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The Effect of Pilates Training on Changes in Hematological Parameters in Women With Breast Cancer

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Introduction: One of the major side effects of chemotherapy is blood cell density reduction and changes in the immune system. The benefits of exercise interventions have been reported for cancer patients. This study aimed to investigate the effect of Pilates training on changes in hematological parameters in women with breast cancer.

Methods: In this randomized controlled trial, 24 women with breast cancer who were referred to health centers therapy and private clinics of Shiraz were selected and divided into two groups: Pilates training and control. The Pilates training group performed exercises for 10 weeks. Each week was compromised of 3 sessions; lasting 60 minutes. The control group performed only their daily activities during this period. Blood sampling and anthropometric measurements were performed before and after the training period. Data were analyzed by independent and dependent t-test.

Results: The results showed that 10 weeks of Pilates training had no significant effect on weight, body mass index, and waist to hip ratio in women with breast cancer. Pilates training had no significant effect on white blood cell count, red blood cells (mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration), hemoglobin, hematocrit, and platelets in women with breast cancer.

Conclusions: It seems that more research is needed to investigate the effects of this type of exercise to achieve their beneficial changes in hematological parameters and the immune system.

INTRODUCTION

Breast cancer is the most common type of cancer among women and is the leading cause of cancer-related disability and mortality worldwide. It is estimated that about 2.1 million new cases of breast cancer have occurred in women worldwide each year [1]. In Iran, more than 70,000 new cases of breast cancer are estimated to occur each year. Iranian women are diagnosed with breast cancer a decade earlier than their counterparts in developed countries. Various factors such as age, premature menstruation, late menopause, family history, obesity or being overweight, physical inactivity, and genetic factors are involved in breast cancer [2]. Despite the increased survival rate, breast cancer is an important event in patients ' life due to the serious side effects of clinical treatments which reduces both the patients' functional capacity and quality of life [3]. Most patients experience a wide range of symptoms and side effects. One of the major side effects of chemotherapy is reduced blood cell density and changes in the immune system [4]. Because chemotherapy drugs strongly

affect the bone marrow, decreased ability to perform daily activities may occur due to anemia; while decreased platelets and white blood cells may cause bleeding or increased susceptibility to infections, respectively [5, 6]. Decreased white blood cells count during chemotherapy is a serious obstacle to further treatment and delays the period of chemotherapy. The success or failure of cancer treatment is almost directly related to the patient's immune system [7]. Also, the high probability of infection (especially nosocomial infections) will require reverse isolation; leading to both increased hospitalization costs and patient mortality rate. In those patients whose granulocyte count is less than 500 per microliter, there is a sharp increase in the incidence of fatal and non-fatal infections. Treatment of anemia can affect the patient's response to cancer treatments and the progression of the disease [8].

Exercise is found to be effective in preventing or reducing the symptoms of cancer and the side effects of cancer treatment [9]. Studies have shown that various exercise interventions (e.g. aerobic exercise or resistance exercise) help improving physical and mental health and quality of life as well as reducing fatigue in patients with cancer [10, 11]. Some studies have emphasized the beneficial physiological effects of Pilates on patients with breast cancer [12-14]. Pilates is a series of special training that affect the body and mind, and in addition to promoting the power of all parts of the body, targets the deepest muscles. This type of exercise is low-cost, healthy, safe, has no side effects, and patients can easily perform it [15]. The growing prevalence of malignancies and the need for their prevention and treatment necessitate the identification and reduction of side effects of cancer treatment. Hematological variables are fundamental for diagnostic, control, and preventive purposes. By evaluating these variables, some abnormalities can be identified. Blood count changes cause many physiological effects in the body, and exercise can affect the improvement, exacerbation, or progression of diseases by affecting these indices. Therefore, it is very important to know how blood parameters are affected by exercise. Accordingly, the present study aims to investigate the effect of Pilates training on hematological parameters changes in women with breast cancer.

METHODS

The present study is a quasi-experimental randomized controlled trial that was performed as a pretest-posttest with a control group. This study was approved by the ethics committee of Iran Islamic Azad University, Marvdasht Branch (IR.MIAU.REC.1396.105). The statistical population of this study was women with breast cancer who were referred to health centers and private clinics of Shiraz and completed the course of chemotherapy. Twenty-four volunteers were selected as the statistical sample. The statistical sample was selected through an invitation in a purposeful and accessible manner. The sample size was obtained; using the following formula with 80% power and 5% curvature level (β=0.1 and α=0.05). The heterogeneity of variance (leads to a higher sample size than the homogeneity of variance) and the standardized value of the effect size was Δ=0.75. The ratio of the two groups' variances was equal to Z=1.5 with the same number of control and case group members. In this formula, α was considered as the first type error (0.05) and β was considered as the second type error (0.02).

Equation 1: $(\sigma_1^2 + \sigma_2^2)\left(Z_{\frac{\alpha}{2}} + Z\beta\right)$

At first, the medical records of patients referred to the Motahari clinic were reviewed. Then, people who completed the chemotherapy stages were invited to participate in Pilates classes. It should be noted that due to the low number of volunteers participating in this study, the duration of the interval between completion of the chemotherapy period and starting the Pilates courses was not the same for all subjects, therefore, no specific time limitation was observed after the end of chemotherapy. Also, some subjects had radiation therapy. At the first session, with the presence of a general surgeon, the research was explained to the volunteers. After completing the questionnaire, a consent form and general information were completed by volunteers. In this questionnaire, the demographic characteristics of subjects such as age, height, and weight were measured. Fasting blood samples were taken and physical composition and demographic characteristics were measured. Subjects were then divided into Pilates training and control groups; based on the table of numbers.

Exercise Training Protocol

Pilates training group performed Pilates exercises for 10 consecutive weeks (3 sessions per week; lasting 60 minutes each session). In the present study, the heart rate had to be increased by about 10 to 20 percent after 5 to 10 minutes of warming. In all sessions, the average heart rate was measured and the training index was calculated. This index indicates the sport type and, if implemented in the range of 42 to 90 units, reduces the risk of chronic diseases and is suitable for people with chronic illnesses [16]. The method for obtaining this index is as follows: 1) determining the maximum heart rate (220-age); 2) calculating the heart rate in each training session; 3) determining the intensity (maximum heart rate/heart rate in each training session); 4) recording the total duration of the exercise; and 5) multiplying the number of step 3 in the number of step 4. After calculating the training index and summing up three sessions per week, the calculated index was supposed to be between 42 to 90. The purpose of the training was to conduct 30 sessions of training concerning the extreme weakness of the trunk, strengthening of the muscles of the hand and arm, and increasing the flexibility in the mentioned area. During the training, static stretching exercises were performed with 4 repetitions for each exercise; lasting at least 10 to 30 seconds. Exercises were performed with 40-60% maximum repetitions and one to three sets, and 8 to 12 repetitions in each set. Exercise sessions were started with standing position by the correct Pilates method, focusing on proper inhalation and exhalation techniques both at the beginning and during the exercises. After warming movements; including warming up of the joints, the muscle strengthening movements were performed with resting intervals. At the end of each session, stretching and cooling exercises were performed [17]. The control group performed only their daily activities during this period.

Sampling Procedures and Measuring of Laboratory Variables

After 48 hours of the tenth week fasting blood samples were taken and the physical composition was measured. About 3mL of blood was taken from the antecubital vein of the left hand at rest and in a sitting position. To prevent the effect of circadian rhythm, both pre and post-exercise blood sampling was performed at a specific time of day (8-9 am). It should be noted that at the end of the study period, 4 subjects from the control group were not present in the post-test. In the present study, the number of red blood cells (RBC), white blood cell (WBC), platelets (PLT), percentage of hematocrit (Hct), the amount of hemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were measured as hematological indicators; using a cell counter.

Statistical Analysis

The Shapiro Wilk test was used to check the normality of the data distribution. To analyze the data, independent and dependent t-test was used to assess differences between groups. All statistical operations were done; using SPSS version 25 and the considered significance level was $P<0.05$.

RESULTS

In Table 1, the mean and standard deviation of age and height in the subjects of Pilates training and control groups are presented. The results of the independent t-test before the intervention showed that there were no significant difference in the number of WBC ($P=0.229$ and $t=1.244$), neutrophils ($P=0.110$ and $t=1.683$), lymphocytes ($P=0.464$ and $t=0.748$), monocytes ($P=0.206$ and $t=-1.311$), and eosinophils ($P=0.106$ and $t=-1.702$) between Pilates training and control groups after 10 weeks. However, in the post-exercise evaluation, the number of basophils in the Pilates training group was significantly lower than the control group ($P=0.042$ and $t=-2.186$) (Table 2).

The results of the dependent t-test showed that there was no significant difference in pre and post-exercise levels of WBC, neutrophils, lymphocytes, monocytes, and basophils between the Pilates and control groups ($P>0.05$). However, the number of eosinophils in the Pilates training group in the post-intervention was significantly lower than the pre-test ($P=0.038$ and $t=2.475$) (Table 2). Independent t-test results showed that there were no significant differences in RBC count, MCV, MCH, and MCHC between Pilates and control groups after 10 weeks ($P>0.05$). Also, the results of the dependent t-test showed that there was no significant difference in pre-test and post-test of RBC, MCV, MCH, and

MCHC in the Pilates and control groups (P>0.05) (Table 3). The results of the independent t-test showed that there were no significant differences in Hb, Hct, and PLT changes between Pilates and control groups after 10 weeks (P>0.05). Also, the results of the dependent t-test showed that there were no significant difference of Hb, Hct, and PLT in pre and post-exercise tests between the Pilates and control groups (P>0.05) (Table 4).

DISCUSSION

The results of the present study showed that 10 weeks of Pilates training do not affect WBC count (neutrophils, lymphocytes, and monocytes) in women with breast cancer. However, basophils and eosinophils were exceptions to these findings. Similarly, Nieman et al., reported that 3 weeks of resistance exercise and walking did not have a significant effect on the number of leukocytes, lymphocytes, neutrophils, and natural killer (NK) cells activity in patients with breast cancer [18]. Accordingly, it is suggested that the type of exercise protocol, intensity, and duration of the activity play an important role in the effect of exercise on the immune system [19]. Therefore, it seems Pilates training of the current study did not have enough

Table 1. The Mean and Standard Deviation of the Anthropometric Characteristics of the Subjects at the Time Before and After the Intervention

	Control Group, mean±SD	Pilates Training, mean±SD	P Value
Age, y	49.10±7.31	49.60±6.30	
Height, cm	155.60±5.42	159.00±5.89	
Weight, Kg			0.09
Pre-exercise	69.90±9.25	67.60±1.10	
Post-exercise	70.50±8.10	65.30±1.32	
Body Mass Index, kg/m²			0.09
Pre-exercise	28.90±4.06	26.60±5.27	
Post-exercise	29.20±3.71	25.70±5.10	
Waist To Hip Ratio, %			0.07
Pre-exercise	0.80±0.04	0.83±0.05	
Post-exercise	0.82±0.05	0.81±0.07	

Table 2. Pre-test and Post-test Levels of White Blood Cells in Pilates and Control Groups With Dependent t-test and Independent t-test

	Pre-Exercise, mean±SD	Post-Exercise, mean±SD	Paired Sample t-test		Independent Sample t-test	
			t Value	P Value	t Value	P Value
White Blood Cells					-1.244	0.229
Pilates Training	4966.6±761.9	5375.0±831.3	-1.806	0.098		
Control	5587.5±780.9	5612.5±1061.5	0.155	0.881		
Neutrophils					1.683	0.110
Pilates Training	51.50±5.70	56.07±8.60	1.906	0.083		
Control	53.08±5.11	52.80±3.22	0.543	0.604		
Lymphocytes					-0.748	0.464
Pilates Training	40.20±7.50	37.70±10.00	-1.806	0.098		
Control	36.08±6.74	37.80±5.64	-0.882	0.407		
Monocytes					-1.311	0.206
Pilates Training	4.58±2.06	3.41±1.78	-1.268	0.231		
Control	4.50±0.75	5.00±2.20	-0.707	0.502		
Eosinophils					-1.702	0.106
Pilates Training	2.88±1.90	1.66±0.86	2.475	0.038		
Control	3.62±1.59	3.50±2.07	0.196	0.850		
Basophils					-2.186	0.042
Pilates Training	2.00±1.15	1.50±1.00	0.522	0.638		
Control	2.20±0.83	2.00±1.00	0.408	0.704		

Table 3. Pre-test and Post-test levels of Red Blood Cells in Pilates and Control Groups With Dependent t-test and Independent t-test

	Pre-Exercise, mean±SD	Post-Exercise, mean±SD	Paired Sample t-test		Independent Sample t-test	
			t Value	P Value	t Value	P Value
Red Blood Cell Count (RBC)					-1.244	0.856
Pilates Training	4.49±0.33	4.49±0.36	1841.017	0.987		
Control	4.63±0.54	4.60±0.58	0.213	0.837		
Mean Globular Volume (MCV)					-1.580	0.569
Pilates Training	85.10±3.62	83.60±5.60	-1.062	0.311		
Control	83.50±5.16	83.10±2.69	0.381	0.715		
Mean Globular Hemoglobin (MCH)					-0.334	0.742
Pilates Training	30.50±3.20	27.70±2.60	-1.936	0.079		
Control	30.20±1.40	29.10±3.30	1.66	0.76		
Mean Globular Hemoglobin Concentration (MCHC)					-1.055	0.305
Pilates Training	33.70±1.42	33.40±1.01	-1.922	0.376		
Control	28.70±3.20	26.70±4.36	-0.319	0.229		

Table 4. Pre-test and Post-test Levels of Hemoglobin, Hematocrit, and Platelets in Pilates and Control Groups With Dependent t-test and Independent t-test

	Pre-Exercise, mean±SD	Post-Exercise, mean±SD	Paired Sample t-test		Independent Sample t-test	
			t Value	P Value	t Value	P Value
Hemoglobin (Hb)					-1.666	0.113
Pilates Training	12.90±0.70	12.50±0.89	1.984	0.073		
Control	12.50±0.70	12.60±0.66	-0.394	0.705		
Hematocrit (Hct)					-1.229	0.235
Pilates Training	38.01±1.98	37.01±1.88	1.605	0.137		
Control	37.40±2.79	37.30±2.78	0.223	0.830		
Platelets (PLT)					-0.869	0.396
Pilates Training	223416.7±49116.6	421833.3±66774.2	-1.044	0.319		
Control	223375.0±33423.4	217375.8±19197.7	0.488	0.641		

intensity and duration to affect hematological parameters. Several mechanisms have been proposed for changes in WBC count. The role of physical activity in oxidative stress, modulation of metabolic hormones by reducing estrogen levels produced by adipose tissue, and reducing contact with carcinogens by improving respiratory function are among these mechanisms. Pilates training can affect the patients' condition by increasing the stimulation of the vagus nerve and subsequently reducing inflammatory cytokines, lowering blood pressure, lowering visceral fat, reducing oxidative stress, and free the mind from negative thoughts [12-14]. However, patients' behavior before blood sampling is an important factor as the cellular and hormonal components of the immune system are affected by diet [20], medication and sleep patterns [21], menopause, body mass index, and hormone receptors [22]. Contrary to the results of our study, in the study of Dimeo et al., the duration of neutropenia and thrombopenia to less than 50,000 per microliter, severity of diarrhea, pain intensity, and length of hospital stay were significantly reduced in the exercise group [23]. Peters et al., reported that 19 weeks of regular moderate-intensity aerobic exercise increased granulocyte counts and decreased lymphocyte and monocyte counts [24]. It seems that the type of exercise is the reason for the opposite results obtained in the present findings. Also, the results of our study showed that 10 weeks of Pilates exercises do not affect RBCs (MCV, MCH, and MCHC), Hb, Hct, and PLT levels in women with breast cancer.

The number of RBCs is closely related to anemia [25]. Some studies showed that aerobic exercise improves the levels of erythrocytes; especially Hb and Hct, in patients with breast cancer during treatment and after chemotherapy [26-28]. However, the results of a study conducted by Dolan et al., showed that regular exercise

training does not prevent the Hb decrease during chemotherapy in patients with breast cancer [29]. Similar to the results of our research, it has been reported that aerobic training has been associated with no significant change in RBCs [30]. The duration and intensity of exercise may be one of the factors affecting the hemoglobin level of patients with breast cancer during chemotherapy. It has been reported that exercise-related humoral and physiological adaptations may lead to an increase in RBC counts; increasing the plasma Hb concentrations [28, 31]. The increase in PLT count during the exercise is related to the release of fresh PLTs from the spleen, bone marrow, and other PLT stores in the body. Exercise-induced epinephrine secretion causes a strong contraction of the spleen, where about one-third of the body's PLTs are made [32]. Long-term exercise activates blood coagulation and fibrinolysis and maintains a delicate balance between blood clot formation and breakdown. The response of PLTs to activity depends on factors such as physiological, nutritional, pharmacological, and even psychological and neurological reasons. Also, many mechanisms such as catecholamines, blood pH, lactic acid, adenosine triphosphate (ATP), and troponin levels in the blood can be considered as effective items in the response of PLT to exercise training. Deep diaphragm breathing during Pilates training increases the amount of energy consumed. Because in addition to active muscles, also respiratory muscles consume energy. On the other hand, the process of delivering oxygen to active muscles is facilitated by deep diaphragm breathing. However, a period longer than 10 weeks of Pilates training could have clearer results. PLTs are produced under stimulating conditions such as physical activity. In general, there is no prohibition for breast cancer patients for Pilate's training. However, physicians are advised to use other effective exercise methods to achieve hematologic benefits for women with breast cancer. One of the limitations of this study is the different adaptation responses of individuals to training and diet. Therefore, it is recommended to consider different exercise protocols with diet control. Also, considering the relationship between stress hormones (cortisol, epinephrine, and norepinephrine) with hematological indicators, it is suggested to evaluate the levels of these indicators following exercise in women with breast cancer in a similar study.

In summary, the results of the present study showed that 10 weeks of Pilates training were not effective on WBC count (neutrophils, lymphocytes, and monocytes), erythrocytes (MCV, MCH, and MCHC), Hb, Hct, and PLTs in women with breast cancer. According to the findings of the present study, it seems that more investigations are needed to determine the effects of this type of exercise to achieve their benefits concerning changes in hematological parameters and the immune system.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

ETHICS APPROVAL

This study was approved by the ethics committee of Islamic Azad University, Marvdasht Branch of Iran (IR.MIAU.REC.1396.105).

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