Assessment of Upper Limbs Functionality, Quality of Life and Postoperative Fatigue in Women with Breast Cancer at a Reference Hospital in the Amazon Region

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Avaliação da Funcionalidade dos Membros Superiores, Qualidade de Vida e Fadiga no Pós-operatório de Mulheres com Câncer de Mama em um Hospital de Referência na Amazônia

Evaluación de la Funcionalidad de Miembros superiores, Calidad de Vida y Fatiga Posoperatoria en Mujeres con Cáncer de Mama en un Hospital de Referencia en la Amazonía

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ABSTRACT

Introduction: Breast cancer has a significant impact on upper limbs (UL) functionality due to treatment and its complications. **Objective:** To assess UL functionality, quality of life and fatigue in women with breast cancer in the Amazon region. **Method:** Cross-sectional study with 42 participants. Data were collected from medical history and quality of life questionnaires Functional Assessment of Cancer Therapy-General (FACT-G) and Functional Assessment of Cancer Therapy-Breast plus Arm Morbidity (FACT B+4), fatigue, with Functional Assessment of Cancer Therapy-Fatigue (FACT-F), functionality, with Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH), and muscle strength, with isokinetic dynamometer. Spearman's correlation and Wilcoxon test were used. **Results:** 71.4% of the participants underwent conservative surgery. QuickDASH correlated with FACT-B+4 (r = -0.796), FACT-G (r = -0.781) and FACT-F (r = -0.815). FACT-F correlated with FACT-G (r = 0.949) and FACT-B+4 (r = 0.903). There was a significant difference in isokinetic strength between the operated and unoperated sides. Isokinetic strength correlated with pain and postoperative time, but not with clinical staging and QuickDASH. **Conclusion:** UL functionality is associated with fatigue and quality of life, but not with isokinetic strength. There was a significant difference between the operated and unoperated sides. Type of surgery, pain and postoperative time influenced isokinetic strength in women with breast cancer.

Key words: Upper Extremity; Muscle Strength; Quality of Life; Fatigue; Breast Neoplasms.

RESUMO

Introdução: O câncer de mama gera impactos significativos na funcionalidade dos membros superiores (MMSS) em razão do tratamento e suas complicações. **Objetivo:** Avaliar a funcionalidade dos MMSS, qualidade de vida e fadiga de mulheres com câncer de mama na Região Amazônica. **Método:** Estudo transversal realizado com 42 participantes. Foram coletados dados da anamnese e dos questionários de qualidade de vida *Functional Assessment of Cancer Therapy-General* (FACT-G) e *Functional Assessment of Cancer Therapy-Breast plus Arm Morbidity* (FACT B+4), de fadiga com *Functional Assessment of Cancer Therapy-Fatigue* (FACT-F), funcionalidade com *Quick Disabilities of the Arm, Shoulder and Hand* (QuickDASH) e da força muscular com dinamômetro isocinético. Foram utilizados a correlação de Spearman e o teste de Wilcoxon. **Resultados:** Foram submetidas à cirurgia conservadora 71,4% das participantes. O QuickDASH apresentou correlação com o FACT-B+4 (r = -0,796), FACT-G (r = -0,781) e FACT-F (r = -0,815). O FACT-F correlacionou-se com o FACT-G (r = 0,949) e com o FACT-B+4 (r = 0,903). Houve diferença significativa na força muscular isocinética entre o lado operado e o não operado. A força isocinética apresentou correlação com a dor e o tempo pós-cirúrgico, contudo não apresentou com o estadiamento clínico e o QuickDASH. **Conclusão:** A funcionalidade dos MMSS está associada à fadiga e à qualidade de vida, e não com a força isocinética. Houve diferença significativa entre o lado operado e o não operado. O tipo de cirurgia, dor e o tempo pós-cirúrgico influenciaram na força isocinética em mulheres com câncer de mama.

Palavras-chave: Extremidade Superior; Força muscular; Qualidade de Vida; Fadiga; Neoplasias da Mama.

RESUMEN

Introducción: El cáncer de mama tiene un impacto significativo en la funcionalidad de los miembros superiores (MMSS) debido al tratamiento y sus complicaciones. **Objetivo:** Evaluar la funcionalidad de los MMSS, la calidad de vida y la fatiga de las mujeres con cáncer de mama en la región amazónica. **Método:** Estudio transversal realizado con 42 participantes. Los datos se recogieron de los cuestionarios de anamnesis y calidad de vida *Functional Assessment of Cancer Therapy-General* (FACT-G) y *Functional Assessment of Cancer Therapy-Breast plus Arm Morbidity* (FACT-B+4), fatiga con *Functional Assessment of Cancer Therapy-Fatigue* (FACT-F) y funcionalidad con *Quick Disabilities of the Arm, Shoulder and Hand* (QuickDASH) y fuerza muscular con dinamómetro isocinético. Se utilizaron la correlación de Spearman y la prueba de Wilcoxon. **Resultados:** El 71,4% de las participantes fue sometido a cirugía conservadora. QuickDASH se correlacionó con FACT-B+4 (r = -0,796), FACT-G (r = -0,781) y FACT-F (r = -0,815). El FACT-F se correlacionó con el FACT-G (r = 0,949) y el FACT-B+4 (r = 0,903). Se observó una diferencia significativa en la fuerza muscular isocinética entre el lado operado y el no operado. La fuerza isocinética se correlacionó con el dolor y el tiempo posquirúrgico, pero no con la estadificación clínica ni con el QuickDASH. **Conclusión:** La funcionalidad de los MMSS se asocia con la fatiga y la calidad de vida, pero no con la fuerza isocinética. Hubo diferencias significativas entre el lado operado y el no operado. El tipo de cirugía, el dolor y el tiempo posquirúrgico influyeron en la fuerza isocinética de las mujeres con cáncer de mama.

Palabras clave: Extremidad Superior; Fuerza Muscular; Calidad de Vida; Fatiga; Neoplasias de la Mama.

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INTRODUCTION

Breast cancer is one of the main public health issues worldwide due to its high incidence and mortality in women, being the second most common type of cancer, with around 2.3 million women diagnosed in 2022, which resulted in 666,103 deaths, becoming the fourth main cause of death worldwide[1,2]. In Brazil, for each year of the 2023-2025 triennium, 73,610 new breast cancer cases are expected, being the leading cause of death by cancer in women, representing 16.1% of total oncological deaths[3].

Breast cancer treatment is multimodal and, depending on the type and staging, can include conservative surgeries or mastectomies, associated or not with (neo)adjuvant therapies. However, the neoplasm itself and the local and/or systemic treatment may generate immediate or late complications. Literature has demonstrated that approximately 70%-90% of women will develop sequelae at some point during treatment, with variations in the level of severity and occurrence, and 50%-55% will present some upper limb (UL) affliction[4,5].

These morbidities may include symptoms like: changes in the center of gravity that affect posture, leading to body misalignment, shoulder asymmetry and inclination ipsilateral to the surgery, compensations and alterations in the scapular biomechanic, antalgic posture, frozen shoulder, asymmetric walking, reduced range of motion (ROM), reduced aerobic ability, reduced muscle strength, fatigue, lymphedema, scarring adherence, seroma, axillary web syndrome, chronic pain syndrome, intercostobrachial neuralgia, neuropathies, radiodermatitis, changes in sensibility, and others[4,6-8].

Upper limbs represent one of the main segments of the body, being the most used and functional in the day-to-day, involving a complex and dynamic relation between muscles, ligaments, joints, and bone structures that allow for a variety of movements in different planes, mainly because this segment helps perform several daily activities[9]. Muscle strength and pain can be considered a predictor for physical UL function and a prognostic factor for quality of life (QoL)[10-12].

Another factor that contributes to negative impacts on the QoL of women with breast cancer is connected to fatigue; 90.6% of oncological patients will present some level of severe fatigue, and patients with higher levels of pain present significantly higher fatigue[13]. Associated factors may be somatic, resulting from the disease or its treatment, or psychosocial, and may also be related to their lifestyle before diagnosis[14].

Functionality is a difficult-to-characterize term due to the variety of different names and denominations for a single phenomenon. Functionality is multidimensional and depends on the interactions between an individual, their health condition, and the social and personal context in which they live, and all the interrelated dimensions that act on the subject and are influenced by others. Thus, assessing UL functionality after breast cancer surgery is a crucial factor for better managing the QoL of these patients[12].

Despite the technological advances in medical techniques that helped increase survival and reduce mortality, surviving patients often ignore the potential symptoms and complications, which leads to delays in diagnosis and treatment, making this UL dysfunction last, affecting work performance, daily living activities (DLA), and QoL[4,5,15].

Therefore, this study aims to understand and assess the physical functional performance of UL in the operated and non-operated sides, isokinetic muscle strength, as well as QoL and fatigue in women with breast cancer to better target the treatment from the moment of diagnosis, thus minimizing the adverse effects of muscle strength decline, fatigue, and QoL. In addition to describing the clinical and sociodemographic profile of women treated at an oncology reference hospital in the Amazon Region.

METHOD

Cross-sectional analytical study conducted with women diagnosed with breast cancer treated at the *Hospital Universitário João de Barros Barreto* (HUJBB), a reference in oncology in the Amazon Region, in the city of Belém, Pará State, which is part of the hospital complex of the *Universidade Federal do Pará* (UFPA).

The sample used in the study was defined in a simple probabilistic and random manner, including the population of mastology oncology patients followed up in the ward over one year. The study included women aged 18 and over, with a breast cancer diagnosis, who had undergone any kind of unilateral breast surgery, within a six-month postoperative period, and who were now in the adjuvant treatment phase. Exclusion criteria were a history of bilateral breast surgery, having undergone mammary reconstruction, presence of UL musculoskeletal and/or neurological dysfunctions before the diagnosis, limited shoulder flexing ROM lower than 180°, and inability to perform the proposed assessment.

The data collection procedures were done in two moments: first, the patient was approached on the first day of the postoperative period from breast surgery, and an initial assessment was done, composed of: anamnesis, sociodemographic data, physical test (inspection and palpation), active ROM, assessments for fatigue, UL, QoL, and functionality questionnaires. Moreover, as protocoled by the hospital, all patients are followed up by the physiotherapy team and receive a booklet with guidance for UL physical exercise, mobility, and flexibility to be performed at home, after surgery; the second moment was previously scheduled at least a month after surgery to perform the isokinetic muscle strength physical test assessment and pain evaluation through the visual analogue scale (VAS).

As a clinical assessment instrument, an evaluation sheet was crafted for filling up sociodemographic data, history of previous pathologies, history of the current disease (type of surgery, immunohistochemistry, (neo)adjuvant treatments, etc.), anthropometric data, life habits, and data on the UL dysfunction.

QoL assessment was done through a Functional Assessment of Cancer Therapy-Breast plus Arm Morbidity (FACT B+4) questionnaire, targeted at patients with breast cancer, already validated for the Brazilian population[16,17]. The questionnaire has 40 questions. The first part has 27 questions that are part of the Functional Assessment of Cancer Therapy-General (FACT-G) questionnaire, which assesses QoL for the cancer population in general, divided into four domains: physical well-being, social/family well-being, emotional well-being, and functional well-being[18].

The other 13 questions are divided into two domains, containing nine questions on the specific problems faced by women with breast cancer and four questions on UL morbidity. Each item has an answer presented as a Likert-type scale ranging from 0 to 4 points, with the answers from each domain added up. The final total score can vary from 0 to 164, with a higher score related to better QoL of patients[16,17].

To assess fatigue, the Functional Assessment of Cancer Therapy-Fatigue (FACT-F) was used, whose validity and reliability have already been verified for the Brazilian population with breast cancer[19]. FACT-F consists of a questionnaire with a total of 40 items, with 27 composing the FACT-G for global QoL assessment and 13 specifically related to fatigue. Each item has five options with answers in a Likert-type scale graded 0 to 4[18]. The final FACT-F score is obtained from adding up the respective domains' scores, varying from 0 to 160 points; the higher the score, the better the QoL and the lower the fatigue[20].

Upper limb functionality was assessed through the Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) questionnaire, an abridged version of DASH[21], a validated, dependable, and responsive instrument in its Brazilian version[22] and validated for the breast cancer population[23]. This questionnaire is composed of two modules that assess the global functionality of UL over the last seven days: a module containing 11 items on UL dysfunctions/symptoms and another with two optional components, each with four items targeted at athletes, musicians, and workers who perform physical activities. Each item is scored on a Likert scale ranging from 1 to 5 points, where 1 indicates "no difficulty" and 5 indicates "extreme difficulty", with the score varying from 0 to 100, in which the lower the score, the better the function; and the greater the score, the greater the inability, thus classified: mild difficulty (0-25), moderate difficulty (45-50), and severe difficulty (>50).

To measure isokinetic muscle strength, the Biodex System 4 Pro® (Biodex Medical Systems, Shirley, NY, USA) isokinetic dynamometer was used, following all the calibration, positioning, and use recommendations proposed by the manufacturer in the instruction manual. The movements were bilaterally assessed in flexion/extension and internal and external shoulder rotation in the scapular plane, with the limb on the non-operated side assessed first, followed by the limb on the operated side[24].

The participants were positioned in the chair with straps on their shoulders and abdomen, and were instructed to hold the side bar of the chair using their opposite hand. The anatomical axis for each movement plane was aligned to the dynamometer axis using visual inspection and manual palpation. Moreover, the assessed limb was weighted while relaxed and semiflexed at 30º degrees for correction of gravity effects at the time of flexion (correction factor performed by the dynamometer).

In an isokinetic assessment, speed of movement is controlled, and the peak of torque is recorded according to the defined speed. In this study, the angular speed used was 60º/s with three maximum repetitions and 180º/s with five maximum repetitions; there was a one-minute break for speed switch. To assess the start of every movement, a familiarization practice round was conducted on the dynamometer, consisting of one to three repetitions at a predefined speed, to minimize learning effects and ensure the reproducibility of the collected data. Moreover, the volunteers received verbal encouragement to perform their maximum possible force during the test, stimulating production and maintenance during maximum effort.

The data analysis was conducted based on the peak of torque, defined as the maximum torque value recorded during movement, that is, the greatest force value generated during the test at a certain angle or joint position. This peak of torque is calculated using the formula: $T = F \times d$, where T is the torque (in Newton-meters, Nm), F is the generated force (in Newtons), and d is the distance between the rotation point and the force application point (lever arm). For data analysis, to adjust information to the anthropometric characteristics of participants and promote greater normality in distribution, the peak of torque index (PTI) value was used, which is calculated as follows: $PTI = T / BMI$ (N.m/Kg), where T is the peak of torque and BMI is the body mass index[25,26].

For statistical analysis, data were tabulated and stored in the Excel 2016™ software and analyzed in the Jamovi 2.3® software. Continuous data were presented as mean and standard deviation, and categorical data were presented as absolute and relative frequency, with a 95% confidence interval.

The Shapiro-Wilk test was used to verify data normality, which showed non-parametric data. Thus, for statistical analysis, the Spearman and Wilcoxon T-test were used, and a *p*-value of 5% was adopted for rejection of the null hypothesis.

This research was conducted following the National Health Council regulations for studies involving human beings [27]. The project has been submitted to the Research Ethics Committee of the UFPA/HUJBB hospital complex, being approved under report number 4.689.283 (CAAE (submission for ethical review): 74984123.4.0000.5634). All the participants signed the Informed Consent Form (ICF) and had their identities and confidential data protected.

RESULTS

The final sample included 42 participants, with a mean age of 51.3 (±9.17) years; 80.5% were retired or unemployed homemakers, 69% presented some comorbidity, and 42.9% were overweight. Other demographic data are described in Table 1.

Regarding oncological characteristics, most participants underwent conservative surgery (71.4%); regarding axillary approach, 64.3% of women underwent sentinel lymph node biopsy (SLNB), and 37.7% underwent lymphadenectomy. Advanced clinical staging predominated in 71.4% of cases. The most common molecular subtypes were luminal B (31%) and triple-negative (31%). Most patients underwent neoadjuvant chemotherapy (71.4%), and 45.2% of patients used anastrozole as hormone therapy. Regarding postoperative complications, paresthesia was the most frequent in 57.1% of women, and 83.3% reported predominantly mild pain, varying from 1 to 3 degrees in the VAS scale (Table 2).

All the assessed questionnaires showed a significant correlation, as demonstrated in Table 3. QuickDASH with FACT-B+4 and FACT-G questionnaires had a high negative correlation (r=-0.796 and r=-0.781), respectively. QuickDASH and FACT-F also had a high negative correlation (r=-0.815). And FACT-F, compared with FACT-G and FACT-B+4, had a high and positive correlation.

Table 4 shows that there was a significant difference in PTI between the operated and non-operated side, exclusively in flexion, extension, and internal rotation movements, at an angular speed of 180°/s.

When analyzing the correlation between PTI isokinetic muscle strength and the other variables, a significantly low negative correlation was observed between the 180º flexion movement and the type of surgery (r = -0.325). Additionally, there was a significant low to moderate correlation between pain and PTI in the extension and internal rotation movements at 60º and 180º.

Table 1. Sociodemographic data

Variables	N values (%)
Age	**Mean 51.3 (SD: ±9.17)**
< 40 years old	5 (11.9%)
40-59 years old	31 (73.8%)
≥ 60 years old	6 (14.3%)
Occupation	
Homemaker	33 (80.5%)
Employed	16 (39%)
Housing	
Metropolitan Region of Belém	29 (69%)
Interior of the State of Pará	11 (26.2%)
Other States	2 (4.8%)
Marital status	
No spouse	20 (47.6%)
Spouse	22 (52.4%)
Smoking	
Yes	14 (33.3%)
No	28 (66.7%)
Comorbidities	
Yes	13 (31%)
No	29 (69%)
Alcohol intake	
Yes	24 (57.1%)
No	18 (42.9%)
Dominant side	
Right	36 (87.8%)
Left	5 (12.2%)
Body mass index	
Underweight	1 (2.4%)
Eutrophy	13 (31%)
Overweight	18 (42.9%)
Obesity	10 (23.7%)

Caption: SD: Standard deviation.

Table 2. Oncological data

Variables	N values (%)
Surgery type	
Mastectomy	12 (28.6%)
Conservative	30 (71.4%)
Involved side	
Right	23 (54.8%)
Left	19 (45.2%)
Time from surgery to assessment day	Mean: 67.4 days (SD± 43.7)
30 to 45 days	15 (37.7%)
> 45 days	27 (64.3%)
Axillary approach	
SNLB*	27 (64.3%)
Lymphadenectomy	15 (37.7%)
Clinical staging	
Initial (0, I and IIA)	12 (28.6%)
Advanced (IIB, III, and IV)	30 (71.4%)
Immunohistochemical classification	
Luminal A	9 (21.4%)
Luminal B	13 (31%)
HER2+	7 (16.7%)
Triple-negative	13 (31%)
Hormone therapy	
Tamoxifen	8 (19%)
Anastrozole	19 (45.2%)
Not applicable	15 (35.7%)
Neoadjuvant chemotherapy	30 (71.4%)
Adjuvant treatment	
Chemotherapy	12 (28.5%)
Radiotherapy	17 (40.4%)
Postoperative complications	
Intercostobrachial neuralgia	11 (26.2%)
Paresthesia	24 (57.1%)
Pain intensity level (VAS)	
Mild (1-3)	35 (83.3%)
Moderate (4-6)	5 (11.9%)
Intense (7-10)	2 (4.8%)

Captions: SD: Standard deviation; HER2+: Human epidermal growth factor receptor type 2; SNLB: Sentinel lymph node biopsy; VAS: Visual analogue scale.

Moreover, the 60° external rotation PTI presented a weak and negative correlation with post-surgery time (r = -0.361). There was no significant correlation between isokinetic muscle strength, disease staging, and UL inability (Table 5).

DISCUSSION

The present study assessed the functionality of upper limbs in women with breast cancer, comparing the operated limb with the non-operated limb, assessed QoL and fatigue, and identified correlations between these variables. All the applied questionnaires presented significant correlations among them, especially QuickDASH, which showed a strong negative correlation with FACT-B, FACT-G, and FACT-F. This suggests that the functional inability of upper limbs can negatively influence QoL and fatigue. The isokinetic test showed a significant difference in the PTI between the operated and non-operated sides at 180°/s in the flexion, extension, and internal rotation movements. Moreover, there was a significant correlation between isokinetic strength and type of surgery, pain, and post-surgery time. However, no significant correlation was observed between isokinetic strength, disease staging, and upper limb inability.

Firstly, a strong and significant correlation is observed between upper limb functionality and fatigue, indicating that greater upper limb functionality represents less fatigue, which is in line with previous studies[28] that demonstrated fatigue to be one of the most prevalent symptoms among women undergoing breast cancer treatment. Fatigue can compromise functional ability, making daily activities more challenging and negatively impacting QoL. This correlation suggests that, in addition to physical limitations, fatigue plays a crucial role in the perception of upper limb functionality, reflecting the difficulties faced by patients not only in the physical, but also in the emotional scope.

The study by Olson et al.[28], conducted with a general cancer population, identified that the fatigue severity levels reported by patients were not significantly related to fatigability or muscle strength. A possible explanation for that is the complexity of global factors that may be related to cancer-related fatigue, like metabolic alterations, sleep disturbances, secondary effects from treatment, anxiety, or even emotional issues. Thus, fatigue can result from a combination of factors and not exclusively from diminished muscle strength.

Additionally, this study showed that upper limb functionality had a significant correlation with QoL, demonstrating that the greater the upper limb inability, the lower the QoL, both overall and specific to breast cancer

Table 3. Analysis of Spearman correlation for the QuickDASH, FACTG, FACT-F, and FACTB+4 questionnaires

	QuickDASH r (CI 95%)	FACT-G r (CI 95%)	FACT-F r (CI 95%)	FACTB+4 r (CI 95%)
FACT-G	-0.778*	-	0.949*	0.946*
FACT-F	-0.819*	0.949*	-	0.903*
FACTB+4	-0.753*	0.946*	0.903*	-

Captions: r: Spearman correlation; CI: Confidence interval; * $p < 0.05$; FACT-G: Functional Assessment of Cancer Therapy-General; FACT B+4: Functional Assessment of Cancer Therapy-Breast plus Arm Morbidity; FACT-F: Functional Assessment of Cancer Therapy-Fatigue; QuickDASH: Quick Disabilities of the Arm, Shoulder and Hand.

Table 4. Isokinetic peak of torque index on the operated and non-operated sides

	Operated side (n=42)			Non-operated side (n=42)			*p*
	Median (SD±)	Minimum	Maximum	Median (SD±)	Minimum	Maximum	
PTI Flexion at 60º	1.110 (0.356)	0.680	2.180	1.210 (0.315)	0.570	1.840	0.189
PTI Flexion at 180º	0.860 (0.284)	0.450	1.470	0.970 (0.296)	0.510	1.490	**0.007***
PTI extension at 60º	1.050 (0.562)	0.050	3.110	1.095 (0.504)	0.380	2.930	0.083
PTI extension at 180º	1.030 (0.591)	0.010	3.110	1.100 (0.588)	0.160	2.930	**0.012***
PTI Internal rotation at 60º	1.010 (0.237)	0.560	1.590	1.085 (0.262)	0.540	1.700	0.060
PTI Internal rotation at 180º	0.980 (0.250)	0.290	1.590	1.020 (0.286)	0.410	1.750	**0.012***
PTI External rotation at 60º	0.435 (0.207)	0.140	1.100	0.415 (0.209)	0.150	1.120	0.872
PTI External rotation at 180º	0.395 (0.195)	0.190	0.910	0.360 (0.209)	0.090	0.780	0.322

Captions: PTI: Peak of torque index; SD: Standard deviation; * $p < 0.05$.

Table 5. Analysis of Spearman's correlation of the isokinetic muscle strength PTI with breast cancer treatment, disease staging, pain, and UL inability variables

	PTI Flexion 60º r (p-value)	PTI Flexion 180º r (p-value)	PTI Extension 60º r (p-value)	PTI Extension 180º r (p-value)	PTI Internal rotation 60º r (p-value)	PTI Internal rotation 180º r (p-value)	PTI External rotation 60º r (p-value)	PTI External rotation 180º r (p-value)
Surgery type	-0.222 (0.163)	**-0.368*** **(0.023)**	-0.004 (0.978)	-0.057 (0.722)	-0.109 (0.493)	-0.095 (0.554)	-0.226 (0.150)	-0.224 (0.202)
Staging	-0.162 (0.312)	-0.139 (0.405)	-0.206 (0.190)	-0.043 (0.101)	-0.278 (0.074)	-0.255 (0.108)	-0.304 (0.050)	-0.223 (0.205)
Post-surgery time	-0.285 (0.087)	-0.098 (0.576)	-0.107 (0.524)	-0.044 (0.791)	-0.150 (0.370)	0.034 (0.840)	**-0.361*** **(0.026)**	0.023 (0.904)
Pain (VAS)	-0.256 (0.106)	-0.311 (0.057)	**-0.353*** **(0.022)**	**-0.508*** **(< 0.001)**	**-0.375*** **(0.014)**	**-0.408*** **(0.008)**	-0.003 (0.984)	-0.032 (0.859)
QuickDASH	-0.096 (0.585)	-0.069 (0.697)	0.093 (0.590)	-0.050 (0.772)	0.177 (0.303)	0.079 (0.650)	-0.130 (0.450)	-0.282 (0.124)

Captions: r: Spearman's correlation; * $p < 0.05$; PTI: Peak of torque index; VAS: Visual analogue scale; QuickDASH: Quick Disabilities of the Arm, Shoulder, and Hand.

treatment repercussions. Such a finding corroborates other studies, like the one from Macdonald et al.[29], which demonstrated that women with upper limb dysfunction related to breast cancer, whose dysfunction persists after the primary treatment, presented a significantly worse QoL than individuals with no dysfunction.

Another study analyzed the impact of breast cancer and its treatment on QoL related to women's health and found that, before and after conservative breast surgery, there was a significant change mainly in the body image, physical function, and emotional function aspects after surgery. Such results reinforce the importance of rehabilitation strategies that promote maintenance or improvement of upper limb function, as this can positively impact the general well-being of patients[30].

Regarding isokinetic muscle strength comparison between the operated and non-operated sides, there was a significant difference in the flexion, extension, and internal rotation movements, exclusively at the angular speed of 180°/s. These findings suggest that strength reduction may be more evident in quick movements, which require more muscle potency, while slower movements did not present such differences. A possible explanation for this difference may be due to kinesophobia that many patients present after surgery, characterized by the fear of making movements due to the anticipation of pain and/or lesion, which tends to limit the execution of quick and explosive movements, contributing to torque decrease on the operated side, even without important structural deficits[15,31].

Other studies also observed similar results, indicating significant differences between the strength in the operated and non-operated sides of women with breast cancer[32,33]. The study by Subasi et al.[33] compared isokinetic parameters of the operated and non-operated shoulders in breast cancer survivors and revealed significant deficits in muscle strength, potency, and endurance on the operated side, especially in internal and external rotation movements at high angular speeds. These limitations may negatively impact upper limb functionality, highlighting the importance of specific physiotherapeutic interventions for better post-surgery recovery.

One of the few studies that assessed isokinetic muscle strength in the breast cancer population analyzed the strength of shoulder and knee at 0º, 60°, and 180°/s in different phases of the treatment and compared groups of women with breast cancer and healthy women, showing that patients with breast cancer in acute treatment had noticeably impaired and reduced muscle strength, as well as muscle fatigue, in comparison to healthy individuals[34]. These differences between patients and healthy individuals reinforce the importance of physiotherapeutic follow-up throughout the treatment process, mainly targeted at muscle strengthening and endurance.

This study also revealed a significantly low and negative correlation between isokinetic muscle strength in the flexion movement at 180º and the type of surgery performed (r = -0.325), suggesting that surgical interventions may result in physical consequences that affect muscle strength. Some studies[34-36] indicate that surgeries like mastectomy and axillary dissection may significantly compromise functionality, in the form of muscle strength loss, mobility limitation, and persistent pain. These effects impair functional recovery and the QoL of patients.

However, in this study, there was a predominance of conservative surgeries (71.4%), which may be associated with a minor upper limb functional impact, as it tends to preserve the integrity of adjacent breast tissues, contributing to better muscle performance in the postoperative period, when compared to the more aggressive effects of mastectomy.

On top of that, local therapies for breast cancer, like surgery, radiotherapy, and mammary reconstruction, are highly invasive and cause significant impacts on the neighboring musculature. Radiotherapy, for instance, can affect molecular regulators responsible for muscle regeneration, impairing recovery of strength and muscle function. Surgery, in turn, causes changes to muscle morphology, resulting in trauma and damage to the adjacent nerves, which may lead to weakness and pain. Mammary reconstruction also contributes to these morphological changes[7]. Given this, continuous muscle health follow-up during and after oncological treatment is key for improving shoulder morbidity management, helping to minimize adverse effects, and promoting a more effective functional recovery[36].

This study also observed that muscle strength, especially in the extension movement, can be influenced throughout time after a surgical procedure; however, this result should be carefully analyzed, considering that the other movements were not statistically significant. However, in literature, other studies also reported an association between strength and post-surgery time, like Carpena-Niño et al.[12], which highlighted that functional post-surgery recovery in women with breast cancer occurs progressively, but is influenced by several factors, such as surgical trauma, and adverse effects of adjuvant therapies, like chemotherapy and radiotherapy. The study demonstrates that, in the immediate period after surgery, patients presented significant deficits in manual strength and functionality, with gradual recovery over time, reflecting neuromuscular and sensory adaptations. This reinforces the importance of early and individualized rehabilitation programs in optimizing functionality and recovery of upper limbs over time.

Isokinetic muscle strength, in extension and rotation movements, showed a correlation with low to moderate pain, which is in line with studies that indicated that pain could interfere with movement execution. A previous study confirmed that pain, from surgical treatment and/or cancer treatment, directly interferes with upper limb function, limiting ROM and reducing manual grip strength, a reflex of muscular ability. The impact of pain manifests itself in the reduction of muscular activation and motor coordination, impairing the execution of complex movements and, consequently, muscle strength, even in isokinetic tests performed at constant speeds. This finding of pain as a key factor that interferes with movement execution, influencing upper limb function and strength, has been broadly documented in literature, particularly in breast cancer survivors[8].

That way, it is important to highlight that the sample was mostly composed of middle-aged women (73.8% were 40-59 years), homemakers (80.5%), who live in the Metropolitan Region of Belém (69%). These factors, combined with the high prevalence of overweight (66.6% were overweight or obese), smoking (33.3%), and presence of comorbidities (31%), compose a risk profile that can significantly interfere with the overall functionality, in the perception of fatigue and QoL in the postoperative period. Disease progression is also related to risk factors, life habits, and access to a multiprofessional team that can contribute to improved QoL related to these women's health.

Early intervention must be a priority since diagnosis, considering evidence that relates these functional changes to a worse cancer prognosis. The implementation of strength and endurance training programs during treatment is a key strategy, capable of attenuating or reversing muscle dysfunction, in addition to improving fatigue and QoL of patients over time.

This research had some limitations. Isokinetic assessment could have included a greater number of repetitions at 180°/s angular speed, which would have allowed for a more thorough analysis of muscle endurance and fatigability. In addition, pain assessment could have been complemented with the use of specific instruments capable of providing a more precise characterization of this symptom. Another limiting factor was applying the QoL and fatigue questionnaires at a different time from the isokinetic muscle strength assessment, which may have compromised comparison between data due to the time interval between collections.

Moreover, patients received guidance for performing physical exercises at home, in the interval between surgery and the isokinetic strength test assessment, which may have influenced their performance. For further studies, we recommend including functional tests that can offer more encompassing insights into the impact of breast cancer and its treatments on upper limb functionality.

CONCLUSION

This study suggests that upper limb functionality is intimately related to fatigue and QoL; however, isokinetic muscle strength, when analyzed in isolation, did not show a significant predictor for these variables. A significant difference was also observed between the operated and non-operated sides in flexion, extension, and internal rotation movements, exclusively at 180°/s angular speed, indicating that strength reduction is more evident in quick movements that require more muscle potency. Moreover, surgery type, pain, and post-surgery time demonstrated important impacts on isokinetic strength.

These findings corroborate the need for early and continuous rehabilitation interventions to optimize functional results and QoL of women with breast cancer, especially in the Amazonian Region, where resources are limited and there is a shortage of professionals specialized in oncological rehabilitation.

CONTRIBUTIONS

All the authors have substantially contributed to the study design, data acquisition, analysis, and interpretation, wording, and critical review. They approved the final version for publication.

DECLARATION OF CONFLICT OF INTERESTS

There is no conflict of interest to declare.

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All the contents associated with the article are included in the manuscript.

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