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Comparison of functional performance, kinesiophobia, muscle strength, quality of life, and fatigue between mastectomy and quadrantectomy in breast cancer survivors

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ABSTRACT

Introduction: Mastectomy and quadrantectomy are the two primary surgical procedures performed on breast cancer survivors. This study aimed to compare functional performance, kinesiophobia, and muscle strength between women who were subjected to mastectomy and those who underwent quadrantectomy. **Methods:** A total of 27 participants were included, divided into a mastectomy group (mean age 51.0, standard deviation ±7.83 years) and a quadrantectomy group (mean age 53.5±9.33 years). Functional performance was assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire; kinesiophobia was measured with the Tampa Scale of Kinesiophobia (TSK); quality of life was evaluated using the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire – Breast Cancer module version 23 (EORTC BR-23); fatigue was analyzed with the Functional Assessment of Cancer Therapy – Breast cancer with arm subscale (FACT-B+4); and muscle strength was obtained through the bilateral isometric strength (BIS) and one-repetition maximum (1RM) tests. Data normality was verified using the Kolmogorov–Smirnov test. The unpaired *t*-test was applied to normally distributed variables, while the Mann–Whitney test was used for non-normally distributed variables. The significance level was set at $p \leq 0.05$. **Results:** No significant differences were found between groups regarding muscle strength ($p=0.213$), functional performance ($p=0.635$), or kinesiophobia ($p=0.752$). However, the mastectomy group reported lower scores in the breast symptoms domain of quality of life ($p=0.050$). **Conclusion:** Although no significant differences were observed in muscle strength, functional performance, or kinesiophobia, women in the mastectomy group reported worse quality of life in the breast symptoms domain.

KEYWORDS: breast cancer; functional capacity; kinesiophobia; psychobiological profile; surgery.

INTRODUCTION

Cancer is a multifactorial disease and a major public health concern, particularly in developing countries, where more than 20 million new cases are expected in the coming decades[1,2]. Among women, breast cancer is the most prevalent type, with the highest incidence and mortality worldwide[3]. In 2020 alone, approximately 2 million new cases were reported, accounting for 11.6% of all cancers diagnosed in women[4]. Breast cancer survivors often experience significant emotional, physical, and social challenges, including increased fatigue and reduced quality of life[5,6]. Furthermore, surgical treatment may exacerbate kinesiophobia and impair functional performance[7,8].

The most common treatment modalities for breast cancer include surgery, chemotherapy, and radiotherapy[1,2]. With respect to surgical procedures, tumor removal can be achieved through mastectomy (total breast removal) or quadrantectomy (removal of a single quadrant of the breast)[9]. Surgery, regardless of type, often negatively impacts quality of life, fatigue, functional performance,

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and kinesiophobia, as it directly affects emotional, social, and physical domains[5,10,11].

It is estimated that 36.4% of women with breast cancer undergo mastectomy[12]. The primary benefit of this procedure lies in reducing the risk of recurrence and preventing tumor spread[13]. However, mastectomy is associated with a nearly 40% increased risk of lymphedema in the upper limbs, which leads to discomfort, functional limitations, fear of limb use, and reduced muscle strength[14-16].

Quadrantectomy, on the other hand, involves localized tumor removal, generally excising two to three centimeters of healthy tissue surrounding the tumor, without removing the entire breast[17]. This approach is most commonly applied in early-stage breast cancer and provides control rates comparable to mastectomy, though adjuvant radiotherapy is typically required[18]. Compared to mastectomy, quadrantectomy is less invasive, associated with lower rates of lymphedema and swelling, and promotes better upper limb mobility. It also has a less detrimental impact on quality of life, fatigue, functional performance, kinesiophobia, and muscle strength[19,20].

Although the adverse effects of surgery on breast cancer are well documented, few studies have directly compared mastectomy and quadrantectomy in relation to quality of life, fatigue, functional performance, muscle strength, and kinesiophobia. Therefore, the aim of the present study was to compare these domains between breast cancer survivors who underwent mastectomy and those who underwent quadrantectomy.

METHODS

Subjects

This study employed a cross-sectional design with a quantitative approach. A total of 27 women were consecutively recruited and allocated into two groups: mastectomy (MG, n=13) and quadrantectomy (QG, n=14). The sample was composed of all women who met the eligibility criteria during the data collection period. Ethical approval was obtained from the Institutional Ethics Committee of the University (Protocol: 50717115.4.0000.5083) and the Research Ethics Committee of the Clinical Hospital of the Federal University of Goiás (HC/UFG) (Protocol: 50717115.4.3001.5078), in accordance with Resolution Nº 466/12 of the Brazilian National Health Council.

Participants were recruited at the Clinical Hospital of the Federal University of Goiás. The inclusion criteria were: being in menopause; not participating in any structured resistance training program during the previous six months; having undergone mastectomy or breast quadrantectomy; and not presenting with metastasis. Exclusion criteria included: diagnosis of diabetes; hypertension or any cardiovascular disease that contraindicated physical exercise; lack of medical clearance for exercise participation; and the presence of musculoskeletal injuries to the shoulders, elbows, or hands that could limit the execution of the proposed exercises.

Design

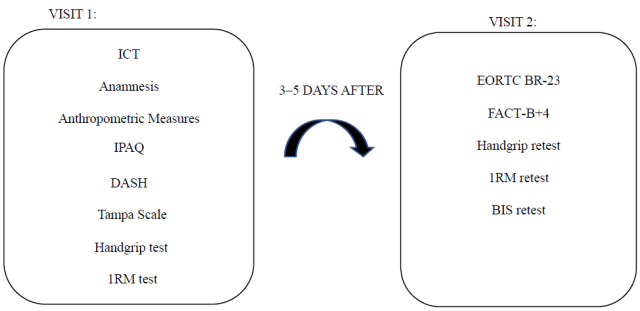
The study required two visits (Figure 1). During the first visit, participants signed the informed consent form and subsequently completed the anamnesis. Anthropometric measurements were then obtained, followed by the administration of the International Physical Activity Questionnaire (IPAQ), the Disabilities of the Arm, Shoulder and Hand Questionnaire (DASH), and the Tampa Scale for Kinesiophobia (TSK). After filling out these questionnaires, participants completed the handgrip strength test (HT), the one-repetition maximum (1RM) test, and the bilateral isometric strength (BIS) test. During the second visit, participants completed the European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire – Breast Cancer module version 23 (EORTC BR-23) and the Functional Assessment of Cancer Therapy – Breast cancer with arm subscale (FACT-B+4). All questionnaires were administered by a trained and experienced researcher. After applying the questionnaires, retests of the strength assessments (HT, 1RM, and BIS) were performed.

Anthropometric assessment

To measure body mass and height, participants were assessed barefoot while wearing swimsuits or comfortable clothing (pants and blouses). Body mass was measured using an analog scale (Filizola, model Personal 7708, Brazil), and height was measured with a stadiometer, with an accuracy of 0.1 cm, following the procedures described by Coswig et al.[21]. Based on these measurements, the body mass index (BMI) was subsequently calculated for each participant.

Physical activity level

The IPAQ (short version) was administered to assess physical activity levels. This instrument consists of seven questions



ICT: inform consent term; IPAQ: International Physical Activity Questionnaire; DASH: Disabilities of the Arm, Shoulder and Hand questionnaire; 1RM: one-repetition maximum test; BIS: bilateral isometric strength test; EORTC BR-23: European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire – Breast Cancer module; FACT-B+4: Functional Assessment of Cancer Therapy – Breast cancer with arm subscale.

Figure 1. Tests performed on the first and second data collection visit.

designed to estimate both the frequency and duration of physical activity across different domains, as well as periods of physical inactivity[22].

Disabilities of the arm, shoulder and hand

The DASH questionnaire was employed to evaluate upper limb functional performance. This instrument was translated, culturally adapted, and psychometrically validated for the Portuguese language by Orfale et al.[23]. The instrument consists of 30 items designed to assess the volunteers' health status. Among these, 21 items evaluate the degree of difficulty in performing specific tasks, five items address the intensity of symptoms such as pain, weakness, paresthesia, and stiffness, and four items are specifically related to work activities. Responses are scored on a scale from 0 "no difficulty" to 5 "unable to perform the task". The final DASH score ranges from 0 to 100 and is calculated by summing the scores of all completed items and dividing the total by 1.5[24].

Kinesiophobia

The TSK was administered to assess kinesiophobia. This instrument consists of 17 items that evaluate fear related to movement and physical activity. The questionnaire is structured on a Likert-type scale, with response options ranging from 1 to 4, corresponding to "strongly disagree", "partially disagree", "partially agree", and "strongly agree". The scale encompasses two dimensions: somatic focus (items 3, 5, 6, 7, and 11) and activity avoidance (items 1, 2, 9, 10, 13, 14, 15, and 17). To calculate the total score, the responses to items 4, 8, 12, and 16 are reverse-coded, as these items are negatively worded. The total score ranges from 17 to 68 points, with higher scores indicating greater levels of kinesiophobia. For classification purposes, scores between 17–34 are considered mild, 35–50 are classified as moderate, and 51–68 are categorized as severe[25].

Muscle strength tests

Muscle strength was assessed using isometric tests (HT and BIS bench press) and the 1RM test to evaluate dynamic strength. HT measurements were conducted in accordance with guidelines established by the American Society of Hand Therapists[26]. The testing protocol consisted of three trials of maximum voluntary contraction, each lasting 3–5 seconds, with the elbow positioned at 90º. Standardized verbal encouragement was provided throughout the attempts, which were performed alternately with the right and left arms. A one-minute rest interval was allowed between trials. Participants were seated with their feet flat on the floor and their back supported against a chair, maintaining a 90º angle at both the hip and knee joints. A digital dynamometer (model EH101, E.clear®) was used to record force production. The highest value obtained across the three attempts was used for analysis.

The BIS test was conducted using a standardized straight bench. Two load cells were attached to a custom support, stabilized with free weights, and connected to handles fixed on each side, while the bench included a vertically adjustable hydraulic seat with the load cells positioned beneath the participants' elbows. Elbow flexion was set at approximately 90º and confirmed with a manual goniometer (Trident®, Brazil). A warm-up/familiarization protocol was performed, consisting of three submaximal trials at 50%, 75%, and 100% of self-perceived effort, each lasting three seconds, with a one-minute rest interval between attempts. Following the warm-up, participants rested for an additional three minutes before commencing the test. Prior to each attempt, participants received standardized verbal instructions from the researcher: "Try to push up as hard and as fast as possible," preceded by a countdown ("three, two, one, go!"), and strong verbal encouragement was provided throughout. Participants then performed three to four maximal voluntary isometric contractions (MVIC), each lasting five seconds, and the highest recorded value was retained for analysis, with a three-minute rest interval between attempts. The same warm-up procedures and MVIC protocol were repeated during the retest session[27].

Two load cells (S-Type Model OP-312, Optima Scale, USA), each with a maximum force capacity of 750 lb, were employed to collect data during the BIS supine test. All digital signal processing was carried out using custom software developed in LabVIEW (National Instruments Corp., Austin, TX, USA). This software received two input signals from the designated electronic hardware channel, which was based on the ESP32 microcontroller. The signals, sampled at 80 Hz, were transmitted in real time via Wi-Fi and subsequently analyzed on a laptop. Prior to each testing session, the system was calibrated using reference masses. Force values were expressed in Newtons (N) and subsequently converted to kilograms of force (kgf).

Dynamic muscle strength was assessed using a 1RM test in the bench press exercise performed in the supine position. Participants completed three to five attempts to determine their 1RM, with a standardized three-minute rest interval between trials. A warm-up was first performed at 50% of the estimated 1RM, after which the initial attempt was conducted at 100% of the estimated load. If the participant successfully performed two repetitions, the load was adjusted in increments of 5–10%. Movement cadence was not externally controlled; however, participants were instructed to execute the eccentric phase in a controlled manner and the concentric phase with maximal velocity. The test was conducted in accordance with the standards of the National Strength and Conditioning Association and supervised by an experienced strength training professional. A second 1RM test was performed 3–5 days later, using the maximum load determined in the initial assessment[28,29].

Quality of life

Quality of life was assessed using the EORTC BR-23. This is a disease-specific instrument designed to evaluate quality of life in patients with breast cancer. It comprises 23 items scored on a four-point Likert-scale, ranging from 1 "not at all" to 4 "very much". Items 31–38 and 47–53 correspond to the symptom domain, whereas items 39–43 correspond to the functional domain. Each scale (symptom and functional) is scored separately on a range from 0 to 100. For the functional scale, higher scores indicate better quality of life, while for the symptom scale, higher scores reflect greater symptom burden and, consequently, poorer quality of life[30].

Fatigue

Fatigue was assessed using the FACT-B+4, a multidimensional questionnaire composed of 37 items distributed across five domains: physical well-being (PWB), social/family well-being (SWB), emotional well-being (EWB), functional well-being (FWB), and the breast cancer subscale (BCS). The Trial Outcome Index (TOI), derived from the sum of the PWB, FWB, and BCS subscales, comprises 23 items and is designed to capture the impact of breast cancer on physical and functional aspects of quality of life. Scoring ranges are defined as follows: PWB and SWB (0–24), FWB (0–28), BCS (0–36), and EWB (0–20). Scores are calculated independently for each domain by summing the item responses, and the overall FACT-B+4 score is obtained by summing across all domains, ranging from 0 to 164 points, with higher values indicating better quality of life[31].

Statistical analysis

Data are expressed as mean ± standard deviation. The assumption of normality was assessed using the Kolmogorov-Smirnov test. For variables that followed a normal distribution (HT, BIS, and 1RM tests, as well as kinesiophobia, weight, height, BMI, and physical activity), group comparisons were conducted using the unpaired Student's *t*-test. Fatigue exhibited normality only in the functional well-being and FACT-TOI domains. Regarding quality of life, normal distribution was observed on functional and symptom scales. For variables that did not meet the assumption of normality, including the DASH score, group comparisons were performed using the Mann-Whitney test. Fatigue did not follow a normal distribution in the physical, social, emotional, breast cancer–specific, and FACT-G total domains. For quality of life, the following domains also showed non-normal distribution: systemic therapy side effects, hair loss, breast symptoms, body image, future perspective, sexual function, sexual enjoyment, and arm symptoms. These results were reported as median and interquartile range. When statistically significant differences were observed in the fatigue and quality of life domains, multiple comparisons were adjusted using the Holm-Bonferroni correction. Statistical significance was set at $p \leq 0.05$.

RESULTS

The study included 13 women in the MG group and 14 in the QG group (Table 1). No significant differences were observed in the 1RM test (p=0.213). Similarly, there were no statistically significant differences between groups in maximum HT, both for the left (p=0.420) and right (p=0.440) hands. In addition, no significant differences were found for maximum BIS values on the left (p=0.119) and right (p=0.263) sides, or total BIS (p=0.316) (Table 2).

Regarding fatigue, the interpretation of the FACT-B+4 instrument indicates that higher scores in each domain reflect lower levels of fatigue, whereas lower scores indicate higher levels of fatigue. No significant differences were found in any of the fatigue-related domains (Table 3).

Table 1. Physical characteristics of the mastectomy and quadrantectomy groups.

Variables	MG (n=13)	QG (n=14)	p-value
Age (years), mean (SD)[a]	51.00±7.83	53.50±9.33	0.630
Body Mass (kg), mean (SD)	63.38±6.58	75.15±15.88	0.019*
BMI (kg/m^2), mean (SD)	27.28±4.41	29.26±5.43	0.140
Height (m), mean (SD)	1.56±0.05	1.58±0.05	0.440
IPAQ (METS), mean (SD)	356. 00±39.4	915.00±78.3	0.001*
Years of study (n)	≥8 (5) <8 (8)	≥8 (8) <8 (6)	
Ethnic	Caucasian (8) No Caucasian (5)	Caucasian (5) No Caucasian (9)	
Lynphedema	Yes (3) No (10)	Yes (7) No (7)	
Type of chemotherapy	Adjuvant (7) Neoadjuvant (6)	Adjuvant (8) Neoadjuvant (6)	

MG: mastectomy group; QG: quadrantectomy group; BMI; body mass index; IPAQ: International Physical Activity Questionnaire; METS: metabolic equivalents of task. [a]Results are presented as means and standard deviation (SD ±).

Table 2. Muscle strength of the mastectomy and quadrantectomy groups.

Variables	MG (n=13)	QT (n=14)	p-value§
HT (max) left (kg)	26.41±4.31	24.98±4.94	0.420
HT (max) right (kg)	27.74±3.54	26.34±5.49	0.440
BIS (max) left (N)	113.58±27.67	94.56±33.92	0.199
BIS (max) right (N)	106.31 [89.69–132.86]*	92.14 [81.35–116.93]*	0.263
BIS (max) total (N)	226.40±50.16	207.33±48.47	0.316
1RM test (kg)	23.00±3.00	25.00±5.13	0.213

MG: mastectomy group; QG: quadrantectomy group; HT (max) left: left maximum handgrip test; HT (max) right: right maximum handgrip test; kg: kilogram; BIS (max) left: left maximum bilateral isometric strength; BIS (max) right: right maximum bilateral isometric strength; BIS (max) total: total maximum bilateral isometric strength; N: newton; 1RM: one-repetition maximum. Results are expressed as mean and standard deviation (±). *Student's *t*-test or median (Q1; Q3). §Mann-Whitney test.

Table 3. Fatigue levels of the mastectomy and quadrantectomy groups.

Variables	MG (n=13)	QG (n=14)	p-value§
Physical well-being	0.00 [0.00–0.00]*	22.50 [18.25–25.75]*	0.199
Social well-being	19.00 [17.50–22.50]*	18.00 [15.50–22.00]*	0.565
Emotional well-being	22.00 [20.50–23.00]*	20.00 [17.25–25.75]*	0.070
Functional well-being	21.00 [16.75–23.00]*	21.50 [17.25–22.00]*	0.383
Breast cancer subscale	29.50 [26.00–32.50]*	28.00 [26.00–29.00]*	0.139
FACT-B-TOI	69.00 [66.75–77.25]*	68.00 [65.25–76.75]8	0.240
FACT-G total	81.50 [77.75–88.00]*	80.00 [75.00–84.25]*	0.238
FACT-B total	112.78±14.24	104.31±16.99	0.167

MG: mastectomy group; QG: quadrantectomy group; FACT-B-TOI: total outcomes index; FACT-G total: general fatigue levels; FACT-B total: fatigue level related to total breast cancer. Results are expressed as mean and standard deviation (±). *Student's *t*-test or median (Q1; Q3). §Mann-Whitney test.

The EORTC BR-23 questionnaire is divided into general symptom scales and functional scales. For the general symptom scales, higher scores indicate poorer quality of life, whereas in the functional scales, higher scores within each domain indicate better quality of life. The results revealed that women who underwent mastectomy exhibited poorer outcomes in the breast symptoms domain (p=0.051). No significant differences were observed between groups in the other domains. Similarly, there were no group differences regarding DASH or kinesiophobia assessments (Table 4).

DISCUSSION

The aim of this study was to compare quality of life, fatigue, functional performance, kinesiophobia, and muscle strength between breast cancer survivors who underwent mastectomy and those who underwent quadrantectomy. The findings indicated no statistically significant differences between the groups in muscle strength, fatigue, functional performance, or kinesiophobia. However, in the quality-of-life domain related to breast symptoms, the mastectomy group reported worse outcomes compared with the quadrantectomy group.

Zabit and Iyigun[32] compared muscle strength between women who underwent mastectomy or quadrantectomy and healthy controls. The findings indicated that women who had undergone surgery exhibited lower muscle strength compared to healthy women; however, no significant differences were observed between the two surgical groups. Ackoochakian et al.[33] compared muscle strength over a 12-month period among women who underwent mastectomy or quadrantectomy, and healthy controls. Their results indicated no significant differences between the surgical groups; yet, both demonstrated lower strength levels compared with healthy women. Consistent with these findings, the present study also revealed no differences in muscle strength between the groups, as assessed by the HT (p=0.440), BIS (p=0.316), and the 1RM (p=0.213) tests.

Fatigue is another factor through which surgery may affect the lives of breast cancer survivors. Jackson et al.[34] conducted a study examining differences in fatigue levels according to the type of surgery. They stated that surgical type influenced fatigue, although no significant differences were observed between groups. Similarly, Williams et al. compared fatigue levels among breast cancer survivors who were subjected to chemotherapy or mastectomy with those of healthy women. Their results showed no differences between the survivor groups; however, both groups showed higher fatigue levels than healthy women. Consistent with these findings, the present study also demonstrated no significant differences in fatigue between

Table 4. Levels of disabilities of the arm, shoulder and hand, kinesiophobia and quality of life of the mastectomy and quadrantectomy groups.

Variables	MG (n=13)	QG (n=14)	p-value§
General Symptoms	1.62±0.63	1.75±0.42	0.524
Effect side	1.37 [1.00–1.81]*	1.64 [1.28–2.25]*	0.215
Hair loss	1.00 [1.00–2.50]*	1.00 [1.00–1.75]*	0.724
Arm symptoms	1.16 [1.00–1.75]*	1.83 [1.00–2.25]*	0.153
Breast symptoms	1.00 [1.00–1.50]*	1.75 [1.31–2.23]*	0.051*
Functional Scales	2.12±0.56	2.08±0.69	0.856
Body image	1.37 [1,00–1,81]*	1.50 [1.00–2.00]*	0.786
Future perspectives	2.50 [1.00–3.25]*	2.50 [1.00–4.00]*	0.659
Sexual function	2.00 [1.00–3.00]*	2.00 [1.00–2.87]*	0.706
Sexual enjoyment	3.00 [1.00–4.00]*	2.00 [1.00–3.00]*	0.511
DASH	20.00 [1.45–37.50]*	16.60 [5.41–41.45]*	0.635
Kinesiophobia	41.35±9.47	40.18±9.86	0.752

DASH: Disabilities of the Arm, Shoulder and Hand Questionnaire; MG: mastectomy group; QG: quadrantectomy group; *p<0.05: significative difference between groups. Results are expressed as mean and standard deviation (±). *Student's *t*-test or median (Q1; Q3). §Mann-Whitney test.

groups (p=0.167). This suggests that, regardless of the surgical procedure performed, fatigue remains a relevant factor affecting patients' daily lives.

In addition to fatigue, other factors may significantly influence patients' lives, among which quality of life is particularly noteworthy. Zehra et al.[35,36] compared quality-of-life outcomes among women who underwent quadrantectomy, breast reconstruction, and mastectomy. The authors revealed that women who underwent quadrantectomy and breast reconstruction reported better quality of life than those who were submitted to mastectomy. Similarly, Kulinski and Kosno analyzed quality of life among breast cancer survivors following mastectomy and found that all participants experienced impaired quality of life. The findings of the present study corroborate these results, as women who underwent mastectomy demonstrated lower quality-of-life scores compared to those who underwent quadrantectomy, specifically in the breast symptoms domain (p=0.051).

Another factor that exerts a direct impact on activities of daily living—and, consequently, on both quality of life and fatigue—is functional performance. Paolucci et al.[17] compared the functional performance of women who were subjected to mastectomy with those who had quadrantectomy. The authors found no significant differences between the groups; however, both surgical procedures were associated with limitations in upper limb movements. Baran et al.[37,38] compared functional performance between women who underwent mastectomy and those who had quadrantectomy, as well as the association of these surgical procedures with the development of lymphedema. Their findings indicated no significant differences in functional performance between the groups but women who underwent mastectomy demonstrated a higher likelihood of developing lymphedema compared with those who had quadrantectomy. Consistent with these results, the present study also found no significant differences in functional performance according to surgery type (p=0.635).

Another variable frequently observed following surgical procedures in breast cancer survivors is kinesiophobia, which can have a direct impact on quality of life, fatigue, and functional performance. Altas and Dermidal[16] investigated the impact of kinesiophobia in women following mastectomy. The authors identified that approximately 70% of the participants who underwent mastectomy experienced kinesiophobia. Erdoganolu et al.[39] conducted a study examining the influence of kinesiophobia on functional capacity, lymphedema, and fear following mastectomy. Their findings indicated that higher levels of kinesiophobia were associated with impaired functional capacity, increased lymphedema, and greater fear. In contrast, the results of the present study did not reveal significant differences between groups regarding these outcomes.

This study presents some limitations, such as the reduced number of participants, which may have decreased the statistical power to detect differences, particularly in domains that showed values close to the significance threshold, such as breast symptoms (p=0.051) and emotional well-being. Although consecutive sampling is acceptable in exploratory studies, no sample size calculation was performed, which should be considered in the interpretation of the findings, as it may limit the generalizability of the results. Further studies could investigate the relationship between the type of surgery and the increase of lymphedema, as well as whether the type of surgery is associated with the practice of physical activity. This study may support health professionals in better understanding the psychological, physical,

and functional impacts of mastectomy and quadrantectomy on breast cancer survivors.

CONCLUSIONS

There were no significant differences between surgical procedures (mastectomy and quadrantectomy) with respect to fatigue, kinesiophobia, muscle strength, and functional performance. However, breast cancer survivors who were subjected to mastectomy reported worse outcomes in the breast symptoms domain of quality of life compared with those who underwent quadrantectomy.

AUTHORS' CONTRIBUTION

VAM: Data curation, Investigation, Methodology, Writing – original draft, Writing – review & editing. WDNS: Data curation, Investigation, Methodology, Software, Writing – review & editing. MSS: Conceptualization, Project administration, Visualization, Writing – review & editing. JFBJ: Formal analysis, Writing – review & editing. LRS: Conceptualization, Project administration, Visualization, Writing – review & editing. NPS: Data curation, Formal analysis, Resources, Writing – review & editing. RFJ: Conceptualization, Project administration, Visualization, Writing – review & editing. CAV: Conceptualization, Project administration, Validation, Visualization, Writing – review & editing.

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