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RESEARCH

Health literacy as a determinant of psychosocial and functional outcomes in individuals at risk for lymphedema

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Abstract

Background Health literacy may influence individuals' understanding of lymphedema, engagement in self-management, and perceived quality of life following breast cancer surgery. This study aimed to evaluate health literacy and its associations with demographic, clinical, functional, and psychosocial characteristics in women following breast cancer surgery.

Methods This cross-sectional study included 59 women who had undergone unilateral breast cancer surgery. Health literacy was assessed using the Turkish Health Literacy Scale-32 (TSOY-32), and lymphedema-related quality of life was evaluated using the LYMQOL-Arm questionnaire. Participants were classified according to lymphedema stage. Between-stage comparisons, correlation analyses, and exploratory ordinal logistic regression were performed.

Results The mean age was 55.71 ± 12.09 years. Health literacy was classified as inadequate in 11.9%, problematic/limited in 27.1%, sufficient in 33.9%, and excellent in 27.1% of participants. Lymphedema stage was associated with differences in the LYMQOL-Arm appearance domain ($p = 0.045$) and function domain ($p = 0.046$), although post hoc comparisons for function did not identify significant pairwise differences. Neither marital status nor occupation was significantly associated with lymphedema stage according to the Fisher–Freeman–Halton exact test ($p = 0.372$ and $p = 0.761$, respectively). In exploratory ordinal logistic regression, older age was associated with lower odds of higher health literacy (OR = 0.916, 95% CI 0.870–0.964; $p < 0.001$), whereas higher educational attainment was associated with greater odds (OR = 1.498, 95% CI 1.011–2.217; $p = 0.044$).

Conclusion Health literacy varied considerably among women following breast cancer surgery and was associated with age and educational attainment. Functional and psychosocial quality-of-life domains were interrelated, while some differences were observed across lymphedema stages. These findings support further investigation of health-literacy-sensitive educational and self-management approaches in breast cancer-related lymphedema care.

Keywords Health literacy · Lymphedema · Quality of life · Chronic disease management · Cancer survivorship · Patient education · Predictive factors · Self-care · Breast cancer · Psychosocial impact

Introduction

Lymphedema is a chronic, progressive condition characterized by the accumulation of protein-rich fluid in the interstitial space due to dysfunction of the lymphatic system. It commonly develops following lymph node dissection, radiotherapy, infection, or trauma and is frequently observed among individuals undergoing breast cancer treatment [1, 2]. As the disease progresses, patients experience swelling, pain, mobility limitations, recurrent infections, and psychosocial distress, all of which substantially impair quality of life and increase long-term healthcare burden [3, 4].

Effective management of lymphedema requires lifelong self-care behaviors, including regular symptom monitoring, skin care, compression therapy, exercise, and weight management [5]. Because these interventions must be applied consistently and correctly, patients play a central role in disease control. Insufficient knowledge, difficulty understanding treatment recommendations, or limited access to reliable information may contribute to poor adherence, worsening symptoms, and preventable complications [6].

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Health literacy, defined as the ability to obtain, understand, evaluate, and apply health-related information, is a key determinant of health behaviors and clinical outcomes, particularly in chronic conditions that require active self-management [7]. Individuals with adequate health literacy demonstrate better treatment adherence, more effective communication with healthcare providers, and improved health outcomes [8]. Conversely, limited health literacy is associated with poor disease control, reduced preventive behaviors, and higher morbidity [9]. In Türkiye, several population-based studies have reported generally low levels of health literacy, suggesting potential challenges in the management of chronic diseases [10].

Although research directly examining the relationship between health literacy and lymphedema is scarce, available evidence indicates that inadequate health literacy may hinder appropriate self-care in patients with or at risk for lymphedema [11]. Furthermore, findings from the COVID-19 pandemic revealed that individuals with lower health literacy were less likely to adopt preventive behaviors, emphasizing the importance of health literacy for behavior-based health outcomes [12].

The present study aimed to (1) assess health literacy levels among women with breast cancer-related lymphedema or at risk of developing lymphedema; (2) investigate the relationship between health literacy and lymphedema-related quality of life, including functional, appearance-related, symptom-related, and emotional domains; (3) compare health literacy and quality-of-life outcomes across lymphedema stages; and (4) identify demographic and clinical factors associated with health literacy. These objectives were intended to provide a better understanding of the relationships among health literacy, clinical characteristics, and quality of life in women following breast cancer treatment.

Materials and methods

Study design and participants

This descriptive, cross-sectional study included 59 women who attended the Physical Medicine and Rehabilitation Department of Ankara Gaziler Physical Medicine and Rehabilitation Training and Research Hospital between April 2025 and December 31, 2025. Participants were recruited through consecutive sampling, whereby eligible patients presenting during the study period were enrolled sequentially.

The inclusion criteria were female sex, a history of unilateral breast cancer surgery, and an interval of at least three months since surgery. The exclusion criteria were (1) a history of bilateral mastectomy, (2) upper-extremity disorders of cervical or intracranial origin, (3) a preoperative diagnosis of shoulder impingement syndrome or adhesive capsulitis, (4) permanent upper-extremity impairment resulting from trauma before surgery, and (5) psychiatric or cognitive disorders that could interfere with reliable participation in study assessments. These criteria were established to reduce potential confounding factors affecting the assessment of health literacy and lymphedema-related quality of life.

Demographic and clinical assessment

Demographic and clinical information was collected through structured interviews and medical record reviews. Recorded variables included age, educational attainment, marital status, occupation, height, weight, body mass index (BMI), age at cancer diagnosis, time since surgery, presence and onset of lymphedema, regular analgesic use, distant metastasis, tumor size, cancer stage, type of surgery, number of lymph nodes removed, number of metastatic axillary lymph nodes, radiotherapy (RT) region, chemotherapy, and tamoxifen use.

Lymphedema assessment and staging

Lymphedema was assessed through clinical examination, patient-reported symptoms, and upper-extremity circumference measurements. Circumferential measurements were performed at 4-cm intervals, starting from the wrist and proceeding proximally along the upper extremity. Clinical assessment included the evaluation of limb swelling and lymphedema-related tissue changes, while patient-reported symptoms such as heaviness, tightness, and fullness were also recorded.

Participants were classified according to the International Society of Lymphology (ISL) staging system (Stages 0–III) [5]. Participants categorized as Stage 0 reported symptoms suggestive of early lymphatic dysfunction, such as heaviness, tightness, or fullness, without clinically apparent swelling on physical examination. Stages I–III were classified according to the clinical characteristics described in the ISL staging system.

Health literacy assessment

Health literacy was assessed using the Turkish Health Literacy Scale-32 (TSOY-32), a 32-item instrument designed to evaluate individuals' ability to access, understand, appraise, and apply health-related information [13]. The standardized health literacy index ranges from 0 to 50 and is classified into four categories: inadequate (0–25), problematic/limited (> 25–33), sufficient (> 33–42), and excellent (> 42–50).

In the present study, participants were classified according to these thresholds, and the four categories were coded as 1, 2, 3, and 4, respectively, for statistical analysis. Higher categories represented better health literacy.

Lymphedema-related quality of life assessment

Lymphedema-related quality of life was assessed using the Turkish version of the Lymphedema Quality of Life Questionnaire for the Arm (LYMQOL-Arm), validated by Borman et al. [14]. The questionnaire evaluates four domains: function, appearance, symptoms, and mood. Domain scores were calculated as the mean of their corresponding item scores, ranging from 1 to 4, with higher scores indicating greater impairment in lymphedema-related quality of life.

Overall quality of life was evaluated separately using the questionnaire's global quality-of-life item, originally scored from 0 to 10. For the present analysis, this score was multiplied by 10 and expressed on a 0–100 scale, with higher scores indicating better perceived overall quality of life.

The questionnaire was administered to all participants, including those classified as Stage 0, to assess self-reported upper-extremity symptoms and quality-of-life concerns across different clinical stages.

Assessment of lymphedema awareness and preventive practices

Lymphedema-related awareness, preventive practices, and educational needs were assessed using an eight-item, study-specific questionnaire. The questionnaire addressed three areas: general health information and perceived health knowledge, lymphedema-related awareness, and preventive practices and educational needs.

Participants were asked about their sources of health information, self-perceived health knowledge, and difficulties understanding health information. Lymphedema-related awareness was evaluated through questions addressing prior knowledge of lymphedema, recognition of its symptoms, and knowledge of lymphedema management.

Self-reported preventive practices were assessed by asking participants which measures they used to reduce the risk of lymphedema, including exercise, dietary management, regular medical follow-up, and information seeking. Participants were also asked about their preferred educational resources. Multiple responses were permitted for applicable questions.

The study-specific questionnaire was used for descriptive data collection and was not considered a validated psychometric instrument. Standardized health literacy and lymphedema-related quality-of-life outcomes were assessed separately using the TSOY-32 and LYMQOL-Arm questionnaires, respectively.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed as mean ± standard deviation for continuous variables and as frequencies and percentages for categorical variables. Health literacy was evaluated using the four ordered categories of the Turkish Health Literacy Scale-32 (TSOY-32): inadequate, problematic/limited, sufficient, and excellent.

Comparisons across lymphedema stages were performed using one-way analysis of variance (ANOVA) for appropriate continuous variables and the Kruskal–Wallis test for ordinal or non-normally distributed variables. Tukey's honestly significant difference (HSD) test was used for post hoc pairwise comparisons following ANOVA. Associations between lymphedema stage and the nominal categorical variables marital status and occupation were evaluated using the Fisher–Freeman–Halton exact test because of small expected cell frequencies.

Spearman's rank correlation coefficient was used to examine associations among health literacy, demographic characteristics, and quality-of-life outcomes. Correlations among LYMQOL-Arm domains were examined as secondary exploratory analyses to characterize the relationships between functional and psychosocial aspects of lymphedema-related quality of life. An exploratory proportional odds ordinal logistic regression model was fitted with the four-category health literacy variable as the dependent outcome and age and educational attainment as predictors. Educational attainment was entered as an ordered numerical covariate. Model fit was evaluated using the likelihood-ratio chi-square test, Pearson and deviance goodness-of-fit tests, Nagelkerke pseudo-R^2, and the test of parallel lines. Regression findings were reported as odds ratios (ORs) with 95% confidence intervals (CIs). All statistical tests were two-sided, and $p < 0.05$ was considered statistically significant.

Results

A total of 59 women participated in the study. The mean age was 55.71 ± 12.09 years, and the mean body mass index (BMI) was 28.20 ± 4.78 kg/m^2. According to the International Society of Lymphology (ISL) staging system, 3 participants (5.1%) were classified as Stage 0, 28 (47.5%) as Stage I, 20 (33.9%) as Stage II, and 8 (13.6%) as Stage III. Overall, 56 participants (94.9%) had clinically manifest lymphedema (Stages I–III), whereas 3 participants (5.1%) were classified as Stage 0.

Regarding health literacy, 7 participants (11.9%) were classified as having inadequate health literacy, 16 (27.1%) as problematic/limited, 20 (33.9%) as sufficient, and 16 (27.1%) as excellent health literacy. Thus, 36 participants (61.0%) had sufficient or excellent health literacy.

For lymphedema-related quality of life, the mean scores were 2.08 ± 0.71 for function, 2.30 ± 0.77 for appearance,

2.30 ± 0.76 for symptoms, and 1.92 ± 0.69 for mood. The mean overall quality-of-life score, expressed on a 0–100 scale, was 58.64 ± 13.95. Higher domain scores indicated greater impairment, whereas higher overall quality-of-life scores indicated better perceived quality of life. Detailed demographic and clinical characteristics are presented in Table 1.

Comparisons across lymphedema stages using the Kruskal–Wallis test revealed no statistically significant differences in body weight, educational attainment, health literacy category, health knowledge, health topic awareness, health information comprehension, lymphedema-related knowledge, symptom awareness, or management knowledge (all $p > 0.05$). However, a statistically significant difference was observed in the appearance domain of lymphedema-related quality of life ($\chi^2 = 8.030$, $p = 0.045$).

Marital status and occupation were analyzed separately using the Fisher–Freeman–Halton exact test because of small expected cell frequencies. Neither marital status (test statistic = 5.973, exact $p = 0.372$) nor occupation (test statistic = 3.765, exact $p = 0.761$) showed a statistically significant association with lymphedema stage. Detailed results are presented in Table 2.

One-way analysis of variance (ANOVA) showed no statistically significant differences in age, height, or BMI across lymphedema stages (all $p > 0.05$). Similarly, symptom and mood scores did not differ significantly between stages. However, an overall difference was observed in the function domain ($F = 2.848$, $p = 0.046$), indicating variation in self-reported functional impairment across lymphedema stages. These findings are presented in Table 3.

Table 2 Comparison of clinical, demographic, and psychosocial variables across lymphedema stages

Variable	Test statistic†	*p*-value
Body weight	4.643	0.200
Marital status	5.973	0.372
Educational attainment	1.630	0.653
Occupation	3.765	0.761
Health literacy category (TSOY-32)	2.909	0.406
LYMQOL-Arm: appearance	8.030	0.045*
LYMQOL-Arm: overall QoL	6.175	0.103
Health knowledge	4.520	0.210
Health topic awareness	1.983	0.576
Health information comprehension	1.211	0.750
Lymphedema knowledge	1.795	0.616
Lymphedema symptom awareness	1.480	0.687
Lymphedema management knowledge	1.880	0.598

Kruskal–Wallis *H* statistics are reported for continuous or ordinal variables. The Fisher–Freeman–Halton exact test was used for marital status and occupation because of small expected cell counts; the corresponding test statistics and exact two-sided *p*-values are reported for these variables

QoL quality of life, *TSOY-32* Turkish Health Literacy Scale–32

*$p < 0.05$ (uncorrected)

Tukey's post hoc pairwise comparisons did not identify any statistically significant differences in function scores between individual lymphedema stages. The comparison between Stages I and II approached, but did not reach, statistical significance (mean difference = −0.5171, 95% CI −1.0432 to 0.0089; $p = 0.056$).

Table 1 Demographic and clinical characteristics of the participants ($n = 59$)

Variable	Mean ± SD	Minimum	Maximum
Age (years)	55.71 ± 12.09	29	76
Height (cm)	161.51 ± 6.85	145	180
Weight (kg)	73.49 ± 13.06	53	98
BMI (kg/m^2)	28.20 ± 4.78	20	37
LYMQOL-Arm: function	2.08 ± 0.71	1.00	3.70
LYMQOL-Arm: appearance	2.30 ± 0.77	1.00	4.00
LYMQOL-Arm: symptoms	2.30 ± 0.76	1.00	3.66
LYMQOL-Arm: mood	1.92 ± 0.69	1.00	3.50
LYMQOL-Arm: overall QoL (0–100)	58.64 ± 13.95	30	80
TSOY-32 health literacy category		**n**	%
Inadequate		7	11.9
Problematic/limited		16	27.1
Sufficient		20	33.9
Excellent		16	27.1

Continuous variables are reported as mean ± standard deviation (SD), with minimum and maximum values. Health literacy is reported as *n* (%) across the four TSOY-32 categories, not as a continuous score. LYMQOL-Arm domain scores range from 1 to 4 (higher scores indicate greater impairment); the overall quality-of-life score was transformed to a 0–100 scale (higher scores indicate better quality of life)

BMI body mass index, *QoL* quality of life

Table 3 Comparison of quality-of-life and anthropometric variables across lymphedemas Stages

Variable	*F* statistic	*p*-value
Age	1.195	0.320
Height	0.998	0.401
BMI	1.039	0.382
LYMQOL-Arm: function	2.848	0.046*
LYMQOL-Arm: symptoms	1.159	0.334
LYMQOL-Arm: mood	2.301	0.087

F statistics are from one-way analysis of variance (ANOVA). Higher LYMQOL-Arm domain scores indicate worse functioning or greater impairment. Interpret stage comparisons cautiously because Stage 0 included only three participants

BMI body mass index, *QoL* quality of life

*$p < 0.05$ (uncorrected)

Table 4 Factors associated with health literacy: exploratory ordinal logistic regression

Predictor	Odds ratio (OR)	95% CI	*p*-value
Age (per year)	0.916	0.870–0.964	< 0.001
Educational attainment (per level)	1.498	1.011–2.217	0.044

The dependent variable was the four-category TSOY-32 health literacy outcome (inadequate, problematic/limited, sufficient, excellent), ordered from lower to higher health literacy. Age and educational attainment were entered as predictors. ORs greater than 1 indicate higher odds of being in a higher health literacy category. The model was exploratory given the sample size ($n = 59$)

OR odds ratio, *CI* confidence interval

Spearman correlation analysis demonstrated significant positive correlations between the function domain and appearance (rho = 0.435, $p < 0.001$), symptoms (rho = 0.735, $p < 0.001$), and mood (rho = 0.650, $p < 0.001$). Appearance scores were positively correlated with symptoms (rho = 0.659, $p < 0.001$) and mood (rho = 0.426, $p < 0.001$), while symptom scores were positively correlated with mood (rho = 0.728, $p < 0.001$). Because higher domain scores indicate greater impairment, these positive correlations reflect the co-occurrence of difficulties across quality-of-life domains.

Overall quality of life was negatively correlated with appearance (rho = − 0.338, $p = 0.009$), symptoms (rho = − 0.425, $p < 0.001$), and mood (rho = − 0.345, $p = 0.007$), indicating that greater impairment in these domains was associated with poorer perceived overall quality of life. Health literacy category was positively correlated with educational attainment (rho = 0.413, $p = 0.001$). No other statistically significant correlations were identified in the reported analyses.

An exploratory proportional odds ordinal logistic regression model was fitted to examine the associations of age and educational attainment with health literacy category. The overall model was statistically significant ($\chi^2(2) = 25.100$, $p < 0.001$; Nagelkerke pseudo-$R^2 = 0.373$). Older age was associated with lower odds of belonging to a higher health literacy category (OR = 0.916, 95% CI 0.870–0.964; $p < 0.001$). Higher educational attainment was associated with greater odds of belonging to a higher health literacy category (OR = 1.498, 95% CI 1.011–2.217; $p = 0.044$), with educational levels modeled as an ordered numerical predictor. These findings are presented in Table 4.

The proportional odds assumption was not rejected (test of parallel lines, $p = 0.870$). However, sparse combinations of predictor values were observed, and the Pearson goodness-of-fit test was significant ($p = 0.002$), whereas the deviance test was not ($p = 0.942$). Accordingly, the regression findings should be interpreted cautiously. In an additional exploratory ordinal logistic regression model including comorbidity status, the associations of age and educational attainment with health literacy remained statistically significant, whereas comorbidity status was not significantly associated with health literacy ($p = 0.855$). The proportional odds assumption was not rejected in this extended model ($p = 0.941$).

Discussion

Despite the growing body of research addressing the physical and psychosocial burden of lymphedema, the role of health literacy in shaping patients' ability to understand, manage, and cope with this condition remains insufficiently explored. Effective lymphedema management relies heavily on patients' capacity to access reliable information, recognize early symptoms, adhere to self-care practices, and navigate complex treatment pathways—skills that are fundamentally determined by health literacy. However, existing literature rarely examines how health literacy interacts with quality of life, functional limitations, and clinical factors specifically among individuals diagnosed with or at risk for lymphedema. The present study addresses this critical gap by providing a comprehensive evaluation of health literacy levels and their associations with demographic characteristics, comorbidity status, and lymphedema-related quality-of-life domains. By integrating validated measurement tools, multidimensional statistical analyses, and a clinically relevant sample, this research aims to generate robust evidence that highlights the need for tailored educational and psychosocial interventions. Ultimately, the study seeks not only to quantify health literacy in this understudied population but also to clarify its contribution to functional outcomes and patient-centered care, offering insights that may inform

rehabilitation strategies and improve long-term disease management.

Lymphedema is increasingly recognized as a chronic, lifelong condition that extends far beyond its physical manifestations and encompasses substantial psychological and social consequences. Its persistence, visibility, and functional impact often lead to emotional distress, altered body image, reduced social participation, and diminished self-efficacy—features that underscore its inherently biopsychosocial nature. Effective management therefore requires not only clinical interventions but also the patient's sustained engagement in self-monitoring, symptom recognition, compression therapy, skin care, and activity modification. Within this context, health literacy becomes a critical determinant of disease trajectory, as patients' ability to understand their condition, evaluate health information, and implement self-care recommendations directly influences treatment adherence and long-term outcomes. Previous research has emphasized that inadequate health literacy can contribute to delayed recognition of symptom progression, poor adherence to therapeutic regimens, and avoidable exacerbations [15, 16]. The present study's findings reinforce this conceptual framework by highlighting the interplay between educational attainment, comorbidity-related health system exposure, and psychosocial factors—suggesting that improving health literacy may serve as a pivotal strategy for enhancing patient engagement and optimizing lymphedema management across all stages of the condition.

In the present study, older age was associated with lower health literacy, consistent with previous research reporting similar patterns across diverse populations. Advancing age has been associated with reductions in cognitive processing speed, working memory, and learning capacity, all of which contribute to challenges in understanding, interpreting, and applying health-related information. In addition, older adults often have limited access to digital health resources and may experience difficulties navigating technology-based platforms that are increasingly used in health communication. Similar findings have been reported by Okyay and Abacigil [13], who demonstrated a significant inverse relationship between age and health literacy in the Turkish population, and by Sørensen et al. [17], whose European Health Literacy Survey (HLS-EU) identified age as one of the strongest predictors of inadequate health literacy. Together, these findings highlight the potential value of age-sensitive, simplified, and visually supported educational strategies to facilitate the engagement of older adults in health management.

Higher educational attainment was associated with better health literacy in our study, consistent with previous national and international research identifying education as an important factor associated with health literacy [8, 17]. Individuals with higher levels of formal education may have greater opportunities to develop the skills needed to access, understand, critically evaluate, and apply health-related information. Nevertheless, this association should be interpreted cautiously given the limited sample size and the assumptions underlying the statistical modeling of educational attainment. These findings highlight the importance of tailoring health communication strategies to individuals with different educational backgrounds, ensuring that educational materials are clear, accessible, and culturally appropriate.

Another finding of the present study was that comorbidity status was not significantly associated with health literacy after adjustment for age and educational attainment. Although chronic diseases are often accompanied by increased healthcare needs and greater interaction with healthcare services, such exposure does not necessarily translate into higher health literacy. Individuals living with chronic conditions may have more frequent opportunities to communicate with healthcare professionals, receive counseling, and engage in disease-monitoring activities. These repeated encounters could potentially enhance familiarity with medical terminology, facilitate navigation of healthcare systems, and encourage the acquisition of health-related knowledge. Paasche-Orlow and Wolf [18] have discussed the complex pathways linking health literacy, healthcare access, patient–provider interactions, and health outcomes. Nevertheless, our findings suggest that the presence of comorbidities alone may not be sufficient to distinguish individuals with higher health literacy from those with lower health literacy. This observation highlights the potential importance of structured, individualized patient education rather than relying solely on repeated healthcare exposure to improve patients' understanding and self-management capabilities.

The patterns identified in the present study are broadly consistent with prior research examining the physical and psychosocial burden of lymphedema. Similar to earlier findings by Ridner [16] and Pusic et al. [19], our results suggest that lymphedema stage may be associated with differences in functional limitations and appearance-related concerns, even when overall quality-of-life scores do not differ significantly across stages. However, our findings do not establish a consistent deterioration in these domains with increasing disease severity. Previous literature has described how visible swelling, limb asymmetry, and discomfort may contribute to emotional distress, social withdrawal, and reduced self-confidence. Our findings should therefore be interpreted within this broader understanding of the multidimensional burden of lymphedema.

However, the present study also provides insights into differences in quality-of-life domains across lymphedema stages. Unlike some previous studies reporting broader impairments across multiple dimensions, our findings suggest that not all quality-of-life domains may be equally associated with lymphedema stage. Differences were observed in the function and appearance domains, whereas symptoms,

mood, and overall quality-of-life scores did not differ significantly across stages. These findings may reflect variation in the physical and psychosocial difficulties experienced by individuals with lymphedema, although the cross-sectional design does not allow conclusions about when these difficulties emerge or how they evolve during disease progression.

Another notable finding of the present study is that, although an overall difference in functional scores was observed across lymphedema stages, post hoc pairwise comparisons did not reach statistical significance. The relatively small sample size, particularly within certain stage subgroups, may have limited the ability to detect differences between individual stages. These findings highlight the importance of interpreting stage-related differences cautiously, while also considering their potential clinical relevance in the context of chronic conditions such as lymphedema. Taken together, our results are broadly consistent with previous research emphasizing the physical and psychosocial burden of lymphedema, although they do not establish a consistent pattern of deterioration with increasing disease severity. The observed differences in functional and appearance-related domains suggest that both aspects deserve attention in comprehensive lymphedema care. Targeted rehabilitation to address functional limitations and psychosocial support for appearance-related concerns may be valuable components of individualized management, although the effectiveness of stage-specific interventions requires further investigation.

In the present study, no statistically significant associations were identified between health literacy and the quality-of-life domains assessed. This finding suggests that differences in health literacy were not clearly reflected in self-reported functional, symptomatic, or emotional outcomes within our sample. In contrast, significant intercorrelations were observed among several quality-of-life domains, particularly function, symptoms, and mood. These associations highlight the interconnected nature of physical and psychosocial difficulties experienced by individuals with or at risk for lymphedema, consistent with previous research describing the multidimensional burden of the condition [20, 21]. However, correlations among domains of the same questionnaire should be interpreted cautiously, as they may partly reflect overlapping constructs measured by the instrument.

Although health literacy was not significantly associated with quality-of-life outcomes in our study, previous literature has emphasized the potential importance of patient education, treatment adherence, symptom monitoring, and self-management behaviors in breast cancer-related lymphedema care [22, 23]. It is possible that health literacy may influence patients' experiences through these behavioral pathways rather than through a readily detectable cross-sectional association with quality of life. Nevertheless, the present study did not examine mediation or establish that health literacy improves self-management or quality-of-life outcomes. Therefore, the potential benefits of health-literacy-sensitive education should be considered a rationale for future research rather than a demonstrated effect of the current study. Prospective and interventional studies are needed to determine whether tailored educational strategies can improve self-management behaviors and patient-reported outcomes.

Collectively, the results suggest that these findings contribute to the growing body of evidence indicating that health literacy functions within a broader biopsychosocial framework. Rather than exerting immediate, direct effects on quality of life, health literacy may act as an upstream factor that shapes how individuals manage their condition, interact with healthcare systems, and sustain long-term self-care behaviors—all of which ultimately influence functional and psychosocial outcomes over time.

The regression findings of the present study suggest that age and educational attainment are associated with health literacy among individuals with or at risk for lymphedema. These findings are consistent with the multidimensional conceptualization of health literacy described in the broader literature, which emphasizes the importance of educational opportunities, cognitive and communication skills, and the ability to navigate health information [8, 17]. Although chronic disease experiences may provide opportunities for repeated healthcare interactions and greater familiarity with medical information [18], comorbidity status was not independently associated with health literacy in our supplementary analysis. Furthermore, while psychological well-being and body-related concerns may influence patients' experiences of illness and healthcare engagement [19, 23], the present findings do not establish these factors as independent correlates of health literacy. From a clinical perspective, these observations suggest that health communication strategies may benefit from being adapted to patients' age-related and educational needs. Nevertheless, the exploratory nature of the analyses and the limited sample size warrant cautious interpretation, and further research is needed to clarify the potential contributions of psychosocial factors to health literacy in this population.

Viewed collectively, the patterns emerging from this study reinforce the need for a comprehensive, multidisciplinary approach to lymphedema care. Because health literacy appears to interact with both demographic resources and psychosocial well-being, interventions should extend beyond standard informational materials to include strategies that support motivation, emotional resilience, and long-term behavioral engagement. Evidence from prior work shows that patients with higher psychological readiness and stronger self-efficacy are more likely to adhere to compression therapy, functional exercise programs, and

symptom-monitoring routines—behaviors known to reduce symptom burden and improve functioning [22, 23].

Educational strategies should therefore be adapted to accommodate different learning capacities and emotional profiles. For example, older adults or individuals with limited formal education may benefit from simplified language, visual demonstrations, and structured repetition, as recommended in health-literacy-sensitive communication frameworks [8]. Meanwhile, patients experiencing diminished body image or emotional distress may require psychosocial interventions—such as counseling, peer support groups, or integrative body-awareness therapies—that address stigma, self-perception, and motivation to engage in self-care [19].

Ultimately, the interplay between health literacy, psychological well-being, and self-management emphasizes that lymphedema rehabilitation cannot be approached solely as a physical treatment process. Instead, a biopsychosocial model—grounded in education, empowerment, behavioral coaching, and emotional support—may yield more meaningful and sustainable improvements in patient outcomes.

This study offers meaningful insights into the multidimensional nature of health literacy within the context of lymphedema risk and survivorship. One of its key strengths lies in the use of validated, reliable measurement tools that allowed for a comprehensive evaluation of health literacy, quality of life, and psychosocial factors. The inclusion of a clinically relevant population and the integration of demographic, functional, and psychological variables also enabled a nuanced interpretation of health literacy as a construct shaped by both structural and emotional determinants. Furthermore, the analytical approach, which considered interactions among physical functioning, body image, and psychosocial well-being, adds conceptual depth to the existing literature and highlights areas that merit targeted intervention in rehabilitation programs.

Despite these strengths, several limitations must be acknowledged. The cross-sectional design precludes causal inferences and limits the ability to assess temporal changes in health literacy or quality of life. The study was conducted at a single clinical center, which may limit the generalizability of the findings to broader and more diverse populations. Furthermore, the relatively small sample size, particularly within certain lymphedema stages (e.g., Stage 0, $n = 3$), may have reduced the statistical power to detect differences between subgroups. The use of self-reported measures may also have introduced recall and response biases, potentially affecting the accuracy of psychosocial and behavioral assessments. In addition, Stage 0 classification was based on patient-reported symptoms and clinical assessment without objective confirmation of subclinical lymphatic dysfunction using specialized diagnostic techniques. Consequently, the possibility of misclassification among participants categorized as Stage 0 cannot be excluded.

The ordinal logistic regression findings should also be interpreted cautiously because of the limited sample size, sparse data patterns, and discrepancies between goodness-of-fit assessments. Furthermore, educational attainment was entered as an ordinal numerical predictor, which assumes a constant effect across successive educational categories on the log-odds scale. Given the exploratory nature of the analyses and the number of statistical comparisons performed, some statistically significant findings may represent chance associations. Finally, the study-specific questionnaire assessing lymphedema awareness, preventive practices, and educational needs was not psychometrically validated; therefore, its findings should be considered descriptive and exploratory.

Conclusion

In this cross-sectional study of women following breast cancer surgery, health literacy levels varied substantially, with approximately two-fifths of participants classified as having inadequate or problematic/limited health literacy. Older age was associated with lower health literacy, whereas higher educational attainment was associated with higher health literacy in an exploratory ordinal logistic regression model. Functional, symptomatic, appearance-related, and emotional aspects of lymphedema-related quality of life were interrelated, highlighting the multidimensional burden of the condition. However, no statistically significant association was observed between health literacy and quality-of-life outcomes.

These findings suggest that patients' age and educational background may be relevant considerations when developing accessible health information and educational support strategies in breast cancer-related lymphedema care. Nevertheless, the cross-sectional design, limited sample size, and exploratory nature of the analyses preclude causal interpretation. Larger prospective and interventional studies are needed to determine whether health-literacy-tailored educational strategies can improve self-management behaviors and patient-reported outcomes.

Author contribution All authors contributed to the concepEtion and design of the study. [S.G.A, H.Aİ] and collected the data. [S.G.A,H.A.İ, S.M.] and [S.U.K] analyzed and interpreted the data. [S.G.A] drafted the manuscript. All authors critically revised the manuscript for important intellectual content and approved the final version to be published. All authors agree to be accountable for all aspects of the work in accordance with ICMJE guidelines.

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Data availability The data that support the findings of this study are available from the corresponding author upon reasonable request. Data sharing is subject to ethical approval and institutional regulations to ensure patient confidentiality and compliance with data protection policies.

Declarations

Ethics approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent to participate The authors certify that they obtained all appropriate patient consent forms. In the form, the patient(s) has/have given their consent for his/her/their images and other clinical information to be reported in the journal. Patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed. Informed consent was obtained from all individual participants included in the study.

Clinical trial number Not applicable.

Competing interests The authors declare no competing interests.

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