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Original Research Article

IMPACT OF AEROBIC EXERCISES ON IRON DEFICIENCY ANEMIA IN GIRLS

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ABSTRACT

Background: Iron deficiency anemia has recently been ranked as the third leading cause worldwide of loss of disability-adjusted life years for women aged from 15 to 44 years.

Objectives: This study was conducted to determine the effect of aerobic exercises on anemia in girls.

Participants and methods: Thirty girls participated in this study, their age ranged from 17 to 22 years. They were divided randomly into two groups equal in number: Study group (group A) performed aerobic exercises in form of bicycling (60-70% of HR_{max}), 30 minutes for each treatment session, for 3 sessions per week, for 12 weeks in addition to iron supplement (Ferro-6) and Control group (group B) received only iron supplement (Ferro-6) for 12 weeks. All participants in both groups (A and B) were assessed pre- and post-treatment through measuring hemoglobin level by blood analysis and scores of total symptoms of anemia by self-administered questionnaire.

Results: The results showed that there was a non-statistical significant difference of Hb level between both groups (A and B) post-treatment, where the p values were (>0.05). Although, the percentage of improvement of Hb level was higher in group (A) (8.58%) than in group (B) (5.23%).There was highly statistical significant decrease in scores of total symptoms of anemia and scores of fatigue in group (A) post-treatment when compared with group (B) where the p values were (< 0.01). Also, the percentage of improvement in the total symptoms of anemia was higher in group (A) (42.9%) than in group (B) (16.7%). The percentage of improvement in scores of fatigue was higher in group (A) (50%).

Conclusion: It could be concluded that adding aerobic exercises to medication has better effect on Hb level and scores of total symptoms of anemia than medication only.

KEY WORDS: aerobic exercises, iron deficiency anemia, girls.

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INTRODUCTION

Anemia describes the condition in which the number of RBCs in the blood is low, or the blood cells have less than the normal amount of hemoglobin. The purpose of the RBCs is to deliver oxygen from the lungs to other parts of the body. The hemoglobin molecule is the functional unit of the RBCs and is a complex protein structure that is inside the RBCs. Even though the RBCs are made within the bone marrow, many other factors are involved in their production. For example, iron is a very important component of the hemoglobin molecule; erythropoietin, a molecule secreted by the kidneys, promotes the

formation of RBCs in the bone marrow [1].

Post-menarche, females are at higher risk of developing iron deficiency because of menstrual losses, and if they do not have an adequate iron intake, this condition can progress to anemia known as iron deficiency anemia (IDA) [2].

Iron deficiency anemia (IDA), referes to decreased concentration of circulating RBCs and hemoglobin level within the blood cells. This leads to decrease in transportation of oxygen to tissues, iron stores and iron dependent oxidative enzymes [3].

One strong risk factor of IDA in developing countries is diet poor in iron rich sources. While, menstrual blood loss is the most important risk factor for IDA in both developing and developed countries [4].

The major cause of anemia and iron deficit in nulliparous women is menstruation. Reduction in serum iron has a negative effect on cognitive and memory capacity. The adverse effects of menstruation are due to the complications which present during pregnancy and anemia [5]. Heavy menstrual bleeding is one of the most important contributing factors to IDA because there was a relation between Hb level and time since menarche. As the time scince menarche increase, the Hb level will decrease leading to development of IDA in menstruating girls [6].

Aerobic exercise is a type of low to moderate intensity physical activity. Aerobic means in presence of oxygen. This oxygen is used to meet demands during exercise via aerobic metabolism. Generally, light to moderate intensity activities that are sufficiently supported by aerobic metabolism can be performed for extended periods of time [7].

Aerobic exercise can change the number of red blood cells and Hb level in several ways. Endurance training may increasethe number of red blood cells and may destruct them in some cases [8].

Exercise training can increase total Hb and red cell mass, which result in enhancing oxygen-carrying capacity. Bone marrow stimulation, including stimulated erythropoiesis with hyperplasia of the hematopoietic bone marrow and improvement of the hematopoietic microenvironment are possible under lying mechanisms of effect of exercise training on Hb and red cell mass [9].

PARTICIPANTS AND METHODS

Subjects: This study was carried out on thirty anemic girls. They were selected from Faculty of Physical Therapy, Cairo University. All participants were given a full explanation of the assessment procedures and informed consent form was signed from each subject before participating in this study.

Inclusion criteria: Thirty girls who were suffering from iron deficiency anemia (hemoglobin level ranged from 8 to 11.5 g/dl and serum ferritin level < 12 µg/l). Their age ranged from 17 to 22 years. Their body mass index ranged from 20 to 25 kg/m^2.

Exclusion criteria: Females with diabetes, cardiopulmonary diseases, kidney disorder, metabolic disorder, menstrual disorders or anemia of other pathological origins other than iron deficiency were excluded from this study. Also, females who had physical impairments preventing them from following the study program were excluded from this study; in addition females who received any medications were excluded.

Randomization: The participants were randomly assigned to group (A) (Aerobic exercises + medication) (n=15) or group (B) (medication only) (n=15) by an independent person who selected blindly from sealed envelopes containing numbers created by a random number generator.

MATERIALS

Bicycle ergometer: Electronic bicycle ergometer (UNIVERSAL, made in New York, USA) equipped with pedals, electronic break, adjustable seat, handle bar, and electronic display screen, also provided with programmable control unit. Its length equal (95cms), height (110cms), and weight (55kgs). The electronic display screen on the frontal part of the bicycle show effort “W” at pedaling and revolution per minute (rpm), time, distance, speed, age, sex, energy consumption (the energy that a person develops during a certain time can be calculated) and pulse rate.

Weight-height scale: It was used to measure weight and height for each subject in both

groups (A and B) before starting the study to calculate the body mass index (BMI).

Self-administered Questionnaire: Self-administrated questionnaire was used to record answers for questions about total symptoms of anemia for each subject in both groups (A and B) before starting the study and after the end of the study as shown in table 1.

Table 1: Total symptoms of anemia

	Symptoms	Scores				
		0	1	2	3	4
1	Fatigue					
2	Dizziness					
3	Shortness of breath					
4	Weakness					
5	Chest pain					
6	(Hands and feet)Coldness					
7	Headaches					
8	Palpitations					
9	Ringing in ears					
10	Restless legs syndrome					
Total score						

METHODS

Evaluating procedures:

Personal data: All data recorded in a recording data sheet.

Estimation of blood hemoglobin level: A blood sample was taken from each subject in both groups (A and B) before and after the treatment at 4th day of menstruation to estimate blood hemoglobin level. This was done two times, before starting the study and after the end of the study. Each subject was asked to lie in half lying position, with well supported back and arms. The antecubital area was cleaned with alcohol. Blood sample was drawn from the antecubital vein from all subjects by disposable sterile syringe by venipuncture to determine the blood hemoglobin level.

Measuring weight and height: The height and weight were measured for each subject in both groups (A and B). Weight-Height scale was calibrated. The female stood on the scale 2 times and the average weight was taken. Weight was measured in the morning not wearing shoes and with the minimum clothing possible (tops and bottoms). Height was measured to the nearest 0.1 cm with the subject standing bare feet, keeping shoulders in a relaxed position, arms hanging freely, and head aligned in horizontal plane. Weight and height were recorded and BMI was calculated according to the formula: BMI = Weight (Kg) / [Height (m)] ^{2}.

Assessment of total symptoms of anemia: The total symptoms of anemia were assessed through a self-administered questionnaire. It was given to each subject in both groups (A and B). A full instruction about the questionnaire was provided for each subject and she was left for enough time to answer all the questions without interfering with her answers. Severity scoring for each symptom:

0 = No symptom.

1= Minimal or slightly apparent.

2= Moderate, awareness of symptom but does not affect the daily routine.

3= A lot, continuously bothered by the symptom and/or unable to carry out the daily routine.

4= Severe, symptom is overwhelming and/or unable to carry out the daily routine.

Treatment procedures:

Study group (group A): Each subject in this group performed moderate intensity aerobic exercises (at a level of 60-70% of HR_{max}) for 30 minutes for each session, 3 sessions per week, for 12 weeks in addition to iron supplement (Ferro-6).

Each subject was instructed about benefits of the aerobic exercise to gain her cooperation.

Vital signs (heart rate, respiratory rate, blood pressure and body temperature) were measured for each subject before starting the exercise program.

Before starting the exercise program, each subject was instructed to wear nonrestrictive light clothes and wear flat shoes to avoid slipping.

Also, each subject was instructed to drink plenty of water to avoid dehydration.

Each subject was instructed to report any symptoms to stop the exercise such as dizziness, headache, chest pain, shortness of breath, overheating, or muscle or joint pain.

Exercise training program on bicycle: Each subject was asked to sit on the adjustable seat of the bicycle ergometer with back erect, eyes look forward, knees bent 45 degrees and both

feet supported on the pedals. Then hold the modified handle bar and then start cycling "pedaling" by her lower extremities. The exercise was performed on bicycle ergometer as the following:

First stage (Warming up(: It was consisted of 5 minutes warming up in the form of pedaling at speed of 60 rpm (revolutions per minute**)** without load.

Second stage (Active stage(: At this stage, the work load was increased until reaching the desired intensity 60% of maximal heart rate which was calculated by the following equation: (Maximal heart rate = 220– age in year). This stage was consisted of 20 minutes pedaling at speed of 60 rpm.

Third stage (Cooling down(: It was consisted of 5 minutes cooling down in the form of pedaling at speed of 60 rpm without load.

Control group (group B): Each subject in this group took only iron supplement (Ferro-6) for 12 weeks.

Statistical analysis: Results were expressed as mean, standard deviation (SD), median (minimum-maximum) or percent. Comparison between mean values of different variables in both groups was performed using unpaired t test while comparison between pre- and post-treatment within the same group was performed using paired t test. Comparison between median values of scale variables in both groups was performed using Mann-Whitney test while comparison between pre- and post-treatment within the same group was performed using Wilcoxon Signed Ranks test. Statistical Package for Social Sciences (SPSS) computer program (version 19 windows) was used for data analysis. P value less than or equal to 0.05 was considered significant and < 0.01 was considered highly significant.

Demographic characteristics of the subjects: Table (2), represents the demographic characteristics of all participants in both groups.

Hemoglobin level: Table (3), represents the Hb level in both groups (A&B). There was a non-statistical significant difference of Hb level between both groups (A and B) pre and post-treatment, where the p values was (>0.05). Although, the percentage of improvement of Hb level was higher in group (A) (8.58%) than in group (B) (5.23%).

Table 2: Mean values and standard deviation of physical characteristics of all participants in both groups(A& B).

Items	Group A	Group B	Comparison	
	Mean ±SD	Mean ±SD	t-value	P-value
Age (yrs)	20.93 ± 1.39	20.13 ± 1.73	1.399	0.173 (NS)
Weight (Kg)	61.67 ± 6.44	61.33 ± 5.31	0.155	0.878 (NS)
Height (cm)	162.67 ± 5.73	164.33 ± 4.67	-0.873	0.390 (NS)
BMI(Kg\m^2)	23.25 ± 1.42	22.67 ± 1.25	1.175	0.250 (NS)

NS: non-significant **SD:** standard deviation

Table 3: Mean values and standard deviation of hemoglobin level of all participants in both groups (A & B).

		Pre-treatment	Post-treatment	T-value	P-value	% of change
		Mean ± SD	Mean ± SD			
Hb level (g/dl)	Group (A)	10.72± 0.70	11.64± 0.84	-4.186	0.001(HS)	8.58%↑
	Group (B)	10.89± 0.64	11-46± 0.57	-4.381	0.001(HS)	5.23%↑
	T value	-0.705	-0.689			
	p value	0.487 (NS)	0.496(NS)			

HS: highly significant **NS:** non-significant **SD**: standard deviation

Scores of total symptoms of anemia and fatigue: Table (4), represents the scores of total symptoms of anemia and scores of fatigue in both groups (A&B). There was highly statistical significant decrease in scores of total symptoms of anemia and scores of fatigue in group (A) post-treatment when compared with group (B) where the p values were (< 0.01). Also, the percentage of change in the total symptoms of anemia was higher in group (A) (42.9%) than in group (B) (16.7%). The percentage of change in scores of fatigue was higher in group (A) (50%).

Table 4: Median values of scores of total symptoms of anemia and fatigue of all participants in both groups (A & B).

		Pre-treatment	Post-treatment	Z-value	P-value	% of change
		Median (min-max)	Median (min-max)			
Scores of total symptoms of anemia	Group (A)	7 (2-13)	4 (1-6)	-3.307	0.0001(HS)	42.9%↓
	Group (B)	6 (3-17)	5 (2-13)	-2.68	0.0007(HS)	16.7%↓
	z value	-1.143	-2.337			
	P value	0.253(NS)	0.019(S)			
Score of fatigue	Group (A)	2 (0-3)	1 (0-1)	-3.153	0.002(HS)	50%↓
	Group(B)	1 (0-3)	1 (0-2)	-2.236	0.0025(S)	0%
	z value	-1.183	-2.923			
	P value	0.237(NS)	0.006(HS)			

S: significant **HS:** Highly significant
NS: non-significant **min:** minimum **max:** maximum

DISCUSSION

The results of the current study revealed that adding aerobic exercise to medication would

improve hemoglobin level and scores of total symptoms of anemia than medication only.

The results of this study agreed with that of Drouin et al., (2006) [10] who found that 7 weeks of moderate intensity aerobic exercise training (walking for 20–45 min, 3–5 times per week, at 50–70% of measured maximum heart rate) increase HCT, Hb, RBC and VO2 peak.

The results of this study agreed with that of Kratz et al., (2006) [11] who revealed that the number of RBCs, Hb and the percentage of HCT increase in 32 runners after completion of the 26.2 mile course.

This study agreed with that of Wasserman et al., (2004) [12] who reported that Hb increase after exercise, primarily due to hemo concentration as fluid shifts intracellular and is also lost during respiration and sweating.

The results of the current study are also come in consistency with Weert et al., (2010) [13] who reported that physical training combined with cognitive-behavioral therapy and physical training alone had significant and more beneficial effects on fatigue compared with no intervention.

The results come also in agreement with Eastwood et al., (2009) [14] who concluded that after 12 months of cycle training with adolescents aged from 11 to15 years, there was no change (<2%) in relative Hb mass.

These results are also consistent with that of Garssen et al., (2004) [15] who concluded that 12-weeks of bicycle exercise training in 20 patients with severe fatigue resulted in decreasing self-reported fatigue scores by 20% ($p = 0.001$). Also, physical fitness, functional outcome, and quality of life were improved.

The result of this study agreed with that of Mostert and Kesselring (2002) [14], who found that after 4 weeks of aerobic exercise training, there was a tendency to less fatigue.

The results are disagreed with that of Eastwood et al., (2012) [17] who reported that there was a non- significant change in relative Hb mass (1.7%) after 40 days of physical activity which comprised of 40 minutes daily of moderate-intensity exercise in previously untrained adults (five males, seven females) their age ranged from 18 to 25 years. This result may be due to small sample of 12 subjects.

The results of this study disagreed with Ramizanpour and Kazemi, (2012) [18] who found that iron supplementation with aerobic exercise (three sessions per week for six weeks), increased the amount of iron, serum ferritin and transferrin while no significant effects were found on hemoglobin, hematocrit and red blood cells. However, in the current study in group (A) who perform aerobic exercise in addition to iron supplement (Ferro-6) and some nutritional advices, there was a highly significant increase in hemoglobin level.

The results of this study disagreed with Mousavizadeh et al., (2009) [19] who found that following 8 weeks of aerobic training (40 min running) at heart rate of 60 to 65% with 16 girls aged from 18 to 22 years, there was a significant decrease in Hb, RBCs and Hct. The difference of the results may be due to the variables such as training period length and economic nutrition.

The results of this study disagreed with that of Schumacher et al., (2002) [20] who conducted a study on the effects of exercise on soluble transferring receptor and other variables of the iron status. 14 subjects were divided into two exercise tests, an incremental running test until exhaustion (test A) and a 45 minute constant speed running test at 70% Vo_2max (test B). The results showed a significant reduction in Hb, HCT, RBC, serum iron, density of transferrin, and serum ferritin. Immediately after exercise, both variables increase as the result of exercise induced hemo concentration. As a reaction to several days of aerobic exercise, plasma volume increases and hemoglobin and packed cell volume decrease on a long term basis. Mairbaurl (2013) [21] reported that the diverging results in the studies on Hb and training are due to the different duration of exercise training. Schmidt and Prommer, (2008) [22] concluded that adjustments of Hb by training are slow, and that a pronounced increase may require several years of training. It could be said that beside the different factors like intensity and duration of exercises, and water which decrease or increase of Hb, RBCs and WBCs, other parameters like energy systems connected to physical activities play an important role.

Therefore, variety of the factors influencing blood factors, induce contradiction in the results of several studies (Pashaei et al., 2012) [23].

CONCLUSION

It could be concluded that adding aerobic exercises to medication has better effect on Hb level and scores of total symptoms of anemia than medication only.

Study limitations: There are some limitations in the present study, the primary limitation was the small sample, and another limitation to our study was that the duration of the treatment.

Conflicts of interest: None

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