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Original Article

The Effect of Pilates Training on Isoprostane, Fasting Glucose and Body Composition in Women with Breast Cancer

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Abstract

Introduction: Addressing physical activities is one of the important pillars of the health management of patients with breast cancer. The purpose of this study was to investigate the effect of Pilates training on isoprostane, fasting glucose and body composition in women with breast cancer.

Methods: In this quasi-experimental study, 24 women with breast cancer who referred to health and therapy centers and private clinics of Shiraz were selected and divided into two groups: Pilates training and control. Pilates training group performed exercises for 10 weeks, 3 sessions per week and 60 minutes each session. The control group performed only their daily activities during this period. Blood sampling and physical examination were performed before and after the training period. For statistical analysis of data Kolmogorov- Smirnov, paired sample t-test and independent sample t- tests ($p \leq 0.05$) were used.

Results: The results showed that ten weeks of pilates training had no significant effect on isoprostane ($p=0.35$), weight ($p=0.09$), body mass index ($p=0.09$) and WHR ($p=0.07$) in women with breast cancer. Also, Pilates training had a significant effect on the reduction of fasting glucose ($p=0.03$) in women with breast cancer.

Conclusion: According to the findings of the present study, although 10-week Pilates training are not effective in improving the isoprostane and body composition of women with breast cancer, it can improve the fasting glucose in these patients.

Keywords: Breast Cancer, Pilates Exercise, Isoprostane, Body Composition, Fasting Glucose

Introduction

Breast cancer is the most common type of malignancy and the second leading reason for death from cancer in women (1- 3), whose cause it is not fully understood, but it seems many factors, including reproductive and endocrine factors such as instability, hormonal history and hormone therapy are involved in it. Other factors such as exposure to ionizing radiation, alcohol consumption, high calorie diets, physical inactivity and obesity are also associated with breast cancer (4). Existing evidence also suggests that oxidative stress plays an important role in the development of various cancers, especially breast cancer, in humans (5). Oxidative stress is an imbalance between the production of reactive oxygen species (ROS) or free radicals and antioxidant defense, resulting in excessive ROS production. ROS leads to chromosomal abnormalities, DNA damage, and mutation to disable the tumor suppressor genes or increase the expression of the pro- ancogens. ROS causes damage to adjacent tissues and the formation of vulnerable processes, including carcinogenesis, by increasing the rate of mutation and tumor progression. Cancer cells usually undergo continuous oxidative stress (6). One of the main challenges in the field of redox biology is the identification of a valid non-invasive index for the diagnosis of oxidative stress. There is much evidence that measuring isoprostanes in body fluids such as plasma and urine is a valid approach to assessing oxidative stress in a natural environment (living tissue). Isoprostanes are produced by the non-enzymatic peroxidation process of arachidonic acid in the tissue site and esterified to phospholipids; they are then hydrolyzed by the phospholipase-A2-free form (7). In addition to the valid index of oxidative stress and lipid peroxidation, this biomarker plays a major role in the pathology of many diseases. Isoprostanes belong to oxidative stress indices associated with DNA oxidative damage that have been observed in cancer etiology studies (8). It is estimated that roughly 25 % of cases of cancer in the world are due to overweight and inactive lifestyle (9), therefore a large part of this health problem can be prevented by an active lifestyle. Physical activity can reduce the risk of breast cancer or its rate of relapse, also the survival rate of breast cancer patients increases after regular physical activity (10- 12). Increase (13, 14), decrease (15, 16) and lack of change (17, 18) have been reported in isoprostanes after physical activity in various studies. Physical exercises stimulate antioxidant defense and prevent damage to cellular structures against oxidative stress (19). Because of the negative effects of radicals in cancer, reduction of oxidative stress is appropriate, especially among overweight people and individuals who generally have high oxidative stress (15, 16). Physical activity also increases the number of mitochondria in the muscles and thus enables the body to be more resistant to oxidative stress. As a result, repetition of the exercise will make the body more capable of resisting oxidative stress and thus reducing oxidative stress. This reduction in both cancer cells and surrounding stromal tumors may be useful to prevent tumor progression and metastasis (20, 21). Although the use of isoprostanes as biomarker for lipid peroxidation is more accurate than malondialdehyde, the response of isopropranes to exercise activity in breast cancer has not been reported. Many studies show a positive relationship between physical activity and the risk of breast cancer, however quantitative features such as the effect of type, amount and time of activity on the improvement of the risk of breast cancer may be different. In this regard, the benefits of using Pilates exercise to retrieve breast cancer have been shown (22). Pilates refers to a series of specialized sports exercises that affect the body and mind and, while increasing the strength and resilience of the entire body, targets the deepest muscles of the body. These types of exercises are low-cost, healthy, safe and have no side effects and patients can easily perform their movements (23). Regarding the severity of physical activity, risk reduction has been observed with moderate activity; also, results of studies have shown that physical activity in older ages has a stronger effect on reducing the risk of breast cancer (24). On the other hand, determining the mechanisms through which physical activity can reduce the risk of breast cancer, in addition to identifying pathways for physical activity, also provides evidence for prescribing optimal exercises to reduce the risk of cancer. To develop sports interventions and potential guidelines for solving the problems of cancer survivors, tests are necessary with accurate measurements with medium to long term follow-up; therefore, the aim of this study is to investigate the effect of Pilates training on isoprostane, fasting glucose and body composition in women with breast cancer.

Methods

The statistical population of this study was women with breast cancer who referred to health centers and private clinics of Shiraz and completed the course of chemotherapy. Twenty-four participating volunteers were selected as the statistical sample. At first, the medical records of patients referred to the Motahari clinic were reviewed. Then, people who completed the chemotherapy stages were invited to volunteer 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 the completion of the chemotherapy period was not the same for all subjects, therefore, no specific time limitation was observed after the end of chemotherapy. Also, some subjects also had radiation therapy. At the first session, with the presence of a specialist general medical surgeon, the research was explained to the volunteers. After completing the health questionnaire, a consent form and general information by volunteer subjects, measuring the demographic characteristics of subjects such as age, height and weight was performed. At first, after a fasting night, blood samples as well as measurements of the physical composition and demographic characteristics were taken. Subjects were then divided into two groups of Pilates training and control group. Pilates training group performed pilates exercises for 10 weeks, 3 sessions per week and 60 minutes each session. In the present study, Pilates exercises were selected based on the easy to high intensity, with the weakness of the upper part of the trunk and the limitations of hand movements, and also it was attempted to use moderate-intensity training exercises to plan the exercise to be used. In these exercises, at the end of 5 to 10 minutes of warming, heart rate had to be increased by about 10 to 20 percent, and in all sessions, the average heart rate was measured and the training index was calculated. This index indicates the prescription of the sports activity version 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 (29). The method for obtaining this index is as follows: (1) determining the maximum heart rate (220- age), (2) calculating 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 should be in the range of 42 to 90. The purpose of the training was to conduct 30 sessions of training with regard to the extreme weakness of the trunk, strengthening of the muscles of the hand and arm, and flexibility in the area mentioned. The training started with 10 minutes of warming, and at the end of the warm up, the heart rate increased by 10% to 20%. During the trainings, static stretching exercises with 4 repetitions for each exercise and at least 10 to 30 seconds were performed. Exercises were performed with 40- 60 % maximum repetitions and one to three sets, and with 8 to 12 repetitions and a maximum of 15 repetitions in each set. Exercise sessions were started from the standing position by the correct Pilates method, performing the right inhalation and exhalation practiced by the Pilates exercise method, and emphasized the proper functioning of the correct breathing both at the beginning and during the exercises. After that, the initiation of warming movements, which included warming up of the joints, was performed, and then the muscle strengthening movements were performed with resting intervals. After doing this, the exercises continued. In the end, stretching and cooling exercises were performed at each session in order to advance the exercises and develop more advanced movements that required stronger upper muscle (25) (Table 1). The control group performed only their daily activities during this period. At the end of the tenth week, 48 hours after the last exercise session, the same as the pretest, blood sampling was taken as a fasting night and also the physical composition was measured. In this study, isoprostanes were measured by the method of ELISA, biochemical kits prepared by Bioassay Technology Laboratory Company made in China with Sensitivity: 2.84 ng/L, and glucose was measured by enzymatic method using commercial biochemical kits prepared by *Yasa Teb* Medical Company. 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, so the number of subjects excluded from the study was 4 subjects. For analyze the data, Kolmogorov-Smirnov test, and independent and dependent t-test were used ($p \leq 0.05$).

Results

In Tables 2 and 3, the mean and standard deviation of age and height, as well as the pre-test and post-test levels of the research variables in the subjects of Pilates training and control groups are presented, respectively. After examining the normal distribution of the findings using the Kolmogorov-Smirnov test, Paired sample t-test results showed no significant difference in the changes in isoprostane (t =-0.94, p = 0.35), weight (t = -1.77, p = 0.09), body mass index (t = 0.99, t =-1.79) and waist to hip ratio (t = -1.90, p = 0.07) between Pilates training and control groups after 10 weeks. However, after 10 weeks fasting glucose in the Pilates training group was significantly lower than the pre-test (t = -2.29, p = 0.03) (Table 3). The results of dependent t-test showed that there was no significant difference in pre-test and post-test levels of isoprostane (t = -0.41, p = 0.68), weight (t =-1.80, p = 0.99), body mass index (t = -1.75, p = 0.10) and waist to hip ratio (t=-1.37, p = 0.19) in Pilates training group. However, fasting glucose levels in the post test were significantly decreased compared to the pre-test (t = -2.70, p = 0.02) (Table 3). In addition, the results of dependent t-test showed that there was no significant difference in the pretest and posttest levels of fasting glucose (t = 0.56, p = 0.58), weight (t = 1.03, p = 0.33), body mass index (t = 1.04, p= 0.33) and waist to hip ratio (t =-1.37, p = 0.19) in control group. However, the level of isoprostane in the post test was significantly increased compared to the pre-test (t =1.83, p = 0.10) (Table 3).

Table 1. Details of the training program during the 30 Pilates training sessions

Rest between sets of exercise	Rest between exercises	Number of repetitions	Rest in the whole exercise	Total exercise time	Sessions
10 sec	20 sec.	7-8	20 min.	60 min.	1-10
8 sec.	15 sec.	8-12	15 min.	60 min.	11-20
6 sec.	10 sec.	12-15	10 min.	60 min.	21-30

Table 2. Mean and standard deviation of age and height of subjects in Pilates training and control group

Group Variable	Control (8)	Pilates Training (12)	P
Age (Year)	49.12±7.31	49.66±6.30	0.86
Height (cm)	155.62±5.42	159.00±5.89	0.70

Table 3. Pre-test and post-test levels of isoprostane, fasting glucose, weight, BMI, and waist to hip ratio of Pilates training and control

Variable	Group	Time	Mean ± Standard deviation	Paired sample t-test	Independent sample t-test
Isoprostane (Ng / liter)	Pilates Training	Pretest Posttest	131.50±24.38 127.41±25.67	t=-0.41 p=0.68	t=-0.94 p=0.35
	Control	Pretest Posttest	129.58±24.12 137.31±30.06	t=2.95 p=0.02	
Fasting Glucose (Mg / dl)	Pilates Training	Pretest Posttest	102.08±14.93 91.50±3.42	t=-2.70 p=0.02	t=-2.29 p=0.03
	Control	Pretest Posttest	99.87±24.38 100.75±7.24	t=0.56 p=0.58	
Weight (Kilograms)	Pilates Training	Pretest Posttest	67.68±14.17 65.30±14.32	t=-1.80 p=0.09	t=-1.77 p=0.09
	Control	Pretest Posttest	69.90±9.25 70.55±8.10	t=1.03 p=0.33	
BMI (Weight in kilograms divided by square meter in height)	Pilates Training	Pretest Posttest	26.67±5.27 25.70±5.10	t=-1.75 p=0.10	t=-1.79 p=0.09
	Control	Pretest Posttest	28.92±4.06 29.20±3.71	t=1.04 p=0.33	
Waist to hip ratio (Percent)	Pilates Training	Pretest Posttest	0.83±0.05 0.81±0.07	t=-1.37 p=0.19	t=-1.90 p=0.07
	Control	Pretest Posttest	0.80±0.04 0.82±0.05	t=1.83 p=0.10	

Discussion

The results of this study showed that 10-week Pilates training did not affect isoprostane in women with breast cancer. However, it had a significant effect on fasting glucose in women with breast cancer. Lipid peroxidation, which is the result of the automatic oxidation of unsaturated fatty acids, occurs continuously in the breast tissue (26). Isoprostanes are considered to be the best systemic oxidative stress biomarkers. Breast cancer treatment may involve the production of free radicals that cause oxidative stress and kill cancer cells. However, high levels of free radicals in the body may also have an adverse effect on breast cancer (27). In the same vein, in a recent study, there was an inverse relationship between the levels of urinary output of isoprostanes and the mortality rate among survivors of breast cancer (28). Exercise can reduce the many side effects of cancer treatment including chemotherapy and radiation therapy. Adaptations that result from regular physical exercises in skeletal muscle and red blood cells may improve the body's ability to protect against free radicals (29). Sport exercises have been reported to improve the antioxidant defense system of non-cancerous individuals. In this regard, a significant reduction in isoprostane levels after exercise in non-cancerous subjects has been demonstrated (15, 16, 30). Cancer is a complex genetic disorder that is associated with a variety of causes. Reduction of oxidative stress is the goal of treatment for breast cancer patients who are undergoing hormone therapy. Therefore, sport activity as a non-pharmacological intervention is a suitable method for the treatment of breast cancer. However, the results of this study showed that Pilates exercises did not affect the isoprostane of women with breast cancer. The contradiction in the results of studies can be attributed to differences in exercise interventions (duration, type, and intensity) as well as subjects. For example, running for a long time, pedaling on an ergometer to the point of fatigue, and confrontation to extreme resistance, each of which has its own metabolic needs and which may have different ROS systems production. Also, it may be related to the subjects' physical activity level, sampling time and type of sample (plasma versus urine) and the biomarker measurement method. Different methods have been used to treat patients with breast cancer that can vary according to the severity and intensity of the disease. Since various studies have shown that urinary and plasma levels of isoprostanes can be related to obesity, the underlying condition of the subjects can affect the results obtained following sport exercise. In a study to evaluate the levels of isoprostanes in breast cancer survivors who participated in weight loss intervention, weight loss was shown to reduce the plasma isoprostanes (31). Since the subjects were not obese in the present study, it can be concluded that no significant change in isoprostanes after exercise is expected, however more research is needed to better explain and interpret the results. Moderate Pilates training helps to improve cardiovascular health compared to high intensity or resistance exercises. During this type of exercise, which is known as parasympathetic exercise, heart rate and respiration rate are not significantly increased, but by performing these exercises, stress levels are significantly reduced (32). The body has enough antioxidant reserves to counteract the production of ROS under physiological conditions and during low and moderate exercise. But when the production of ROS is too high, as in high intensity exercise, the imbalance between proxidants and antioxidants may be in favor of the proxidants and may result in disturbances in redox control and signaling or molecular damage (33). The effect of the exercise on the conditions of the redox depends on many factors, such as the type of exercise, the exercise load, as well as the age, sex, and factors associated with the risk and physical condition. Based on findings from sport interventions, it has been proposed that interactions of caloric restriction with physical exercises may be effective in reducing isoprostanes in obese individuals. Since in this study, the diet was not controlled during the exercise intervention period, it may explain no significant change in the levels of isoprostanes. Also, the present study showed that pilates physical exercises had no significant effect on waist to hip ratio in women with breast cancer. There is consistency between this finding and the findings of Matthews *et al.* And McNeely *et al.*, who reported lack of significant effect of physical activity on body weight, body mass index and waist to hip ratio in women with breast cancer (34, 35). Matthews *et al.* used an unmonitored walking program for 12 weeks. However, this finding is not consistent with the findings of Ohira *et al*. and Wilson *et al*. (36, 37). The possible cause of this discrepancy may be related to the type and duration of exercise. The results of this study showed that Pilates trainings reduced fasting glucose in women with breast cancer. This finding is consistent with the results of the study by Nuri *et al.* And Ligibel *et al.* that 15-week combined sport exercises can reduce the level of glucose in breast cancer survivors (38, 39). However, Fairey *et al.* reported that sport exercises on the ergometer for 15 weeks did not have a significant effect on glucose levels in survivors of breast cancer (40), which is not consistent with the present study. Possible mechanisms by which sport exercises in the present study reduce glucose levels include increased glucose transporters in the muscle, increased delivery of glucose to the muscle, and changes in increased tendency of muscles to available glucose. However, the approval of this subject requires more research. Overall, based on limited evidence, to date, more research is needed to explain the response of isoprostane to exercise and its potential role in breast cancer.

Conclusion

In summary, the results of this study showed that 10 weeks Pilates trainings was not effective in improving the isoprostane and body composition of women with breast cancer, however, it could improve the fasting glucose in these patients. According to the findings of the present study, patients with breast cancer can benefit from Pilates trainings along with other therapies. Further advances in research on oxidative stress and the identification of potentially useful responses to exercise may lead to improved conditions for patients with breast cancer.

Ethical issues

Not applicable.

Authors' contributions

All authors equally contributed to the writing and revision of this paper

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