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Original Research

Validity and reliability study of the Turkish version of the Lower Extremity Functional Scale in elderly adults

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ABSTRACT

Background: The World Health Organization's disability and health model implicates activity limitation based on the International Classification of Functioning, Disability, and Health (ICF). The Lower Extremity Functional Scale (LEFS) was developed in the framework of the ICF to define the functional status of the lower extremities as an important indicator of the health, activity, and participation of the elderly.
Objective: To analyze the psychometric properties of the Turkish version of LEFS (LEFS-T) in older individuals.
Methods: A total of 214 older individuals were included in the study and the LEFS-T, Five-Times-Sit-to-Stand Test (FTSTS), and Falls Efficacy Scale-International (FES-I) were administered. Reliability and validity were evaluated according to Cronbach's alpha internal consistency coefficients (ICC), spearman correlation analysis, and confirmatory factor analysis (CFA).
Results: LEFS-T was feasible, had good internal consistency (0.93), good reliability (ICC = 0.98), good construct, and discriminant validity, and showed no floor or ceiling effects. The results of CFA are at excellent levels (Root Mean Square Error of Approximation = 0.004, Goodness of Fit = 0.974, Comparative Fit Index = 0.991, Non-Normed Fit Index = 0.990). For construct validity, LEFS-T showed a better correlation with FTSTS (r = -0.555, $p < 0.001$) and FES-I (r = -0.756, $p < 0.001$).
Conclusion: The Turkish version of LEFS has good psychometric properties to evaluate functional capacity in older adults without lower extremity musculoskeletal disorders. LEFS-T can be used in future studies to evaluate and follow changes in lower extremity functional capacity as well as strength problems and fall prevention interventions, as it is a valid, reliable, and easily applicable scale with self-report.

Introduction

Functional capacity decreases due to the loss of muscle strength, flexibility, and balance with the aging process and causes reduction in activities of daily living (ADL). In this context, functional status has been defined as an important indicator of the health of the elderly, considering that factors such as illness or inactivity can substantially affect their quality of life.[1] The decline in functional status leads to increased risk of falling in the elderly, limitations in activity and participation defined by the International Classification of Functioning, Disability, and Health (ICF), and decline in lower extremity functionality. It adds to functional disability and accelerates multimorbidity.[2,3] Regular application of appropriately designed scales, which validity and reliability have been determined in the population to which they will be applied, is non-invasive, inexpensive, and easy to administer and score. Such scales make it easier to follow the physiological changes that occur with aging and help to implement preventive approaches.[2,4]

The Lower Extremity Functional Scale (LEFS) has been developed after various limitations during the use of general health status or disease-specific measurements.[5] It is a widely used and site-specific measure of functional status that can be applied to a wide range of patients with lower extremity musculoskeletal disorders.[5,6] This questionnaire has been designed on the basis of the World Health Organization's (WHO) disability and health model and provides useful information on "activity limitation" based on the ICF. LEFS is easy to use in terms of time and scoring (<3 min), as it consists of 20 items.[5,6]

Due to its clinical use, simplicity, and psychometric properties, the LEFS has been translated into different languages and cross-culturally translated into Dutch,[7] Italian,[8] Persian,[9] Greek,[10] Brazilian Portuguese,[11] and Spanish[12] and adapted to Taiwan-Chinese[4] languages. The

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cross-cultural adaptation and validation of the Turkish version of the scale was performed by Citaker et al.[13] on patients with knee injuries, and its reliability and validity were investigated in patients with different musculoskeletal disorders.[14] However, no study has been conducted on the psychometric properties of the Turkish version in the elderly. The primary aim of this study was to examine the psychometric properties of the Turkish version of the Lower Extremity Functional Scale (LEFS-T) among elderly adults. The secondary aim of this study was to examine LEFS's concurrent validity with the Falls Efficacy Scale-International (FES-I) and Five-Times-Sit-to-Stand Test (FTSTS) to provide evidence for its validity. We hypothesized that psychometric analysis could verify whether the LEFS-T scale has strong internal consistency (reliability) and construct validity.

Methods

The psychometric properties of LEFS-T were evaluated according to standard methodology as outlined by the Consensus-based Standards for the selection of health Measurement INnstruments (COSMIN) guidelines.[15,16]

Participants

Individuals who were 65 years old or older were included in the study. Informed consent was obtained from all participants. Approval for the study was also obtained from the Pamukkale University Ethics Committee of Non-Interventional Clinical Studies (E-60,116,787–020–29,008). This study was conducted in accordance with the principles of the Declaration of Helsinki.

The number of cases was determined according to the protocol stated by Kline and Beaton. According to this protocol, the number of participants should be at least 5–10 times the number of items.[17-19] Based on these criteria, 214 people were included in this study. Being 65 years old or older and the ability to speak and read Turkish fluently were the inclusion criteria. The exclusion criteria were having neurological, cognitive, and communication problems that could severely affect lower extremity function and not being able to answer the questionnaires due to inability to understand.

Outcome measures

Lower extremity functional scale (LEFS)

LEFS is a one-dimensional, valid, and reliable scale. It consists of 20 items that include ADL related to lower extremity function. Items are scored on a 5-point Likert Scale. The highest total score of 80 indicates that the person has a high functional level.[5]

Falls efficacy scale-international (FES-I)

The Prevention of Falls Network Europe developed the FES-I to assess people's fear of falling during ADL. The scale consists of 16 items (minimum 16 = no concern about falling; to maximum 64 = severe concern about falling).[20,21]

Five-times-sit-to-stand test (FTSTS)

Each participant was asked to stand up as quickly as possible in succession from a standard chair with their hands crossed in front of their chest. Meanwhile, the physical therapist observed the participants during the test for the risk of falling. The duration of the test was recorded.[22]

Translation and cross-cultural adaptation

Validity analysis

Language validity. Permission for the translation process of the LEFS in the elderly population was obtained from Jill Binkley, via email. The scale was translated into Turkish independently by three experts whose native language is Turkish but who are capable of using English fluently and working in the health field. Then, a single form was prepared by the consensus of two separate researchers in a meeting. Subsequently, the LEFS-T in a written form was tested by each translator with 10 elderly people to evaluate its comprehensibility and appropriateness. In a second meeting, which was conducted for consensus on necessary changes, it was decided that no cultural adaptation was needed. Two bilingual professional translators whose native language was English back-translated the Turkish version to English and cross-checked it with the original English version. In the third phase, it was determined that there was no change in meaning from the original scale items. The pre-final version of the questionnaire was completed after the third meeting.

Content validity. Five experts in the fields of physical therapy, orthopedics, and public health were referred for content validity (CV). The Davis technique was used to calculate the content validity index (CVI), and $>$ 0.80 was accepted as the criterion for each statement on a scale.[23]

Construct validity. To examine the construct validity of LEFS-T, confirmatory factor analysis (CFA) was performed.

Concurrent validity. In this study, FES-I and FTSTS were used to determine the concurrent validity of LEFS-T. Concurrent validity was evaluated with the Spearman correlation coefficient between the LEFS-T scale with the FES-I and FTSTS; r $\langle$ 0.25 were interpreted as weak, $r = 0.25$ - 0.50 as medium, 0.50 - 0.75 as strong, and r $\rangle$ 0.75 as perfect correlation.[24]

Floor and ceiling effects

The floor and ceiling effects were determined by calculating the number of individuals with minimum (0) or maximum (80) LEFS-T scores. In addition, a floor or ceiling effect was considered when >15 % of the participants achieved the maximum or minimum score.[25]

Reliability analysis

The reliability of LEFS-T was tested using the item-total correlations, test-retest reliability coefficient, and intraclass correlation coefficient (ICC). LEFS-T was administered to each participant again after seven days, the test-retest reliability coefficients of LEFS-T were calculated. In addition, the total LEFS-T mean scores were compared using the Wilcoxon signed-rank test. In this study, the test-retest reliability of LEFS-T was tested on 156 participants.

We also used standard error of measurement (SEM), the smallest detectable change (SDC), limits of agreement (LOA), and Bland–Altman analyses to quantify absolute reliability.[26-32] The formulas in the COSMIN checklist were used.[16]

Lower extremity functional scale pilot study

The pre-final version of the scale was tested on 30 elderly adults to determine any misunderstandings and problems. No correction was needed for the final form. Data from the pilot study were not used in this study.

Data analysis

Version 3.6.2 of the R statistical program was used to evaluate the data. Descriptive statistics regarding the variables were given as numbers, percentages, arithmetic mean, and standard deviation. Normal distribution was tested using Kolmogorov-Smirnov analysis. The "Lavaan" package was used for CFA.[26]

Results

Two hundred and fourteen elderly adults participated in this study. Their mean age was 71.94 ± 6.41 (range 63 and 94) years and 54.2 % of the participants were female.

Content validity

The CVI values were higher than 0.80 in this study. For this reason, the experts agreed and did not change the questions.

Construct validity

Confirmatory factor analysis results

The Diagonally Weighted Least Squares Method (DWLS) was used in the CFA because the distribution of the given responses in the LEFS-T was not suitable for normal distribution. As a result of CFA, the chi-square value (χ^2 = 398.377, sd = 170, $p < 0.001$) was significant and the χ^2 / sd ratio was 2.34. The other fit indices were found as follows: Standardized Root Mean Square Residual (SRMR) = 0.080, Goodness of Fit (GFI) = 0.954, Root Mean Square Error of Approximation (RMSEA) = 0.080, Comparative Fit Index (CFI) = 0.963, and Non-Normed Fit Index (NNFI) = 0.959. Fit indexes were within perfect fit values in the CFA (Table 1). The factor loadings of LEFS-T were presented in Fig. 1. Factor loadings ranged between 0.46 and 0.98.

Concurrent validity analysis

Correlations were evaluated between LEFS-T and FES-I, and FTSTS in concurrent validity analysis. There was a negative statistically significant-excellent correlation between LEFS-T and FES-I ($r = -0.756$, $p < 0.001$), whereas a negative good correlation was found between LEFS-T and FTSTS ($r = -0.555$, $p < 0.001$).

Reliability of LEFS-T

Internal consistency and item analyses

Accordingly, the corrected item-total correlations of the items in LEFS-T ranged from 0.423 to 0.765. The Cronbach's alpha coefficient of the whole scale was 0.934 (Table 2).

Test-retest analysis

The ICC was calculated using a single measurement absolute agreement and a two-way random effect analysis of variance (ANOVA) model. As a result of the test-retest reliability analysis, the in-class reliability coefficient of LEFS-T was found to be $r = 0.982$. No statistically significant difference was found between the mean LEFS-T scores of 156 participants in the test and re-tests ($p = 0.263$) (Table 3).

SEM, SDC95, and LOA

The SEM and SDC95 values of LEFS-T were 1.88 and 5.21, respectively. The mean difference between the test-retest measures of LEFS-T was 0.33. The 95 % CI for the mean difference included 0 (−0.08, 0.75), demonstrating that there was no significant systematic bias between the test and retest measures. The Bland–Altman plot (Supplementary Material 1), which was representative of the LEFS-T, showed the variability between the test-retest measures. The repeatability for most of the test-retest measures was within the 95 % CI. The Bland–Altman plot showed reasonable agreement between the test–retest scores. The LOA range was −4.87 to 5.53 (Table 4), and four outliers were shown in the plot (Supplementary Material 1).

Floor and ceiling effects

None of the participants were scored 0 or 80 points from the test (n = 214) and re-test (n = 156) in the LEFS-T. It can be concluded that LEFS-T has no floor or ceiling effect.

Table 1
Fit index values of LEFS-T and cut-off values of the fit indices.

	Model*	Perfect Fit	Acceptable Values	Results
χ^2 p value	0.002	< 0.05	–	*Perfect Fit*
χ2 / sd	1.337	< 2	*< 5*	*Perfect Fit*
RMSEA	0.040	≤ 0.05	*< 0.08*	*Perfect Fit*
SRMR	0.079	≤ 0.05	*< 0.08*	*Acceptable Fit*
GFI	0.974	≥ 0.95	*> 0.90*	*Perfect Fit*
CFI	0.991	≥ 0.95	*> 0.90*	*Perfect Fit*
NNFI	0.990	≥ 0.95	*> 0.90*	*Perfect Fit*

* Model: Two-factor Level 1 CFA

CFI, Comparative Fit Index; GFI, Goodness of Fit; NNFI, Non-Normed Fit Index; RMSEA, Root Mean Square Error of Approximation; SRMR, Standardized Root Mean Square Residual; χ^2,Model Chi-Square.

Discussion

This study aimed to adapt the original version of LEFS for use in Turkish-speaking elderly adults without severe musculoskeletal problems and to evaluate its psychometric properties. The results of the study indicated that LEFS-T is a reliable, consistent, and valid tool with good psychometric properties for determining the functional status of the elderly with no ceiling or floor effects. LEFS-T can be used to assess self-reported physical functioning and detect the strength and fear of problems of elderly adults in effortful activities.[13,14]

In the translation of the questionnaire, no severe difficulty was encountered. The minor problems encountered were "walking two blocks" in question 11 and "walking a mile" in question 12. In question 11, "walking two blocks" was defined as walking approximately 500 m. For the Turkish version of the 12th question, 1.5 km was used. Similarly, the imperial measurement system was used in the Dutch,[7] Italian,[8] Brazilian,[11] Spanish,[12] and Turkish versions for knee injuries[13] and musculoskeletal dysfunctions.[14]

Regarding the psychometric properties of LEFS-T, Cronbach's alpha value was 0.93, showing a high internal consistency and correlation and homogeneity of the items in the scale. Cronbach's alpha values for the Taiwanese,[4] English,[5] Dutch,[7] Italian,[8] Greek,[10] and Canadian-French[33] versions were respectively, 0.98, 0.96, 0.96, 0.94, 0.97, and 0.95. These results were found to be consistent with the literature. In addition, the results of other studies in our country were also similar (α = 0.92, 0.93).[13,14]

High test-retest reliability was demonstrated by the ICC, and the result obtained was found to be better than the original scale. It was also recorded that the correlation coefficients are consistent with the original (0.86),[5] Dutch (0.86),[7] Italian (0.91),[8] Persian (0.97),[9] Brazil (0.96),[11] and Canadian-French (0.92)[33] versions of LEFS. The ICC values of the recent study (0.98) were better than those of the Turkish version for patients with knee injuries (0.96)[13] and musculoskeletal disorders (0.92).[14] Therefore, the LEFS-T for healthy elderly adults could also be considered as a reliable tool.

SEM is described as "the determination of the amount of variation or spread in measurement errors for a test".[28] The SEM is a measure of the degree of measurement error in a scale and is subsequently an indicator of the reliability of that scale. The SEM, like the standard deviation around the mean, can be used to indicate a range around the observed value within which the hypothesized "true" value lies. Establishing a measure's absolute dependability is essential to guarantee that measurements are repeated with adequate stability and sensitivity to actual changes over time.[31] The instrument's score changes at the 95 % confidence interval (CI) level that goes beyond measurement error and is referred to as the SDC95.[30] In other words, the SDC gives a number for the minimal change that must be detected to ensure that the observed change is real and not a result of measurement error in the instrument. The SEM and SDC95 of the test-retest measurements provide the absolute values of measurement errors between repeated measures and indicate whether changes in repeated measures are real. If the change in

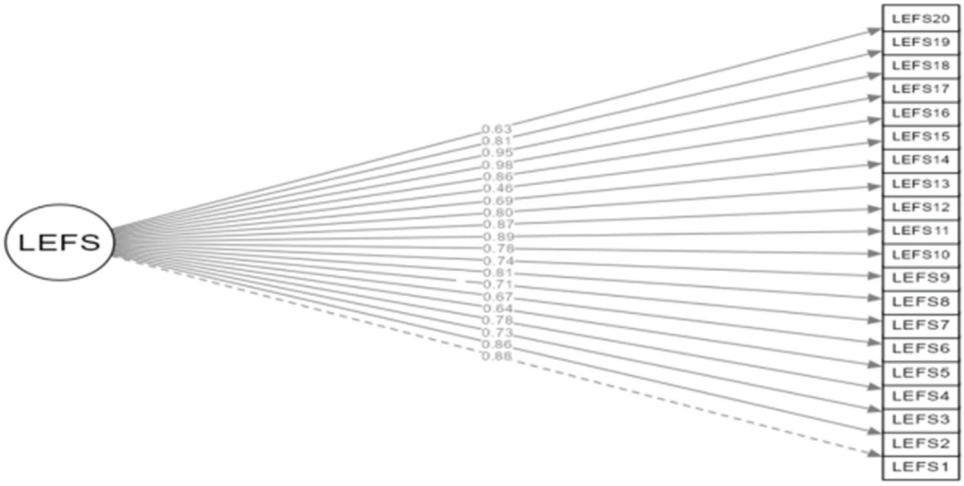

Fig. 1. Path diagram of LEFS-T.
* The dotted line indicates the first factor item. All factor loadings are above 0.40.

Table 2
Corrected Item-Total Correlations and Cronbach's Alpha value of the LEFS-T.

Item No	Corrected Item-Total Correlations	Cronbach's Alpha
1	0.732	0.934
2	0.700	
3	0.677	
4	0.584	
5	0.576	
6	0.639	
7	0.664	
8	0.665	
9	0.716	
10	0.692	
11	0.698	
12	0.704	
13	0.765	
14	0.666	
15	0.423	
16	0.599	
17	0.509	
18	0.495	
19	0.565	
20	0.485	

repeated LEFS-T measurements was greater than 5.21, the change was considered to be a real change or a true change beyond measurement error at the 95 % CI based on the LEFS-T SDC95 result. SEM and SDC95 were not calculated in other studies investigating the psychometric properties of LEFS and were evaluated only in our study. The SEM and SDC values were 1.88 and 5.2, respectively, and higher in this study than that of the other studies.[4,12,14,34]

The Bland–Altman plot provides a visual representation of the presence of systematic errors in an instrument, illustrates the agreement between the test and re-test, and identifies possible outliers. The 95 % CI of the mean difference was used to determine systematic bias. If zero is included within the 95 % CI, no significant systematic bias between measurements can be inferred.[31] The 95 % LOA were used to examine the natural variation over time, with a narrow LOA indicating higher stability.[32] In this study, the Bland–Altman statistics for LEFS-T indicated no significant systematic bias and a narrow LOA between the repeated measures. This value can guide physical therapists in their interpretation of LEFS-T change scores to evaluate the changes in functionality level during aging and the effectiveness of therapeutic interventions. The Bland–Altman plot showed no systematic bias; however, it showed rather random error along different levels of the scale in the Arabic version.[34] The LOA values were −8 to 11, −9.32 to 13.02, and −11.56 to 15.30 for stroke survivors,[35] Chinese version,[4] and Dutch version,[7] respectively. The LOA was between −4.87 and 5.53 in this study. The mean difference between the two applications of the LEFS was 1.87 points in the Bland–Altman plot for the Dutch version.[7] A good Bland–Altman agreement with the difference between the average

Table 4
Reliability of the Turkish version of the Lower Extremity Functional Scale.

			Blant-Altman Analysis				
Scale	SEM	SDC95	d	SDdiff	SE of d	95 % CI of the d	LOA
LEFS-T	1.88	5.21	0.33	2.65	0.21	−0.08, 0.75	−4.87 – 5.53

SEM: standard error of measurement = SDpooled × $\sqrt{(1 - ICC)}$, where SDpooled is the standard deviation for all observations from the test and re-test
SDC95: Smallest Detectable Change at the 95 % CI level = 1.96 × $\sqrt{2}$ × SEM, where 1.96 is the 2-tailed tabled z value for the 95 % CI and $\sqrt{2}$ represents the variance of 2 measures
d: mean of difference between the test and re-test scores
SDdiff: standard deviation of mean difference
SE: standard error, 95 % CI of the d: mean difference ± 1.96 × SE
95 % LOA: 95 % limits of agreement = d ± 1.96 × SDdiff.

Table 3
Test-retest reliability analysis of LEFS-T.

	Mean ± SD	Median (IQR)	Wilcoxon Signed-Rank Test p	ICC (95 % CI)	ICC p
Test	50.16 ± 14.02	53.00 (40.00 - 60.75)	0.263	0.982 (0.976, 0.987)	< 0.001
***Re*-test**	49.83 ± 14.17	53.00 (39.25 - 61.75)			

CI, Confidence Interval; ICC, Internal Consistency Coefficient; IQR, Inter Quantile Range; SD, Standard Deviation,.

close to zero was found in the Brazilian version.[11]

The internal structure of the LEFS has been a challenging issue in previous studies. The reduction based on the Rasch analysis was suggested to ensure the unidimensionality of the questionnaire. However, any comparison was not possible because of the difference in included items after the analysis.[11,34-39] Although we found that there is no need to delete any item from the questionnaire, the Italian (excluded items 12, 15, 16, 17, and 18),[37] Arabic (excluded items 2, 11, 16, 18, and 19),[34] and Finnish (excluded items 10, 11, 16, 17, and 18)[38] versions offered one domain, 15 items version of the LEFS. The commonly deleted items were 16, 17, and 18. A study suggested a 10-item LEFS including items 2, 3, 4, 5, 8, 10, 12, 17, 19, and 20 with one dimension as the original LEFS within the same theoretical frame despite fewer items and less time.[39] When analyzed through a single factor model, CFA results were at excellent levels (χ^2 / DF = 398.377, sd = 170, $p < 0.001$, RMSEA = 0.004, GFI = 0.974, CFI = 0.991, NNFI = 0.990) in the study, whereas the 10-item LEFS showed adequate fit indices (χ^2 / DF = 1.88, CFI = 0.975, TLI = 0.968, RMSEA = 0.079, and SRMR = 0.058). In the Greek version, factor loads ranged between 0.304 and 0.934, and it was found that GFI was 0.856, RMSEA was 0.052, and CFI was 0.94.[10] In our study, it was observed that the factor loads of the scale were between 0.46 and 0.98 in the one-factor and, as a result, the obtained fit indices were found to be within perfect fit values. Because the distribution of the answers given to the questions in the LEFS-T was not suitable for normal distribution, DWLS was used in the CFA and fit indexes were found to be excellent.

Instruments with an acceptable CV are expected to have less ceiling or floor impact. In our study, no ceiling or floor effect was detected for LEFS-T, which was also confirmed by CV. Consistent with this result, there was no ceiling or floor effect in the original,[5] Dutch,[7] Italian,[8] and Turkish versions of LEFS.[13,14]

Increased fear of falling (FES-I scores) restricts ADL including lower extremity functionality.[15,16] Decreased physical function indicates lower LEFS scores, higher fear-avoidance beliefs are negatively correlated with lower LEFS-T scores. In a previous study, there was a negative correlation between LEFS and fear of falling scores ($r = -0.714$, $p < 0.001$).[40] Due to the fear of falling, elderly adults may become more cautious in performing indoor and outdoor ADLs and begin to restrict physical activity and function.[40,41] In addition, FTSTS shows efficiency and independence in activities and has been frequently used to evaluate lower extremity function. As FTSTS assesses lower extremity muscle strength, especially of the quadriceps femoris, and it is an easy-to-apply test,[42] a higher duration of FTSTS shows lower LEFS values, which indicates worse lower extremity function. These are interrelated variables that are influenced by each other. Therefore, we found that LEFS-T had a negative relationship with these scales. As a result, there was a negative-excellent correlation between LEFS-T total score and FES-I scale ($r = -0.756$, $p < 0.001$), and a negative good correlation between LEFS-T total score and FTSTS ($r = -0.555$, $p < 0.001$) performance duration in the study. COSMIN indicates that correlations above 0.70 are sufficient for criterion validity.[17] During the performance of the tasks to prevent balance losses, coordinated trunk and lower extremity muscle function and strength are also likely required.[42] The LEFS-T, assesses 20 ADL-related items that require lower extremity strength and balance. Therefore, LEFS-T could have validity in predicting, determining, and following problems in functionality, lower extremity strength, balance, and mobility, fear of falls, restricted participation in ADL and social activities in elderly adults.

The Bland–Altman plot showing reasonable agreement between the test–retest scores, low measurement error, and minimum change values; the good psychometric properties of LEFS-T; and the significant relationship between LEFS-T and FES-I and FTSTS could be considered as evidence indicating that LEFS-T was sensitive in detecting true changes in clinical practice and research in elderly adults.

This research has both strengths and limitations. A strength of our study is that participants were randomly selected from a well-defined target population. This is one of the first studies conducted on elderly adults without severe lower extremity musculoskeletal problems. Other strengths of the study are that convergent validity was determined by examining its relationship with valid, reliable, and frequently used performance measures and that a long enough time for test-retest was allocated to avoid memory recall. A possible limitation of our study was that it was conducted on healthy elderly adults. However, retesting with larger samples and with different study groups consisting of patients with neurological and mild cognitive problems will ensure its generalizability. The distribution of the answers given to the questions in the LEFS-T was not suitable for normal distribution, which could be considered as another limitation of this study.

Conclusions

The Turkish version of LEFS has good psychometric properties, internal consistency, reliability, validity, and sensitivity to be used to evaluate functional capacity in elderly adults without severe lower extremity musculoskeletal disorders. Therefore, we believe that LEFS-T can be used in future studies to evaluate and follow changes in lower extremity functional capacity as well as strength problems and fall prevention interventions, as it is a valid, reliable, and easily applicable scale with self-report.

Declaration of competing interest

The authors declare no competing interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.bjpt.2025.101196.

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