Cultural adaption and multicenter validation of the German version of the LYMPH-Q Upper Extremity Module

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ABSTRACT

Objective: Upper extremity lymphedema is a burdensome disease with significant effects on quality of life, underscoring the importance of quality of life measures for this patient population. Only recently, the LYMPH-Q Upper Extremity Module, a new patient-reported outcome measure, was developed. The aim of the present study was to translate the LYMPH-Q Upper Extremity Module from English to German and perform a comprehensive validation.

Methods: Translation was performed in accordance with the International Society for Pharmacoeconomics and Outcomes Research best practice guidelines. To validate the German LYMPH-Q, a multicenter study was conducted. Internal consistency was determined using Cronbach's α. Reliability was assessed using the intraclass correlation coefficient. To analyze construct validity, the Pearson correlation coefficient between the LYMPH-Q, quickDASH (disabilities of the arm, shoulder, and hand), and short-form 36-item health survey was calculated. Responsiveness was assessed by comparing the pre- and postoperative LYMPH-Q scores in five patients who had undergone lymphatic reconstructive surgery.

Results: Validation was performed using a cohort of 65 patients. The internal consistency of the different domains was good to excellent (α, 0.87-0.97). The intraclass correlation coefficient ranged from 0.74 to 0.92. The domains of the LYMPH-Q correlated significantly with the corresponding domains of the short-form 36-item health survey and quickDASH. Construct validity was good, with 8 of 10 hypotheses confirmed. Significant improvements in function (46.4 ± 13.3 vs 77.8 ± 11.5; $P = .03$), symptoms (42.0 ± 10.7 vs 70.6 ± 11.6; $P = .02$), and psychological well-being (40.4 ± 14.6 vs 78.0 ± 17.3; $P = .03$) were observed after lymphatic reconstructive surgery.

Conclusions: The German version of the LYMPH-Q Upper Extremity Module was shown to be conceptually equivalent to the original English version. It was shown to be a reliable and valid patient-reported outcome measure to assess the physical and psychological impairments in patients with upper extremity lymphedema. (J Vasc Surg Venous Lymphat Disord 2022;10:922-8.)

Keywords: Lymphatic reconstructive surgery; Lymphedema; Patient-reported outcome measurements; Quality of life

Lymphedema is a chronic and burdensome disease, which, in developed countries, occurs most often after cancer treatment.[1] Upper extremity lymphedema (UEL), in particular, often develops after breast cancer treatment, with an incidence of 5.6% after sentinel lymph node biopsy and an up to four times greater incidence after axillary lymph node dissection (13.5%-28.2%). Given these incidence rates, we postulated that more than one in five women who have survived breast cancer will develop UEL.[2]

Although the survival of patients with cancer has continued to improve, no cure for lymphedema exists up to date. However, lymphedema is considered to be one of the most significant survivorship issues.[3] UEL can cause a wide range of symptoms known to affect both physical and mental health. Patients regularly experience swelling, tingling, arm or shoulder pain, difficulties in arm movement, psychological distress, and serious problems in daily functioning.[3-5] Studies have also reported a significantly greater level of anxiety and depression in these patients. Furthermore, it is known that these patients will more frequently receive mental health care compared with breast cancer survivors without UEL.[3,6] All these factors highlight the importance of quality of life (QOL) measures for this patient population.

An increasing body of literature has evaluated different patient-reported outcome measures (PROMs) for lymphedema.[7,8] Although many investigators still use ad hoc questionnaires, only a few disease-specific PROMs have been validated for patients with UEL.[9]

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These include the lymph QOL measure for limb lymphedema (LYMQOL),[10] upper limb lymphedema 27-item scale (ULL-27),[11] lymphedema life impact scale,[12] and the lymphedema functioning, disability, and health questionnaire (Lymph-ICF).[13] Although each tool is distinctive in its assessment of patients' QOL, none have undergone complete validation using the COSMIN (consensus-based standards for the selection of health measurement instruments), and no current consensus has been reached regarding which instrument to use for patients with UEL.[8,14] Recently, Klassen et al[15] introduced the LYMPH-Q Upper Extremity Module, which had been developed under rigorous guidelines and assessed in a cohort of 3222 patients in the United States and Denmark. The questionnaire includes 68 questions and is separated into the following domains: symptoms, function, appearance, psychological, information, and arm sleeve. The scales were originally validated using the Rasch measurement model, generating a conversion table in which the sum scores of the scales are converted to equivalent Rasch transformed scores (range, 0-100).[16]

The aim of our study was to translate the recently reported LYMPH-Q from English to German and perform a comprehensive cross-cultural validation of the German version.

METHODS

Advanced translation of LMYPH-Q Upper Extremity Module. The use of this questionnaire, developed by Drs Klassen, Pusic and Cano, was allowed under license from Memorial Sloan Kettering Cancer Center (New York, NY). Translation of the LYMPH-Q was performed in accordance with the International Society for Pharmacoeconomics and Outcomes Research best practice guidelines.[17] A translation was provided by two German natives who spoke English fluently. Afterward, a backward translation was prepared by a third person with English as their mother tongue and a good knowledge of German who had not seen the original English version. This was followed by a translation review by the Q-Portfolio team, an organization that provides clinicians and researchers with the ability to tailor their own version of the Q-Portfolio questionnaires to suit their needs (available at: https://qportfolio.org). Finally, cognitive debriefing interviews were conducted with five patients who were interviewed using the questions provided by the cognitive debriefing interview guide. The purpose of these interviews was to determine whether the patients had appropriately understood the translation of the items, instructions, and response options, for example, whether any words were misleading or might convey a different meaning. Furthermore, the participants were asked whether the questions were relevant and if any content were missing. If the participants had experienced any difficulties, they could suggest changes to the translation. The final German version of the LYMPH-Q was approved and formatted by the Q-Portfolio team.

ARTICLE HIGHLIGHTS

- **Type of Research:** A multicenter, prospective cohort study
- **Key Findings:** The German version of the LYMPH-Q Upper Extremity Module was validated in 65 patients and shown to be conceptually equivalent to the original English version. The internal consistency of the different domains was good to excellent. The domains correlated significantly with the expected corresponding domains of the short-form 36-item health survey and quickDASH (disabilities of the arm, shoulder, and hand).
- **Take Home Message:** The German version of the LYMPH-Q was shown to be a reliable and valid patient-reported outcome measure to assess the physical and psychological impairments of patients with upper extremity lymphedema.

Patients and data sampling. We conducted a multicenter study at the Department of Plastic Surgery and Hand Surgery and the Rehabilitation Clinic (Bad Zurzach, Switzerland). Patients with UEL were invited to participate. The cantonal ethics committee of Zurich, Switzerland approved the present study (ethical approval no. 2020-00110). The inclusion criteria were as follows: age ≥18 years; approval for participation in the study; and a diagnosis of UEL stage I to III, according to the International Society of Lymphology. All included patients were also seen by an angiologist specializing in lymphedema, who confirmed the diagnosis and excluded other reasons for extremity edema such as lipedema. Patients who were not able to complete the questionnaires because of an insufficient knowledge of the German language, impaired psycho-intellectual abilities, or any psychiatric disorder were excluded. All the patients had provided written informed consent before study participation.

The participants completed the following questionnaires: quick disabilities of the arm, shoulder and hand (quickDASH), short-form 36-item health survey (SF-36), and LYMPH-Q Upper Extremity Module. The patients either completed the questionnaires at our outpatient clinic or at home and were mailed in a prepaid envelope to the first author (L.G.). Additionally, we collected the following patient data: age, body mass index (BMI), onset of lymphedema, underlying cause, lymphedema stage according to the International Society of Lymphology, comorbidities, prior lymphedema-related surgery (eg, liposuction, dermolipectomy, lymphovenous anastomosis [LVA], free vascularized lymph node transfer [VLNT]), and recurrent infections.

Table I. Patient demographics[a]

Variable	Cohort 1 (n = 33)	Cohort 2 (n = 32)
Age, years	56.3 ± 13.4	NA
BMI, kg/m^2	27.8 ± 4.8	NA
Lymphedema stage		
I	12	8
II	18	22
III	3	2
Lymphedema duration, years		
<5	11	10
5-10	10	12
>10	12	10
Lymphedema etiology		
Primary	4	NA
Secondary	29	NA
Recurrent erysipelas	12	NA
Prior surgery		
Liposuction	1	5
Dermolipectomy	0	0
LVA/VLNT	5	0
Concomitant disease	17	NA

BMI, Body mass index; *LVA,* lymphovenous anastomosis; *NA,* not available; *VLNT,* vascularized lymph node transfer.
Data presented as mean ± standard deviation or number.
[a]Cohort 1, patients from our institutions invited to participate in the study; cohort 2, participants contacted via different lymphedema associations and asked to participate anonymously.

Because many of the patients treated at our institutions (cohort 1) had been actively seeking a change in their current lymphedema management, which could have had an effect on the results of the questionnaires, we included a second cohort of patients (cohort 2) to obtain a representative overall collective. The second cohort of participants was contacted via different lymphedema associations and asked to participate anonymously. If they were willing to participate, they completed the LYMPH-Q via a password-protected online link. Additionally, they were asked for their lymphedema grade as determined by their practitioner.

Comprehensive validation of the German LYMPH-Q Upper Extremity Module. Cronbach's α was used to measure the internal consistency of the six domains and was classified as followed: excellent, α ≥0.9; good, α ≥0.8 but <0.9; acceptable, α ≥0.7 but <0.8; questionable, α ≥0.6 but <0.7; and poor, α ≥0.5 but <0.6. Test–retest reliability measures the consistency of results when the same test is repeated using the same sample at different points in time. To assess the test–retest reliability, the participants were asked to complete the questionnaire at two different time points with an interval of 2 weeks. This allowed us to calculate the intraclass correlation coefficient (ICC) for the different domains between the two time points. The data were interpreted as described. An ICC of ≥0.70 was considered acceptable.[14] To interpret the magnitude of the within-subject variation between the scores from the two testing times, we calculated the standard error of the measurement (SEM) using the following formula: $SEM = SD_{12}\sqrt{1 - ICC}$, where SD_{12} was the average standard deviation of the two ratings. To evaluate for clinically important changes, we calculated the smallest real difference (SRD) using the following formula: $SRD = 1.96 \times SEM \times \sqrt{2}$.[18] To obtain a reference range for the mean difference between the scores on the two test occasions, the 95% SRD was calculated as the mean difference between the scores on the two test occasions plus or minus the SRD.

For the comparison between the LYMPH-Q, quickDASH, and SF-36, the Pearson correlation coefficient was determined. Values of <0.40 were considered weak; 0.40 to 0.74, moderate; 0.75 to 0.90, strong; and >0.90, very strong. If the *P* value was < .05, the correlation was considered statistically significant.

Construct validity is the extent to which a measure correlates with variables consistent with the theoretical hypotheses. To analyze construct validity for the LYMPH-Q, the following 10 hypotheses were raised.

Table II. Internal consistency and reliability of LYMPH-Q domains

	Test–retest				Clinically important changes	
LYMPH-Q scale	ICC	95% CI	Consistency (α)	Variability (SEM)	SRD	95% SRD
Symptoms	0.85	0.61-0.94	0.93	7.0	19.4	−9.2 to 29.6
Function	0.92	0.80-0.97	0.94	6.7	18.6	−2.5 to 34.7
Appearance	0.81	0.51-0.93	0.97	12.3	34.1	−17.8 to 50.4
Psychological	0.82	0.54-0.93	0.96	8.5	23.6	−5.0 to 42.2
Information	0.78	0.43-0.92	0.93	13.0	36.0	−20.4 to 51.6
Arm sleeve	0.74	0.26-0.91	0.87	9.7	26.9	−16.3 to 37.5

α, Cronbach's α coefficient; *CI,* confidence interval; *ICC,* intraclass correlation coefficient; *SEM,* standard error of measurement; *SRD,* smallest real difference.

Table III. Pearson correlation coefficient for various domains of LYMPH-Q and short-form 36-item health survey (SF-36) and disabilities of the arm, shoulder, and hand (quickDASH)

	LYMPH-Q scale			
SF-36 domain	Symptoms	Function	Appearance	Psychological
Physical functioning	0.22	0.62[a]	0.09	0.40[b]
Role limitations physical	0.34	0.54[a]	0.05	0.50[a]
Pain	0.59[a]	0.71[a]	0.12	0.43[b]
General health	0.43[b]	0.47[a]	0.15	0.40[b]
Emotional well-being	0.23	0.40[b]	0.17	0.49[a]
Role limitations emotional	0.31	0.45[a]	0.23	0.60[a]
Vitality	0.40[b]	0.50[a]	0.27	0.53[a]
Social functioning	0.33	0.44[b]	0.24	0.50[a]
quickDASH	−0.63[a]	−0.85[a]	−0.05	−0.40[b]

[a] $P < .01$.
[b] $P < .05$.

Considering all correlation coefficients for the various domains of the SF-36 and the LYMPH-Q and the overall score for the quickDASH, significant correlation coefficients would occur for the following: (1) LYMPH-Q "symptoms" and SF-36 "pain"; (2) LYMPH-Q "symptoms" and SF-36 "physical functioning"; (3) LYMPH-Q "function" and SF-36 "role limitations physical"; (4) LYMPH-Q "psychological" and SF-36 "emotional well-being"; (5) LYMPH-Q "function" and quickDASH; and (6) LYMPH-Q "function" and SF-36 "social functioning." In addition, we hypothesized a nonsignificant correlation for the following: (7) LYMPH-Q "appearance" and quickDASH; (8) LYMPH-Q "appearance" and SF-36 "role limitations physical"; (9) LYMPH-Q "symptoms" and SF-36 "role limitations emotional"; and (10) LYMPH-Q "function" and SF-36 "emotional well-being." Good construct validity would be considered present if 75% to 90% of the hypotheses were confirmed.

To analyze the effects of age, BMI, comorbidities, and lymphedema grade on the LYMPH-Q scales, we compared the Rasch score between the different patient groups. Responsiveness was further assessed by comparing the preoperative and postoperative LYMPH-Q scores for the five patients who had undergone LVA and VLNT. For the group analysis, either a *t* test (two groups) or one-way analysis of variance (three or more groups) was performed. *P* values $< .05$ were considered to indicate statistical significance.

For statistical analysis, IBM SPSS Statistics, version 22 (IBM Corp, Armonk, NY), was used. The graphs were plotted in GraphPad Prism, version 7.04 (GraphPad, La Jolla, Calif).

RESULTS

Advanced translation. We found a high level of consensus between the two forward translations. Individual differences were found owing to variations in wording and were discussed with a third translator to reach a consensus. The back translation review identified 27 items, response options, or instructions that had required repeat translation. After retranslation, the German version corresponded well with the meaning of the original English version. Cognitive debriefing interviews were conducted with the four female and one male patient with UEL. The patients did not identify any problems with understanding the items, instructions, or response options, and no content was considered to be missing or irrelevant. Thus, no further changes were made after the cognitive debriefing interviews. Finally, the German version of the LYMPH-Q Upper Extremity Module was approved by the Q-Portfolio team.

Patient collective. A total of 65 patients (Table I) completed the LYMPH-Q Upper Extremity Module, which required 7 minutes on average. Of the 65 patients, 40 had had lymphedema grade 2, followed by 20 with grade 1 and 5 with grade 3 lymphedema. The duration of lymphedema ranged from <5 to >10 years. In patient

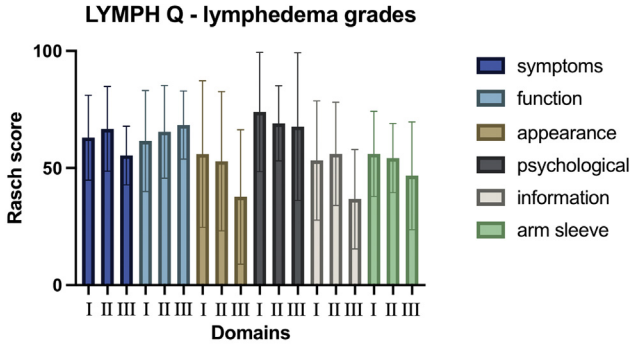

Fig 1. LYMPH-Q Upper Extremity Module scores for the six LYMPH-Q domains (symptoms, function, appearance, psychological, information, arm sleeve) stratified by lymphedema grade (I, II, III). Although no significant correlation was found between the scores and lymphedema grade, a trend was seen toward worse outcomes in the LYMPH-Q scores for patients with advanced lymphedema.

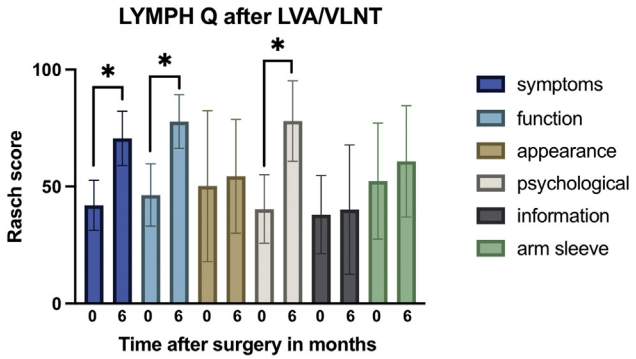

Fig 2. Pre- and postoperative LYMPH-Q Upper Extremity Module scores for the patients who had undergone lymphovenous anastomosis (LVA) or free vascularized lymph node transfer (VLNT). Improvements were found for all six scores but were statistically significant for symptoms, function, and psychological. *$P < .05$.

cohort 1, 29 patients had had secondary lymphedema. In contrast, primary lymphedema was only noted for a few patients (n = 4). Of the participants, 11 patients had undergone prior surgery such as liposuction (n = 6) or LVA or VLNT (n = 5). Almost one third of the patients had had concomitant diseases such as arterial hypertension or diabetes.

Internal consistency. The analysis of internal consistency (Table II) of the scales regarding symptoms, function, appearance, psychological, and information showed Cronbach's α values of 0.93 to 0.97 and was categorized as excellent. The internal consistency of the different items for the arm sleeve was also good (α, 0.87).

Test–retest reliability. Based on the scores from 21 participants, who had completed the LYMPH-Q Upper Extremity Module at two different occasions with an interval of 2 weeks, the ICC was acceptable for the information and arm sleeve scales (Table II). Although the ICC was good for the symptoms, appearance, and psychological scales, it was excellent for the function scale. The scores for the different domains showed a variability (SEM) between 6.7 and 13. The SRD ranged from 18.6 to 36. Based on the 95% SRDs, a SRD of 19.4 that was assessed for the symptoms domain, a decrease of ≥9 and an increase of 30 should be considered clinically relevant. The scores for the remaining domains should be similarly interpreted.

Construct validity. The domains of the LYMPH-Q Upper Extremity Module correlated significantly with the corresponding domains of the SF-36 and quickDASH (Table III). In particular, the symptoms scale showed moderate correlation with the SF-36 domain of pain, general health, and vitality. The LYMPH-Q function and psychological domains correlated significantly with all eight SF-36 domains. In contrast, we found no correlation between the LYMPH-Q appearance domain and the different SF-36 domains. Although the score of the quickDASH correlated negatively with arm function, we found a significantly negative correlation between the score and the LYMPH-Q symptom, function, and psychological domains. Construct validity was good, with 8 of the 10 hypotheses confirmed.

Responsiveness. The mean scores of the different LYMPH-Q domains were as follows: symptoms, 56.7 ± 18.7; function, 55.5 ± 22.4; appearance, 57.4 ± 29.6; psychological, 58.6 ± 23.7; information, 55.1 ± 25.0; and arm sleeve, 55.6 ± 14.9. Although no correlation was found between the LYMPH-Q score of the different domains and lymphedema grade (Fig 1) or with age, BMI, or comorbidities (Supplementary Tables I–IV, online only), we observed statistically significant improvements after LVA/VLNT (Fig 2) in the symptom domain (42.0 ± 10.7 vs 70.6 ± 11.6; $P = .02$), function domain (46.4 ± 13.3 vs 77.8 ± 11.5; $P = .03$), and psychological well-being (40.4 ± 14.6 vs 78.0 ± 17.3; $P = .03$).

DISCUSSION

In the present study, we have provided a comprehensive evaluation of the German version of the LMYPH-Q Upper Extremity Module. The well-established translation process allowed for the development and cultural adaption of the German LYMPH-Q that is conceptually equivalent to the original English version.

The internal consistency of the different domains was considered to be good to excellent and was comparable that of with other available PROMs for UEL such as the Lymph-ICF upper extremity or ULL-27.[13,19] The reliability of the LYMPH-Q Upper Extremity Module was good to excellent for most of the scales. In addition, we assessed measurement variability and clinically important changes, as recommended by Lexell and Downham.[18] Although we noted relatively high values regarding clinically important changes for the different domains, those were comparable to the Lymph-ICF upper extremity scales.[13] Nevertheless, an interval of 2 weeks between the test and retest might have been too long, because other investigators had used 24 to 48 hours to assess test–retest reliability.[7,13] Considering the effect of a single session of decongestive therapy on limb volume and QOL, an interval of 2 weeks might have resulted in different scores for certain domains. The assessment of test–retest reliability was further limited by the small number of 21 patients. To detect an ICC of 0.80 with a power of 80% and type I error of 0.05, a sample size of 36 patients would have been necessary.[20] However, excellent test–retest reliability with an ICC of ≥0.92 using data from 79 participants had already been confirmed by the original investigators.[15]

The criterion validity of the LYMPH-Q Upper Extremity Module could not be determined because it would have required a comparison with a reference standard

questionnaire for patients with UEL, which is not available. Instead, we assessed the construct validity, which was proved to be good. In line with previous studies, we chose the SF-36 and quickDASH to analyze convergent validity and divergent validity.[13,21] The SF-36 is a valid and reliable generic PROM that has been extensively studied for patients with lymphedema.[22-24] Although other investigators assessed construct validity using a comparison with the disease-specific LYMQOL, we have recently shown that the LYMQOL lacks comprehensive validation.[8,12] Moreover, to the best of our knowledge, a German version of the LYMQOL does not yet exist. The LYMPH-Q symptom, function, and psychological domains correlated significantly with the corresponding SF-36 domains. In contrast, we found no correlation with the LYMPH-Q domain on appearance. This is not surprising, because neither the SF-36 domains nor the quickDASH includes questions regarding the appearance of the limb such as "how the arm looks in photographs" or "how clothes fit your arm." Considering that many young women will be affected by arm lymphedema after breast cancer, this domain is of utmost importance and fundamental when assessing QOL for that patient population. It is well-known that UEL also interferes with activities of daily living that involve the shoulder, arm, and hand. The quickDASH is a widely established and well-validated self-reported disability score that allows patients to rate the difficulties and interferences with daily life due to impaired function of the upper extremity.[25-27] Hence, its use allowed us to specifically compare and correlate the quickDASH score with the LYMPHQ domain on function. We confirmed a significant correlation between both scores, strengthening the validity of the LYMPH-Q to assess limb function.

Our results have provided further evidence that the LYMPH-Q is a valid PROM to capture QOL and disease-related symptoms after surgical treatment. As such, we observed statistically significant improvements after LVA/VLNT regarding symptoms, function, and psychological well-being. Although we noted a trend toward worse outcomes for patients with grade III lymphedema, no significant correlation was found. Klassen et al[15] reported that increased arm swelling severity and wearing of a compression sleeve during the previous 12 months correlated with worse outcomes for all six LYMPH-Q Upper Extremity Module scales. Given the small number of patients with grade III lymphedema, we assumed that our patient cohort was not appropriate for analysis of the correlations between lymphedema severity and the LYMPH-Q scores.

Lymphedema is a complex and burdensome disease that affects both physical and mental health.[3-5] Patients with lymphedema can experience a remarkably greater level of anxiety and depression and have been more frequently followed up by mental health services compared with breast cancer survivors without UEL.[3,6] Although the limb volume has often been used measure to monitor lymphedema, it does not reflect patients` complaints and impairments. The LYMPH-Q Upper Extremity module eliminates this lack and provides a more complete picture of patients with lymphedema. Compared with other disease-specific PROMS, the LYMPH-Q was developed with patient input, ensuring that the concepts most important to patients with lymphedema were identified and used to form the scales. As such, the LYMPH-Q includes scales on the appearance of the affected arm and satisfaction with the patient's current arm sleeve, which are of significant importance for patients with lymphedema and not covered by other existing disease-specific PROMS such as the ULL-27, LYMPH-ICF upper limb, lymphedema life impact scale, and LYMQOL. Most importantly, the additional information domain permits the evaluation of the quality of patient counseling and patient education, making the LYMPH-Q Upper Extremity Module a noteworthy tool for assessing the quality of care from different departments.[15]

CONCLUSIONS

The results of the present study have shown that the German version of the LYMPH-Q Upper Extremity Module is conceptually equivalent to the original English version. It provides clinicians and researchers with a rigorously developed PROM for patients with arm lymphedema. Compared with the existing PROMS for UEL, the LYMPH-Q is unique in terms of the range of patient concerns and impairments covered by the six domains.

AUTHOR CONTRIBUTIONS

Conception and design: LG, HH, NL
Analysis and interpretation: LG, PG, NL
Data collection: LG, FA, CB, HH, EG, SU, SL, SW, NL
Writing the article: LG
Critical revision of the article: LG, FA, CB, HH, EG, SU, SL, SW, PG, NL
Final approval of the article: LG, FA, CB, HH, EG, SU, SL, SW, PG, NL
Statistical analysis: LG
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Overall responsibility: NL

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Supplementary Table I (online only). Comparison of LYMPH-Q domain scores stratified by age group

LYMPH-Q scale	Rasch score		*P* value
	Age 29-64 years	Age >65 years	
Symptoms	60.9 ± 16.0	72.1 ± 19.5	.1
Function	62.7 ± 19.2	67.8 ± 21.3	.5
Appearance	50.7 ± 31.1	57.0 ± 27.4	.6
Psychological	68.6 ± 21.4	75.5 ± 19.6	.4
Information	52.6 ± 25.8	54.5 ± 16.2	.8
Arm sleeve	55.0 ± 16.1	51.5 ± 18.1	.6

Data presented as mean ± standard deviation.

Supplementary Table II (online only). Comparison of LYMPH-Q domain scores stratified by presence of comorbidities[a]

LYMPH-Q scale	Rasch score		*P* value
	No comorbidities	Comorbidities	
Symptoms	62.9 ± 17.9	66.2 ± 17.6	.6
Function	68.2 ± 20.9	58.9 ± 17.1	.2
Appearance	48.9 ± 32.3	57.6 ± 26.2	.4
Psychological	70.6 ± 23.6	70.8 ± 16.9	.9
Information	52.3 ± 24.1	54.1 ± 22.9	.8
Arm sleeve	57.4 ± 16.8	49.6 ± 15.3	.2

Data presented as mean ± standard deviation.
[a]Comorbidities included arterial hypertension, diabetes, coronary heart disease, any malignancy requiring ongoing treatment, obstructive pulmonary disease, and chronic inflammatory bowel disease.

Supplementary Table III (online only). Comparison of LYMPH-Q domain scores stratified by lymphedema (*LE*) grade

	Rasch score			
LYMPH-Q scale	**LE grade I**	**LE grade II**	**LE grade III**	***P* value**
Symptoms	62.9 ± 18.2	66.7 ± 18.1	55.3 ± 12.5	.6
Function	61.5 ± 21.6	65.4 ± 19.8	68.3 ± 14.6	.8
Appearance	55.9 ± 31.3	65.4 ± 19.8	37.7 ± 28.7	.6
Psychological	73.9 ± 25.5	52.9 ± 29.8	67.8 ± 31.5	.8
Information	53.2 ± 25.5	69.1 ± 16.0	36.7 ± 21.2	.4
Arm sleeve	56.0 ± 18.2	56.0 ± 22.1	46.7 ± 23.0	.7

Data presented as mean ± standard deviation.

Supplementary Table IV (online only). Comparison of LYMPH-Q domain scores stratified by body mass index (BMI)

	Rasch score			
LYMPH-Q scale	**BMI ≤25 kg/m^2**	**BMI >25 but ≤30 kg/m^2**	**BMI >30 kg/m^2**	***P* value**
Symptoms	62.5 ± 6.4	73.0 ± 17.5	61.5 ± 26.2	.4
Function	64.5 ± 16.0	73.3 ± 19.9	57.8 ± 22.8	.3
Appearance	53.1 ± 30.3	56.6 ± 28.7	43.8 ± 29.8	.6
Psychological	74.0 ± 20.9	74.3 ± 14.4	59.2 ± 19.5	.2
Information	51.7 ± 27.5	64.2 ± 21.4	48.8 ± 20.2	.5
Arm sleeve	53.8 ± 18.5	55.0 ± 14.3	52.9 ± 16.1	.9

Data presented as mean ± standard deviation.