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Normative data for the lower extremity functional scale (LEFS)

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Background and purpose — The lower extremity functional scale (LEFS) is a well-known and validated instrument for measurement of lower extremity function. The LEFS was developed in a group of patients with various musculoskeletal disorders, and no reference data for the healthy population are available. Here we provide normative data for the LEFS.

Methods — Healthy visitors and staff at 4 hospitals were requested to participate. A minimum of 250 volunteers had to be included at each hospital. Participants were excluded if they had undergone lower extremity surgery within 1 year of filling out the questionnaire, or were scheduled for lower extremity surgery. Normative values for the LEFS for the population as a whole were calculated. Furthermore, the influence of sex, age, type of employment, socioeconomic status, and history of lower extremity surgery on the LEFS were investigated.

Results — 1,014 individuals fulfilled the inclusion criteria and were included in the study. The median score for the LEFS for the whole population was 77 (out of a maximum of 80). Men and women had similar median scores (78 and 76, respectively), and younger individuals had better scores. Participants who were unfit for work had worse scores. There were no statistically significant correlations between socioeconomic status and type of employment on the one hand and LEFS score on the other. A history of lower extremity surgery was associated with a lower LEFS score.

Interpretation — High scores were observed for the LEFS throughout the whole population, although they did decrease with age. Men had a slightly higher score than women. There was no statistically significant correlation between socioeconomic status and LEFS score, but people who were unfit for work had a significantly worse LEFS score.

The lower extremity functional scale (LEFS) is a well-known and validated patient-rated outcome measure (PROM) that can be used to measure lower extremity function. It was developed in 1999 by Binkley et al. (1999) in a group of patients with various musculoskeletal conditions. The score consists of 20 questions, which are subdivided into 4 groups. These groups consist of activities with increasing physical demands. Questions on activity vary from walking between rooms to running on uneven ground. The LEFS is used for measuring lower extremity function in a wide variety of disorders and treatments (Backes et al. 2015, Mahler et al. 2016, Rehman et al. 2016, Telles et al. 2016). In orthopedic (trauma) surgery, patients present with an existing disorder. This makes it impossible to assess pre-disease physical function, as questionnaires regarding pre-disorder physical functioning are affected by recall bias (Last 2008). For this reason, it is challenging for physicians to reliably measure the effect of their treatment regarding return to pre-disorder physical functioning. Normative data for PROMs can aid in this problem by acting as reference data for a healthy population. Normative data are available for a few PROMs (Aasheim and Finsen 2014, Schneider and Jurenitsch 2016). For the LEFS, however, no such data are available.

Therefore we provide normative data for the lower extremity function scale. In addition, we wanted to investigate the influence of sex, age, type of employment, socioeconomic status, and history of lower extremity surgery on the LEFS score.

Methods

Adult visitors to the outpatient clinic of the Department of Surgery and also staff at 4 different Dutch hospitals were asked to participate in this study. The 4 hospitals were located in different regions (both rural and urban) and consisted of 1 university hospital and 3 teaching hospitals. Since it was not possible to perform a prospective sample size calculation, we chose to include a minimum of 250 individuals at each hospital. We considered this to be a large enough population to be representative of the whole population. We constantly monitored the age and sex of the respondents in order to obtain comparable group sizes. As data collection took several days at each hospital, after each day we checked the numbers of men and women and the distribution across different age categories. When differences arose, specific sex and/or age groups were approached to participate in the day(s) that followed.

The study consisted of a short questionnaire in which the postal code, age (as a continuous variable and subdivided into 3 categories (18–39, 40–64, and over 64 years)), sex, and work status (student, working, retired, unemployed, unfit for work, or other) of the subjects were recorded. When participants were actively employed at the time of filling out the questionnaire, they were requested to report whether they considered their employment to be blue-, pink-, or white-collar (i.e. very physically demanding, moderately physically demanding, or not physically demanding). After this, they were asked whether they had a history of lower extremity surgery and—if this was the case—how long ago. In addition, they were asked whether they were currently scheduled for lower extremity surgery. Next, they were presented with the Dutch version of the lower extremity functional scale (LEFS) (Hoozeboom et al. 2012). The LEFS has 20 items in 4 categories. For each question, 0 to 4 points can be earned, so 80 points can be earned in total—indicating maximal lower extremity function (Binkley et al. 1999). The Dutch version of the LEFS has been validated using the SF-36 as a reference and proved to have good internal consistency, good reliability, and good construct and discriminant validity, while showing no floor or ceiling effects (Hoozeboom et al. 2012).

Individuals were excluded if they had had lower extremity surgery within 1 year of filling out the questionnaire. Participants who were scheduled for lower extremity surgery were also excluded. Missing data in the LEFS were treated according to the instructions of the developers of the questionnaire (Stratford et al. 2005). When questionnaires contained more than 4 missing answers, or 3 missing within 1 domain, they were excluded (Stratford et al. 2005).

We obtained data on socioeconomic status (SES) from the Netherlands Institute for Social Research (Sociaal Cultureel Planbureau). For all postal codes, a number is available that reflects the SES of that particular area. This figure ranges from –6.7 to +3.1, where 0 represents the average SES for the Netherlands.

Table 1. Demographic data. Values are n (%) unless otherwise stated

	LEFS (n = 1,014)
Age, median [IQR] (range)	51 [37–64] (18–90)
Age 18–39 years	291 (29)
Age 40–64 years	471 (46)
Age ≥ 65 years	252 (25)
Sex	
Female	571 (56)
Male	443 (44)
Hospital	
University hospital	250 (25)
Teaching hospital	264 (26)
Teaching hospital	248 (25)
Teaching hospital	252 (25)
Daily activities	
Working	580 (57)
Student	53 (5)
Homemaker	67 (7)
Unemployed	23 (2)
Unfit for work	45 (5)
Retired	234 (23)
Other	10 (1)
Type of employment	
Blue collar	128 (22)
Pink collar	194 (34)
White collar	257 (44)
Medical history	
Fracture or surgery more than 1 year ago	131 (13)
No history	883 (87)

Statistics

Normal distribution was assessed using histograms and plots. Continuous variables are presented as mean with standard deviation (SD) or median with interquartile range (IQR), as appropriate. Categorical variables are given as frequencies and percentages. Due to the non-parametric distribution, LEFS score is presented as median and IQR. The mean and SD are also provided, to show the variability of the whole population and to allow comparison with other studies. The Mann-Whitney U-test and Kruskal-Wallis test were used to check for differences in non-parametric outcome variables. Spearman's rho was used to investigate correlations between the LEFS score and age, and LEFS score and SES. All analyses were performed using SPSS version 23).

For this study, the need to obtain informed consent was waived by the local Medical Ethics Committee.

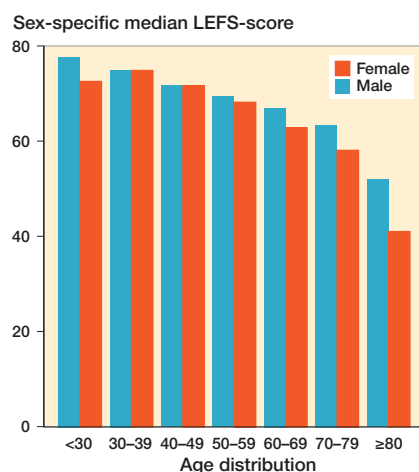
Results

Demographics (Table 1)

The questionnaire was filled out by 1,155 individuals. Of these, 141 participants had to be excluded because they had a history of lower extremity surgery or because they were

Table 2. LEFS scores related to percentiles

5th	10th	25th	Percentile 50th (median)	75th	90th	95th	Mean (SD)
32	43	63	77	80	80	80	69 (16)



Sex-specific median LEFS scores for each age category.

scheduled for lower extremity surgery ($n = 62$), or because there was too much missing data that could not be imputed ($n = 79$). For 9 questionnaires, there were no more than 4 questions missing (or 3 within one domain). These missing values were imputed according to the method of the developers of the questionnaire (Stratford et al. 2005).

LEFS scores

Median LEFS score for the population was 77 (IQR: 63–80, range: 4.5–80) (Table 2). None of the participants scored zero points, and 383 individuals (38%) achieved the maximum score of 80 points. The LEFS score showed a statistically significant correlation with age (correlation coefficient: -0.357 ; $p < 0.001$) (Figure), but not with SES (correlation coefficient: 0.017 ; $p = 0.6$). Men had a statistically significant better score than women. Volunteers who were unfit for work had worse LEFS scores than participants with other daily activities ($p < 0.001$). The level of physical demand of employment was not statistically significantly related to LEFS score. Individuals with a history of lower extremity surgery generally had a worse LEFS score than individuals with no history of lower extremity surgery ($p < 0.001$) (Table 3).

Discussion

In healthcare studies, outcomes are often measured through patient-rated outcome measures (PROMs). These outcome

Table 3. Subgroups. LEFS score values are median [IQR] (range)

	LEFS scores	p-value
Sex		0.03 ^a
Female	76 [62–80] (5–80)	
Male	78 [64–80] (11–80)	
Age		< 0.001 ^b
Age 18–39 years	80 [75–80] (19–80)	
Age 40–64 years	77 [64–80] (6–80)	
Age ≥ 65 years	66 [52.5–78] (4.5–80)	
Daily activities		< 0.001 ^b
Working	79 [72–80] (19–80)	
Student	79 [73–80] (37–80)	
Homemaker	63 [46–80] (19–80)	
Unemployed	80 [69–80] (44–80)	
Unfit for work	40 [24–73] (6–80)	
Retired	67 [53–78] (5–80)	
Other	71.5 [49–80] (14–80)	
Type of employment		0.8 ^b
Blue collar	79 [67.5–80] (21–80)	
Pink collar	79 [72.5–80] (20–80)	
White collar	79 [72–80] (19–80)	
History		< 0.001 ^b
Lower extremity fracture or surgery more than 1 year ago	64 [44.5–64] (11–80)	
No history	78 [66–78] (5–80)	

^a Mann-Whitney U-test; ^b Kruskal-Wallis test.

measures are, however, often determined in patients rather than in healthy volunteers (Olerud and Molander 1984, MacDermid 1996, Binkley et al. 1999). This means that it is unknown what normal scores for a healthy individual should be. Earlier research has shown that a healthy population does not necessarily score a maximum amount of points on a PROM (Schneider and Jurenitsch 2016). The latter study showed that mean score for the foot function index (FFI) was 10 (out of 100 points, where 0 points means no foot disability), and only one-third of the respondents achieved the maximum score of 0 points. These figures indicate that it is of importance to be aware of the normative data of a PROM. Presenting the results of a study in the light of normative values is far more informative than presenting outcome scores alone.

Several studies have used the LEFS to evaluate treatment effect. For example, a study by Pinsker et al. (2015) used the LEFS to compare the effects of ankle arthrodesis and ankle arthroplasty. They found a median score of 44 for both ankle arthrodesis and ankle arthroplasty, which was considerably lower than in a healthy population. Demetracopoulos et al. (2014) evaluated the effect of peroneal tendon repair using the LEFS. They found a mean LEFS score of 71, indicating a good result of their treatment.

When less than 15% of the individuals have the minimum score, no floor effect is present, and when less than 15% reach the maximum score, there is no ceiling effect (McHorney and Tarlov 1995). The absence of any floor and/or ceiling is beneficial, as it enables researchers to differentiate better between

patients at the low and high ends of a scoring system (Scheepers et al. 2008). In the present study, none of the participants scored 0 points, but almost 40% of the participants scored the maximum amount of points—indicating that there was a ceiling effect. This contrasts with an earlier study by Hoozeboom et al. (2012) who found no ceiling effect while evaluating the LEFS. This difference is easily explained by the fact that we only included “healthy” volunteers while Hoozeboom et al. included patients with hip and/or knee osteoarthritis. In addition, since the LEFS was designed for use in individuals with lower extremity conditions, the fact that a ceiling effect was found for healthy individuals is notable, but it should not limit the validity of the test in the population that it was designed for.

As expected, the LEFS score showed a negative correlation with age; i.e. lower extremity function decreases with increasing age. We observed a gradual decrease in function from the age of 50. This finding is of importance for future studies, as the results for a population as a whole should be interpreted with care. It would be more appropriate to do a separate analysis of the results for different age categories, particularly young patients and elderly patients.

Men had a statistically significantly better LEFS score than women; however, the difference was only 2 points. This is not clinically relevant, as the minimum clinically important difference in the LEFS ranges between 9 and 12 points (Binkley et al. 1999, McCormack et al. 2015). Furthermore, we found that participants who were unfit for work had significantly worse scores. Compared to the working population, this difference was of clinical importance (29 points). Lower socioeconomic status has repeatedly been correlated to poorer health and lower quality of life (Pickett and Pearl 2001, Clement and Court-Brown 2014, Kristensen et al. 2016). However, we failed to detect any such significant correlation between SES and LEFS score—indicating that the influence of SES on the LEFS score in a normal population is very small. This contrasts with the results of various other studies in which it was found that lower SES had a negative influence on outcome following treatment for proximal and distal radius fractures, humeral fractures, and hip fractures (Chung et al. 2007, Duckworth et al. 2012, Clement et al. 2014, Paksima et al. 2014, Orive et al. 2016). This suggests that function may be independent of SES in a normal population, but in posttraumatic patients SES may negatively influence (treatment) outcome. We know no other study relating socioeconomic status to the results of lower extremity or foot/ankle questionnaires.

A possible weakness of our study was that our sample was not representative of the population as a whole. However, we tried to balance the numbers of females and males. Furthermore, we constantly monitored the distribution of the responses in the different age categories. When necessary, we requested that more males than females (or vice versa) should fill out the questionnaire, and we did the same for the 3 age categories used. For other subpopulations (e.g. SES and

heaviness of employment), this was unfortunately not possible and may have biased our results. We do feel, however, that with our study population of over 1,000 individuals, we were able to make an accurate estimate of normative values for the LEFS—especially as we had individuals from different regions and different types of hospitals. Using the results of the present study will help researchers to interpret their data and physicians to set goals for treatment results.

Conclusion

High scores were observed for the LEFS throughout the whole population, although it did decrease with age. Men had a slightly higher score than women. There was no statistically correlation between socioeconomic status and LEFS score, but people who were unfit for work had significantly poorer LEFS scores.

Design of the paper: SD, MM, and TS. Data acquisition and analysis: SD, SK, MM, JW, and NS. Interpretation of the data: SD, SK, MM, CG, and TS. Drafting of the work: SD, SK, and MM. Critical revision of the work: SD, SK, MM, JW, NS, CG, and TS.

No competing interests declared.

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