Original Article

SAGE Open Medicine

SAGE Open Medicine
Volume 12: 1–9

DOI: 10.1177/20503121241283341
journals.sagepub.com/home/smo
Sage

Upper limb disabilities and associated factors among breast cancer survivors: A quantitative cross-sectional study

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Abstract

Objectives: Complications following breast cancer treatment result in chronic upper limb disabilities. To plan an informed and effective rehabilitation for timely intervention to prevent, mitigate, or manage the functional impairments for breast cancer survivors, especially in settings with limited resources, the burden of upper limb disabilities needs to be ascertained. This study examined upper limb disabilities and associated factors among breast cancer survivors.

Methods: This cross-sectional quantitative study recruited 60 breast cancer survivors using purposive sampling method. Text messages and face-to-face interactions were used to inform participants about the study. Disability of the Arm, Shoulder and Hand questionnaire was used to ascertain the upper limb disabilities. To determine lymphedema, tape measurements of upper limb circumference were translated into a limb volume with the geometric formula for a truncated cone. Visual analogue scale, hand dynamometer, and goniometer were used to measure pain, grip strength, and shoulder range of movement, respectively. Descriptive statistics were used to summarize data. Linear regression was used to determine the correlation between upper limb disabilities and selected variable. Alpha level was set at $p < 0.05$.

Result: The prevalence of upper limb disabilities was 73%. Pain, lymphedema, shoulder range of movement, and grip strength showed strong correlation with upper limb disabilities. Pain and lymphedema increased by around 0.095 and 0.061 units, respectively, for every unit increase in disability. Conversely, there was a decrease of 1.394, 0.770, 0.285, and 0.045 in shoulder flexion, shoulder abduction, grip strength, and body mass index, respectively, for every unit increase in disability.

Conclusion: Upper limb disabilities had high prevalence and significantly correlated with every variable that was examined. The high prevalence of upper limb disabilities and their interaction with related variables calls to action for routine screening and prompt intervention to identify, prevent, or manage upper limb functional impairments in breast cancer survivors.

Keywords

Upper limb, disabilities, breast cancer, survivors

Date received: 21 May 2024; accepted: 28 August 2024

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Introduction

Globally, breast cancer (BC) is the most common life-threatening malignancy diagnosed in women, and it is also the primary cause of cancer-related deaths in women.[1] 129,000 women in Sub-Saharan Africa had a new diagnosis in 2020, and it is anticipated that this number would rise.[1] In 2020, 28,380 new instances of BC were reported by the International Agency for Research on Cancer[2] in Nigeria. This accounted for the greatest proportion of all cancer types and represented 22.7% of new cancer cases.[2] Nigeria has the highest age-standardized BC mortality rate in Africa and among the highest in the world.[3] BC accounts for 14,274 (18.1%) of all cancer-related fatalities in Nigeria, making it the most prevalent cause of cancer-related mortality.[1] The occurrence of long-term post-treatment side effects or complications has increased in tandem with the notable advancements in BC medical treatment in terms of extending survival.[4,5]

Chronic upper limb (UL) disability are the consequence of complications after BC treatment, including radiotherapy, surgery, and chemotherapy.[6] Following axillary lymph node removal, mastectomy, chemotherapy, and radiation therapy, arm and shoulder issues characterized by stiffness, discomfort/pain, and swelling were often observed in BC survivors.[7] Surgery and treatments for BC can result in arm morbidity that lasts longer than 2.5 years.[8] Reduced range of motion (ROM), functional limitations in the ULs, and postoperative pain are the most frequent side effects of BC surgery.[9] Up to 68% of patients may experience pain and impairments in UL mobility following surgery due to axillary web syndrome (AWS).[9] Adjuvant therapies and tissue damage exacerbate the functional limitations caused by lymphedema, which is estimated to be prevalent in 6%–52% of cases, particularly following axillary lymph node dissection.[9] This suggests a significant decline in the patients' health-related quality of life[10] and may indicate greater challenges carrying out routine daily activities including getting dressed, brushing one's hair, working, going shopping, exercising, etc.

The growing incidence of BC, particularly in developing nations and low- and middle-income countries (LMICs), has resulted in a greater demand on these nations' healthcare systems for the treatment and rehabilitation of BC survivors. UL disabilities can have a detrimental effect on a BC survivor's quality of life and capacity to perform everyday tasks effectively. To plan an informed and effective rehabilitation for timely intervention to prevent, mitigate, or manage the functional impairments for BC survivors, especially in settings with limited resources, the burden of functional impairment and physical disability needs to be ascertained. Our aim was to examine UL disabilities and associated factors among BC survivors.

Methods

Research design

This study utilized a cross-sectional quantitative study design.

Sampling and sample technique

The study involved 60 BC survivors. The sample size was calculated using the Taro Yamane's formula[11] $n = N/1 + N(e^2)$, where n is the required sample size population under study, N is the whole population that is under study, and e is the precision or sampling error which is 0.05, $N = 70$; $e = 0.05$; $e^2 = 0.0025$, $n = 70/1 + 70$ (0.0025) $n = 60/1 + 0.175$ $n = 70/1.15$ $n = 59$.

Participants were notified about the study both in person at the clinic by the attending physician and oncology nurses and through bulk text messaging by one of the researchers.

Participants were recruited from 1st September to 15th November 2023. Data were collected from 20th November 2023 to 15th March 2024. They were consecutively recruited from the oncology center of Alex Ekwueme Federal University Teaching Hospital, Ebonyi State, Nigeria using a purposive sampling method. Inclusion criteria for participation were: Age ⩾ 18 years, BC survivors who have received any type of medical treatment (surgery, chemotherapy, radiotherapy) not less than 6 months, availability, and willingness to participate. BC survivors with significant cognitive impairment or inability to follow instruction, presence of a concurrent systemic or venous cause of limb swelling, such as axillary vein stenosis, hypoalbuminemia, venous insufficiency, heart failure, or renal failure, and those who are enrolled in any rehabilitation or physiotherapy treatment were excluded from the study.

Ethical issues

Ethical approval was sought and obtained from the Health Research and Ethics Committee of Alex Ekwueme Federal University Teaching Hospital, Ebonyi State, Nigeria. HREC APPROVAL NUMBER: NHREC/A0022250. All the participants signed a written informed consent form prior to participating in the study.

Data collection

Two of the researchers who are trained physiotherapists collected the data. One of the researchers collected data of the circumference measurement for lymphedema and grip strength in all the participants. While the other collected data for body mass index (BMI) and shoulder ROM in all the participants. Protocol for measurement was agreed on by all the researches. Data collectors satisfactorily practiced the procedure before data collection.

Disability of the UL: The Disability of the Arm, Shoulder and Hand (DASH) questionnaire, which takes 10–15 min to complete, was used to quantify this. The 30-item DASH questionnaire rates disabilities and symptoms from 0 (no impairment) to 100 (Severe disability). Participants score upper-extremity disability and symptoms on a five-point Likert scale using this self-report questionnaire. It is scored in two sections: The disability/

symptom section (30 items, scored 1–5) and the high-performance sport, music, or work component (4 items, scored 1–5). The DASH has a validity index of 0.70 and a reliability index of 0.96.[12]

Participants were given the DASH questionnaire to complete. The affected breast's ipsilateral UL was examined. The ULs on both sides were examined and scored if both breasts are affected. For the purpose of calculating the disability/symptom score, it is necessary to complete at least 27 out of the 30 items. To get a score out of five, the given values for each completed response are simply totaled and averaged. Subtracting one and multiplying by 25 converts this number to a score out of 100. This conversion is carried out to facilitate the comparison of the score with other metrics that are rated on a 0–100 scale. A higher rating denotes greater disability.

$$\text{DASH disability / symptom score} = \frac{\left[\left(\begin{matrix}\text{sum of n}\\ \text{responses}\end{matrix}\right) - 1\right]}{\text{n}} \text{ x } 25,$$

n = equal number of completed responses.

Optional modules (sport/music or work): The purpose of the optional modules is to pinpoint the unique challenges that performers, professional athletes, and other worker groups may face, but which might not have an impact on their daily activities and, as a result, might go "undetected" in the DASH's 30 items. The optional 4-item module score was computed using the same process as described above. To determine the score, all four questions must be answered. Each response's assigned values were totaled, divided by the number of items (4), subtracted from 1, and multiplied by 25 to obtain a score out of 100.

Missing items: The DASH disability/symptom score was not be computed if the respondent leaves more than 10% of the items blank, or more than three items. The high-performance sports/performing arts or work module only has four items; hence, no missing values are allowed under the same condition (i.e., no more than 10% of the items can be left blank). Both the original and updated scoring systems are subject to this "rule" about missing data.

Lymphedema: A non-elastic tape measure with range 0–150 cm was used to measure the UL circumference/volume for lymphedema. A systematic review reported a strong pooled intraclass correlation coefficient (0.99 (95% CI: 0.99–0.99)) and strong pooled interclass correlation coefficient (0.98 (95% CI: 0.98–0.98)) with 2.8% weighted standard error of measurement (3.2% variance) among studies using a manual tape measure for measuring lymphedema.[13] Given its popularity and reliability, the manual tape measure method has been used as a comparative standard of limb measurement in those with lymphedema of the extremities.[14,15]

The arm circumferences measurements were performed on the affected and unaffected ULs using the landmark method.[16] Measurements were taken 10 cm distal to and proximal to the medial epicondyle of the elbow (or halfway between the wrist and elbow or elbow and axilla). These UL locations were measured by passing a low-stretch tape around them in direct contact with the skin, and the circumference was recorded. Measurements were frequently done bilaterally because the unaffected side was utilized to compare for the at-risk or affected side, either as an interlimb ratio or as an interlimb difference, the at-risk or afflicted side. The geometric formula for a truncated cone (frustum) was applied to convert the measurements into a limb volume.

$$V = h * \left(C_1^2 + C_1C_2 + C_2^2\right) / \left(12\pi\right)$$

where V = volume of a segment of the upper extremity,
C_1 and C_2 = circumferences (in cm) at the ends of the determined segments of the arm,
h = distance between circumferences (C_1, C_2) (segment length).

The lymphedema is categorized as mild (<20% increase in extremity volume), moderate (20%–40%), or severe (>40%).[17]

Measurement of lymphedema by conversion of landmark method of circumference measurement into limb volume using the geometric formula for a truncated cone is valid and reliable.[18–20]

Pain: Pain was measured using the visual analogue scale (VAS). It consists of a 10-cm line, with two end points representing 0 ("no pain") and 10 ("extreme pain/pain as bad as it could possibly be"). It has a reliability index of 0.99,[21] and a construct validity of 0.91.[22] The subjects independently filled out and returned the VAS. A VAS that was based on pencil and paper was employed. The participants were told to draw the spot on the 10-cm line that represented how much pain they were experiencing at the time. The distance between the participant's mark and the "no pain" anchor on the 10-cm line was measured using a ruler, providing the final score, which ranged from 0 to 10.[23] This provides objective measure of symptom intensity. Higher scores signify higher pain intensity. The following cut points for pain on the VAS have been recommended: 0 (no pain), 1–3 (mild pain), 4–6 (moderate pain), and 7–10 (severe pain).

Grip strength: This was measured with a digital hand held dynamometer (DynEx Dynamometer; 4QQ89, MD systems, USA). It measures the maximum isometric strength of the hand (grip strength) of the participants. It has a reliability index of 0.99 and a validity index of 0.98.[24] The participant was seated with their elbow resting at a right angle flexed position at their sides and, their wrists in a neutral position, The subject applied maximal force three times to each hand's handle on the dynamometer. For 3–5 seconds, the hold is maintained. Next, using the measurements, an average score is determined. It has been extensively shown that the average of three grip strengths for each hand is reliable.[25] Measurements

were performed for any of the affected extremities. No verbal encouragements were given.

Shoulder ROM: The active ROM of the shoulders were assessed in flexion and abduction using a goniometer. Goniometric measurements were obtained while the participant was in sitting position. Regardless of the testing posture, shoulder ROM tests in supine and sitting position have demonstrated strong intrarater reliability for both active and passive measures, as revealed by the inter class correlation coefficients across trials on comparable measurements in the same position.[26] By positioning the goniometer's fulcrum in relation to the approximate location of the glenohumeral joint axis and matching its arms to bony landmarks, the goniometric measurement was produced. A circular piece of opaque paper covered the goniometer's face. This made it easier to interpret the measurements from the other side while hiding the tester's numbers to account for experimenter bias. The tester positioned the goniometer for each measurement, while an assistant read and recorded the information. Since goniometric measurements' intrarater reliability has been proven to be higher than their interrater reliability, just one tester collected the data.[27,28]

BMI: Height was measured with a SECA 700 mechanical health Meter Scale with built in scale and meter rule. This device is reliable and certified by the International Standards Organization.[29] The participants were instructed to stand barefooted in an upright position on the platform of the height meter. The horizontal projection of the height meter was placed on the vertex of the participants, crushing the hair as much as possible. The readings were read off by the researcher to the nearest 0.1 cm. The weight of the participants was taken in minimal clothing. Participants were instructed to stand barefooted on the platform of the weighing scale with the feet apart and weight evenly distributed. The researcher checked that the reading of the scale was on zero. The reading was recorded to the nearest 0.1 kg. The BMI in kg/m^2 was computed from the readings of the weight and the height of the participants using the formula: BMI = weight /height^2.

Data analysis

Data was analyzed with SPSS (Statistical Package for Social Sciences) Version 29. Descriptive statistics of mean, standard deviation, frequency, and percentages were used to summarize data. Inferential statistics of Pearson correlation and linear regression were used to determine the relationship between UL disability and the selected variables. The Shapiro–Wilk test of normality was used to ascertain the assumption of normality of the data before applying the inferential statistics. Level of significance was set at $p < 0.05$.

Result

Data of 60 BC survivors were collated and analyzed. The participants comprised of 56 (93.3%) females and 4 (6.7%) males. The age range of the participants is between 28 years and 54 years. Majority of the participants are females (93.3%), married (73.3%), and employed (80%). Table 1 shows the sociodemographic data of the participants.

Clinical characteristic of the participants is shown in Table 2.

The participants showed high (73.3%) occurrence of UL disabilities. While 53.3% of the participants developed AWS, 60% of the participants had their right breast affected by cancer. More of the participants (60%) are within the 6–12-month duration of treatment, and majority of the participants (66.7%) had only chemotherapy treatment as at the time of the study.

Table 3 shows that pain and lymphedema had a strong positive correlation with UL disabilities. Shoulder flexion ROM, shoulder abduction ROM, and grip strength showed strong negative correlation with UL disabilities. Also, there was a weak negative correlation between UL disabilities and BMI.

Table 4 shows that a significant relationship exists between pain, lymphedema, shoulder flexion ROM, shoulder abduction ROM, grip strength, BMI, and UL disabilities. Table 4 also shows the unit increase or decrease in the selected variables for every unit increase in UL disability.

Table 1. Sociodemographic characteristics of the participants.

Variable								
Marital	Status, *N* (%)	Gender, *N* (%)		Educational	Level, *N* (%)		Employment	Status, *N* (%)
Married 44(73.3)	Single 16(26.7)	Male 4(6.7)	Female 56(93.3)	Primary 4(6.7)	Secondary 28(46.7)	Tertiary 28(46.7)	Employed 48(80)	Not employed 12(20)
	Age			Weight		Body	Mass index	
	Mean	SD		Mean	SD	Mean	SD	
	41.67	4.51		68.97	17.76	29.20	5.67	

N: number of respondents; %: percentage; SD: standard deviation.

Table 2. Clinical characteristics of the participants.

	Location, *N* (%)			RX	Received	Rx	Duration, *N* (%)	Axillary, *N* (%)	Web	Disabilities, *N* (%)
Right breast	Left breast	Both breast	Chemo	Chemo/ surg	Chemo/ surg/radio	6–12 months	1–2 years	Present	Absent	
36 (60)	20 (33.3)	4 (6.7)	40 (66.7)	8 (13.3)	12 (20)	36 (60)	24 (40)	32 (53.3)	28 (46.7)	44 (73.33)

N: number of participants; %: percentage; Rx: treatment; Chemo: chemotherapy; Surg: surgery; Radio: radiotherapy.

Table 3. The relationship between upper limb disabilities and selected variables among breast cancer survivors.

	Pain	Lymphedema	Flexion ROM	Abduction ROM	Grip strength	BMI
Upper limb disability	0.929	0.883	−0.769	−0.815	−0.695	−0.284
p-Value	0.001*	0.001*	0.001*	0.001*	0.001*	0.028*

ROM: range of movement; BMI: body mass index.
*Significant difference.

Table 4. The result of linear regression analysis between upper limb disabilities and associated variables.

	Unstandardized coefficient		Standardized coefficient	*T*	Sig
	B	Std error	Beta		
Pain	0.095	0.005	0.929	19.147	0.001*
Lymphedema	0.061	0.004	0.883	14.31	0.001*
Shoulder flexion ROM	−1.394	0.152	−0.769	−9.149	0.001*
Shoulder abduction ROM	−0.770	0.072	−0.815	−10.719	0.001*
Grip strength	−0.285	0.039	−0.695	−7.371	0.001*
BMI	−0.045	0.020	−0.284	−2.252	0.028*

ROM: range of movement; BMI: body mass index; Std error: standard error; *T*: tolerance; *B*: beta coefficient.
*Significant difference.

Discussion

The prevalence of UL disabilities was 73%. Pain, lymphedema, shoulder ROM, and grip strength showed strong correlation with UL disabilities. Pain and lymphedema increased by around 0.095 and 0.061 units, respectively, for every unit increase in disability. Conversely, there was a decrease of 1.394, 0.770, 0.285, and 0.045 in shoulder flexion, shoulder abduction, grip strength, and BMI, respectively, for every unit increase in disability. The findings of this study gives a clear indication of high level of UL disabilities among BC survivors and the increasing rehabilitation demand placed on the health-care professional for this population especially in LMICs or resource-limited settings where there is inadequate availability of rehabilitation professional.

The significant strong positive correlation between UL disability and pain among the participants of the present study is similar to the findings of Klein et al.[30] and Boucheron et al.[31] that observed a significant positive relationship between UL disabilities and pain after BC treatment. They reported that the pain is usually as a result of the surgical removal of tumor and breast tissue or dissection/removal of lymph node causing great discomfort enhancing disability in the ipsilateral upper.[30,31] The present study indicated that when there is increase in pain intensity, there is increase in disability of the UL. Pain impairs normal hand strength and function, which may make actions requiring the hand that are part of daily life appear unachievable. Pain has a severe negative impact on a person's quality of life as it severely affects all facets of their existence, causing anxiety and emotional distress as well as compromising their general well-being and making it difficult for them to carry out their daily social, familial, and work-related responsibilities.[32] Problems with physical abilities were more severe, and they had trouble even with simple tasks like sitting and reaching.[33,34] Pain-affected patients express concerns about performance issues at work, a reduction in their working days because of pain, or absenteeism.[35]

Because of painful symptoms, patients find themselves compelled to often change professions as well as lose their jobs. According to studies, between 26% and 53% of cancer survivors stop working during or after treatment, or lose their jobs.[36] Cancer survivors are 1.4 times more likely to experience unemployment than healthy controls.[37]

BC survivors whose occupational/vocational roles involve accomplishing tasks using the UL such as teaching, secretarial works, petty trading, and artisans, may lose their jobs as a result of UL pain syndrome. This may be a result of inability to cope with job demands involving the use of the hand due to UL pain and disability. Moreover, chronic painful individuals have a greater decrease in their productivity.[32] Optimizing care, which includes reducing pain and disability and improving physical performance and quality of life, is the aim of every healthcare system.[38] Physiotherapy as a form of rehabilitation intervention could often help BC survivors regain strength and physical function and improve quality of life and independent living that may have been lost due to UL pain and disability associated with BC treatment.

This study showed a significant positive strong correlation between UL disability and lymphedema. It was indicated that for every one-unit increase in disability, there is an approximately 0.06 volume increase in lymphedema. The result of the present study is in tandem with the findings of previous studies that reported that women with lymphedema has greater disability (higher DASH scores) than normal women.[39,40] Similarly, Siqueira et al.[41] reported that lymphedema was associated with some level of UL dysfunction in BC survivors. In contrast, Hayes et al.[42] and O'Toole et al.[43] found no correlation between UL disabilities and severity of BC-related lymphedema. Lymphedema is brought on by the obstruction or disruption of lymphatic vessels as a result of cancer treatments leading to accumulation of fluid in the affected arm,[43] resulting in abnormal swelling of the affected side, which may adversely affect the breast, trunk, and/or UL.[44] Decreases in shoulder and arm ROM cause physical disability among BC-related lymphedema survivors,[45] while difficulties performing daily activities lead to psychological disturbances such as distress, depression, irritability, and social limitations.[46] Shoulder discomfort and functional abnormalities, including decreased strength and ROM, can result from lymphedema in the UL, which is a complication of BC[47-49] that obviously impairs UL function leading to disability.

The uncomfortable sensation of tightness or heaviness, heightened skin sensitivity, limited ROM, and most importantly swelling associated with lymphedema can make it impossible to utilize the UL to accomplish functional tasks of daily living. Although it is documented that symptoms of lymphedema could inhibit UL functions, there seem to be inconclusive evidence on the correlation of UL disability with lymphedema.

The present study reported that shoulder ROM had a significant negative strong correlation with UL disability. For every one-unit increase of disability, there is approximately 1.349 and 0.770 decrease in shoulder flexion and abduction respectfully. Significant relationship between UL disability and a reduction in shoulder ROM in flexion, abduction, and external rotation has been documented in previous studies.[13,39,40] The most common cause of a restriction in shoulder flexion and abduction ROM is AWS, which limits these motions and causes pain during passive movement.[48] Functional tasks and activity of daily living are greatly affected by reduced ROM. Disorders affecting the ULs result in substantial discomfort, impaired mobility, and decreased worker productivity. If an individual is no longer productive, they may lose their employment.

This study also reported a significant strong negative correlation between UL disabilities and grip strength. It was also observed that for every unit increase in disability, there is an approximate 0.285 decrease in grip strength. The finding is in agreement with the report of previous studies that greater UL disability is correlated with lesser grip strength.[39,50–52] The afflicted UL is not used as much because of the decreased general strength. The bulk of UL function, which is often performed by the hand, is lost when grip strength is compromised, which has a significant impact on UL function. Another study reported a significantly impaired muscle strength and function in women with BC who underwent chemotherapy, or a radical mastectomy as compared to healthy women.[53] Winters-Stone et al.[54] reported a significantly lower handgrip strength and function in older women with breast carcinoma than healthy older adults. In addition to being suggested as a predictor of cancer mortality and cardiometabolic risk, muscular strength is a potent indicator of both current and future health in the general population.[55] Handgrip strength is necessary for carrying out UL functional activities of daily living.[56] The loss in grip strength may be the result of hand and wrist edema, which also reduces the initiation of wrist extension and finger flexion and reduces wrist and finger ROM.[39] Three of the most common side effects during and after cancer treatments are shoulder-arm disabilities, cancer-related fatigue, and a decline in quality of life in BC survivors.[51] Evaluation of hand grip strength may assist clinicians in starting a process to identify the presence of these conditions.[51] The identification of these adverse consequences may prompt the adoption of measures to ameliorate them, resulting in a noteworthy enhancement in the quality of life for cancer survivors.[51]

The findings of this study show a significant negative weak correlation between BMI and UL disabilities. It was observed that for every unit increase in disability, there is an approximately 0.045 decrease in BMI. There is scarcity of studies showing the relationship between BMI and UL disability among BC survivors. From available literature, only one study by Fuentes-Afolafia et al.[52] reported a relationship between UL disability and BMI. They reported that black BC survivors had higher upper extremity disability, which was partially mediated by higher BMIs.[57] However, in the general population, in a cross-sectional study by Ferraro et al.,[58] obese individuals (BMI $>$ 30 at baseline) or those who gained weight throughout the study were linked to greater levels of upper-body and, particularly, lower-body disability. Disability did not decrease among those who had a BMI of 30 or above at the start of the research and lost

weight to a normal level. In most cases, underweight people (BMI < 18.5) also showed greater levels of disability.[58] Their study showed that those at the tails of the BMI distribution had a higher likelihood of having both upper and lower extremity disability. They reported that baseline underweight often was related to disability, and becoming underweight was associated with greater upper- and lower-body disability. It is noteworthy that participants in the present study had a mean BMI of 29.20 kgm^2 (over weight). Increasing weight or becoming underweight is associated with increasing upper and lower limb disability. The finding from the present study that decreasing weight correlated with increasing disability may be a mechanism due to the progression of cancer disease, which is associated with weight loss. Incident weight loss is likely a consequence of incident morbidity and disability.[59] Further research on the relation between cancer disease progression, weight loss, and UL disability is needed.

Limitation of the study

One of the major limitations of the study was resource limitation in terms of finance. Because the study was performed in resource-limited settings, we resorted to using a cost-effective method of measuring limb lymphedema. This is because gold standard equipment for measuring or detecting lymphedema even at early state was not available at the center.

The geometric formula for truncated cone volume using circumference measurements has some limitations such as follows: It cannot show structural changes in soft tissue; it cannot distinguish the volume of soft tissue from that of deep structures such as muscles and bones.

While this method has a high reliability, this may reduce if protocols are not followed (e.g., differences in amount of tension applied to the tape measure can, especially in an arm with soft swelling, greatly change the measured circumference of a limb). Recording circumference measurement and conversion to volumes can be burdensome. The range of measurement protocols results in difficulties comparing outcomes between studies and potentially between clinicians.

Conclusion

UL disabilities had high prevalence and significantly correlated with every variable that was examined. The high prevalence of UL disabilities and their interaction with related variables calls to action for routine screening and prompt intervention to identify, prevent, or manage UL functional impairments in BC survivors. There should be training for healthcare professionals to be sensitive to these issues to institute early detection and rehabilitation of disabilities and also for enabling them to empower cancer survivors to recognize and prevent complications early and seek appropriate and timely treatment.

Acknowledgements

Not applicable.

Author contributions

All authors on this paper meet the four criteria for authorship as identified by the International Committee of Medical Journal Editors (ICMJE); all authors have contributed to the conception and design of the study, drafted or have been involved in revising this manuscript, reviewed the final version of this manuscript before submission, and agree to be accountable for all aspects of the work. Specific contributions of each author are as follows: Davidson Okwudili John, Augustine Amaeze, Onyinyechi Peace Ransome, and Jeneviv Nene John: Conception and design, acquisition of data, analysis and interpretation of data, and drafting of the manuscript. Obinna Chinedu Okezue, Oluwatoyin Iyare, and Ngozi Ugwu: Conception and design, revising critically for important intellectual content. All the authors approved the final version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethics approval

Ethical approval for this study was obtained from Research and Ethics Committee of Alex Ekwueme Federal University Teaching Hospital, Abakaliki, Ebonyi State, Nigeria (HREC Approval Number: NHREC/A0022250).

Informed consent

Written informed consent was obtained from all subjects before the study.

Trial registration

Not applicable.

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Supplemental material

Supplemental material for this article is available online.

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