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Effects of Yoga on Phase Angle and Quality of Life in Patients with Breast Cancer: A Randomized, Single-Blind, Controlled Trial

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Keywords
Breast cancer · Hatha yoga · Phase angle · Quality of life · Body composition

Abstract
Introduction: Phase angle (PA), a parameter that is obtained from body composition analysis, is an indicator of cellular health status. A lower PA in cancer patients can lead to a decrease in functional status and quality of life (QoL) and increased mortality. Studies have shown that physical activity increases PA. In this study, we aimed to examine the effects of Hatha yoga on PA, body composition, and QoL in patients with breast cancer. ***Methods:*** Thirty-one patients were randomized into the yoga (group 1, $n = 15$) and the control group (group 2, $n = 16$). Hatha yoga was practiced twice a week for 10 weeks in the intervention group. The PA of the patients was assessed using a body analysis instrument, and QoL was evaluated with an EORTC QLQ questionnaire both before treatment and at week 10. ***Results:*** Group 1 had significant improvements in the posttreatment EORTC QLQ functional and global scores ($p < 0.05$). In group 2, a significant improvement was observed in the EORTC QLQ symptom subscale ($p = 0.035$). PA values did not show any improvements in both groups ($p > 0.05$). Comparison of the 2 groups revealed no differences. ***Conclusion:*** Yoga may have beneficial effects on QoL in patients with breast cancer but does not have a significant effect on PA. There is a need for further studies to make a definitive statement.

This study was conducted at the Department of Physical Medicine and Rehabilitation, Ege University Faculty of Medicine.

Auswirkungen von Yoga auf den Phasenwinkel und die Lebensqualität von Patientinnen mit Brustkrebs: Eine randomisierte, kontrollierte Einfachblindstudie

Schlüsselwörter
Brustkrebs · Hatha-Yoga · Phasenwinkel · Lebensqualität · Körperzusammensetzung

Zusammenfassung
Einleitung: Der Phasenwinkel (phase angle, PA), ein Parameter, der bei der Analyse der Körperzusammensetzung bestimmt wird, ist ein Indikator für den Gesundheitszustand der Zellen. Ein niedriger PA-Wert kann bei Krebspatienten zu einem Rückgang des Funktionszustands und der Lebensqualität (quality of life, QoL) sowie zu einer erhöhten Mortalität führen. Studien ergaben, dass körperliche Aktivität einen Anstieg des PA-Werts zur Folge hat. Mit der vorliegenden Studie sollten die Auswirkungen von Hatha-Yoga auf den PA-Wert, die Körperzusammensetzung und die Lebensqualität von Patientinnen mit Brustkrebs untersucht werden. ***Methoden:*** Einunddreißig Patientinnen wurden randomisiert der

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Yoga-Gruppe (Gruppe 1, $n = 15$) und der Kontrollgruppe (Gruppe 2, $n = 16$) zugewiesen. Die Interventionsgruppe praktizierte zweimal wöchentlich Hatha-Yoga für 10 Wochen. Die Bestimmung des PA-Werts erfolgte mithilfe eines Instruments zur Körperanalyse und die Lebensqualität wurde vor der Behandlung sowie 10 Wochen danach anhand eines EORTC-QLQ-Fragebogens bewertet. ***Ergebnisse:*** Gruppe 1 zeigte signifikante Verbesserungen in den nach der Behandlung ermittelten funktionalen und globalen EORTC-QLQ-Scores ($p < 0{,}05$). In Gruppe 2 war eine signifikante Verbesserung bei der Symptom-Subskala des EORTC-QLQ zu beobachten ($p = 0{,}035$). Die PA-Werte zeigten in beiden Gruppen keine Verbesserung ($p > 0{,}05$). Beim Vergleich der beiden Gruppen fanden sich keine Unterschiede. ***Schlussfolgerung:*** Yoga kann sich günstig auf die Lebensqualität von Patientinnen mit Brustkrebs auswirken, hat jedoch keinen signifikanten Effekt auf den PA-Wert. Um eine definitive Aussage treffen zu können, sind weitere Studien erforderlich.

Introduction

Cancer is a growing health problem around the world, with breast cancer being the most common type of cancer seen in women [1]. Patients with breast cancer can experience side effects such as fatigue, loss of appetite, weight loss, depression, pain, and decreased physical performance, some of which are dependent on the course of the disease and treatment methods. These side effects may be detrimental to patients' quality of life (QoL) [2].

It is important to assess the changes in body composition associated with the nutritional status of cancer patients. Body composition analysis is a useful method used to gain information about the clinical outcomes and nutritional status of patients, and there are several methods to evaluate the body composition in these patients [3, 4]. There are pros and cons of each method developed towards this goal. While densitometry calculated with computerized tomography, magnetic resonance imaging techniques, and dual energy X-ray absorptiometry are complex and high-cost methods that are hard to apply in the routine clinical care, phase angle (PA) values obtained with bioimpedance analysis are rapid, low-cost, and easy to apply in the clinical settings [5]. PA is one of the parameters evaluated during a body composition assessment, is an indicator of cellular health status, and is a parameter that also provides a high-level estimate of impaired clinical condition and mortality in the presence of various diseases [6]. In a study by Norman et al. [7], a PA below the reference value (< 3.5°) in cancer patients ($n = 399$) was associated with a deterioration in nutritional and functional status, decreased QoL, and increased mortality.

PA increases in correlation with the muscle and fat cell population in the body [8]. Physical activity also plays a role in the PA value. Dittmar [9] showed that the PA increases significantly with increased physical activity in individuals aged 60–90 years. A lower PA measured by Bioimpedance Analysis (BIA) indicates decreased cell integrity, while a higher PA indicates healthy and intact cell membranes. It is also one of the best indicators of cell membrane function in relation to the ratio between extracellular water and intracellular water. In patients with colorectal and pancreatic cancer, an increased PA has been associated with an increase in physical function, which is undoubtedly related to an increase in QoL [10, 11]. Moreover, it was found that the PA in patients with breast cancer is an independent prognostic indicator and affects survival [12].

The long duration and side effects of cancer treatments, particularly the decreased aerobic capacity, can worsen muscle strength, flexibility, and health-related QoL [13]. For this reason, patients are usually given appropriate exercise programs to counter the above-mentioned situations. Yoga is a comprehensive exercise program that affects the mind and body, promoting proper body position through concentration, relaxation, respiration, and physical exercise [14]. In a high-quality review by Cramer et al. [15], it was reported that patients with breast cancer had improvements in their QoL with a 6- to 12-week yoga program.

In various studies in the literature, PA has been reported to increase with exercise, particularly with resistive forms of exercise. However, to the best of our knowledge, there has to date been no study investigating the effect of yoga on PA in breast cancer patients. Therefore, in the present study, we investigate whether yoga has an effect on PA and QoL in breast cancer patients.

Materials and Methods

This prospective, randomized, single-blind study included patients between the ages of 18 and 70 years, all of which had been diagnosed with breast cancer. All were being followed up in our physical medicine and rehabilitation department, and all had completed their breast cancer treatment (surgery, radiotherapy, chemotherapy) programs. Patients with recurrent or progressive disease, serious cardiac or pulmonary disease, uncontrolled hypertension, infection, cognitive function disorder, psychiatric disease, or musculoskeletal system conditions that would prevent exercise, and those who had taken part in a regular exercise program in the past 6 months, were excluded from the study.

Participants

Based on the previous studies investigating the effects of yoga on patients with breast cancer, it was decided that at least 15 patients were required in each group [15, 16]. A total of 55 patients who applied to our out-patient clinic were evaluated for inclusion-exclusion criteria. Of the 40 patients who were found to be eligible

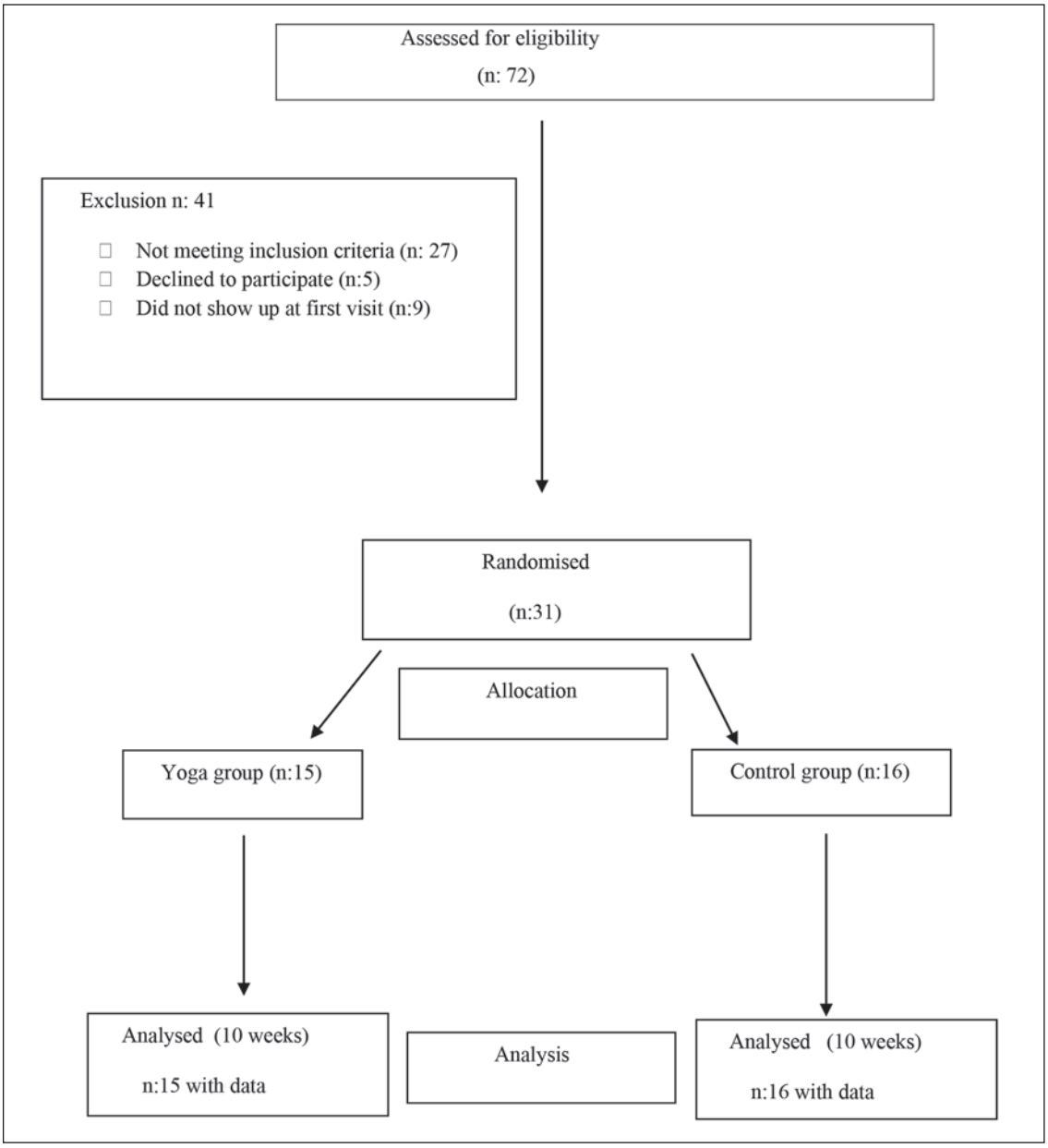

Fig. 1. Study flow chart.

for the study, 9 declined to take part, leaving 31 patients who were included in the study (Fig. 1). The participants were informed on the purpose and length of the study, the methods, the probable side effects, and problems they may encounter throughout the intervention. All those who took part signed a voluntary consent form.

Patients were evaluated immediately before and 10 weeks after treatment. All of the patients in group 1 and 12 of those in group 2 attended their posttreatment visits (Fig. 1). The evaluations were made by a physiatrist who was blind to the patient groups.

Primary Outcome

Phase Angle

PA was evaluated with a Tanita body composition monitor (Tanita Corp., Tokyo, Japan) [17]. Electrodes that send electrical signals from the body to an independent unit were placed on both feet and both hands. Voltages were measured at the top of the thumbs on both hands and both heels. A high-frequency electric current (90 μA at 50 kHz) was applied, and the Resistance (R) and Reactance (xc) values were measured between the hands and feet. Internal software calculated the PA based on the following formula: PA = Reactance (xc)/Resistance (R) × (180/π) [18, 19].

Secondary Outcomes

The European Organization for Research and Treatment of Cancer Quality of Life (EORTC QLQ-C30) Questionnaire

This 30-question survey was conducted to evaluate QoL in patients with breast cancer and assesses any symptoms that occurred in the previous 2 weeks. The questionnaires are divided into 3 scales: global health scale, functional scale, and symptom scale. Higher scores in the functional and global health scales indicate a better QoL, while lower scores on the symptom scale point to a higher level of problems [20].

Table 1. Demographic characteristics of patients

	Yoga group (n = 15)	Control group (n = 16)	p value
Age, years	51.40±10.6	50.7±7.6	0.831
Education level			0.494
Literate to elementary school	2	5	
Middle or high school	1	2	
College	12	9	
Occupation			0.531
Housewife	1	4	
Retiree	9	7	
Officer	4	3	
Employee	0	1	
Other	1	1	
Dominant hand (right)	14	13	0.316
Smoker	1	2	0.714
BMI, kg/m^2	26.0±4.9	24.5±3.4	0.755

Values are means ± SD or n. BMI, body mass index; SD, standard deviation.

Upper-Extremity Lymphedema Evaluation

Patients were also evaluated for lymphedema of the limbs using circumferential and volumetric methods. Circumferential upper limb measurements were carried out with the arm abducted to 30°, starting at the level of the carpometacarpal joint, with 5-cm intervals proximal to this point in both limbs [21].

Interventions

The 31 patients were randomized into 2 groups using a random number table: group 1 – yoga exercise group (n = 15) and group 2 – control group (n = 16). The randomization table and the groups were concealed from the investigators who performed the analyses and measurements. The patients in group 1 practiced Hatha yoga [22] for an hour with a certified trainer 2 days a week for 10 weeks, while the patients in the control group were included in a 10-week follow-up program.

The group 1 patients listened to relaxing music selected for them during their yoga sessions, and at the end of each session, the patients were left in the resting position covered with blankets with their eyelids covered with eye patches containing lavender. This was a beginner-level yoga class, and the patients included in the study had no previous yoga experience.

Each class started with a check-in period during which questions or concerns could be raised, after which the patients were given 5 min for seated meditation and 10 min for *Shavasana* (lying down in a restorative position).

The following poses were instructed during the course: standing poses with mountain pose (*tadasana*), chair pose (*utkatasana*), extended triangle pose (*utthita trikonasana*), extended side angle pose (*utthita parshvakonasana*), warrior 1 (*virabhadrasana 1*), warrior 2 (*virabhadrasana 2*), and tree pose (*vrikshasana*).

Due to the possibility of lymphedema, the chest and poses involving shoulder elevations were given greater emphasis during the yoga class. The included poses were the raised arms pose, arms overhead and parallel (*urdhva hastasana*), cow face pose (*gomukhasana*), bridge pose (*setu bandha sarvangasana*), supine pectoralis muscle stretches on a blanket, and supine twists. Relaxing music was selected for each session. At the end of each session, the patients were covered with a thin blanket while in the rest position, and eye patches with lavender were placed on their eyelids.

All patients (groups 1 and 2) were informed about breast cancer, lymphedema, methods of protection from lymphedema, and daily life activities. All patients were also advised to do regular exercises and exercises designed for lymphedema.

A written consent form was obtained from all participants, and this study was approved by the Institutional Review Board for Ethics (App. No. 14.11/7). This study was retrospectively registered in www.clinicaltrials.gov with the number NCT04692090.

Statistics

Data were analyzed using software SPSS version 20.0. The results of the variables were summarized as means ± SD. The pre- and posttreatment differences for patients undergoing different treatment methods were evaluated using Kruskal-Wallis test. Pearson's χ^2 test was used to assess differences between the treatment methods according to categorical variables. Comparisons between pre- and posttreatment values for continuous variables were done using the paired t test within groups. A p value of < 0.05 was considered significant.

Results

Thirty-one patients completed the trial between May 2015 and November 2015. The demographic characteristics of the patients are presented in Table 1. There was no difference between the groups regarding age, education level, occupation, and body mass index (BMI) ($p > 0.05$). In the baseline assessment, there was also no difference between the groups regarding the operation type, numbers of chemotherapy or radiotherapy sessions, numbers of patients who underwent hormone treatment, duration of hormone treatments, PA values, and EORTC QLQ-C30 scores ($p > 0.05$; Table 2).

Table 2. Clinical characteristics of patients

	Yoga group (n = 15)	Control group (n = 16)	p value
Operation type			0.489
Total mastectomy + AD	7	4	
Modified mastectomy + AD	3	2	
Partial mastectomy + AD	4	5	
Partial mastectomy + SLNB	1	2	
Other	0	3	
CT patients	14	14	1
Number of CT cures	6.2±3.3	4.8±2.4	0.189
RT patients	13	13	1
Number of RT sessions	25.2±10.5	23.2±11.8	0.621
HT patients	9	7	0.479
Duration of HT, months	26.9±27.7	16.6±22.9	0.268
EORTC QLQ-C30			
Functional	74.9±12.1	74.9±12.8	0.981
Symptom	19.3±8.1	26.7±14.5	0.092
Global	56.6±16.7	66.6±15.5	0.095
Phase angle	5.2±0.7	5.2±0.4	0.934
Arm volume, operation site	2,511.5±490.0	2,413.2±423.8	0.910

Values are means ± SD or n. AD, axillary dissection; SLNB, sentinel lymph node biopsy; CT, chemotherapy; RT, radiotherapy; HT, hormonotherapy; SD, standard deviation; EORTC QLQ-C30, The European Organization for Research and Treatment of Cancer Quality of Life Core-30 questionnaire.

Table 3. Comparison of the pretreatment and 10-week follow-up visit variables between groups

Variable	Yoga group (n = 15)			Control group (n = 16)			
	T1	T2	p value[a]	T1	T2	p value[a]	p value[b]
Phase angle	5.2±0.7	5.2±0.5	0.959	5.2±0.4	5.2±0.5	0.935	0.76
Arm volume	2,511.5±490.0	2,413.6±479.7	0.069	2,413.2±423.8	2,408.3±412.8	0.593	0.11
BMI	26.0±4.9	25.7±4.5	0.108	25.6±3.7	24.7±3.5	0.259	0.13

Values are means ± SD. SD, standard deviation; BMI, body mass index; T1, pretreatment evaluation; T2, posttreatment evaluation. [a] Within groups. [b] Pretreatment and posttreatment differences between groups.

Phase Angle

The 10-week evaluation of the yoga and control groups revealed no significant improvements in PA values (p = 0.959, p = 0.935, respectively; Table 3), and no significant difference was noted between the groups in terms of their PA values (p = 0.76; Table 3).

Arm Volume and BMI

The 10-week evaluation of the yoga and control groups revealed no significant improvements in arm volume and BMI values (p = 0.069, p = 0.593; and p = 0.108, p = 0.259, respectively; Table 3), and no significant difference was found between the groups in terms of their arm volume and BMI values (Table 3).

EORTC QLQ-C30

A significant increase was observed in the EORTC QLQ functional and global scores in the yoga group after treatment when compared to the pretreatment scores (p = 0.007, p = 0.032, respectively). In the control group, a significant improvement was noted in the symptom subgroup (p = 0.035; Table 4). A comparison between the groups revealed no statistically significant differences for the subgroups of the EORTC QLQ-C30 assessed at the end of week 10 (Table 4).

Adverse Events

None of the patients reported an adverse event during the course of the study, and yoga is considered a safe intervention, similar to reports in previous studies [23].

Table 4. Comparison of the pretreatment and 10-week follow-up visit variables of quality of life between groups

Variable	Yoga group (n = 15)			Control group (n = 16)			
	T1	T2	p value[a]	T1	T2	p value[a]	p value[b]
EORTC QLQ-C30-F	74.9±12.1	82.4±5.5	0.007*	74.9±12.8	81.4±9.2	0.121	0.99
EORTC QLQ-C30-S	19.3±8.1	17.2±7.3	0.267	26.7±14.5	17.7±8.9	0.035*	0.24
EORTC QLQ-C30-G	56.6±16.7	68.3±20.6	0.032*	66.6±15.5	69.7±20.7	0.692	0.13

Values are means ± SD. SD, standard deviation; EORTC QLQ-C30, The European Organization for Research and Treatment of Cancer Quality of Life Core-30 questionnaire; F, functional; S, Symptom; G, Global; T1, pretreatment evaluation; T2, posttreatment evaluation. [a] Within groups. [b] Pretreatment and posttreatment differences between groups. * $p < 0.05$.

Discussion

Our study has shown that yoga treatment has no effect on PA in patients with breast cancer when compared to the control group but has a positive effect on QoL. Furthermore, no increase was noted in the arm volume of the patients following yoga treatment.

PA can be an important tool in the evaluation of the clinical outcome or the progression of the disease and can even be superior to other nutritional, biochemical, or anthropometric indicators. Studies have shown that patients have a lower PA than healthy individuals, scaling with the severity of the condition [24]. This may aid the estimation of prognosis (mortality, disease progression, postoperative complications, hospital stay) and can facilitate the diagnostic process in some diseases (pancreas, colorectal, breast, and lung cancer, HIV, cirrhosis, renal failure, sepsis). It has been shown that the PA in cancer patients is an important predictor of malnutrition and disease severity [24].

Studies have also shown that PA is affected by physical activity [25, 26]. A review of studies analyzing the effects of exercise on PA found that such studies are focused mainly on resistive exercises. In a recent study by Souza et al. [27] involving older adults, participants were found to have increased PA values after the application of a 12-week constant-load method resistive training program. Similarly, a study by Ribeiro et al. [28] investigating the effects of a hypertrophy-type resistance training protocol on PA in young adult men (n = 28) and women (n = 31) identified a significant increase in PA values following a 16-week progressive resistance training program involving both men and women, with no significant difference noted between the sexes in PA values ($p < 0.05$). In another study including 33 older women, after taking part in a 12-week resistive training program, participants had an increase in PA values during the training periods, and the values decreased after detraining periods [29]. However, a recent randomized controlled trial including postmenopausal women determined that isoflavone supplementation plus combined aerobic and resistance exercise did not change PA values [30].

In the present study, we sought to investigate whether yoga improved PA values in patients. Recently, yoga has been shown to have positive effects on QoL, fatigue, sleep problems, and emotional state in patients with breast cancer. We used Hatha yoga, which is a branch of yoga. Hatha focuses on general well-being through *pranayamas* (breathing control exercises), *asanas* (yoga postures), and *chanda* (meditation). In our study, we found that yoga did not affect PA; however, the result may be due to the short duration of the yoga period. To the best of our knowledge, this is the first randomized controlled study to compare the effects of yoga on PA in breast cancer patients, so it is not possible to make comparisons with the previous literature.

There have been a few studies in the literature investigating the effect of yoga on body composition [31–33]. Yoga involves physical activity but differs from purely gymnastic exercise in that the practitioner focuses his/her mind on specific postures with inner awareness and a meditative focus of the mind [34, 35]. A study by Tran et al. [31] including 10 healthy volunteers investigated the effects of Hatha yoga on body composition. The participants practiced yoga 4 days a week for 8 weeks but were reported to have no significant improvement in body composition at the end of the study. Previous yoga studies, calculating body composition by measuring skin layer thickness, also garnered mixed results. Madhavi et al. [32] showed that 3 months of yoga training led to a significant reduction in percent body fat, while Prasad et al. [33] reported a significant reduction in blood lipid values in a group of 64 healthy individuals who had undergone 3 months of yoga training. Conversely, Gharote and Ganguly [36] observed an increase in percent body fat after 9 weeks of yoga practice. These contradictory results may be attributed to differences in yoga training programs, the intensity of exercises, duration of yoga studies, and lack

of nutritional data from the 3 reports. In our study, the yoga exercise program was applied for 10 weeks, twice a week, and so it can be said that this program, which was carried out for 10 weeks and included 2 sessions per week, was not long enough to bring about a notable change in body composition. Thus, no significant change was observed in BMI and arm volumes of the patients, which are indirect indicators of body composition. An intervention that aims to change these indicators may also have a beneficial effect on PA. Increases in physical activity and muscle mass may also improve PA values. A combination of yoga exercises with a strict dietary control may show the potential benefits that could not be shown in this study. Moreover, studies with a higher number of participants can show smaller changes we could not show in this study.

As survival increases with the modern treatment options available to patients with breast cancer, health-related QoL becomes a more important issue [37, 38]. Exercise training was shown to be beneficial on QoL during and after cancer treatment in patients with breast cancer by many studies [39–41]. Recent randomized controlled trials focusing on yoga programs showed improvements in the QoL of patients with breast cancer [42–44]. A recently published Cochrane review that evaluated 24 randomized controlled trials (n = 2,166 female patients) provided evidence in favor of yoga in comparison to no treatment for QoL [45]. In a previous study that included 42 breast cancer patients, a significant improvement in QoL was observed in EORTC scores following 10 weeks of yoga training [46]. Similarly, in the present study, the patients' QoL was assessed by way of the EORTC, and it was found that both functional and global scores in the yoga group improved significantly after treatment when compared to the scores before treatment. Significant improvement was also noted in the symptom subgroup of the control group. This result may have been due to the fact that we were instructing all patients to do regular exercises and exercises for lymphedema while giving education to all patients. Although they did not reach statistical significance, it should be noted that the EORTC global and symptom scores were different between the groups at the beginning, which may have affected the outcome. While our findings were not contradictory with the previous literature on QoL, these differences imply that the results should be carefully interpreted.

The present study has some limitations, one of which is related to the duration of yoga exercise, as longer exercise periods could be more effective in reflecting the benefits of yoga. Another limitation was the relatively small group of patients involved in the study. Besides, the study also has several strengths, being the first to investigate the effects of yoga on PA values in breast cancer patients. Although no effect on PA was detected, the results of the present study may guide further studies exploring this subject. Furthermore, the investigated effect might be better observed in future studies with a longer period and with a larger number of patients. The adherence to the yoga program was seen to be excellent. It is also important to note that the training was not video-based and was performed in a class environment instead.

Conclusion

In recent years, PA has been identified in the literature as a prognostic indicator of breast cancer. One of the advantages of PA measurement is that it is noninvasive and easy, and for this reason, methods that can improve PA values could potentially lead to improved survival rates in patients with breast cancer. Exercise is known to be one such method. A small number of studies in the literature have reported that resistive exercises increase the PA of individuals, and it was the intention here to investigate whether or not yoga had any effect on PA in breast cancer patients. In conclusion, a 10-week yoga training program created no significant effect of yoga on PA but, on the other hand, did induce improvement in QoL.

Statement of Ethics

All procedures performed in this study were conducted under the ethical standards of the institution with approval and in accordance with the 1964 Helsinki Declaration and its later amendments. Informed consent was obtained from all individual participants included in the study. This study was approved by the Institutional Review Board for Ethics (App No. 14.11/7).

Conflict of Interest Statement

None of the authors declare any conflicts of interest.

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Author Contributions

S.E. and H.Y.: investigation, methodology, writing, review and editing. S.A.: investigation, conceptualization, writing. G.T. and D.H.B.: investigation, acquisition of data.

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