ORIGINAL PAPER

Physiotherapy Quarterly (ISSN 2544-4395)
2023, 31(2), 14–20

The relationship between lymphedema, posture, respiratory functions, exercise capacity, and the quality of life after breast cancer treatment

DOI: https://doi.org/10.5114/pq.2023.112271

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Abstract

Introduction. To evaluate the relationship between lymphedema, posture, respiratory functions, exercise capacity, and the quality of life after breast cancer treatment.

Methods. This cross-sectional study consisted of 38 women who had unilateral breast cancer treatment. Pulmonary function with a spirometer, functional exercise capacity via a six-minute walk test, postural alignment changes, and quality of life were evaluated. Circumferential measurements were used to determine the severity of lymphedema.

Results. The median age of the female participants was 53 years (range 40–64). The mean body mass index was 26.66 ± 2.96 kg/m^2, of which 76% had lymphedema. The expected changes in posture were moderate. The mean of the 6-minute walking distance decreased, corresponding to 58.55% of normative values. MIP and MEP values were significantly lower than the expected values. An intermediate negative correlation was observed between postural changes and body mass index ($r = -0.348$; $p = 0.05$). Moreover, there was a positive correlation between forced expiration volume and forced vital capacity values, and walking distance ($p < 0.05$).

Conclusions. After breast cancer treatment, 76% of the female patients had lymphedema; the functional exercise capacity, MIP and MEP, were below the expected values. As functional capacity decreased, respiratory parameters were affected negatively.

Key words: breast cancer, spirometric tests, posture, exercise capacity

Introduction

Breast cancer is one of the most common types of cancer. Although it is more common after age 30 worldwide, it is seen in one in eight women [1]. The primary treatment method for breast cancer is a surgical operation to remove cancer from the area and control the condition's stage. Surgical procedure is generally combined with targeted treatment methods such as radiotherapy, hormone therapy, and chemotherapy, optimizing local control and survival [2]. However, with these applications, different complications such as pain, shoulder problems, fatigue, cachexia, respiratory problems (decrease in the expansion of the rib cage), nerve damage, infection, and lymphedema may occur, which negatively affect body structure and reduce the functional exercise capacity [3–5].

Lymphedema is characterized by increased extremity volume with proteins and liquids in the interstitial space. Breast cancer–related lymphedema (BCRL) is the most widely recognized type of lymphedema in the World. It might happen months to years following breast cancer treatment (BCT). The women who experience lymphedema have to live with a range of problems, including changed sensation in the limb, loss of body self-reliance, reduced functional mobility, tiredness, psychosomatic distress, and a general decline in the quality of life (QoL) [6]. Axillary lymph node dissection and adjuvant radiation therapy have a greater risk.

There is limited data about the effects of BCT on body posture. Still, recent articles indicate that BCT, especially surgical operations, can have destructive results on body composition and the musculoskeletal system, such as changes in spinal alignment and increased thoracic kyphosis [7].

Patients with clinically stable breast cancer are remote from treatment interventions, possible contributors to decreased respiratory function and exercise intolerance with the results of the underlying condition, the side effects of the treatments (chemotherapy and / or radiotherapy), and deconditioning effects due to decreased physical activity. Some researchers have stated the significance of deconditioning and reduced functional capacity in breast cancer survivors, although the part of pulmonary deficiency, especially respiratory muscle strength, remains unknown [8, 9].

BCT could lead to a dramatic decrease in the QoL of patients, especially in the physical and emotional functioning components. Reliance on others for help with everyday activities and a negative self-perception identified with lymphedema can affect their mental, social, and sexual prosperity and diminish their QoL [10].

This study aims to determine the relationship between the severity of lymphedema, posture, respiratory function, functional exercise capacity, and QoL after BCT.

Subjects and methods

The study design was cross-sectional. This study was performed on 38 women with breast cancer. They were evaluated at the Department of Physical Therapy between Oc-

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Received: 30.11.2020
Accepted: 01.03.2021

Citation: Kutlu E, Ergin G, Alptuğ B, Karadibak D. The relationship between lymphedema, posture, respiratory functions, exercise capacity, and the quality of life after breast cancer treatment. Physiother Quart. 2023;31(2):14–20; doi: https://doi.org/10.5114/pq.2023.112271.

tober 2018 and March 2019. Necessary descriptions were made for the participants who gave informed consent. This study was conducted with the approval of the local ethics committee, with informed consent gained from each individual.

Inclusion criteria were: (a) diagnosed with unilateral breast cancer and at least one-year post-treatment, (b) female, and (c) a volunteer. Exclusion criteria were: the (a) presence of known cardiopulmonary chronic disease, (b) underwent an operation that could affect posture and / or movement systems before BCT and / or the presence of chronic musculoskeletal, neurological, and / or cardiopulmonary problems, (c) underwent an operation of the upper extremity before BCT, and / or the presence of a chronic musculoskeletal disorder in the upper limb, (d) the presence of infection in the affected side, and (e) the presence of metastatic disease.

Data collection

Sociodemographic and clinical characteristics (age, BMI, education status, smoker / alcohol user, exercise habit, dominant and affected side, radiation / chemo / hormone therapy, surgery type, time after surgery, and comorbidities) of all participants were obtained in face-to-face meetings with the participants and from their medical records.

Circumference measurement

Circumference measurement was used to assess the severity of lymphedema. Half an hour before the assessment, the participants rested supine with 60° arm elevation. Next, the arm was placed at 30° abduction. The circumference was measured in this position with a tape measure. Measurements with 5 cm intervals started from the styloid process of the ulna and continued for 40 cm proximally for both limbs. Frustum Formula was used to calculate volume [11]. The severity of lymphedema was identified by comparing bilateral limb volume and classified as 'mild' if it was ≤ 250 ml, 'moderate' if between 250 and 500 ml, and 'severe' if it > 500 ml [11].

$$V = [h \times (C_1^2 + C_1 \cdot C_2 + C_2^2)] / (4 \times л) \text{ [11]}$$

where: V – the volume of each conical segment, h – the interval between circumference measurement, C_1 – base perimeter measurement of the conical segment, C_2 – top perimeter measurement of the conical segment, h = 5 cm. For ease of calculation, л = 3 was used [11].

New York Posture Rating chart

The New York Posture Rating (NYPR) was used to evaluate posture. During the evaluation, attention was paid to ensuring the participants wore suitable attire for the analysis. For correct rating, the patients were placed in front of a specially designed posture paper suitable for individuals of all ages. For documentation, the assessor took photographs in the anterior, posterior, and lateral (right-left) views. Posterior view segments (head, shoulders, spine, hips, feet, and arches) and lateral view segments (neck, rib cage, shoulders, back, hips, and abdomen) in the NYPR were scored. Each segment had its scores; 5 (correct posture), 3 (slight deviation), to 1 (problematic posture). The total score was between 13–65 points. A higher score represents better postural alignment [12].

Spirometric tests

Spirometric tests were used as an objective assessment of respiratory functions. Lung capacity and respiratory muscle strength were assessed according to the criteria of the American Thoracic Society. Tests were carried out with a Cosmed Pony Fx pulmonary function test. During the assessment, participants were asked to sit with their arms crossed, with clips on their noses [13].

Assessments were conducted with the filter within the disposable mouthpiece. Evaluation of lung capacity started with normal breathing, continued with deep inspirations, and ended with a strong and long expiration from the participant. For the first second, the values of forced expiration volume (FEV1) and forced vital capacity (FVC) were recorded. The best values were recorded after repeating the assessments three times [13].

For maximal inspiratory pressure (MIP), the nose of the participant was first closed with a clip; after the forced expiration, maximal inspiration was recorded. The length and MEP were recorded after the deep inspiration for maximal expiratory pressure (MEP). The tests were repeated three times, and the best value was documented [13]. To calculate the expected values [14];

For the female participants:

- age 20–54; MIP = 100 – (age × 0.39) and MEP = = 158 – (age × 0.18)
- age 55–86; MIP = 122 – (age × 0.79) and MEP = = 210 – (age × 1.14)

Six-minute walk test

The six-minute walk test (6MWT) is a submaximal test used to determine functional exercise capacity. A physiotherapist conducted the test. Closed flat corridors 30–100 m in length (at 3 m intervals) were used for the test. Blood pressure, oxygen saturation, pulse, and fatigue were assessed before and after the trial [15]. The modified Borg scale (MBS) assessed dyspnoea and fatigue [16]. Participants were allowed to rest during the experiment before the time ran out but should continue walking until the end. The distance was measured (in meters) at the end of the test [15]. To calculate expected values [17]:

For women participants, 6MWD = (2.11 × height cm) – (2.29 × weight kg) – (5.78 × age) + 667 m.

Short Form 36

Short Form 36 (SF-36) was used to evaluate QoL. SF-36 is a 36-item scale related to a general concept of health, not a specific condition. The questionnaire has eight sub-dimensions: physical functioning (PF), physical role functioning (PRF), emotional role functioning (ERF), bodily pain (BP), social functioning (SF), mental health (MH), vitality (V), and general health (GH). Each sub-dimension scores between 0 and 100. QoL is associated with high scores [18].

Sample size

Breast cancer ranks first with 37% among the most common types of cancer in women in North Cyprus [19]. Based on this, the minimum sample size for the study was calculated as 38 women for the probability, and the statistical power level as 95% using G*Power Software (Version 3.1.9.2, Düsseldorf University, Düsseldorf, Germany).

Statistical analysis

Statistical Package for Social Sciences (SPSS) software was used for statistical analysis. Descriptive statistics used for physical measurements included circumference measurement (volume) and BMI values, NYPR, SF-36, 6MWT, and spirometric tests. Frequency analysis was used to determine the distribution of the participants according to their sociodemographic characteristics and breast cancer histories.

The compliance of the data obtained in the study with the normal distribution was analysed using the Shapiro–Wilk test. It was determined that the data did not correspond to the normal distribution, so nonparametric hypothesis tests were used. The Wilcoxon test was used to compare the circumference (volume) of the participants' affected and non-affected sides. A Spearman test was used to analyse the relationship between the circumference measurement values of participants between the BMI, NYPR, SF-36, and spirometry findings. According to Fleiss et al. [20], if the correlation coefficient was < 0.40, it was considered low; if it was between 0.40–0.75, medium; and if it was > 0.75, high.

Table 1. Characteristics of the participants (n = 38)

Age (years) (mean ± *SD*)		53 ± 6.17
BMI (kg/m^2)	mean ± *SD*	27.36 ± 4.59
	normal (%)	26.32
	preobese (%)	60.53
	obese (%)	13.16
Education status	PE (%)	21.05
	HS (%)	44.74
	undergrad / grad	34.21
Smoker / Alcohol user	yes (%)	36.84
	no (%)	63.16
Alcohol user	yes (%)	13.16
	no (%)	86.84
Exercise habit	yes (%)	65.79
	no (%)	34.21
Dominant / Affected side	right (%)	76.32 / 26.32
	left (%)	23.68 / 73.68
Comorbidity	DM / HT (%)	10.5 / 36.8
Treatments (RT / CT / HT)	yes (%)	94.74 / 34.21 / 97.37
	no (%)	5.26 / 65.79 / 2.63
Surgery type	lumpectomy (%)	63.16
	TM (%)	13.16
	MRM (%)	23.69
Time after surgery (years)	≤ 2 (%)	28.95
	3–5 (%)	50
	≥ 5 (%)	21.05

BMI – body mass index, PE – primary education, HS – high school, undergrad / grad – undergraduate / graduate, DM – diabetes mellitus, HT – hypertension, CT – chemotherapy, RT – radiotherapy, TM – total mastectomy, MRM – modified radical mastectomy

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the ethics council of the European University of Lefke (approval No.: ÜEK/30/01/02/1819/04).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

At the beginning of the study, we had 40 participants, but two withdrew from the research due to not completing the tests. The data obtained from 38 women with breast cancer were analysed. The findings regarding the distribution of the sociodemographic characteristics of the participants assessed in this study are given in Table 1 and Table 2.

When the circumference measurement of the participants was evaluated, it was determined that 76% of them had lymphedema (Table 2).

Table 2. Outcomes of the participants

Variables	
The severity of lymphedema (%)	
None	24
Mild	10
Moderate	58
Severe	8
Total lymphedema	76
Spirometric test (mean ± *SD*)	
FEV1 / FVC (%)	88.76 ± 11.45
FEV1 (l/s)	77.82 ± 10.98
FVC (l)	80.16 ± 11.26
MIP (cm H_2O)	50.47 ± 12.70
MEP (cm H_2O)	52.21 ± 8.82
Functional exercise capacity (mean ± *SD*)	
6MWT (m)	317.63 ± 51.59
Quality of life – SF-36 (mean ± *SD*)	
Physical functioning (score)	86.18 ± 11.05
Role physical (score)	75.66 ± 34.13
Bodily pain (score)	65.64 ± 20.27
General health (score)	71.18 ± 13.23
Vitality (score)	72.37 ± 12.07
Social functioning (score)	67.43 ± 18.73
Role emotional (score)	87.74 ± 31.39
Mental health (score)	73.82 ± 12.32
Posture (mean ± *SD*)	
NYPR (score)	45.42 ± 6.56

FEV1 – the first second of forced expiration volume, FVC – forced vital capacity, MIP – maximal inspiratory pressure, MEP – maximal expiratory pressure, 6MWT – six-minute walk test, SF-36 – Short Form 36, NYPR – the New York Posture Rating

Table 3. Comparison of results of participants between the 6-min walking distance and the expected distance

		Mean	*SD*	Lower	Upper	*Z*	*p*
6MWT (m)	Walking distance	317.63	51.59	210.00	480.00	–5573.000	$p < 0.001$*
	Expected distance	542.42	47.65	459.06	637.93		
MIP (cm H_2O)	MIP	50.47	12.70	28	78	–5.373	$p < 0.001$*
	Expected MIP (%)	78.66	3.20	71.44	84.4		
MEP (cm H_2O)	MEP	52.21	8.82	26	67	–5.373	$p < 0.001$*
	Expected MEP (%)	146.48	3.52	137.04	150.8		

6MWT – six-minute walk test, MIP – maximal inspiratory pressure, MEP – maximal expiratory pressure
* $p < 0.05$ for 6MWT

Table 4. Correlation of all parameters to each other

Correlation between severity of lymphedema (volume) and other assessments	*r**	*p*
Body composition		
BMI (kg/m²)	–0.014	0.935
Posture		
NYPR (score)	–0.041	0.808
Quality of life – SF-36		
Physical functioning (score)	0.146	0.383
Role physical (score)	0.239	0.149
Bodily pain (score)	0.083	0.620
General health (score)	–0.013	0.938
Vitality (score)	–0.139	0.405
Social functioning (score)	0.197	0.235
Role emotional (score)	0.178	0.284
Mental health (score)	–0.074	0.660
Functional exercise capacity		
Distance of 6MWT (m)	–0.302	0.065
Spirometric tests		
FEV1 / FVC (%)	–0.041	0.805
FEV1(l/s)	0.309	0.059
MIP (cm H_2O)	–0.211	0.202
MEP (cm H_2O)	–0.173	0.300
Correlation between spirometric tests and walking distance	***r****	***p***
Spirometric tests		
FEV1 / FVC (%)	0.368	0.023*
FEV1 (l/s)	–0.046	0.783
MIP (cm H_2O)	0.276	0.093
MEP (cm H_2O)	0.288	0.080

BMI – body mass index, NYPR – the New York Posture Rating chart, SF-36 – Short Form 36, 6MWT – six-minute walk test, FEV1 – the first second of forced expiration volume, FVC – forced vital capacity, MIP – maximal inspiratory pressure, MEP – maximal expiratory pressure
*$p < 0.05$

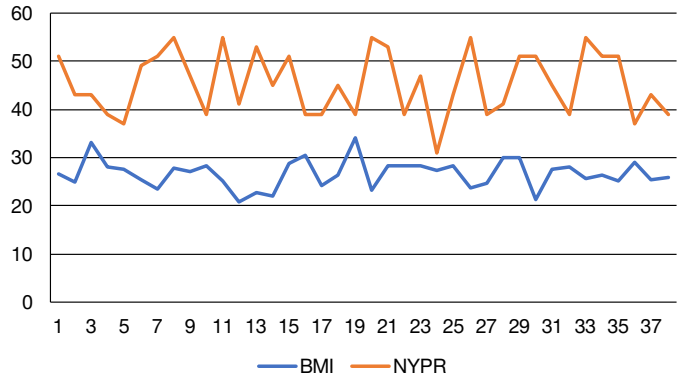

Figure 1. Relationship between participants' body mass index (BMI) values and the New York Posture Rating Chart (NYPR) values

The distance women walked at the end of 6MWT was significantly lower than the expected distance. At the same time, the MIP and MEP were considerably lower than the expected values ($p < 0.05$) (Table 3).

There was no significant relationship between the affected side volume values with BMI, the NYPR, respiratory functions, and distance walked at 6 minutes and QoL ($p > 0.05$, Table 4).

A significant negative correlation was found between the participants' BMI and NYPR values ($r = –0.348$, $p = 0.05$). As the participants' BMI values increased, the NYPR values decreased (Figure 1).

When the relationship between the participants' spirometry results and walking distance at 6 min was analysed, there was a significant correlation between FEV1 / FVC values and walking distance ($p < 0.05$). As the participants' FEV1 / FVC values increased, the distance they walked at the end of 6MWT increased (Table 4).

Discussion

As far as we know, this is the first study to examine the relationship between exercise capacity, posture, respiratory functions, the severity of lymphedema, and QoL after BCT. According to the data obtained, our main findings after BCT as FEV1 / FVC decreases, the walking distance decreases. Also, a significant correlation was detected between BMI and postural alignment. However, there was no relationship between the severity of lymphedema and posture, respiratory functions, functional exercise capacity, or QoL. In other respects, we determined that 66% of women had lymphedema and moderate postural malalignment; the functional exercise capacity and respiratory muscle strength were substantially below the expected value.

In the studies, the results showed that lymphedema increased if BMI exceeded 25 kg/m^2. Quirion et al. [21] determined that the risk of lymphedema amplified three times in patients with BMI > 30 kg/m^2. Sagen et al. [22] found in a randomized control study of 204 cases that a BMI greater than 25 kg/m^2 significantly increased the development of lymphedema. In our study, 73.69% of the individuals were > 25 kg/m^2, and the results are consistent with those reported in the published studies.

It is known that lymphedema is a vital complication seen in many women after BCT [23]. Pasket and Stark [24] conducted a study about general information given to people diagnosed with cancer, treatment, and the effects on the participants that survive and concluded that using the affected arm after surgery increased lymphedema by 40%. Another study evaluated 100 women diagnosed with lymphedema after breast cancer and concluded that 66% of the participants developed lymphedema in the arm they actively used, 71% of the lymphedema developed in the arm and hand, and 36% experienced moderate lymphedema [25]. This study detected lymphedema in 76% of the individuals; however, lymphedema was higher in the arm that was not used actively. The right extremity of most of our cases was dominant, but we think such an outcome occurred because the left breast was more affected than the right breast, and thus the development of lymphedema in the left limb was high.

After BCT, it is possible to see mechanical disorders in the upper body and shoulder region, loss of muscle strength, stiffness in soft tissue, and restrictions in joint movement. These symptoms can be reflected in the person's posture and cause various postural malalignments [26]. Stout et al. [27] stated that there was a statistically significant disorder in the body posture of participants after mastectomy. Kabała et al. [28] determined that the sagittal plane body composition could change due to mastectomy surgery. According to this, there is an increase in thoracic kyphosis and lumbar lordosis among women who had BCT [28]. Although it was concluded that the posture of 31% of the participants was affected, no control group in our study indicated this result was related to BCT. Similarly, our study supports other studies on the NYPR mean score of participants after BCT.

It was determined that functional exercise capacity and cardiorespiratory fitness decrease with all types of cancer that affect the cardiopulmonary system, directly or indirectly [9, 29]. Our study observed that participants' functional capacities were low, reaching up to 58% of the expected value. In the literature, according to the 6MWT results, the mortality risk is determined as 350 m for patients with cardiopulmonary diseases [30], but the shortest distance in our study was 210 m. Also noted, although not statistically significant, the limb volume increased as the walking distance decreased. Also, considering the absence of exercise habits of 34.21% of breast cancer patients in our study, this situation reveals the need for comprehensive studies on the determinants of functional exercise capacity in individuals with breast cancer.

To the best of our knowledge, limited research evaluates the respiratory muscle strength in breast cancer patients. Our study determined that participants' MIP and MEP results were significantly lower than the expected values. Parallel to our study, Abreu et al. [31] evaluated MIP and MEP scores on 20 breast cancer patients before mastectomy. The results were 43% and 40%; however, these results dropped significantly after mastectomy surgery. In the same study, they observed that patients who underwent neoadjuvant treatment had decreased pulmonary function of the FVC and FEV1 values [31]. Respiratory muscle strength measurement methods are generally evaluated with FVC, VC, and other spirometric test parameters [32]. Odynets et al. [9] studied the respiratory parameters compared to the control group in breast cancer patients, finding that all parameters decreased. We were considering spirometric tests because we did not have a control group; a definite interpretation could not be made about respiratory muscle strength. Considering the limitations in the literature, studies planned to determine the severity and course of muscle weakness are needed if MIP and MEP tests are performed correctly, and other factors that may affect it are excluded.

Breast cancer can lead to further losses of function due to radical surgical interventions and radiotherapy after treatment [23]. Loss of function may include pain limitations in the shoulder area, loss of muscle strength in the upper limb, and locomotor system disorders such as lymphedema and psychological and cosmetic problems. As a result, a decrease in the QoL can be expected [23, 33]. Bouya et al. [33] conducted a systematic review to assess the QoL of Iranian women with breast cancer and indicated a moderate level. Ho et al. [34] showed that in Asia, patients with breast cancer have a lower QoL than the overall population. Comorbidities, chemotherapy, lower social support, and neglected requirements are related to decreased QoL. Taghian et al. stated that lymphedema affects many essential aspects of a woman's life, including physical, psychological, and emotional health [35]. In our study, there was no relationship between QoL and the severity of lymphedema. This situation reveals that more than one factor is related to the QoL and may also relate to our sample number.

Limitation

A literature review found limited studies on posture, functional capacity, and respiratory function tests after BCT. Our study is essential in investigating the relationship between these parameters, lymphedema, and common problems. However, the sample number was low, there was no control group, and the evaluations could not be compared with healthy participants, which are significant limitations of this study. More studies need more details and objective assessments, especially for posture and exercise capacity. As a result, disorders related to BCT, such as lymphedema, often occur in women, respiratory functions can be adversely affected, and functional capacity may be reduced. Evaluating and following these parameters after BCT is essential for establishing preventive rehabilitation programs and / or designing appropriate physiotherapy programs.

Conclusion

BMI in women with breast cancer can be increased by worsening postural alignment. This study shows that walking distance and respiratory muscle strength had lower than normative values. Future studies with increased sample sizes would clarify the predictors and relationships of all these parameters in women with breast cancer.

Acknowledgments

This research did not receive any financial or technical support.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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