Effect of High Intensity Interval Training on Serum Ferritin and Haematological Parameters in Anaemic Women: A Prospective Randomized Clinical Trial

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Abstract: Purpose of the study: The aim of this study was to examine the impact of high intensity interval training on serum ferritin and other hematological parameters in anemic women. Methods: Forty anemic women using intrauterine device diagnosed as having iron deficiency anemia with age ranged between 20-35 years old and BMI <30 kg/m² allocated to either study group (n=20) treated by high intensity interval training (3 sessions/week) for 8 weeks and iron supplementation or control group (n=20) treated only by iron supplementation. Both groups followed diet rich in iron. Serum ferritin, RBCs, Hb and MCV were measured at baseline and after 8 weeks of intervention. Results: Statistical analysis revealed that there was significant increase (P<0.05) in RBCs, Hb and serum ferritin in the post treatment condition compared with the pretreatment in both groups, while there was significant increase (P<0.05) in MCV in group (A) only. Between subject effect, there was significant increase (P<0.05) in RBCs, MCV, Hb and serum ferritin in favor to group A than group B. Conclusion: high intensity interval exercise can be suggested as an effective management for anemic women.

Key words: Anemia • Hematological Parameters • Serum Ferritin • High Intensity Interval Exercise

INTRODUCTION

Iron deficiency anemia is the most common form of anemia all over the world [1]. Its deleterious effect is due to impaired delivery of oxygen to the tissues [2], with reduction in serum iron which adversely affect cognitive and memory capacity and hence affect quality of life [3]. Decrease iron stores lead to a low red blood cell count (RBCs) [4] which represent approximately 40-45% of the total blood volume and contain hemoglobin (Hb) which constitutes (99%) of the cytosolic protein in mature RBCs [5]. The mean corpuscular volume (MCV) has been used most widely and is a measure of the average size of the RBCs [6].

The most common cause of iron deficiency anemic is excessive menstrual bleeding which can be affected by the usage of intra-uterine device (IUD). Lowe and Prata [7], Which represent an important contraceptive option for millions of women worldwide [8]. However, its main side effect is the heavy vaginal bleeding during menstruation [9], a condition that may result in iron deficiency anemia and in some women, they may need iron supplements and diet rich in iron [10]. Oral iron supplementation which is used in prevention and treatment of iron deficiency has been criticized because of its side effects and increased risk of iron toxicity associated with its usage [11].

High intensity interval training is a repetitions of high intensity work followed by periods of rest or low activity and works on both aerobic and anaerobic systems. Guimaraes et al. [12] During this type of exercise, the body’s energy production system is utilized leading to activation of both aerobic and anerobic energy sources, which is then distributed throughout the body for the duration of the work out period [13]. The effect if interval exercise training on erythrocyte system of the peripheral blood cells, was studied and it was proved that it results in increasing number of red blood cells due to elevation of the oxygen carrying capacity of the blood [12].

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To our knowledge, only a few studies examined the effect of his type of exercise on iron metabolism and other hematological parameters on anaemic women. So, our aim from this study was to examine the therapeutic effect of high intensity interval exercise, on anaemic women, aiming for decreasing side effects of iron supplements and improving their conditions through improving their serum ferritin and other hematological parameters and hence improving their quality of life.

MATERIALS AND METHODS

Participants: 50 anaemic women using intrauterine device aged between 20 and 35 years were recruited to this study in outpatient clinic of obstetric department of Kasr-El-Aini Hospital. The evaluation procedure was explained to each participant. Prior to baseline measurement, 10 women dropped out, 7 of them didn’t follow the inclusion criteria and 3 because they wished to withdraw from the study. Of the remaining women, 40 were recruited for blood examinations. Assessment were done at (1) baseline and (2) after 8 weeks of intervention from [January to November] 2018.

The inclusion criteria were participants aged between 20 and 35 years, body mass index (BMI) <30 kg/m², haemoglobin level ranged from 9.5 to 11g/dl and serum ferritin level <15Mg/L. All anemic women were assignable for randomization, all had iron deficiency anemia and were non-athletes. All participants were free from cardiopulmonary disorders or anemia of other pathological origin. Ahead of enrollement, a full explanation of the treatment protocol was given to each participant to obtain their confidence and informed consent.

Design: This is a randomized controlled trial with blinding of participants and examiners. As participants selected a numbered envelope, which did not let the participant know the group that she would comprise (study or control). Thus the anemic participants were randomized into blocks allocated using a simple –non probability sampling method to either the study group (SG=20) which were treated by high intensity interval exercise (3 times/ wk) for 8 weeks, in addition to iron supplements in the form of ferrous sulphate once daily after the main meal [14], or the control group (CG=20) which were treated only by the same iron supplement once daily after the main meal. Both groups followed the same advices about taking diet rich in iron.

Outcome Measures:
1- primary: serum ferritin
2- secondary: Hemoglobin level (Hb), Red blood cell count (RBCs) and Mean corpuscular volume (MCV)

Assessment: Assessment included detailed medical and gynecological history, body mass, height to calculated body mass index (BMI). A venous blood sample of 5cms was drawn after 12 hours fasting then serum was separated and analyzed using Mindray BC-2800 auto-hematology analyzer. All the biochemical checkup was done for both groups, study and control at (1) baseline and (2) after 8 weeks of intervention.

Intervention: High intensity interval training procedures for training of participants in group A (study group). Electronic Bicycle Ergometer: Biodex LBC, Biodex INC, New York, equipped with electronic break, display screen, adjustable seat, handle bar and foot straps, was used for training. Pulsometer was connected with the electronic bicycle ergometer giving continuous reading of pulse rate throughout the session. The load was determined according to maximum heart rate, calculated as (220-age) each participant was instructed to avoid heavy meal for 2 hours before training. Seat height of the electronic bicycle ergometer was adjusted to a comfortable position and each participant was instructed to perform 5 minutes warming up on the electronic bicycle ergometer with no resistance, high intensity training was performed at (85%- 95%MHR) and interval period at (60% - 75%MHR) [15] for 20 to 30 minutes. Finally, each participant was instructed to perform 5 minutes cooling down with no resistance, with total duration of 30-40 minutes a session performed 3 times / week for 8 weeks.

RESULTS

Statistical Procedures: SPSS for windows, version 23 (SPSS, Inc., Chicago, IL) was used to conduct the statistical analysis. Two independent variables were
Table 1: Demographic characteristics of patients in both groups:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group A</th>
<th>Group B</th>
<th>t-test</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>26.86±3.29</td>
<td>27.13±2.97</td>
<td>-0.233</td>
<td>0.80</td>
</tr>
<tr>
<td>BMI (Kg/m²)</td>
<td>25.84±1.6</td>
<td>26.39±1.76</td>
<td>-0.892</td>
<td>0.4672</td>
</tr>
</tbody>
</table>

*Significant level is set at alpha level <0.05.

Table 2: Descriptive statistics for the all dependent variables for both groups at different training periods

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group A</th>
<th>Group B</th>
<th>Pre</th>
<th>Post</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBCs</td>
<td>3.17±0.24</td>
<td>4.47±0.41</td>
<td>3.2±0.34</td>
<td>3.42±0.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCV</td>
<td>75.66±3.75</td>
<td>87.76±4.65</td>
<td>78.66±3.71</td>
<td>80.1±3.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hb</td>
<td>9.86±0.55</td>
<td>12.73±0.69</td>
<td>10.14±0.53</td>
<td>10.81±0.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serum ferritin</td>
<td>12.62±1.61</td>
<td>19.3±1.55</td>
<td>12.29±1.25</td>
<td>13.14±1.18</td>
<td></td>
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</tr>
</tbody>
</table>

Values of all dependent variables are expressed as mean±SD.

Table 3: Comparison tests for the all dependent variables at both groups

<table>
<thead>
<tr>
<th>p-value</th>
<th>RBCs</th>
<th>MCV</th>
<th>Hb</th>
<th>Serum ferritin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study group</td>
<td>0.0001*</td>
<td>0.0001*</td>
<td>0.0001*</td>
<td>0.003*</td>
</tr>
<tr>
<td>Control group</td>
<td>0.0001*</td>
<td>0.143</td>
<td>0.001*</td>
<td>0.046*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>p-value</th>
<th>RBCs</th>
<th>MCV</th>
<th>Hb</th>
<th>Serum ferritin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre treatment</td>
<td>0.832</td>
<td>0.05</td>
<td>0.157</td>
<td>0.533</td>
</tr>
<tr>
<td>Post treatment</td>
<td>0.0001*</td>
<td>0.0001*</td>
<td>0.0001*</td>
<td>0.0001*</td>
</tr>
</tbody>
</table>

*Significant at the alpha level (p<0.05).

Included in this test. Firstly, the tested group between subject’s factor with two levels; group (A) receiving high intensity interval training (3 sessions / week) for 8 weeks and iron supplementation and group (B) receiving iron supplementation. Secondly, the measuring periods; within subject factor which had two levels (pretreatment and post-treatment). Moreover, this test analysed four involved dependent variables (RBCs, MCV, Hb and serum ferritin). Accordingly, 2x2 Mixed MANOVA test was conducted in the comparison of the tested variables of interest at the determined measuring periods at both groups. The initial alpha level was set at 0.05.

The independent t test revealed that there were no significant differences (p>0.05) in the mean values of age and BMI between both tested groups (Table 1).

Statistical analysis using mixed design MANOVA analyzed forty patients assigned into two equal groups. It revealed that there were significant within subject effect (F = 154.572, p = 0.0001) and treatment*time effect (F = 78.993, p = 0.0001), while there was significant between subject effect (F = 19.408, p = 0.001). Table 2 and 3 present descriptive statistic (mean ± SD) and multiple pairwise comparison tests (Post hoc tests) for the all dependent variables. In the same context regarding within subject effect, the multiple pairwise comparison tests revealed that there was significant increase (p <0.05) in RBCs, Hb and serum ferritin in the post treatment condition compared with the pre treatment in both groups while there was significant increase (p <0.05) in MCV in group A only. Regarding between subject effects multiple pairwise comparisons revealed that there was significant increase (p <0.05) in RBCs, MCV, Hb and serum ferritin in favor to group A than group B.

**DISCUSSION**

Iron deficiency anemia is the most common form of anemia, occurring very frequent in menstruating women and probably underestimated [16]. This study aimed to examine the effect of high intensity interval training on serum ferritin and other hematological parameter in anemic women. This treatment modality was accompanied by iron supplements and diet rich in iron for 8 weeks. The following values were measured for participants in both groups (serum ferritin, Hb, RBCs count and MCV) before the study and after 8 weeks of treatment. Intense exercise has been shown to regulate proliferation and maturation of stem cells [17].

Analysis of the results of the study group showed that there was significant increase (P<0.05) in RBCs, Hb concentration and MCV values after the training program which was in agreement with Dimeo et al. [17] who reported that performing fifty-three-minute exercise bouts at an intensity of 80% of MHR lead to significant increase in MCV values and RBCs count [17].
Furthermore, regarding the MCV values, the results of this study revealed significant increase (P>0.05) in MCV in study group and this came in agreement with Munker et al. [18] who stated that MCV are correspondent to the iron status in the body. So, the significant change in MCV values within the study group may indicate that iron status did not decrease by the exercise program [18].

In agreement with results of our study, Hu and Lin 2012, explained the higher total Hb mass following exercise training, by the alteration of erythropoietin receptor affinity and increased transferring receptor expression in the bone marrow [19]. Also, high intensity interval training tend to increase Hb, red blood cell count in order to try to maintain membrane fluidity during exercise and provide adequate O2 supply to metabolically active cells [20].

In addition, it was stated that intense exercises affect the concentration of several cytokines and hormones that regulate proliferation and maturation of blood stem cells [17]. Furthermore, the enhancement of the process of hematopoiesis in anemic patients, could be explained by the increased production of growth hormone, following exercises training, which may result in increasing in red blood cell production [19].

Results of our study showed significant increase (P>0.05) in serum ferritin level post treatment in favor to study group which was in agreement with previous studies [21-23] however, in contrary to our results, Wilkinson et al. [24] found a reduction in serum ferritin in male cyclists following 6 weeks of high intensity interval training. Also, the reduction in blood ferritin concentration after 32 weeks of Nordic walking training in elderly people was reported by Kortas et al. [25].

Actually, few studies have been run concerning this point of research and further studies are needed to study the impact of this type of training on hematological indices especially in non-trained anaemic women. Based on results of the current study, it could be concluded that high intensity interval training is considered an effective and an appropriate non-pharmacological intervention to improve anemia.

REFERENCES


