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SELF-REPORTED ARM FUNCTION IS ASSOCIATED WITH STRESS AND FEAR OF PHYSICAL ACTIVITY AMONG WOMEN TREATED FOR BREAST CANCER

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ABSTRACT

Background

Self-reported upper extremity function and objective measures are not strongly associated with each other in women treated for breast cancer (BC). It is not known if the lack of relationship between self-reported upper extremity function and objective measurements may be influenced by perceived levels of stress and fear of physical activity. The purpose of this study was to investigate the relationships between self-reported upper extremity function and the following: perceived stress levels (PS), fear of physical activity (FPA), health-related quality of life (HRQOL), and objective measures of upper extremity function among women treated for BC.

Methods

This cross-sectional observational study included 23 women diagnosed with breast cancer 12-60 months prior to data collection. Self-reported upper extremity function, PS, HRQOL and FPA were assessed using the Disabilities of the Arm, Shoulder and Hand (DASH), Perceived Stress Scale (PSS), Functional Assessment of Cancer Therapy-Breast Cancer (FACT-B), and Fear of Physical Activity and Exercise for Breast Cancer (FPAX-B), respectively. Objective shoulder measures included range of motion (ROM), strength, and muscular endurance.

Results

The DASH was significantly correlated ($p<0.001$) with the FACT-B, PSS, and FPAX-B ($r=-0.863$; $r= -0.733$; $r= -0.709$ respectively). No significant correlation was found between the DASH and objective measures except non-dominant shoulder endurance ($p<0.05$, $r=-0.432$).

Conclusions

There is a significant relationship between the self-reported arm function, PS, HRQOL and FPA among women treated for BC. Further research should be done to understand the role that PS and FPA have on the perceived level of upper extremity function that women treated for BC report.

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QUALITY OF LIFE, SHOULDER, BREAST NEOPLASMS, UPPER EXTREMITY, RANGE OF MOTION, EXERCISE, FEAR, ACTIVITY, PERCEPTION, DISTRESS

INTRODUCTION

In 2021, an estimated 281,550 women were projected to be diagnosed with breast cancer in the United States (US), accounting for more than 30% of all new female cancers; over 90% will likely survive 5-years.[1,2] Another important fact is that the breast cancer death rate has decreased by 40% from 1989 to 2016.[2] As a result, women treated for BC have the potential to regain the same life expectancy as the general population with time after diagnosis.[3]

New cancer treatments have resulted in improved life expectancy but have also left many women treated for BC with treatment-related impairments, such as restricted shoulder movement, reduced strength, and pain.[4,5] Although these physical impairments are often the primary focus of providers, other impairments, such as fatigue, impaired cognition, and psychological deficits may lead to greater functional impairments.[6,7] For instance, survivors who experience stress report limited coping strategies and ability to manage cancer and its treatment side-effects, and those with traits of anxiety describe self-imposed limitations in their daily life.[8,9] These limitations are often characterized as impaired function measured subjectivity through the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire and include difficulty performing lifting and carrying tasks, self-care activities related to dressing and bathing, as well recreational activities.[4,13]

Of the physical impairments experienced by women treated for BC, upper extremity impairments have been the primary physical complaint and concern. Despite improvements in objective measures of upper extremity function such as range of motion and strength, survivors' self-reported upper extremity function and objective measures are not strongly associated with each other.[10] Instead self-reported upper extremity function has been more closely related to health-related quality of life (HRQOL) measures than objective measurements of upper extremity function.[4,11] This inconsistency between self-reported upper extremity function and objective measurements may be influenced by psychological factors such as perceived levels of stress and fear of physical activity.[12]

Psychological factors may be one of the explanations for women treated for BC perceived impaired upper extremity function despite having objective upper extremity physical measurements similar to that of a population of women without cancer.[13] However, physical rehabilitation continues to be the primary intervention for treating physical impairments, with much of the rehabilitative focus aimed at restoring upper body function by addressing physical impairments such as lack of motion or strength, with little regard to the increasing evidence indicating that psychological factors should also be considered, such as fear of physical activity or kinesiophobia[14,15] Kinesiophobia is a common phenomenon that is associated with a past experience of pain with a particular activity. As a result, the individual is less likely to participate in this activity in the future.[16,17] This fear has also been reported to limit activity among those with lung cancer[18,19] and those who are at risk for breast cancer-related lymphedema.[12,20-22]

Currently, there is limited research exploring the relationship between fear of physical activity and recovering function after cancer diagnosis.[12,20,22,23] Specifically, there is limited understanding of why women with BC do not perceive that they have normal arm function and if this is associated with perceived stress or fear of physically using the arm. This study addresses this limited understanding by examining the relationships between self-reported arm function and each of the following: perceived stress levels, health-related quality of life, fear of physical activity, and objective measures of upper extremity function.

METHODS

Participants

A convenience sample of 25 women diagnosed with breast cancer between 12-60 months prior to data collection were recruited into the study. Participants had surgery for stage I, II or III breast cancer, and could read and write English. Those diagnosed with metastatic cancer; had a history of current or past shoulder injury within the previous 6 months; previous neck, shoulder, or chest surgery unrelated to breast cancer treatment; or had cognitive or cardiovascular dysfunction; were excluded from the study. The early time frame of one year post diagnosis was used to ensure that participants had completed most surgical, chemotherapy, and radiation treatment at the time of participation. The cut point of five years was used to capture functional changes as a consequence of cancer treatment rather than those related to aging. Five years also marks the typical transition from regular follow-up with oncology to primary care practitioners. This study was approved by the Institutional Review Boards of the University of Dayton and Eastern Kentucky University. All participants completed informed consent prior to data collection.

Procedure

Participants completed questionnaires and had objective measurements of their upper extremity function collected by researchers in an academic laboratory setting. The questionnaires included: a demographics questionnaire, self-reported arm function using the Disabilities of the Arm, Shoulder and Hand (DASH), stress assessment using the Perceived Stress Scale (PSS), HRQOL assessment using the Functional Assessment of Cancer Therapy for Breast Cancer (FACT-B), and assessment of fear of physical activity using the Fear of Physical Activity and Exercise – Breast Cancer (FPAX-B) questionnaire. Objective measurements of function included shoulder range of motion (ROM), strength, muscular endurance, height, and weight for body mass index calculation. Each participant moved through stations for data collection in a variable sequence dependent upon researcher availability at each station: questionnaires, ROM, strength, and muscular endurance. All questionnaires were completed independently by each participant, with the researcher available to answer clarifying questions. Objective measurements were taken by the same physical therapy researcher.

Questionnaires

Disabilities of the Arm, Shoulder and Hand (DASH). This 30-item self-report scale of upper extremity function was used to assess participant's perception of arm function. Lower scores (0 – 100) indicate less disability or more function. The DASH has been validated against other shoulder scales, and it demonstrates excellent test-rest reliability (ICC=0.97) and internal consistency (Cronbach's alpha 0.92-0.98) in women with BC.[24,25]

Functional Assessment of Cancer Therapy for Breast Cancer (FACT-B). This 36-item self-report scale assesses the HRQOL in breast cancer patients. The scale has four subscales – physical, social, emotional, and functional well-being – comprising the FACT general scale, plus 9 items covering specific concerns for those with BC. Higher scores (0-148) indicate greater HRQOL. The scale has been extensively used in breast cancer research, has good reliability (ICC=0.85) and is validated against the Functional Living Index – Cancer (r=0.87).[26]

Perceived Stress Scale (PSS). This 10-item self-report scale

that measures stress in the past month with each question rated on a 0-4 Likert scale. Higher scores (0-40) indicate greater stress. Scores exceeding 27 suggest a high level of stress. This scale has been used to measure stress among women treated for BC;[27] it also demonstrates good internal consistency (Cohen's alpha 0.74-0.91), test-retest reliability r>0.77, and is validated against the mental component of the Short Form 36 (SF-36).[28]

Fear of Physical Activity and Exercise Scale - Breast Cancer (FPAX-B). This 17-item self-report scale measures the amount of kinesiophobia experienced by those with breast cancer when participating in physical activities. Each item is scored on a 0 to 4 ("not at all" to "very much") Likert scale. The stem for each question is "I am concerned about participating in physical activity and/or exercise because…" Higher scores (0-68) indicate greater fear of physical activity. The internal consistency of the scale is excellent (Cronbach's alpha = 0.95) and it is validated against the Tampa Kinesiophobia Scale (r=.53).[20]

Objective measures

Range of motion. Using standard motion testing guidelines,[29] bilateral arm flexion, external rotation, and internal rotation range of motion (ROM) measurements were taken using a digital inclinometer (Dualer, JTech Medical, Midvale, UT). Shoulder flexion was measured with the participant standing, while shoulder internal and external rotation were measured with the participant lying supine with upper arm propped on towels and elbow bent 90 degrees, following established protocols.[29] Participants were instructed to move through the motion as far as they could comfortably. The participant completed each motion 2 times and the average of these measurements was used for analysis.

Strength. A handheld dynamometer (Lafayette Instrument Company, Lafayette, IN) fixed to a stationary device was used to measure strength. Using standard manual muscle testing positions, participants completed measures for shoulder flexion, internal, and external rotation strength. For flexion, the participant was standing. External and internal rotation were measured with the arm placed at 90 degrees shoulder abduction and flexion, with the upper arm supported by a towel. Participants were instructed to increase the muscle contraction force to their maximum voluntary force and hold the motion until the dynamometer beeped at the end of 5 seconds. The average of 2 trials was used for analysis.

Bilateral arm muscle endurance. The Upper Limb Lift Test was used to simulate repetition to fatigue. The participant was instructed to lift a dumbbell scaled to 4% of her body weight from shoulder height to 25 cm above her shoulder for a maximum of 17 repetitions, at a rate of 60 hertz as measured by a metronome. The test was ended if the participant: a) could not keep pace with the metronome, b) demonstrated poor movement patterns, c) stopped early, or d) completed all 17 repetitions. The final number of repetitions for each limb was recorded.

Statistical Analysis

Participants' demographics, survey results and objective physical measurements were analyzed using SPSS version 27 (IBM, Chicago, IL). Demographic data were summarized using descriptive statistics for all variables. With alpha at 0.05 a priori, independent samples t-tests were conducted to evaluate differences in all variables among participants who received rehabilitation (yes/no); had axillary node dissection (yes/no); type of surgery (lumpectomy/mastectomy); and limb involved (dominant/non-dominant) to control for their potential influence on perceived function. If group differences were found, separate correlation analyses were performed on each group. In the absence of group differences, correlation analyses were performed on the full group of participants. The relationship between self-reported arm function measured by the DASH and each variable: HRQOL (FACT-B), stress (PSS), fear of physical activity (FPAX-B), ROM, strength, and muscular endurance, was analyzed using Pearson's *r*. Post hoc analysis of the power of this study comparing DASH scores of participants in this studied to that of the published literature for women with BC reveals power of >95%.

RESULTS

Two participants were removed from data analysis after consent and data collection; one participant was diagnosed with BC less than 6 months prior to data collection (5.25 months), and the second revealed a subsequent diagnosis of stage IV cancer. A total of 23 participants are included in the final analysis.

Summary of the participant demographics are found in Table 1.

Table 1 - Demographic and Clinical Characteristics (n=23)

Characteristics	Mean	Range
Age, years	52	31-66
Characteristics	**Mean**	**SD**
Body Mass Index	28.40	6.79
Duration in months since		
Diagnosis	31	13
Surgery	27	13
Characteristics	***n***	**%**
Stage†		
0	1	5
1	7	32
2	8	35
3	5	23
Cancer Type		
DCIS	5	22
IDC	12	52
ILC	4	17
Unknown	2	9
Surgery		
Lumpectomy	8	35
Mastectomy	15	65
Lymph Node surgery		
SLNB	14	61
ALND	9	29
Cancer treatment		
Radiation	5	22
Chemotherapy	3	13
Both	10	43
Neither	5	22
Involved limb		
Dominant	11	48
Non-dominant	12	52
Currently Working	17	74
Involved in a Support Group	4	17
Previous Rehabilitation	14	61

Abbreviations:
ALND = Axillary lymph node dissection; DCIS = Ductal carcinoma in situ; ICD = Invasive ductal carcinoma; ILC = Invasive lobular carcinoma; SD = Standard Deviation; SLNB = Sentinel lymph node biopsy.
†One participant did not indicate her stage of breast cancer

Participant mean age was 52 (range 31-66) and mean BMI was 28.40 (SD 6.79). The time from date of diagnosis to data collection ranged from 13 to 59 months, with an average of 31 months (SD 13). The time from date of surgery to data collection ranged from 5 to 58 months, with an average of 27 months (SD 13). The majority of the participants reported having stage I (n=7) or stage II (n=9) cancer. Self-reported breast cancer types were ductal carcinoma in situ (n=5), invasive ductal carcinoma (n=12), invasive lobular carcinoma (n=4), and unknown (n=2). Breast surgery procedures included lumpectomy (n=8) and mastectomy (n=15). Cancer treatments received were radiation (n=5), chemotherapy (n=5), both (n=11), or neither (n=2). Cancer was diagnosed

on the dominant arm side in 11 of the subjects. Most of the participants were working (n=17), received rehabilitation (n=14) and had not been a member of a support group (n=19).

Table 2 provides a summary of the outcome measurements. Statistical analyses revealed no significant group differences between participants: who received rehabilitation or did not; by type of cancer treatment received; and whose involved limb was dominant and those whose involved limb was non-dominant. Therefore, all analyses were performed on the full sample of participants.

Table 2 - Questionnaire and Objective Measures (n=23)

	Mean (SD)	95% CI
DASH	18.13 (15.22)	(11.9-24.3)
FACT-B	112.34 (15.45)	(106-119)
PSS	16.43 (6.01)	(14-18.9)
FPAX-B	25.58 (21.89)	(17.3-33.9)

	Dominant Operated Side		Non-Dominant Operated Side	
	Mean (SD)	95% CI	Mean (SD)	95% CI
Flexion ROM (degrees)	146 (11)	(142-151)	150 (15)	(144-156)
Internal rotation ROM (degrees)	68 (13)	(63-73)	71 (17)	(64.2-77.8)
External rotation ROM (degrees)	84 (16)	(78-91)	82 (14)	(76.4-87.6)
Flexion Strength (kg force)	9.5 (3.38)	(8.12-10.9)	9.91 (4.23)	(8.22-11.6)
Internal rotation Strength (kg force)	4.86 (2.77)	(3.73-5.99)	4.48 (1.77)	(3.77-5.19)
External rotation Strength (kg force)	5.12 (2.35)	(4.16-6.08)	4.21 (1.55)	(3.59-4.83)
Muscular Endurance (repetitions)	13 (7)	(10.1-15.9)	14.8 (5.04)	(12.8-16.8)

Abbreviations:
CI = Confidence Interval; DASH = Disabilities of the Arm, Shoulder and Hand; FACT-B = Functional Assessment of Cancer Therapy – Breast; FPAX-B = Fear of Physical Activity and Exercise for Breast Cancer; kg = kilogram; PSS = Perceived Stress Scale; ROM = range of motion; SD = Standard Deviation

Perceived Arm Function and Health-Related Quality of Life. The DASH scores were significantly correlated with the FACT-B scores ($p<0.001$, $r=-0.863$) (Figure 1a). Specifically, DASH scores were significantly correlated with the physical, emotional, and functional subscales of the FACT-B ($p<0.01$, $r=-0.802$, $r=-0.612$, $r=-0.806$ respectively).

Perceived Arm Function, Perceived Stress, and Fear of Physical Activity. The DASH was significantly correlated with PSS ($p<0.001$, $r=0.733$), and FPAX-B ($p<0.001$, $r=0.709$) (Figure 1b and Figure 1c).

Perceived Arm Function and Objective Arm Function Measurements. No significant correlations were found between the DASH and all objective ROM, strength, or endurance measures ($p>0.05$) for those whose cancer was on the dominant limb. The DASH was significantly correlated with only with muscular endurance for those whose cancer was on the non-dominant limb ($p=0.045$, $r=-0.432$).

Figure 1a - Relationship between DASH and FACT-B

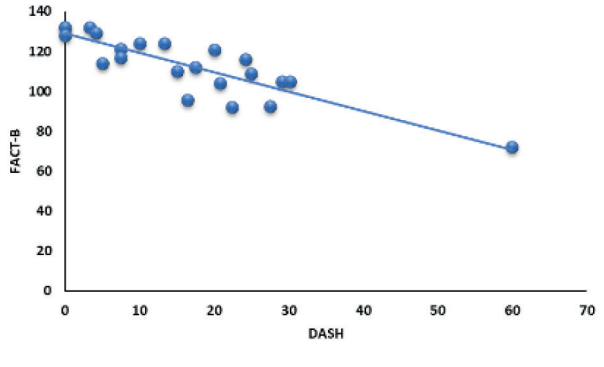


Figure 1b - Relationship between DASH and Perceived Stress Scale

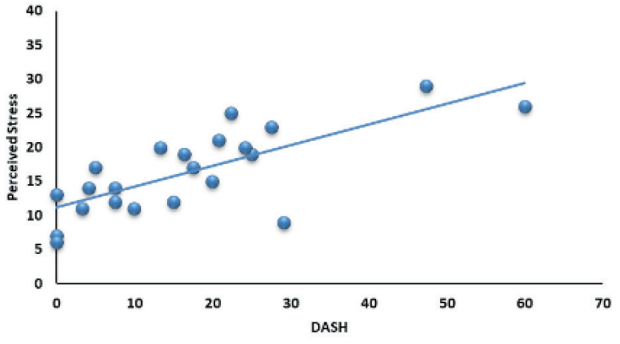
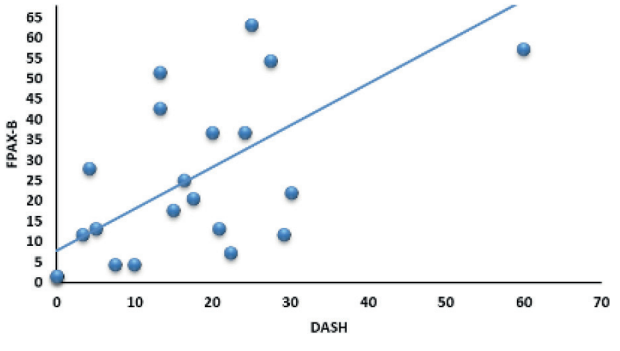


Figure 1c - Relationship between DASH and FPAX-B



DISCUSSION

We sought to investigate the relationship between self-reported arm function and each of the following: HRQOL, perceived stress, fear of physical activity, and objective measures of arm function. Our findings demonstrate minimal to no association between self-reported arm function and objective physical measurements in this sample of women treated for BC. Rather, self-reported arm function was significantly and strongly related to HRQOL, perceived stress, and fear of physical activity. Furthermore, these relationships were not influenced by pain, rehabilitation received, surgical procedure, nor involved arm dominance.

HRQOL

The link between self-reported arm function and HRQOL has been investigated previously. Studies report declines in self-reported function and lower HRQOL among women treated for BC compared to control groups as measured by the DASH and FACT-B.[4,13] The relationship between self-reported arm function and the physical and functional subscales of FACT-B was highlighted in a group of 30 women treated for BC, where the relationship between the DASH and FACT-B was strong ($r>0.80$), consistent with our findings.[30] Furthermore, the relationship between self-reported arm function was significantly correlated with the physical, emotional, and functional well-being subscales, again consistent with our findings. It appears that how women perceive their arm function may influence their reported HRQOL, such that greater disability is related to lower quality of life, while less disability is related to higher levels of quality of life. Because HRQOL is a typical endpoint and

outcome of interest for many protocols for care, it is important to consider what impacts HRQOL, and how to address those areas. Our findings add to the research by illustrating a relationship between perceived stress and fear of physical activity with self-reported arm function. This suggests that understanding the complex interplay between self-reported arm function, perceived stress, and fear of physical activity may ultimately lead to interventions that address these factors resulting in a positive influence on reported levels of HRQOL.

Perceived stress

The relationship between self-reported arm function and perceived stress among women with BC has not been described in the literature, but a variety of other factors related to the outcome of BC treatment and perceived stress have been described: hope and psychological hardiness,[31] social constraints and sleep,[32] partial vs. whole breast radiation,[33] sexual orientation,[34] self-esteem, income, and number of children.[35] The results from this study provide an awareness that personal and cancer-related stress may negatively impact women with BC's perception of their ability to complete tasks requiring the use of their involved arm. Understanding the impact of stress on self-perceived function is important when interpreting common outcome measures such as the DASH. If not, interventions may focus primarily on physical deficits and not potential stressors that could be influencing perceived function. Indeed, findings from earlier studies substantiate the disconnect between physical impairment and functional abilities. In a study by Fisher, et al,[13] women with a history of BC reported functional impairments on the DASH despite having what are considered functional levels of strength and range of motion. This study adds to the understanding that physical impairment alone cannot account for perception of functional abilities.

This recognition fits within an interprofessional care rehabilitation model that includes team members beyond physical rehabilitation providers, such as counseling or psychology providers. This interprofessional approach is supported by research indicating significant improvements in outcomes, such as reduced perceived stress, and HRQOL, among those receiving comprehensive interprofessional care.[36-40]

Fear of physical activity

Physical activities, such as exercise, yard work, and home maintenance, are important to many women treated for BC and have been explored in previous studies. However, the influence of fear of activity participation and the perceived ability to complete physically demanding activities among women diagnosed with BC have not been explored,[41,42] but has been studied in relation to perceived arm function.[22] In a recent study of 81 women treated for BC, those with greater levels of fear of movement had lower levels of self-reported arm function, similar to our findings.[22]

Among women treated for BC, fear of movement may limit confidence in engaging in physically demanding activities which require the use of the involved arm. Therefore, recognizing when fear is limiting willingness to participate in physically demanding activities could lead to interventions to reduce fear, and increase ability and confidence to complete desired physically demanding activities. For example, when a woman with BC is afraid to use her involved arm to complete physically demanding activity, a rehabilitation professional could use a cognitive behavioral approach while monitoring the activity to increase her confidence in completing this physically demanding activity without pain or injury.[43]

Distress

Further understanding of perceived stress and fear of physical activity may be linked to understanding distress among women with BC. Evidence supports that distress – the individual's heightened perception and response to symptom-related stress – is greater among those treated for BC.[44,45] Distress is often linked to physical symptoms, such as pain and the perception of disability among women treated for BC. While the presence of pain was not controlled for in this study, when objective measures were taken, the participants were asked to not move to the point of pain, and strength measurements did not induce pain or grimacing. Being aware of distress related to arm function is important when considering the comprehensive care for women with BC. As mentioned earlier, the interprofessional healthcare team is important, and the inclusion of counseling and psychological services are necessary to positively impact outcomes and overall HRQOL for women treated for BC.[36-40]

It is important to consider whether pain plays a role in the perceived or real ability to complete functional activities. Indeed, it is possible that pain could contribute to the discrepancy between self-reported and objective measures of function. To capture this possibility, participants were asked to answer two pain questions within the DASH: "Arm, shoulder or hand pain," and "Arm, shoulder or hand pain when you performed any specific activity" (none-mild-moderate-severe-extreme). In this group, 87% of the participants rated their pain none-mild; only 3 participants noted moderate pain. With this in mind, pain does not appear to account for the lack of relationship between self-reported and objective measures of function.

Strengths and Limitations

The primary strengths of this study include a novel and relevant research question, and gathering objective data in a variable sequence based on research station availability. As a result of the latter, some women completed self-reported measures prior to objective data collection and vice versa, thereby minimizing systematic bias.

Limitations include the use of a convenience sampling to obtain research participants as this sample may not be representative of all women treated for BC. Anxiety and depression may also play a role in perceived function, and these constructs were not evaluated in this population. Furthermore, one of the main limitations of this cross-sectional study is that it does not address causation. Following these survivors from diagnosis up to 5 years post-treatment would have allowed for a better understanding of how the outcome measures of HRQOL, perceived stress, fear of physical activity, and objective arm functions changed over time. Additionally, we have relied on self-reported measures for arm function, HRQOL, perceived stress and fear of physical activities that are subject to recall bias. We described some demographic variables, but additional ones should be included in the future (i.e., income, number of children, sexual orientation); these characteristics could be confounders since these have been associated with perceived stress. Results could potentially be related to a physiologic factor that we have not measured, such as sensation and pain. These constructs and their interplay need further investigation.

CONCLUSIONS

The aim of our study, which was to describe the relationship between perceived arm function and each of these characteristics: quality of life, perceived stress, fear of physical activity, and objective measures of arm function, was met. The findings of this study indicate a significant relationship

between fear of physical activity and perceived stress with self-reported function, while objective measures do not. This suggests that women diagnosed with BC may be continuing to limit using their affected arm in physically demanding upper extremity activities, possibly due to fear of injury and lymphedema, or to an unidentified stress. Implementing a team approach to recovery for women with BC could address the complex interplay of psychological stress, fear of physical activity, and physical impairments that might ultimately impact self-reported arm function and HRQOL. When addressing rehabilitation needs, person-centered care and evidence-based practice are needed to identify the personal factors limiting self-perceived functional recovery. These results provide support for the importance of targeting interventions to address personal factors beyond impairments when managing the functional deficits of women treated for BC.

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MIF, AF, KU, MM, RW, LD have contributed to the study conception and design, data acquisition, analysis, or interpretation. MIF, AF, KU, MM, RW, LD have drafted the manuscript. MIF, AF, KU have contributed to the critical revision of the manuscript. Statistical Analysis was performed by MIF, AF. Material preparation was performed by MIF, AF. MIF and AF have completed the supervision of the manuscript. All authors read and approved the final manuscript.

Conflict of interest
The Authors have no conflicts of interest to report.

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