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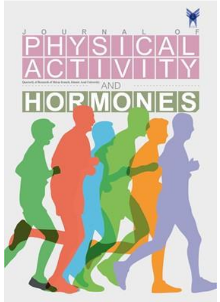

The effect of combined exercise training on Body composition, Upper limb Range of motion, Shoulder pain, and Glucose homeostasis in type II diabetic patients after breast cancer surgery

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Keywords
Breast cancer, diabetes type II, glucose homeostasis, combined exercise exercises, range of motion.

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Abstract

Introduction: The main objective of this study was to evaluate the effect of combined exercise training on body composition index (BMI), upper limb range of motion (ROM), shoulder pain, and glucose homeostasis in type II diabetic patients after breast cancer (BC) surgery.
Material & Methods: The sample of the study included 30 individuals who underwent breast cancer surgery and were divided into two equal groups (n=15): the experimental (EG) and the control group (CG). The EG had resistance exercise training (with Pilates band) and aerobic exercise training with 50%-70% maximum heart rate, and CG had their usual life (n=15). The training sessions were planned as three days per week for 8 weeks. All individuals' BMI, ROM, pain, and glucose homeostasis were evaluated before and after training.
Results: According to the measurements, the study showed that 8-week resistance–endurance exercise significantly reduced BMI (P <0.05). The results also demonstrated a significant reduction in fasting blood sugar, HOMA-ir, and HbA1C in EG (P <0.05). After 8 weeks of exercise, a significant improvement in flexion and extension of the shoulder, and elbow; the internal and external shoulder rotation was observed (P <0.05). However, the pain, weight, WHR, and subcutaneous fat were not significantly changed.
Conclusion: The results of this study showed that 8 weeks of combined resistance- aerobic exercise training can reduce body mass index, and increase the upper limb ROM and glucose homeostasis in women with type II diabetes in BC survivors.

1. Introduction

Breast cancer is the most common malignancy in women and the main cause of morbidity and mortality and its prevalence is increasing. Today, one out of every eight women in the world is at risk of breast cancer. There are 1.67 million new cases of breast cancer in the world each year and 458,000 annual deaths (1). On the other hand, in Iran, 16% of all cancers are related to breast cancer and it ranks first among Iranian women. Breast cancer can be a genetic disease caused by a series of mutations in human genes. In the human body, there are millions of cells with a special order, and disrupting this order destroys tissues and organs and finally death (2). In solid tumors, vascular impairment that results in poor blood supply is an important mechanism of resistance to chemotherapy and also promotes metastasis (3). Tumors lacking adequate oxygen delivery adapt to the resultant hypoxic environment by metabolizing glucose without oxygen (anaerobically) to produce energy. Combining chemotherapy treatment with inhibition of glycolysis would be expected to improve overall therapeutic efficacy (4). In addition, Epidemiological studies demonstrate an association between breast cancer (BC) and systemic dysregulation of glucose metabolism. Insulin resistance (IR) has also been associated with BC incidence and poor survival (5, 6). Minghui et al showed that BC-derived extracellular vesicles (EVs) suppress pancreatic insulin secretion to impair glucose homeostasis. EV-mediated impairment of whole-body glycaemic control may contribute to tumor progression and incidence of type 2 diabetes in some BC patients (7). Taking some drugs directly and indirectly leads to an increase in blood sugar and diabetes. Research has shown that corticosteroids work against insulin and lead to an increase in blood sugar (8). Diabetes mellitus has been associated with increased breast cancer (BC) risk; however, the magnitude of this effect is uncertain. One of the factors that put people with breast cancer at risk of developing diabetes is estrogen resistance in the semi-therapeutic stages. The use of some drugs such as glucocorticoid in the semi-therapeutic stages can increase a person's blood sugar (9).On the other hand, alterations in physical and cognitive function during cancer treatment are pervasive. It is estimated that 25–99% of patients undergoing cancer treatment suffer from cancer-related fatigue (10). Pain is one of the most common side effects of radiotherapy in breast cancer treatment Irradiation of the muscles and connective tissues within the shoulder joint can also lead to the formation of fibrosis and atrophy. Neuropathic pain can also occur following the use of hormonal therapy with aromatase inhibitors. This pain occurs in about 50% of women who survived breast cancer (9). Body composition changes in patients with breast cancer typically occur during menopause or as a result of chemotherapy or endocrine therapy. Dysfunction of visceral adipose tissue (VAT) in the setting of obesity underlies insulin resistance and chronic inflammation, which can lead to breast cancer development and progression. Insulin resistance and chronic inflammation are also observed in patients with breast cancer who have sarcopenia or sarcopenic obesity. A better understanding of the biology of body composition phenotypes is key to determining the best intervention program for patients with breast cancer (2). Many breast cancer survivors experience shoulder and arm dysfunction (11), Shoulder and arm pain, restricted motion, upper-limb weakness, sensory change, and edema are common complaints. Operations and radiation that involve the breast and axilla are routinely performed for the treatment of breast cancer, and these procedures directly involve the neuromusculoskeletal tissues around the shoulder girdle regions. Those injuries as well as post-surgical pain, scar tissue formation, and protective posturing may lead to shortening of the anterior chest wall and could cause changes to the resting alignment of the shoulder girdle, limited ROM of the shoulder, and rotator cuff injury (11).

The failure of prior research to apply the exercise principles may largely explain the heterogeneity observed across study outcomes in various studies (12-14). Despite the well-documented neuromuscular and functional adaptations resulting from strength training, very few studies have, somewhat surprisingly, investigated the effects of strength training in the initial critical phase of breast cancer treatment. Furthermore, the few previous studies that have applied strength training also appear to have applied low to moderate loading intensities (15-17) (Relatively few data are available, from studies aimed at identifying the most effective aerobic training protocol, in terms of exercise modality, timing, and duration, to increase cardiorespiratory fitness and lower the risk of cancer-related mortality (18, 19).

Therefore, the current study aimed to examine if combined exercise impact on BMI, ROM, pain, and glucose homeostasis in breast cancer survivors scheduled for adjuvant treatment. Specifically, it was hypothesized that upper limb ROM and glucose homeostasis, pain, insulin resistance, and BMI would be superior after the intervention in patients receiving combined resistance and endurance exercise as a part of the adjuvant therapy, compared with standard treatment alone.

2. Materials and methods

30 eligible breast cancer (BC) survivors (age 35-65 years) were recruited in this clinical trial study. The eight-week exercise intervention was designed based on combined resistance exercise (elastic Pilates band) and endurance training (60 min, three days per week). Samples were divided into two equal groups: experimental (EG) and control group (CG) Table 1.

Table 1. *A summary of the research method*

Groups	Exam	Intervention	Exam
Experimental (EG)	Pre-test	eight weeks of combined training	Post-exam
Control(CG)	Pre-test	No intervention	Post-exam

2.1. Subjects

Analysis and reporting of this study was following the recommendations of the Consolidated Standards of Reporting Trials (CONSORT) statement. The study was approved by the ethical committee (IR.IAU.RASHT.REC.1396.157), Rasht Branch, Islamic Azad University, and was conducted by adhering to the Declaration of Helsinki. Inclusion criteria for eligibility were the following: woman aged 35–65 years; diagnosed with BC; no evidence of tumor recurrence or metastasis; ≤ 5 years after last anti-cancer treatment (chemotherapy or radiotherapy); BC with type II diabetes mellitus; absence of orthopedic, blood, cardiovascular and liver diseases, not drinking alcohol and smoking, and signing the written informed consent. Subjects were excluded if they presented one or more of the following conditions: unable to perform the exercise sessions due to mobility limitations; treated with beta-blockers. A special health questionnaire was used to find out about the health status of the patients.

The statistical population of this research consisted of 400 women with breast cancer who had been referred to the Iran Radiotherapy Center in Rasht.30 inactive breast cancer survivors (less than 150 min activity in a week) according to the research criteria, volunteered in this study. The volunteers were randomized into two groups: the control group (CG = 15), the control group gave standard treatment, and the combined endurance – Pilates exercise group (EG = 15). Finally, 15 patients from each group managed to complete the research period.

2.2. Measurements

All measurements were done at 8-9 am. The anthropometric characteristics of the subjects were assessed. Height and weight were measured with a digital scale (SOEHNLE, Germany). Waist and hip circumference were measured using a tape measure. It was calculated by dividing the waist circumference by the hip circumference (WHR). Fat percentage and BMI were measured with body composition inbody270 (USA). Patients were asked to refrain from eating heavy food and drinking 3 hours before the test.

2.3. Shoulder Pain assessment

McGill questionnaire was used to measure shoulder pain during movement.

Using the McGill questionnaire, the pain level of the subjects during the movement of the shoulder joint was evaluated. The said questionnaire has 11 items related to pain sensory components (throbbing pain, stabbing pain, stabbing pain, sharp, twisting, tearing, feeling hot and burning, having pain, heaviness, sensitivity, and separation) and emotional components of pain including Excessive fatigue, discomfort, fear, brutality and punishingness of pain were also graded visual criteria of pain and choosing one of 6 criteria of pain intensity (from painless to excruciating), which was completed by asking the studied units.

The questionnaire has 20 items that examine people's perception of pain in terms of sensory perception, emotional perception, evaluation perception, as well as various pains. The items are scored based on the table of pain dimensions. The total score ranges from 0 to 82. This questionnaire was reviewed for use in Iran, and its validity and reliability were confirmed. For example, Noura et al. reported the total Cronbach's alpha of this questionnaire as 0.85, and Cronbach's alpha of all four components above in the Khosravi et al study was 0.80 (20, 21).

2.4. Glucose hemostasis measurement

From each participant, blood venous samples (5ml) were obtained after an overnight (10 to 12 hours) fast before and after the study (at 8:00 a.m.). Plasma fasting blood sugar (FBS) was measured on an autoanalyzer by the Glucokinase method with used Pars Azmoun Kit (Pars Azmoun Co, Tehran, Iran). Hemoglobin A1C (HbA_{1c}) was measured by the Auto analyzer with the biochemical kit of Pishtaz Kit (Pishtaz Teb Co., Tehran, Iran). Serum insulin was measured using ELISA kits (Monobind kit, USA). The homeostasis model assessment for insulin resistance (HOMA-IR) was calculated as follows:

Fasting glucose (mg/dL) × fasting insulin (mU/L) / 405

2.5. Range of motion measurement

We defined shoulder ROM as the range through which the participant could move the shoulder while maintaining a neutral thorax. Measurements were taken with a single plastic universal goniometer (Germany) with the participant positioned supine on a plinth-like platform, using standardized procedures (22) to measure ROM. The range of motion was measured in a supine position to decrease variability related to the placement of the thorax. Active shoulder flexion and extension, as Internal and external rotations (with the shoulder in 90° of abduction) were measured bilaterally, using the unaffected shoulder (measured first) for comparison. Three consecutive measurements were taken in each plane, with trials averaged for the final score.

2.6. Exercise program

EG participated in supervised 60-minute group classes (including 10-minute warm-up and cool-down periods) 3 times per week for 8 weeks led by certified exercise physiologists or fitness trainers. Training sessions started with a 10-minute warm-up consisting of respiratory and mobility exercises. The volume of resistance and aerobic exercise gradually and progressively increased from low to moderate intensity over 4 weeks of training to provide continuous overload and then remained steady for 4 weeks (Table 2). On other days of the week, they were advised to walk for 30 to 60 minutes a day, do breathing exercises, and perform movements that increase the range of motion of the shoulder. A week before the start of the research, the exercise instructor verbally educated the participants about the side effects related to the exercise programs.

In the first four weeks, resistance exercises were performed with a yellow elastic band while standing and sitting on a chair for 20 minutes at an intensity level of 11–12 (i.e. fairly easy to moderate) on the 6 to 20 Borg's rating of perceived exertion (RPE) scale. In the second four weeks, training continued with a red elastic band with an intensity score of 12–13 on Borg's scale (i.e. moderate to severe). These exercises were done with a focus on increasing the lymphatic flow through the effect of continuous muscle contraction on the lymph nodes. Resistance training was also individually supervised and included exercises with elastic bands that involved the major muscle groups (i.e. biceps, triceps, chest, deltoid, back, and abdominal muscles). Participants performed 4–7 exercises per session depending on their perceived fatigue, with 3-5 sets per exercise (3 sets of 9-15 repetitions during weeks 1–4, 5 series of 9-15 repetitions during weeks 5–8, and a rest period of 30-60 second between sets and 30 seconds between exercises. Thus, each participant progressed in training intensity such as to maintain the aforementioned RPE score throughout the 8-week intervention period. After the resistance training, the program of aerobic exercises including treadmill (Turbo 2200, Taiwan), bike, and elliptical exercise training was performed with an intensity of 50-70% of the maximum heart rate. The aerobic component of the session lasted approximately 20 minutes and was divided into three consecutive periods of 5–10 minutes, in which patients could choose to perform individually supervised cycle-ergometer pedaling, treadmill running, or elliptical ergometer exercise. The aerobic exercises (AET) consisted of low-impact aerobic exercises designed to increase heart rate (HR) by working large muscle groups of the lower body. In the first to fourth week of the study, each training session consisted of AET, with a maximum heart rate of 50% to 60% of maximum heart rate (MHR) at an intensity level of 11–12 RPE, and from the fourth to the eighth week, the MHR increased to 60% - 70% at an intensity level of 12–13 RPE. During this time, the daily and normal activities remained constant in the CG.

Table 2. *Summary of the training method*

week	Aerobic exercises			Resistance exercises			
	duration (minutes)	Intensity (percentage of maximum heart rate)	Rest (second)	number of repetitions	set number	Type of movement	Color of band
1-4	20	50-60	30-60	9-15	3	4-7	yellow
4-8	20	60-70	30-60	9-15	5	4-7	red

2.7. Statistical analysis

Data are shown as mean ± standard deviation (SD). The paired and independent t-test was used for within and between-group differences respectively. Shapiro-Wilk test was used to determine the normality of the data distribution. Statistical analysis was done with SPSS statistical software version 21 and P-values less than 0.05 were considered statistically significant.

3. Results

The average age and height of BC survivors were 50.53±7.62 years and 161±5.79 cm respectively. The Shapiro-Wilk test also showed that the research variables had a normal distribution. Table 3 shows the anthropometric variables, table 4 shows glucose homeostasis variables, and Table 5 shows the amount of pain & the upper limb Range of motion of BC survivors.

Table 3. *Anthropometric variables of BC survivors (n=30 in each group)*

variable	group	Pre-test M±SD	Post-test M±SD	Paired t-test
Weight (Kg)	EG	69.66±19.14	67.73±9.66	.153
	CG	67.88±15.23	68.06±15.03	.396
Independent t-test		.697	.08	
BMI(Kg/m^2)	EG	27.13±2.51	26.20±2.46	.001*
	CG	27.54±2.85	27.76±2.87	.123
Independent t-test		.671	.001*	
Subcutaneous fat%	EG	37.30±5.10	36.92±4.96	.007*
	CG	36.90±4.84	36.90±4.90	1.00
Independent t-test		.827	./08	
WHR	EG	.81±.06	.81±.05	.294
	CG	.83±.12	.83±.11	.797
Independent t-test		.308	.308	

EG: Experimental group, CG: control group, BMI: Body mass index, WHR: Waist–hip ratio
* statistics significant P<0.05

The results of Table 3 showed that in the EG, there was a significant decrease in subcutaneous fat percent and body mass index in the post-test compared to the pre-test. The results of the independent t-test showed a significant decrease in BMI in the experimental group compared to the control group in the post-test.

Table 4. *Glucose homeostasis variables of BC survivors (n=30 in each group)*

variable	group	Pre-test M±SD	Post-test M±SD	Paired t-test
FBS(mg/dl)	EG	127.16±12.47	120.06±15.83	.004*
	CG	128.76±10.06	126.76±11.66	./208
Independent t-test		.702	.049*	
Insulin(IU)	EG	5.04±1.82	4.70±1.63	.005
	CG	5.37±1.64	5.36±1.72	1/00
Independent t-test		.604	.024*	
HbA$_{1C}$ (%)	EG	5.92±.59	5.76±.43	.032*
	CG	6.26±.47	6.31±.48	.261
Independent t-test		.477	.013*	
HOMA-Ir	EG	28.30±10.71	25.32±10.42	.001*
	CG	31.07±10.29	30.78±10.68	.66
Independent t-test		.477	.007*	

EG: Experimental group, CG: control group, FBS: fasting Blood Sugar, HbA$_{1C}$: Hemoglobin A1C, HOMA-Ir: Homeostatic Model Assessment for Insulin Resistance
* Statistics significant P<0.05

Compared to the pre-test, the results showed a significant decrease in the HbA1C & HOMA-Ir in the post-test of the experimental group. Also, the results indicated that combined aerobic–resistance exercises were effective on FBS, insulin, HbA$_{1C,}$ and HOMA-Ir in BC survivor women.

Table 5. *The amount of pain & the upper limb Range of motion of BC survivors (n=30 in each group)*

variable	group	Pre-test M±SD	Post-test M±SD	Paired t-test
Pain	EG	32.66±3.39	31.80±2	.103
	CG	33.46±4.89	33.93±5.10	.150
Independent t-test		.607	.58	
Shoulder flection (^{0})	EG	113.85±15.60	141.38±18.31	.001*
	CG	112.42±18.89	112.08±19.07	.057
Independent t-test		.822	.001*	
Shoulder extension (^{0})	EG	119.32±19.67	141.57±19.88	.001*
	CG	119.82±22.70	119.47±22.91	.037*
Independent t-test		.499	.001*	
Shoulder Internal rotation(^{0})	EG	54.77±7.18	64.54±8.13	.001*
	CG	55.44±7.81	55.49±7.59	.637
Independent t-test		.810	.001*	
Shoulder external rotation(^{0})	EG	52.37±6.77	60.80±7.73	.001*
	CG	53.84±6.56	54±6.54	.155
Independent t-test		.551	.001*	
Elbow flection(^{0})	EG	109.45±12.32	123.01±12.59	.001*
	CG	109.92±12.11	110.57±11.89	.301
Independent t-test		.919	.001*	
Elbow extension(^{0})	EG	110.79±13.20	123.54±12.18	.001*
	CG	112.72±12.18	113.30±11.71	.359
Independent t-test		.681	.001*	

EG: Experimental group, CG: control group, (^{0}): degree * statistics significant P<0.05

The results indicated that combined exercises were effective on Upper limb Range of motion, but did not affect pain in BC survivors.

4. Discussion

The purpose of this study was to determine the effect of combined endurance–reistance exercise training on body composition, upper limb range of motion, shoulder pain, and glucose homeostasis in type 2 diabetic patients after breast cancer surgery. Findings of the present study concerning body composition showed a significant decrease in BMI in

EG compared to the CG group. However, this difference in weight, body fat percentage, and WHR was not significant. Brown et al. showed that after 52 weeks, compared with control, diet alone and exercise plus diet reduced body weight; exercise alone did not change body weight. Compared with control, diet alone and exercise plus diet reduced fat mass, and visceral adipose tissue area; exercise alone did not change fat mass and visceral adipose tissue area in Survivors of BC with overweight or obesity (23). On the other hand, the results of another study showed that after 16 weeks of training, in addition to a significant decrease in body mass index in the exercise group compared with baseline and the usual care group, The exercise group experienced significant decreases in body weight and all indicators of adiposity (fat mass, body fat, and trunk fat) compared with baseline and the usual care group in overweight or obese Survivors of BC (24). It is also well documented that over two-thirds of breast cancer survivors are overweight or have obesity(25), Current guidelines advise overweight females to avoid gaining weight and females with obesity to lose weight after treatment to improve breast cancer outcomes(26). Therefore, reducing BMI and percent body fat while maintaining or increasing LBM may have strong clinical benefits.

The present study showed that significant decrease in serum insulin, HOMA-Ir, and HbA1C.The benefit observed in the current study is impressive and parallels the findings of Dieli-Conwright et al. that 16-week exercise training caused significant reductions in all biomarkers, including those that are related to insulin resistance containing glucose, HOMA-ir, and insulin in overweight or obese Survivors of BC (24). D'Alonzo et al. After conducting a randomized controlled trial consisting of four intervention groups comparing the individual and combined effects of exercise and weight loss in breast cancer survivors with excess body weight and lymphedema, concluded that weight loss with or without exercise led to significant reductions in insulin and insulin resistance. They observed decreased insulin, C-peptide, HOMA2-IR, and HOMA2-β levels with a weight loss intervention and a combined weight loss and exercise intervention but did not observe any change in insulin levels or insulin resistance in the exercise group. This study reinforces the current association between markers of insulin resistance and body composition(27). Virto et al. showed that after 12-week combined exercise intervention resulted in a reduction in HbA1c levels, but this change was not associated with changes in body composition(28). Schmidt et al. (2017) reported significant reductions in HbA1c following a 24-week walking training program(29). However, other studies failed to find significant differences in HbA1c values. Guinan et al. (2013) reported no significant change in HbA1c values after 8 weeks of aerobic intervention(30). Moreover, studies that have conducted aerobic interventions of longer duration in cancer patients have also failed to find significant differences in HbA1c levels (31, 32). One of the reasons that could explain the significant reductions in HbA1c values could be that the training sessions were supervised. Thus, interventions that were not fully supervised failed to find significant differences. Another reason that could partially explain the different results obtained would be the mode of training, as most of the studies that did not find significant differences only included aerobic exercises.

Compared with the control group, the exercise group experienced significant increases in shoulder active range of motion (the mean between-group differences and 95% confidence intervals (CIs) were as follows: shoulder flexion, external rotation, and external rotation.

Significant improvements in upper extremity volitional mobility following participation in combined exercise training have been reported previously in women with BC. The results of the present study are consistent with contemporary literature, including the most recent Cochrane review by McNeely et al,(33) which concludes that exercise results in meaningful improvements in the aforementioned measures of upper extremity functional capacity. Cho et al.(34) suggested that a 10-week, multimodal group intervention including aerobic exercise at 40% to 60% of the maximal heart rate and home-based stretching techniques caused significant changes in shoulder strength and active range of motion compared with the control group. Courneya et al.(15) examined the effects of progressive resistance exercise during concurrent chemotherapy treatment (average of 17 weeks) on muscular strength, reporting associated correlative increases in health-related quality of life. Sweeney et al. showed that a supervised 16-week aerobic and resistance exercise intervention led to significant improvements in upper extremity functional mobility, including active range of motion, strength, and perceived limitations to activity and participation.

Resistance exercise was included in our intervention to elicit an impact on lean mass and glucose metabolism. Aerobic exercise has traditionally been viewed as the main mode of exercise that is effective at reducing waist circumference, fasting glucose, HDL-C, and triglyceride (30, 35, 36). Resistance exercise induces changes in insulin sensitivity by increasing lean body mass, and glucose storage, facilitating glucose clearance from circulation, and reducing the amount of insulin that is required to maintain normal glucose tolerance in obese adults(37). Combined aerobic-resistance exercise decreases metabolic syndrome in dyslipidemic patients (38), and obese postmenopausal females (39), similar to our study. Thus, combining resistance and aerobic exercise may improve metabolic health-related outcomes more than aerobic exercise alone, although no randomized controlled trials have directly addressed this question in survivors of breast cancer. Insulin resistance is associated with increased cancer recurrence and mortality(40), which probably promotes the survival and growth of the remaining cancer cells; thus, the decreases in circulating insulin and HOMA-IR with exercise that was observed in the current study represent an additional mechanism that might translate into survival benefits. Whereas a variety of exercise approaches have been shown to reduce insulin levels in survivors of cancer(41), it is unclear which exercise methodology will provide optimal results. Future studies that evaluate exercise periodization, design, conditioning, and intervention periods on insulin sensitivity are needed to best advise clinical practice and patient care.

Strengths of our study include a focus on high-risk survivors of BC with diabetes type II, inactivity, and overweight/obesity; the comprehensive assessment of insulin resistance and hemostasis; and the randomized controlled trial design. Limitations include possible recruitment bias, a lack of intervention reproducibility with high adherence outside of a supervised setting (eg, home-based or virtually coached exercise interventions), lack of an attention control group, and limited frequency of dietary recall information.

Conclusions

Eight-week endurance resistance exercise effectively improved glucose hemostasis, shoulder function, and BMI following breast cancer treatment in women who were overweight or obese, who were ethnically diverse, and who had breast cancer.

Our findings support eight-week supervised aerobic and resistance exercise as an effective strategy to attenuate glucose homeostasis, and body composition, and effectively improve shoulder function in survivors of BC in females who were overweight or obese. Our findings support the incorporation of supervised clinical exercise programs into breast cancer treatment and survivorship care plans. The results of this research are inconsistent with the research of Burno et al. (2018), and Moraharigan et al. (2016) and consistent regarding fat percentage and weight with Akyol et al (2016) (1). Among the possible reasons for the disparity between the present research and the study of Burno et al., it can be mentioned that the said research was conducted for three months and only aerobic exercises were used every day, similarly, in the study of Murat Akyol et al. aerobic exercises were performed between 40 and 60 minutes.

The present study showed that the subjects' BMI decreased significantly, but other body composition indices did not change significantly. Regarding the studies, it was shown that the effect of six months of aerobic exercise on BMI (body mass index) and body fat percentage in women who exercised has a significant decrease, so that regular moderate to intense aerobic exercise can reduce body fat without reducing calorie intake. It has been shown in numerous studies that a certain volume and intensity are needed to make significant changes in the body composition of a person. Postmenopausal women can reduce body fat and BMI (body mass index), which are important risk factors for breast cancer if they do long-term aerobic activity with moderate intensity for 3 days a week. But if the exercises are not done with the right time and intensity, it is probably not possible to expect significant changes in fat mass and subsequent reduction of other body composition indicators.

There was a significant difference in glycosylated hemoglobin, but this difference was not significant in the insulin resistance index. However, there was a significant change in the insulin resistance index compared to the pre-test in the experimental group. A period of sports training could have a significant effect on the variables of glucose, insulin, and glycosylated hemoglobin, but it was not effective on the index of insulin resistance. These findings contradicted the results of some studies and confirmed some of them. The results of the current research were inconsistent with Barno et al. (2018). One of the possible reasons for the inconsistency of the present results with the research of Barno et al. is that the exercises were performed for three months and only aerobic exercises were used every day.

After 8 weeks of combined training, the range of motion of the subjects showed a significant difference between the experimental group and the control group in the range of motion of shoulder flexion and extension, shoulder internal and external rotation, elbow flexion and extension. The range of motion of shoulder flexion and extension, shoulder internal and external rotation, elbow flexion, and extension of the subjects also improved after 8 weeks of combined training. These findings contradicted the results of some studies and confirmed some of them. The results of this research were consistent with the results of Kias et al. (2018) and contradicted with the results of Foley et al. (2018). In resistance exercises, usually, the movements are accepted through the full range of motion and are done by the body position considering the safety of the athlete. The position of the muscle (toward full ROM) requires that it experience greater lengthening and a certain tensile load, which leads to the uniformity of stimuli caused by the applied load, and requires more forces in the starting position. This can be explained by the fact that a greater range of motion is required for a set of exercises with dumbbells compared to barbells (for example, dumbbell bench press vs. barbell bench press). Therefore, contraction force is exerted through a higher amount of range of motion (higher ROM). Research has shown that muscle activity that involves greater ROM causes more damage to the muscle, thus creating a higher functional stimulus. Of course, the effect of sports training on people with special limitations such as disease, pain, increasing age, etc. requires a long period (7). However, the subjects of this research, had movement restrictions in the upper body due to breast surgery, naturally, 8 weeks of resistance training can create significant changes in the first weeks of training.

There was no significant difference between the two study groups in the pain level of the research subjects after 8 weeks of the mentioned exercises. These findings contradicted the results of some studies and confirmed some of them. The present results were inconsistent with the research of Bruce et al. (2018), and Kias et al. (2018).In Bruce's research, 350 subjects were used, naturally, a larger number of subjects can provide more accurate results. Most of the pains go away immediately after the painful stimulus is removed and the body heals, but sometimes the pain continues despite the removal of the stimuli and the physical improvement of the body; sometimes the pain is increased due to the lack of identifiable conditions, injury or pathology (3). Further research is needed to elucidate if the benefits provided by high-intensity concurrent training are superior to those elicited by moderate-intensity training in breast cancer survivors.

5. Conclusion

The results of this research showed that 8 weeks of combined exercise in women with type 2 diabetes after breast cancer surgery could affect BMI, glucose, insulin, hemoglobin A1C, range of motion of shoulder flexion and extension, shoulder internal and external rotation, flexion and elbow extension is effective But, no significant change was observed in body fat percentage, weight, insulin resistance index, and pain after these combined exercises. Overall, the results of this research showed that 8 weeks of combined exercises can probably be beneficial to body mass index, glucose homeostasis, and upper limb range of motion in women with diabetes after breast cancer surgery.

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Conflict of interests: The authors declare that they have no conflict of interest relating to the publication of this manuscript.

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