Ergogenic Food*

Ergogenic aids are ingested to enhance energy utilization in sports persons and could influence during the period of rapid growth and sexual maturation and marked hormonal fluctuations. Ephedra alkaloids, pain relief medications, diuretics, anabolic steroids and hormones are among the ergogenic aids used by young sports person[40].

In the present study, the selected sports person consume coffee and dark chocolate which contain considerable amount of caffeine that works as a central-nervous-system stimulant and a muscle relaxant. There is much scientific research to suggest that caffeine is an effective ergogenic aid for increasing endurance exercise performance, anaerobic performance and muscle strength[41].

## 3.3 Impact of Supplementation on Biochemical Parameters

The mean haemoglobin level had significantly increased from 14.09±0.77 to 14.70±025 g/dl ($p<0.05$) after supplementation (Table 3). Likewise the mean serum iron and transfer in saturation also showed a significant increase ($p<0.05$) after supplementation. The initial TIBC level was high and reduced after the supplementation period by 4.55 µg/dl.

**Table 3.** Bio-chemical parameters

| Sl No. | Parameter | Mean±SD | | t value |
|---|---|---|---|---|
| | | Before Supplementation | After Supplementation | |
| 1 | Haemoglobin (gm/dl) | 14.09± 0.77 | 14.70±0.25 | 2.827* |
| 2 | Serum Iron (µg/dl) | 116.59± 20.94 | 130.47±15.16 | 1.992* |
| 3 | Transferin Saturation (%) | 34.38± 8.98 | 40.95±05.57 | 2.375* |
| 4 | TIBC (µg/dl) | 347.49± 39.97 | 342.94±39.74 | 0.302 NS |

* Significant at 5% level, NS - Not Significant

Study on impact of oral iron supplementation on body iron status, and the maximal oxygen uptake in female athletes with latent iron deficiency and iron-deficiency anemia concluded iron supplementation during a two-month period significantly improved body iron status[42].

The plasma iron was significantly lower and TIBC higher ($p < 0.001$) in iron-deficient subgroups than in the non-deficient ones[43]. In the present study, the initial TIBC level was found to be higher. However, the mean TIBC level had decreased from 347.49±39.97 to 342.9 4±39.74 µg/dl. Dietary iron interventions using a cereal product offer an alternative way of improving dietary iron intake[44]. The relation between iron status and physical working capacity was evaluated, and the effect of oral iron treatment on these variables, in athletes with borderline iron status was assessed[45]. The results of the study showed Hb, serum iron, serum ferritin, and transferrin saturation increased with iron treatment in both males ($P < 0.01$) and females ($P < 0.05$).

### 3.4 Impact of Supplementation on Physical Fitness

From the mean physical fitness test scores (Table 4) it was observed that the selected sports persons were average performers. However, there was a significant improvement in the 12 minute run test score ($p<0.05$) on supplementation. A negligible increase in the performance of Pull-ups and Bent Knee sit ups was observed after the supplementation period.

The results of the present study goes in accordance with findings[46] which showed iron-depleted female athletes when given oral iron supplementation in doses of 100-mg $FeSO_4$/day improves iron status and may improve physical performance. Iron supplementation was found to be beneficial for mood and physical performance in female soldiers during military training[47].

## 4. Conclusion

The biochemical parameters and 12 minute run test have shown a definite improvement on account of supplementation of iron rich formula. However, the period of supplementation has to be increased to show a statistically significant impact in TIBC level and other physical fitness parameters.

**Table 4.** Physical tests value

| Sl. No. | Parameter | Mean±SD | | t value |
|---|---|---|---|---|
| | | Before Supplementation | After Supplementation | |
| 1 | Pull-Ups (No of Pull - Ups) | 5.93±2.99 | 6.27±2.69 | 0.310 NS |
| 2 | Bent – Knee Sit- Ups (No of Sit -Ups) | 29.67±7.46 | 31.93±7.43 | 0.805 NS |
| 3 | Sit and Reach ( Distance in cm) | 5.93±2.31 | 6.47± 2.10 | 0.638 NS |
| 4 | 12 Minutes Run ( Distance in m) | 2181.85±283.53 | 2386.79±153.80 | 2.377* |

* Significant at 5% level, NS Not Significant

## 5. References


1. Birch K, Maclaren D, George K. Screening and Testing, Body Composition and Fatigue and Ergogenic Aids. Sports and Exercise Physiology. BIOS Scientific Publishers; 2004. p. 121-123, 179-182, 192.
2. Eberle SG. Stategies for training, racing, and recovery. Endurance Sports Nutrition. 2nd ed. Human Kinetics publishers; 2007. p. 71, 110, 157, 171, 174.
3. Finch CA, Huebers MD. Perspectives in iron metabolism. N Engl J Med. 1982; 25:1520–5. https://doi.org/10.1056/NEJM198206243062504 PMid:7043270.
4. Dallman PR. Manifestations of iron deficiency. Semin Hematol. 1982; 19:19–30. PMid:6763336.
5. Adler NE, Boyce T, Chesney MA, Cohen S, Folkman S, Kahn RL, Syme SL. Socioeconomic status and health: The challenge of the gradient. American Psychologist. 1994; 49:15–24. https://doi.org/10.1037/0003-066X.49.1.15 PMid:8122813.
6. Anderson NB, Armstead CA. Toward understanding the association of socioeconomic status and health: A new challenge for the biopsychosocial approach. Psychosomatic Medicine. 1995; 57:213–25. https://doi.org/10.1097/00006842-199505000-00003.
7. Chen E, Matthews KA, Boyce WT. Socioeconomic differences in children's health: How and why do these relationships change with age? Psychological Bulletin. 2002; 128:295–329. https://doi.org/10.1037/0033-2909.128.2.295 PMid:11931521.
8. Bloom M, Grant M, Watt W. Strengthening Canada: The socio-economic benefits of sport participation in Canada. Conference Board of Canada; Ottawa, ON. 2005.
9. Booth D, Loy J. Sport, status, and style. Sport History Review. 1999; 30:1–26. https://doi.org/10.1123/shr.30.1.1 PMid:22439214.
10. Donnelly P, Harvey J. Overcoming systemic barriers to access in active living. Report presented to Fitness Branch. Health Canada and Active Living Canada; 1996.
11. Gruneau R. Class or mass: Notes on the democratization of Canadian amateur sport. Gruneau R, Albinson J, editors. Canadian sport: Sociological perspectives. Don Mills, ON: Addison-Wesley; 1976. p. 461–519.
12. Scheerder M, Vanreusel B, Taks M. Statification patterns of active sport involvement of adults. International Review for the Sociology of Sport. 2005; 40:139–62. https://doi.org/10.1177/1012690205057191.
13. Wilson T. The paradox of social class and sports involvement: The roles of cultural and economic capital. International Review for the Sociology of Sport. 2002; 37:5–16. https://doi.org/10.1177/1012690202037001001.
14. Estabrooks P, Lee R, Gyurcsik N. Resources for physical activity participation: Does availability and accessibility differ by neighborhood socioeconomic status? Annals of Behavioral Medicine. 2003; 25(2):100–4. https://doi.org/10.1207/S15324796ABM2502_05 PMid:12704011.
15. Kamphuis C, Van Lenthe F, Giskes K, Huisman M, Brug J, Mackenback J. Socioeconomic status, environmental and individual factors, and sports participation. Medicine and Science in Sports and Exercise. 2008; 40:71–81. https://doi.org/10.1249/mss.0b013e318158e467 PMid:18182936.
16. Vertinisky P. Gender relations, women's history and sport history: A decade of changing enquiry, 1983-1993. Journal of Sport History. 1994; 21:1–24, 25–8.
17. Alper, Loretta, King K, Jhally S, Nachem J, Kane MJ, Griffin P, Messner MA. Plaving unfair: The media image of the female athlete. Northampton, MA: Media Education Foundation; 2002.
18. Kumudini RD . Nutritional status of sports women. Indian Streams Research Journal. 2011; 1(V):1–4.
19. Nieman DC. Physical fitness and vegetarian diets: is there a relation? Am J ClinNutr. 1999; 70(3):570s–5s. PMid:10479233.
20. Khanna GL, Lal PR, Kommi K, Chakraborty T. A comparison of a vegetarian and non-vegetarian diet in indian female athletes in relation to exercise performance. Journal of Exercise Science and Physiotherapy. 2006; 2:27–34.
21. Lukaski HC. Micronutrients (magnesium, zinc, and copper): are mineral supplements needed for athletes? Intl J Sport Nutr. 1995; 5:S74–3. https://doi.org/10.1123/ijsn.5.s1.s74 PMid:7550259.
22. Grandjean A. The vegetarian athlete. Phys Sportsmed. 1987; 15:191–4. https://doi.org/10.1080/00913847.1987.11709361 PMid:27463882.
23. Seiler D, Nagel D, Franz H, Hellstern P, Leitzmann C, Jung K. Effects of long-distance running on iron metabolism and hematological parameters. Int J Sports Med. 1989; 10:357–62. https://doi.org/10.1055/s-2007-1024928 PMid:2599724.
24. Nazni P, Vimala S. Nutrition knowledge, attitude and practice of college sportsmen. Asian Journal of Sports Medicine. 2010; 1(2):93–100. https://doi.org/10.5812/asjsm.34866 PMid:22375196 PMCid:PMC3289172.
25. Sandercock GRH, Voss C, Dye L. Associations between habitual school-day breakfast consumption, body mass index, physical activity and cardiorespiratory fitness in English schoolchildren. European Journal of Clinical Nutrition. 2010; 64:1086–92. https://doi.org/10.1038/ejcn.2010.145 PMid:20683459.
26. Meyers A. Undernutrition, hunger and learning in children. Nutr News. 1989; 52:5–7.
27. Pollitt E, Mathews R. Breakfast and cognition: An integrative summary. Am J ClinNutr. 1998; 67:804S–13S. PMid:9537633.
28. Shaw ME. Adolescent breakfast skipping: An Australian study. Adolescence. 1998; 33:851–61. PMid:9886013.
29. Kreider RB, Wilborn CD, Taylor L, Campbell B, Almada AL, Collins R, Cooke M, Earnest CP, Greenwood M, Kalman DS, Kerksick CM, Kleiner SM, Leutholtz B, Lopez H, Lowery LM, Mendel R, Smith, A, Spano M, Wildman R, Willoughby DS, Ziegenfuss TN and Antonio J. ISSN ex-

ercise and sport nutrition review: Research and recommendations. J Int Soc Sports Nutr. 2010; 7:7. https://doi.org/10.1186/1550-2783-7-7 PMid:20181066 PMCid:PMC2853497.
30. Beek VE. Vitamin supplementation and physical exercise performance. Journal of Sport Sciences. 1991; 92:77–9. https://doi.org/10.1080/02640419108729868 PMid:1895365.
31. Jacobson BH, Sobonya C, Ransone J. Nutrition practices and knowledge of college varsity athletes: A follow-up. Journal of Strength and Conditioning Research. 2001; 15:63–8. https://doi.org/10.1519/1533-4287(2001)015<0063:NPAKOC>2.0.CO;2 PMid:11708709.
32. Singh A, Moses FM, Deuster PA. Chronic multivitamin-mineral supplementation does not enhance physical performance. Medicine and Science in Sports and E.
33. Weight LM, Myburgh KH, Noakes TD. Vitamin and mineral supplementation: Effect on the running performance of trained athletes. American Journal of Clinical Nutriti.
34. Telford RD, Catchpole EA, Deakin V, Hahn AG, Plank AW. The effect of 7 to 8 months of vitamin/mineral supplementation on athletic performance. International Journal of Sport Nutrition. 1992; 2:135–53. https://doi.org/10.1123/ijsn.2.2.135 PMid:1299489.
35. Armstrong LE, Costill DL, Fink WJ. Influence of diuretic-induced dehydration on competitive running performance. Med Sci Sports Exerc. 1985; 17:456–61. https://doi.org/10.1249/00005768-198508000-00009 PMid:4033401.
36. Maughan RJ. Fluid and electrolyte loss and replacement in exercise. Journal of Sports Sciences. 1991; 9(special issue):117–42. https://doi.org/10.1080/02640419108729870 PMid:1895359.
37. Sawka MN, Pandolf KB. Effects of body water loss on physiological function and exercise performance. Perpectives in exercise science and sports medicine. Fluid Homeostasis during exercise. Gisolfi CV, Lamb DR, editors. Carmel, IN: Benchmark Press; 1990. p. 1–38.
38. Osterberg KL, Horswill CA, Baker LB. Pregame urine specific gravity and fluid intake by National Basketball Association players during competition. Journal of Athletic Training. 2009; 44(1):53–7. https://doi.org/10.4085/1062-6050-44.1.53 PMid:19180219 PMCid:PMC2629040.
39. Casa DJ, Armstrong LE, Hillman SK, Montain SJ. National athletic trainers' association position statement: Fluid replacement for athletes. Journal of Athletic Training. 2000; 35(2):212–24. PMid:16558633 PMCid:PMC1323420.
40. Nemet D, Eliakim A. Banned performance enhancing ergogenic aids in children and adolescent athletes. Journal of Harefuah. 2007; 146(10):794–9, 812.
41. Beck TW, Housh TJ, Schmidt RJ, Johnson GO, Housh DJ, Coburn JW, Malek MH. The acute effects of a caffeine-containing supplement on strength, muscular endurance, and anaerobic capabilities. J Strength Cond Res. 2006; 20:506–10. https://doi.org/10.1519/00124278-200608000-00008 PMid:16937961.
42. Radjen S, Radjen G, Zivotic-Vanovic M, Radakovic S, Vasiljević N, Stojanovic D. Effect of iron supplementation on maximal oxygen uptake in female athletes, Vojnosanit Pregl. Serbian Journal. 2011; 68(2):130–5. https://doi.org/10.2298/VSP1102130R.
43. Malczewska J, Szczepańska B, Stupnicki R, Sendecki W. The assessment offrequency of iron deficiency in athletes from the transferrin receptor-ferritin index. Int J Sport Nutr Exerc Metab. 2001; 11(1):42–52. https://doi.org/10.1123/ijsnem.11.1.42 PMid:11255135.
44. Alaunyte I, Stojceska V, Plunkett A, Derbyshire E. Dietary iron intervention using a staple food product for improvement of iron status in female runners. J IntSoc Sports Nutr. 2014; 11(1):50. https://doi.org/10.1186/s12970-014-0050-y PMid:25339853 PMCid:PMC4205294.
45. Karamizrak SO , Islegen C, Varol SR, Taskiran Y, Yaman C, Mutaf I, Akgün N. Evaluation of iron metabolism indices and their relation with physical work capacity in athletes. Br J Sports Med. 1996; 30:15–9. https://doi.org/10.1136/bjsm.30.1.15 PMid:8665109 PMCid:PMC1332258.
46. Della Valle DM, Haas JD. Iron supplementation improves energetic efficiency in iron-depleted female rowers. Med Sci Sports Exerc. 2014; 46(6):1204–15. https://doi.org/10.1249/MSS.0000000000000208 PMid:24195864.
47. McClung JP, Karl JP, Cable SJ, Williams KW, Nindl BC, Young AJ, Lieberman HR. Randomized, double-blind, placebo-controlled trial of iron supplementation in female soldiers during military training: Effects on iron status, physical performance, and mood. Am J ClinNutr. 2009; 90(1):124–31. https://doi.org/10.3945/ajcn.2009.27774.