Erythrocytes response to aerobic exercises in aging versus young anemic women.

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Anemia is a common public health problem affecting all ages in both developing and developed countries. The present study constructed to observe the response of erythrocytes parameters and fatigue to aerobic exercise in different age anemic women. In a comparative study, forty anaemic women were randomly allocated into two groups (group 1 included 15 old women with mean age (64.07 ± 2.71) and (group 2 included 17 young women with mean age (27.35 ± 2.29). All Patients performed moderate endurance exercise program at a frequency of three times per week for three months. Both groups were similar at the baseline (p>0.05). Results of study showed significant difference of mean values of all variables (p<0.05). But the improvement in Hemoglobin level, Erythrocytes count, Hematocrit was more in group 1 while the improvement in fatigue level was more in group 2 than group (I). Moderate-intensity aerobic exercise is a useful complementary method for management of anemia and improving Erythrocytes parameters and fatigue response, but there was significant different response according to the patient's age.

Keywords: Erythrocytes, fatigue, aerobic exercises, anemic women.

INTRODUCTION

Anemia is defined as a decrease in the total red blood cells (RBCs) amount or hemoglobin level in the blood (Williams and Wilkins, 2006). Anemic patient is always complaining of weakness and easy fatigability (Ferrari et al., 2015). There is direct relationship between hemoglobin levels and both quality of life, and exercise capacity (Jaime et al., 2001). WHO 2001, sets that the prevalence of anemia among people is commonly used through determining the hemoglobin and its cut-off levels according to sex, age and physiological status (Tawfik et al., 2015). In Egypt, Micronutrients deficiencies, particularly anemia, were a public health issue where the incidence of anemia about 40% (Hwalla et al., 2017).

Some previous studies had investigated the
changes of red blood cell (RBC) and platelet biology that might be induced by endurance exercise (Hart, 2013).

There is a temporal relation between the decrease of mitochondrial and skeletal muscle quality, volume and function with aging (Konopka and Nair, 2013).

Generally, exercising regularly is traditionally known to decrease fatigue response (Chang et al., 2005). Aerobic exercise training is accompanied by improving blood parameters (Brun, 2002).

Decreased muscle capability to produce suitable amounts of force or power during continuous contraction is muscle fatigue (Finsterer, 2012). Exercise results in muscle fatigue is known as a reversible loss of muscle contractility during work over time (Gosker and Schols, 2008). Incidence of fatigue relies on variables as duration, type and intensity of exercise and the subject training level (Enoka and Duchateau, 2008). Other factors as age and gender also affect the ability of skeletal muscles contraction and fatigue resistance (Hunter et al., 2004).

There are different methods in the assessment of fatigue depending on the aspects of interest to the individuals being assessed. The Fatigue Severity Scale (FSS) questionnaire particularly addresses whether individuals feel tired after exercise and whether they suffer dysfunction after working out (Oh et al., 2016). The 9-item Fatigue Severity Scale (FSS) is one of the most usually used self-report questionnaires to assess fatigue (Valko et al., 2008).

So, the purpose of this study was to examine whether moderate-intensity aerobic exercise would have an effect on erythrocyte, hemoglobin, hematocrit and fatigue level in old anemic women compared with young anemic women.

MATERIALS AND METHODS

A comparative study was approved by the Ethical Committee of the Faculty of Physical Therapy, Cairo University. Forty sedentary anemic women were recruited from the kerdasa hospital, Giza, Egypt. Approval from all Patients was formally obtained by signing a consent form. Eligibility criteria for participation in this study were: age for young women was (20-30 y) and old women were (60-70 y), BMI ranged between 22.05-29.94 Kg/m², haemoglobin level was below 12 g/dL, erythrocyte count ranged from (3.8-5 Mil/mm), Hematocrit level range (36.0-46.0 %). Patients were assigned randomly to either group 1 or group 2. Group 1 included 20 old women and group 2 included 20 young women. Randomization of patients was done by rolling of a dice by an independent person: group 1 (as the dice revealed an odd number) and group 2 (as the dice revealed an even number). Permutated blocks size of 4 was used to ensure that every patient has an equal chance to be allocated to each group. All Patients practiced moderate endurance exercise program three times per week for three months. Patients underwent complete history taking, including the patient’s name, age, address, and telephone number, followed by the height and weight of each participant recorded from the height and weight scale.

Outcome measure

Primary outcome measures were erythrocytes parameters including hemoglobin, erythrocyte count, and hematocrit level. Blood samples were taken from both groups from the antecubital veins. Samples were assessed after centrifugation and freezing at -20°C. Standardized kits used to assess complete blood picture (SISMEX SE-2100). Automatic ELISSA immunoassay analyzer was used for assessment. Hemoglobin levels were expressed in g/dL while erythrocyte count was expressed in Mil/mm and Hematocrit range was expressed in percentage.

Secondary outcome measure was the fatigue level. It was assessed using Fatigue assessment questionnaire (FSS Questionnaire). Fatigue severity scale is formed of nine items. The patient was asked to choose a suitable answer from a seven choices for each item. Total score of less than 36 suggests that the patient may not be suffering from fatigue. A total score of 36 or more suggests that the patient have fatigue and may need further evaluation by a physician.

Treatment procedure

All Patients performed moderate endurance exercise program using electronic treadmill (Proform 505 CST) at frequency of three times per week for three months. The session consisted of warming up phase of about five minutes followed by conditioning phase of about 20 min of walking/running at moderate intensity (60-75% of HRmax or 12-14 on Borg scale) then cooling down phase about five minutes. Aerobic exercise intensity was determined by two parallel methods (percentage from predicted maximum heart rate and Borg scale). Maximum heart rate was determined using Gulati formula (HRmax = 206 – (0.88 × age))
Sample size calculation
Power analysis was conducted to determine the optimal sample size using G*power software (version 3.1.0). Estimates of the means and standard deviation for the response to fatigue were collected from a preliminary study including ten women who received the same program. The mean values were 54.80 and 45.20, whereas the standard deviation values were 8.14 and 5.97 respectively. Two tailed t-test, alpha level of 0.05, and power of 95%. The analysis created a total sample size of 26 subjects (13 subjects for each group). We recruited 40 subjects to account for the dropout rates.

Statistical analysis
All data are presented as means ± standard deviations. Data analysis was performed by using paired and unpaired t-test respectively to estimate the differences of Hb level, erythrocytes count and HCT within and between groups. Whereas, the differences of response to fatigue, within and between both groups were calculated by using Wilcoxon Signed-rank test and Mann-Whitney U test respectively. P-values less than 0.05 were considered significant for all statistical tests.

RESULTS
A total of 40 anemic women were selected for participation in the present study; there were 17 young women age group with age group between (20-30) years old with a percentage (42.5%) and mean value was (27.35 ± 2.29), and there were 15 women with age group between (60-70) years old with a percentage (37.5%) and mean value was (64.07 ± 2.71). Flow chart was shown in figure 1 and there were eight women withdrawn from the study due to unknown cause and healthy problem. The demographic characteristics of both groups are summarized in table (1).

Table -1-: Demographic characteristics of all participants.

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (n=15)</th>
<th>Group2 (n=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ages(Years)</td>
<td>64.07 ± 2.71</td>
<td>27.35 ± 2.29</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>28.27 ± 1.62</td>
<td>28.06 ± 1.48</td>
</tr>
</tbody>
</table>

BMI: body mass index X: mean  SD: standard deviation

Figure (1): Flowchart of participants
Table 2: Within and between group differences in means and standard deviation of Hb, Erythrocytes, and HCT.

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (n=15)</th>
<th>Group 2 (n=17)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(gm/dl)/Hb</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>10.32± 0.77</td>
<td>10.02±0.76</td>
<td>0.285</td>
</tr>
<tr>
<td>Post</td>
<td>11.95 ± 0.66</td>
<td>11.37± 0.81</td>
<td>0.035</td>
</tr>
<tr>
<td>p-value</td>
<td>0.001</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Erythrocytes (pr cmm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>3.94 ± 0.46</td>
<td>4.03±0.40</td>
<td>0.560</td>
</tr>
<tr>
<td>Post</td>
<td>4.69 ± 0.35</td>
<td>4.42±0.24</td>
<td>0.043</td>
</tr>
<tr>
<td>p-value</td>
<td>0.001</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>Hct(%fl)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>36.20 ± 2.78</td>
<td>34.12±3.54</td>
<td>0.084</td>
</tr>
<tr>
<td>Post</td>
<td>38.67 ± 1.68</td>
<td>35.76±2.31</td>
<td>0.003</td>
</tr>
<tr>
<td>p-value</td>
<td>0.002</td>
<td>0.024</td>
<td></td>
</tr>
</tbody>
</table>

Level of significance at P<0.05. * = significant.
gm/dl: gram/deciliter /Pr mm: Cubic Meter per Minute /%fl: femtoliters

Table 3: Within and between group’s differences in median and inter quartile range of fatigue Score.

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (n=15)M (IQR)</th>
<th>Group 2 (n=17)M (IQR)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-treatment score of fatigue</td>
<td>55 (53 – 63)</td>
<td>52 (42 – 58)</td>
<td>0.087</td>
</tr>
<tr>
<td>Post-treatment score of fatigue</td>
<td>53 (50 – 56)</td>
<td>33 (31 – 36)</td>
<td>0.002</td>
</tr>
<tr>
<td>p-value</td>
<td>0.009*</td>
<td>0.001*</td>
<td></td>
</tr>
</tbody>
</table>

M: Median, IQR: Inter quartile ranges, Significant at p<0.05

Table (2) showed that there were significant differences between pretreatment and post treatment mean values within Group 1 regarding Hb, Erythrocyte and Hct level with p value (0.001, 0.002 and 0.001, respectively). Additionally, there was significant differences between pretreatment and post treatment mean values within Group (I I) regarding Hb level, Erythrocyte and Hct level with p value (0.002*, 0.002 and 0.001, respectively). There were significant differences in post treatment mean values between both Groups (P-value <0.05) regarding all outcome measures of Hb level, Erythrocyte and Hct level as the mean value of Hemoglobin was (11.95 ± 0.66g/dl) in group (I), while it was (11.37 ± 0.81g/dl) in group 2. The mean value of Erythrocytes was (4.69 ± 0.35g/dl) in group (I), while it was (4.42 ± 0.24g/dl) in group 2. The mean value of Hematocrit was (38.67 ± 1.68g/dl) in group (I), while was (35.76 ± 2.31g/dl) in group 2, these result in favor to group(I).

As presented in Table (3) Mann-Whitney U test revealed that there were non-significant differences in the pretreatment values of fatigue score between both groups (P=0.087) However, as regards post treatment values of fatigue score, there was a significant difference between both groups (p=0.002) but in favor of group 2. The Wilcoxon test revealed that there was a statistically significant improvement of fatigue score on comparing between pre and post treatment within Group 1 (P=0.009). And, there was a statistically significant improvement of fatigue score on comparing between pre and post treatment within Group 2 (P=0.001).

Discussion
The present study investigated response of parameters and fatigue to moderate intensity endurance training in old anemic women compared to young anemic women. The results of the study revealed that moderate intensity endurance training had significant effect on hemoglobin level, erythrocytes count, hematocrit level and fatigue response in both group of old and young anemic women but in favor of group 2 which indicated that response of fatigue to aerobic exercise in young women is better than the old women but the response of erythrocyte count, hemoglobin level and hematocrit level to aerobic exercise in old women is better than the young women.

These findings suggest a safe, economical method to improve Hemoglobin level, erythrocytes
count, and hematocrit level and fatigue response in anemic women. Results of study showed a significant difference of mean and standard deviation (SD) values of Hemoglobin, Erythrocyes and Hematocrit values within and between group (A) and group (B) but in favor of group 1 which indicated that response of erythrocyte count to aerobic exercise in old women is better than the young women. In agreement with the present study (El-Lithy et al., 2015), have shown that in young anemic women; hemoglobin, hematocrit, red cell count and platelet count were significantly increased after 3 months of aerobic exercise. Furthermore (Hu and Lin, 2012), demonstrated that endurance training promoted oxygen carrying capacity, possibly by elevating hemoglobin (Hb) level and erythrocyte mass in blood and recommend the exercise training as a favorable, additional, safe and economical intervention to help relieve anemic-related problems. (Mauney et al., 2004) Supported the useful impact of walking as a weight-bearing activity on bone and bone marrow a dynamic tissue, has the capability to detect and adjust to mechanical stimulation of walking by modifying its geometry, mass and structure. This mechanical stimulation had an impact on the blood formation process that happens mainly in the bone marrow. From this, it could be concluded that there is a direct relation between bone tissues and hematopoietic approaches. (Montero D. and Lundby, 2017) in systematic review and meta-analysis explained that so RBCV somewhat increased through exercise training within middle aged and young but not among older subjects due to plasma volume expansion caused by exercise that stimulate the erythropoietic system to promote a new balance into that hematocrit is gently or in part restored to pre-training levels. However, the notice of greater elevation of red blood cells volume than plasma volume post training for 6 weeks suggests that red blood cells volume expansion may be independent of plasma volume. Additionally, for the underlying mechanisms, cardiopulmonary baroreflex dysfunction is related to impaired vascular compliance which may limit the BV expansion with aging induced by exercise. Conversely, previous studies had demonstrated that intensive training led to anemia-like status, called sports anemia, which may be due to an expanded plasma volume and/or increased oxidative damage of erythrocytes (Brun et al., 2010).

In contrast, (Eastwood A. et al., 2012), reported that in untrained adults, VO2max elevated by 11% without increasing the Hb mass after 40 days of exercise and explained that the increment in blood volume was due to the plasma volume expansion rather than the red blood cells proliferation and physical activity duration may not be sufficient to cause changes of Hb mass. Regarding fatigue response, results of the current study were agreeing with (Dimeo et al., 2004), who demonstrated an improvement in fatigue response after aerobic exercise which could be explained by the increases of the oxidative capacity and the maximal oxygen uptake. One of the primary mechanisms for increasing the maximal oxygen uptake is the enhancement of central cardiovascular function (cardiac output). Aerobic exercise provides the greatest impact on both oxygen uptake and carbon dioxide production with significant increase in oxygen delivery to the tissue and carbon dioxide return to the lungs resulting in increase in ventilation. In a pilot study by (Yang and Chen, 2018), it proved the results of this study by performing 12 weeks moderate-intensity aerobic gymnastic exercise and found significantly positive effects on Taiwanese postnatal women’s fatigue in addition to that, fatigue can be relieved after 4 weeks of aerobic gymnastic exercise and the positive effect extends to 12 weeks of practice. The significant differences in the post treatment mean values of response to fatigue between both groups could be attributed to changes with aging, there is an accumulation of changes in a human being over time, encompassing physical, psychological, and social changes (Bowen and Atwood, 2004).

A limitation of the present study was the lack of control group who did not participate in the physical training program.

CONCLUSION
The findings of the present study highlight the significance of aerobic exercises in the treatment of anemic women in different age. It is likely to have been the driving force behind the positive effects on Hb, Erythrocyes, hematocrit levels and fatigue. To draw a definitive conclusion, further researches are still necessary.

CONFLICT OF INTEREST
There is no conflicts of interest.
ACKNOWLEDGEMENT
The authors express their sincere gratitude for all participants and their guardians.

AUTHOR CONTRIBUTIONS
HMM and MMT designed and performed the experiment and also wrote the manuscript and shared in all processing of the study. HEH and SAF shared in selecting the idea of the study, following the cases and data analysis. MAS shared in writing, data collection data analysis and editing. All authors read and approved the final version.

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