



Dutch normative values for the LIMB-Q: A step toward international standardization of patient-reported outcomes after lower extremity trauma

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Summary Background: The LIMB-Q is a patient-reported outcome measure (PROM) developed to assess multiple key health-related domains after lower extremity trauma. This study aimed to translate the LIMB-Q into Dutch and establish normative data for the Dutch population.

Methods: The LIMB-Q was translated and culturally adapted in line with established international guidelines using forward and backward translation. A representative general population sample was recruited via an online research panel. Participants completed the Dutch LIMB-Q (33 items) and reported sociodemographic and health information. Poststratification weights were applied based on the 2025 Statistics Netherlands [Centraal Bureau voor de Statistiek (CBS)] age-sex distribution. Descriptive statistics and multivariable regression analyses were performed for all domains.

Results: A total of 1188 respondents were included in the analyses. The sample reflected the Dutch adult population (55.7% women; mean age, 49.6 years). On a 0 to 100 scale, the mean (standard deviation) scores were 87.3 (17.3) for appearance, 81.6 (19.8) for function, and 85.3 (18.0) for symptoms. The ceiling effects were modest ($\leq 11\%$). The scores were stable across age groups, with slight declines in older adults. In multivariable regression, comorbidity was

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significantly associated with lower scores in all domains ($p < 0.001$), whereas sex and age were not significantly associated ($p > 0.27$). Weighted and unweighted results were nearly identical, confirming demographic representativeness.

Conclusions: This study provided the first Dutch translation and normative reference values for the LIMB-Q. It aimed to support clinicians and researchers in interpreting patient-reported outcomes after lower extremity trauma by offering population-based reference data.

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Complex lower extremity injuries are devastating events with profound consequences for physical function, psychosocial well-being, and quality of life.¹⁻³ Treatment is often lengthy and involves multiple surgical procedures, carrying a high risk of complications and substantial impact on patients' daily lives.^{4,5} To fully understand these outcomes, it is crucial to assess not only clinical recovery but also the patient's own experience using patient-reported outcome measures (PROMs) that capture aspects such as pain, function, body image, and social participation.

The LIMB-Q is the first PROM specifically developed for patients with lower extremity trauma, including those who undergo fracture repair, limb salvage, or amputation. Developed by an international, multidisciplinary team of surgeons and outcomes researchers, the LIMB-Q provides a set of independently functioning scales that reflect what matters most to patients after limb-threatening injuries.⁶ The original validation demonstrated strong content validity, reliability, and applicability across different settings.⁷

For meaningful use in another country, PROMs require careful translation and cultural adaptation to ensure conceptual equivalence.⁸ Furthermore, establishing normative values is essential to facilitate the interpretation of scores in clinical and research contexts, as they provide a benchmark for distinguishing between patient populations and the general population. Until now, no validated Dutch translation of the LIMB-Q, nor normative values for its scales, have been available.

The aim of this study was therefore twofold: (1) to translate and culturally adapt the LIMB-Q into Dutch and (2) to establish normative values in a representative Dutch population. By providing these foundations, this study enabled the use of the LIMB-Q in Dutch clinical practice and research, allowing for more precise evaluation of outcomes after complex lower extremity trauma.

Methods

The World Health Organization and the Professional Society for Health Economics and Outcomes Research guidelines were used to conduct this translation.⁸

Forward translation

Two academic translators performed independent forward translations of the field-test version of the LIMB-Q scales. Both translators were native Dutch speakers and fluent in

English. At an expert panel meeting, the two translations were compared, and discrepancies were discussed and resolved. The two translations were reconciled into one translation. The final forward translation produced was the Dutch LIMB-Q version 1.0.

Backward translation

A translator bilingual in Dutch and English performed the backward translation of Dutch LIMB-Q version 1.0. This backward translation was compared to the English version of LIMB-Q. At an expert panel meeting, all discrepancies were noted and discussed with the LIMB-Q developers. After the meeting, items were re-translated and discussed until a consensus was reached, leading to the Dutch LIMB-Q version 2.0.

Normative values

The LIMB-Q includes domains covering the physical, psychosocial, and care-related outcomes of lower extremity conditions, with scales that include function, appearance, symptoms, expectations, psychological, and treatment experience. For the study of the normative values, only the three domains that can be meaningfully evaluated by individuals without hospital care were administered: function (e.g., mobility and daily activities), appearance (e.g., overall limb appearance and scarring), and symptoms (e.g., pain, swelling, and stiffness). Data collection was carried out by the panel research company NiQ-GfK (<https://www.gfk.com>), which contacted their panel members for participation in this study. Participants completed a total of 33 items of the Dutch LIMB-Q based on appearance, symptoms, and physical functioning. Besides the Dutch LIMB-Q, the participants answered six additional questions assessing the sociodemographic characteristics and the presence of doctor-diagnosed chronic conditions. The selection of chronic conditions was based on their prevalence in the community (i.e., chronic pain, heart disease, cancer, depression, chronic obstructive pulmonary disease, arthritis, diabetes, asthma, anxiety disorder, obesity, and drug/alcohol use disorder).⁹ Participants with incomplete LIMB-Q responses were excluded from the analysis. Missing demographic or comorbidity data were minimal (< 1%) and were not imputed. The participants selected for this study by GfK are representative of the Dutch population in terms of age and educational level. Data was collected in August and September 2025, and only complete data sets were eligible for the analysis.

Statistical analysis

To assess representativeness, poststratification weights were calculated based on the Dutch population distribution by sex and age using data from Statistics Netherlands (CBS, 2025).¹⁰ Weighted analyses were compared to unweighted results. As weighting did not materially change the descriptive or normative values (all differences < 0.5 points), only unweighted results were reported. The weighting diagnostics are provided in Table S1.

The sample characteristics are provided in Table 1. The general population normative values are presented as the mean and standard deviation (SD) for groups defined according to sex, age (18-39, 40-49, 50-59, 60-69 and ≥70

years), and existing health conditions (none vs. one and more). Floor and ceiling effects were defined as the percentage of respondents scoring the minimum or maximum possible score on a scale, respectively. A threshold of < 15% was considered acceptable.¹¹

Additionally, this established a multivariable linear regression model estimating the effects of sex, age (continuous variables with linear and quadratic terms), and the presence of comorbidities (none, one or more) for each Dutch LIMB-Q scale. The multivariate regression model aimed to allow a precise calculation of normative values for the Dutch population and to supplement the descriptive normative data tables. The selection of covariates was consistent with previously applied methods, whereby the

Table 1 Sample characteristics and comorbidities.

Sex (%)	Male	524 (44.1%)	
	Female	662 (55.7%)	
	Other/NA	2 (0.2%)	
Age (years)	Mean (SD)	49.6 (17.3)	
	Median [IQR]	49 [29]	
Education (%)	Less than compulsory education	10 (0.8%)	
	Compulsory school	94 (7.9%)	
	Some post-compulsory education	99 (8.3%)	
	Post-compulsory below university	693 (58.3%)	
	University degree (bachelor)	126 (10.6%)	
	Postgraduate degree (master's/Ph.D.)	158 (13.3%)	
Marital status (%)	Prefer not to answer	8 (0.7%)	
	Married or in steady relationship	817 (68.8%)	
	Single/not in steady relationship	236 (19.9%)	
	Separated/divorced/widowed	118 (9.9%)	
	Prefer not to answer	17 (1.4%)	
Employment (%)	Full-time employed	414 (34.8%)	
	Part-time employed	280 (23.6%)	
	Self-employed	55 (4.6%)	
	Student	31 (2.6%)	
	Unemployed	40 (3.4%)	
	Retired	239 (20.1%)	
	Homemaker	30 (2.5%)	
	Other	84 (7.1%)	
	Prefer not to answer	15 (1.3%)	
	Comorbidity count (%)	None	609 (51.3%)
		One health condition	233 (19.6%)
Two to three health conditions		233 (19.6%)	
Four or more health conditions		51 (4.3%)	
Prefer not to answer		62 (5.2%)	
Specific comorbidities	Diabetes	82 (17.1%)	
	Heart disease	33 (6.9%)	
	Lung disease	16 (3.3%)	
	Depression	43 (9%)	
	Cancer	16 (3.3%)	
	Osteoarthritis	30 (6.3%)	
	Chronic pain	22 (4.6%)	
	Rheumatoid arthritis	40 (8.4%)	
	Neurological disorder	22 (4.6%)	
	Back problems	44 (9.2%)	
	Skin disease	3 (0.6%)	
	Injury	119 (24.8%)	
	Other condition	9 (1.9%)	

Note: Data are the total number with percentage (%), unless otherwise specified. Ages in years. Comorbidity categories reflect self-reported doctor-diagnosed chronic conditions.

full model (block entry) retained all covariates in the model. Because the relationship between age and health-related quality of life might not be strictly linear, the regression model included both linear and quadratic age terms to capture potential nonlinear effects.

All analyses were performed using R version 4.3.2 (R Foundation for Statistical Computing, Vienna, Austria). Regression models were constructed using the “lm” function, and tables were exported with the “flectable” and “officer” packages.

Ethical considerations

This study used anonymous survey data from the NiQ-GfK panel members who gave informed consent. No patient or identifiable data were collected. Under Dutch WMO regulations, fully anonymized survey research without intervention does not require ethics committee review.

Results

Forward and backward translation

Two independent forward translations of the LIMB-Q were completed by native Dutch speakers (TdJ and LCB) with professional experience in medical translation. Both versions were conceptually equivalent and linguistically consistent. Minor wording differences were reviewed and harmonized during the expert panel meeting, resulting in the reconciled Dutch LIMB-Q version 1.0.

The backward translation demonstrated conceptual equivalence with the original English instrument. After review by the original developers, only small stylistic refinements were made to improve clarity and cultural appropriateness. No semantic inconsistencies or translation errors were identified, and all items were retained, resulting in the Dutch LIMB-Q version 2.0.

Normative value

A total of 1226 individuals completed the Dutch LIMB-Q survey. After excluding incomplete responses, 1188 participants were included in the final analysis. The mean (SD) age was 49.6 (17.3) years, ranging from 18 to 88 years. Most participants were employed (69.3%), married or cohabiting (68.8%), and had completed postsecondary or higher education (82.2%). Comorbidities were reported by 48.7% of the respondents, whereas 51.3% reported none. The most common conditions were injury (24.8%), diabetes (17.1%), depression (9.0%), back problems (9.2%), and rheumatoid arthritis (8.4%). Table 1 summarizes the participant characteristics.

Weighting diagnostics (Table S1) confirmed excellent representativeness across sex and age strata, with negligible differences between unweighted and weighted distributions (maximum deviation, < 3%). Therefore, unweighted results were reported throughout.

Normative LIMB-Q domain scores for the Dutch population are presented in Table 2. The mean (SD) scores were 87.3 (17.3) for appearance, 81.6 (19.8) for function, and 85.3 (18.0) for symptoms. Overall, scores were high, reflecting a healthy population without lower extremity pathology. Weighted and unweighted results were nearly identical, confirming that demographic balance was already achieved in the unweighted sample. The ceiling effects were low to moderate (9% for appearance, 7% for function, and 11% for symptoms), indicating adequate score variability and sensitivity across all scales. In Table 2, the mean scores were generally stable across age groups, with a gradual decline in function and, to a lesser extent, in symptoms among older participants. Appearance scores remained high across all ages. Men reported consistently higher scores than women across domains, although these differences were not statistically significant (all $p > 0.27$) (Table 3).

Neither sex nor age demonstrated statistically significant associations with the LIMB-Q outcomes, and no quadratic relationship between age and domain scores was observed. The adjusted R² values ranged from 0.14 for appearance to 0.29 for function, which are typical for population-based

Table 2 LIMB-Q domain scores by age group.

		All (N=1188), mean (SD)	18-39 years, mean (SD)	40-49 years, mean (SD)	50-59 years, mean (SD)	60-69 years, mean (SD)	≥70 years, mean (SD)
Appearance	Male	93.9 (13.2)	91.3 (16.3)	93.3 (11.7)	93.4 (13.5)	94.2 (12.6)	95.8 (8.9)
	Female	81.8 (18.3)	82.1 (19.1)	82.5 (18.1)	79.7 (18.0)	80.6 (20.5)	82.1 (16.8)
	Other/NA	84.0 (22.6)*	84.0 (22.6)	—	—	—	—
	All	87.3 (17.3)	85.7 (18.2)	87.0 (16.4)	85.8 (16.9)	86.9 (17.2)	90.3 (14.1)
Function	Male	84.5 (17.4)	89.1 (18.5)	91.3 (13.1)	88.3 (16.4)	78.5 (21.8)	73.9 (19.2)
	Female	77.3 (20.6)	86.8 (16.3)	84.8 (17.6)	73.7 (18.9)	69.0 (23.7)	60.1 (18.6)
	Other/NA	71.5 (28.9)*	71.5 (28.9)	—	—	—	—
	All	81.6 (19.8)	87.7 (17.6)	87.5 (16.9)	80.1 (19.5)	73.6 (22.7)	68.4 (19.1)
Symptoms	Male	87.4 (17.3)	89.5 (18.2)	93.2 (13.1)	92.0 (13.6)	84.5 (18.3)	85.6 (16.2)
	Female	82.3 (19.0)	86.7 (17.4)	86.2 (17.8)	79.2 (18.5)	75.7 (22.7)	71.7 (18.7)
	Other/NA	77.5 (31.8)*	77.5 (31.8)	—	—	—	—
	All	85.3 (18.0)	87.6 (17.7)	89.2 (16.5)	84.8 (17.6)	79.9 (20.7)	79.9 (17.6)

Note: Values are the mean (SD) LIMB-Q scores for each domain by age category. Higher scores indicate better outcomes. Ceiling effects < 15% were observed across all domains.

*Values for the “Other/NA” sex category should be interpreted with caution due to the small sample size in this group.

Table 3 Regression models for the LIMB-Q domains in the Dutch population.

	Intercept (est.)		Sex (est.)		Age (est.)		Age ² (est.)		Comorbidity (cst.)		Adj. R ²
			Coeff.	p	Coeff.	p	Coeff.	p	Coeff.	p	
Appearance	33.27		-2.04	0.273	-0.00	0.914	0.00	0.934	-1.85	< 0.001***	0.14
Function	63.32		-2.17	0.348	0.05	0.597	-0.00	0.592	-8.09	< 0.001***	0.29
Symptoms	42.43		-1.44	0.494	-0.03	0.593	0.00	0.033*	-4.42	< 0.001***	0.21

Note: Adjusted R² for the full model (block entry).

Sex (coding: 0=male; 1=female). Age (> 18 years; continuous). Age² (quadratic term; continuous). Comorbidity (coding: ≥1 condition=1; none=0).

*p < 0.05; ***p < 0.001.

models of patient-reported outcomes, where substantial individual variability limits the proportion of explained variance.

Discussion

This study established the Dutch translation and first normative reference values for the LIMB-Q, a PROM designed to evaluate appearance, function, and symptoms after lower extremity trauma. The Dutch LIMB-Q demonstrated excellent comprehensibility and conceptual equivalence with the original version, ensuring suitability for use in both clinical practice and research. By providing normative data derived from a representative Dutch population, this study enables clinicians and researchers to interpret patient scores relative to population benchmarks, thereby enhancing the interpretability of outcomes.

Normative values showed high average scores across all three domains, consistent with expectations for a general population without limb pathology. The ceiling effects were < 15% for all scales, confirming adequate score range and sensitivity.¹² These results aligned with previous studies of other PROMs, which similarly demonstrated high population scores and low ceiling effects in healthy respondents.^{13,14} The small differences between weighted and unweighted results underscored that the sampling procedure achieved demographic balance, confirming the robustness of the findings.

Comorbidity emerged as the principal factor associated with lower LIMB-Q scores, emphasizing the instrument's discriminative ability. Individuals reporting one or more chronic health conditions had notably lower appearance, function, and symptom scores, highlighting the impact of general health on perceived limb well-being. Neither sex nor age showed significant effects, suggesting that the LIMB-Q performs consistently across demographic groups.

Beyond score interpretation, recent advances in prognostic stratification for complex lower extremity trauma highlight the importance of standardized, patient-centered outcome assessment. Meccariello et al. proposed classification and scoring systems that combine clinical injury characteristics with functional and PROMs, improving prognostic accuracy and cross-study comparability.^{15,16} These developments reinforce the value of population-based normative reference data, such as those provided in this study, for contextualizing LIMB-Q scores relative to general population benchmarks rather than injury-based classifications alone.

Direct comparison to population-based reference values from the original LIMB-Q is currently limited, as such normative data have not yet been published. It is suggested that future translations of the LIMB-Q, where feasible, be accompanied by population-based normative studies to support international benchmarking and cross-country comparability of patient-reported outcomes.

The primary strength of this study lies in its large, population-based sample and rigorous adherence to international translation and adaptation standards. Limitations include reliance on self-reported comorbidity data and the cross-sectional design, which precludes longitudinal interpretation. Although women were slightly overrepresented in the sample, sensitivity analyses using weighted data yielded nearly identical outcomes (all differences < 0.5 points), confirming that the deviation did not bias the results. Nevertheless, the Dutch LIMB-Q normative dataset provides a valuable reference for future studies assessing outcomes after lower extremity trauma, reconstructive surgery, and amputation. Establishing these normative values represents a crucial step toward standardized, patient-centered outcome evaluation in Dutch trauma care. In addition, making the LIMB-Q available in multiple languages, including Dutch, is a key step toward an internationally harmonized Core Outcome Set for lower extremity trauma. This global alignment will allow pooling and comparison of outcome data across countries, helping to close current knowledge gaps and improve patient outcomes through collaborative research.

Author contributions

All authors contributed to the design, interpretation of data, manuscript drafting, and approval.

Ethical approval

Not required.

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Declaration of Competing Interest

The authors declare no conflicts of interest.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.bjps.2026.02.055](https://doi.org/10.1016/j.bjps.2026.02.055).

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