Research Article

Reliability and Validity of the Lower Extremity Motor Activity Log in Persian People with Ankle Sprain

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Article info:
Received: 13 Apr 2025
Accepted: 10Jun 2025

Citation: Ahmadi AS, Lajevardi L, Taghizadeh Gh, Azad A. Reliability and Validity of the Lower Extremity Motor Activity Log in Persian People with Ankle Sprain. Journal of Modern Rehabilitation. 2025;19(4):?-?

Running title: LE-MAL's validity and reliability in ankle sprain

Abstract

Background: Ankle sprains are among the most common injuries and affect functional mobility, lower extremity function, and health status. Access to a reliable measurement tool to assess diverse real-world lower extremity use in patients following ankle sprain seems essential. Researchers have developed a number of measurements to determine rehabilitation goals and to measure the effects of therapeutic interventions. This study was conducted to translate the original English Lower Extremity Motor Activity Log (LE-MAL) into Persian and to investigate the psychometric properties of the Persian version.

Material and methods: The LE-MAL was translated into Persian and adapted to the Persian culture. Then, a total of 140 patients with ankle sprain filled out the Persian LE-MAL, Lower Extremity Functional Scale (LEFS), and Life Space Questionnaire (LSQ). The Persian LE-MAL was re-completed by participants with an interval of two weeks, and internal consistency, test-retest reliability, and construct validity were investigated.

Results: The Persian LE-MAL had good internal consistency (Cronbach's α = 0.95) and test-retest reliability (ICC = 0.76). The construct validity of the Persian LE-MAL was demonstrated to be acceptable, as a result of its significantly strong correlations with LEFS and LSQ (0.74 < r < 0.77). The standard error of measurement was less than 10% of the total instrument score (SEM = 0.43), and the minimal detectable change was 1.2. No ceiling or floor effects were observed.
Conclusion: The Persian version of the LE-MAL is a valid and reliable measurement to assess lower extremity function in people with ankle sprain.
Keywords: Reliability; Validity; Ankle injuries; Self-report; Outcomes assessment.

1. Introduction

Ankle sprain is one of the most common musculoskeletal injuries experienced by active young adults at least once during their lifetime and impacts their quality of life and health status (1). Ankle ligamentous injuries are among the most frequent injuries in the Iranian population and have different distribution patterns in specific age and sex groups (2). Ankle sprains lead to secondary deficits and impairments in the kinematic characteristics of the lower extremities, such as neuromuscular functions of the hip and trunk, resulting in limited mobility, functional instability, and disability (3-5).

Accurate assessment and proper treatment are very essential following an ankle injury; otherwise, chronic ankle instability may develop (4, 6-8). Obtaining comprehensive information about the performance of the lower limb following an ankle sprain is essential for implementing rehabilitative interventions(9, 10).

Previously, researchers and clinicians focused on assessing parameters such as muscle strength, joint range of motion, pain, and balance in patients, while none of these measures evaluated how individuals use their lower limbs outside the clinical setting and in daily life (8, 11). Recently, the use of self-report tests has increased (12), especially those that measure changes in the health status of individuals with ankle sprains (10). Several self-report tools have been developed to assess the performance of the lower limb in individuals with ankle sprains, but these tools have limitations (13).

One of these limitations is the lack of assessing an individual's use of assistive devices, such as crutches, orthoses, and the level of assistance from others. Another significant limitation of other available tools is their inability to assess lower extremity function in real-life activities. There is a need for the development of more precise assessment tools for patients.

The LE-MAL is a self-report test that assesses the use of the lower limb in real-life situations and evaluates 14 functional activities (such as walking indoors and outdoors, using stairs, getting into a car, etc.) across three subscales (14, 15). This tool not only assesses lower limb performance but also measures balance maintenance during daily activities. Additionally, it measures the use of assistive devices in daily tasks and evaluates the level of assistance from caregivers. Since there was no accurate scale in the Persian language to assess the lower limb's real-world use in individuals with ankle sprains, the aim of this study was to translate and investigate the validity and reliability of the LE-MAL.

2. Materials and methods

This cross-sectional study was conducted on 140 patients referred to hospitals and rehabilitation centers in Shiraz, Iran, from January 2024 to July 2024. The inclusion criteria were grade 2 unilateral acute ankle sprains, diagnosed by an orthopedic physician based on medical records

such as X-ray radiography, anterior drawer test, and figure-of-8 measurement score. Age was restricted to between 18 and 65, with no other injuries or concurrent diseases reported, and the ability to read and write in the Persian language was required. Patients who withdrew from participation for any reason, did not attend the follow-up session on time, or experienced sudden changes in their health conditions were excluded from the study.

Permission to translate the LE-MAL into Persian was obtained from the copyright holder (University of Alabama at Birmingham). Subsequently, the study protocol was approved by the Ethics Committee of Iran University of Medical Sciences (IR.IUMS.REC.1400.1238), and all study participants signed an informed consent form before participation.

In this study, the LE-MAL tool was first translated into Persian. Then, to assess the construct validity of the Persian LE-MAL, 140 participants were asked to complete the Lower Extremity Functional Scale (LEFS) and the Life Space Questionnaire (LSQ). Both the LEFS and the LSQ are self-report measures, have a similar number of items, and assess functional mobility. To assess test-retest reliability, the Persian LE-MAL was administered again with a two-week interval to 80 randomly selected participants.

The English version of the LE-MAL was translated into Persian based on the standardized cross-cultural translation guidelines provided by the International Quality of Life Assessment (IQOLA) project(16). Permission for translation was obtained from the developer, Prof. Uswatte. The translation process began with forward translation from English to Persian by two bilingual translators whose native language was Persian. Each translator provided a list of possible alternative translations for each item to ensure clarity. The most accurate translations were selected by the researcher.

Subsequently, back-translation was performed by two other bilingual translators who were native English speakers and had no knowledge of the original LE-MAL. They translated the Persian version back into English. To assess conceptual equivalence, the back-translated version was compared with the original by the research team, and feedback was obtained from the test developer.

The Persian LE-MAL was pilot-tested with 20 participants, including 10 patients and 10 occupational therapy and physiotherapy specialists (each with ≥5 years of experience in orthopedics). Questionnaires were completed face-to-face, and participants were asked to evaluate the comprehensibility of the questions. No difficulties in understanding were reported, and the clarity, simplicity, and relevance of each question were confirmed, indicating acceptable face validity.

2.1. Tools

2.1.1. Lower Extremity Motor Activity Log (LE-MAL)

The LE-MAL is a 14-item self-report questionnaire, and its psychometric properties have been evaluated in individuals with stroke, spinal cord injury, multiple sclerosis, and pelvic injuries in various countries, including the United States and Brazil(15, 17-21). The LE-MAL was developed to assess a person's real-world performance, such as walking indoors and outdoors, stepping over an object on the floor, rising from and sitting down in a chair or toilet, getting in and out of a bathtub, and standing while washing hands and face. This questionnaire comprises three subscales:

- Functional performance level
- Confidence level (fear of falling during task execution)

- Assistance level (need for assistance from others, use of a walker or cane, use of orthoses or modified shoes, use of handrails).

All subscales are scored on a Likert scale from 0 (inability to perform the task) to 10 (fully able). In some studies, the LE-MAL has been used to collect data before and after treatment or as an entry criterion for study participants(22-35).

2.1.2. Lower Extremity Functional Scale (LEFS)

The LEFS is an assessment tool designed for patients with musculoskeletal disorders, including ankle sprains. This self-report questionnaire assesses 20 different daily life activities, with each item scored from 0 (complete inability to perform the activity) to 4 (complete ability to perform the activity). The maximum score is 80, and a lower score indicates worse function (13). The Persian version of this questionnaire has been validated and shows good reliability (36).

2.1.3. Life Space Questionnaire (LSQ)

This test assesses the extent and frequency of a person's functional mobility in the community (37). The self-report questionnaire consists of 9 questions evaluating a person's ability to leave their room, house, local community, and regional area. Scores range from 0 (bed-bound) to 9 (ability to independently travel outside the city daily). The LSQ is a reliable and valid measure that captures real-world home and community mobility in people with lower extremity impairments (38). It has been used in multiple studies examining quality of life and functional mobility (39-41).

2.2. Statistical analysis

The statistical analysis was performed using SPSS version 26. Descriptive statistics including means, standard deviations, and frequencies were calculated for all demographic variables. The normality of data distribution was assessed using the Kolmogorov-Smirnov test. Ceiling and floor effects were evaluated by determining the percentage of participants scoring at the minimum and maximum possible values, with less than 15% of respondents at either extreme considered acceptable (42).

Internal consistency was examined using Cronbach's alpha coefficient, with values greater than 0.80 indicating excellent consistency, 0.70-0.79 indicating moderate consistency, and values below 0.70 suggesting poor consistency (43).

Test-retest reliability was assessed using the intraclass correlation coefficient ($ICC_{2,1}$), where values ≥ 0.75 were considered excellent, 0.40-0.75 moderate, and <0.40 poor (44).

The standard error of measurement (SEM) was calculated using the formula:

$$SEM = SD_{pooled} \times \sqrt{1 - ICC_{2,1}},$$

with acceptable values defined as being less than half of the pooled standard deviation or less than 10% of the total and subscale scores (45).

The minimal detectable change (MDC) at the 95% confidence level was determined using the equation:

$$MDC_{95\%} = 1.96 \times \sqrt{2} \times SEM \text{ (45)},$$

representing the smallest change that can be considered clinically meaningful beyond measurement error (46, 47).

Construct validity was evaluated by computing Pearson correlation coefficients between the LE-MAL total score and its subscales, as well as between the LE-MAL total score and the LEFS and

LSQ total scores. Correlation coefficients were interpreted as follows: ≥0.90 very strong, 0.68-0.89 strong, 0.36-0.67 moderate, and <0.35 weak (48).

3. Results

3.1. Translation, floor, and ceiling effect

The study included 140 patients (57 males, 83 females) with grade 2 ankle sprains. Table 1 presents the demographic characteristics of participants. All data showed normal distribution. The Persian translation of LE-MAL demonstrated excellent clarity, requiring no modifications to the translated items. Neither ceiling nor floor effects were observed for the total score or any subscales (assistance, functional performance, confidence). The Persian LE-MAL showed excellent internal consistency for both the total score (α=0.97) and all subscales (α=0.95-0.97) (Table 2).

Table 1. Demographic characteristics of patients with grade 2 acute ankle sprain (n=140)

Variable	Category	Frequency	Percentage (%)
Sex	Male	57	40.7
	Female	83	59.3
Affected side	Right	77	55.0
	Left	63	45.0
Education	High school or less	19	13.6
	Diploma	67	47.8
	University degree	54	38.6
Diagnosis	Medial ankle sprain	38	27.1
	Lateral ankle sprain	102	72.9
NSAID usage	Yes	54	38.6
	No	86	61.4

Age: Mean = 35.2 years (SD = 13.37)

Table 2. Psychometric properties of the Persian LE-MAL: Reliability and internal consistency measures

Construct	ICC (95% CI)	ICC Interpretation	Sig.	SEM	MDC	Test Mean ± SD	Retest Mean ± SD	Cronbach's Alpha
Assistance	0.44 (0.10–0.66)	Moderate	0.000	0.55	1.52	9.2 ± 0.81	9.7 ± 0.54	0.96
Functional performance	0.75 (0.41–0.85)	Excellent	0.000	0.57	1.58	7.41 ± 1.40	8.32 ± 0.96	0.95

Confidence	0.78 (0.62–0.87)	Excellent	0.000	0.54	1.50	7.68 ± 1.53	8.48 ± 1.04	0.97
Total score	0.76 (0.24–0.89)	Excellent	0.000	0.43	1.20	8.13 ± 1.12	8.89 ± 0.75	0.97

Abbreviations: ICC, Intraclass Correlation Coefficient; CI, Confidence Interval; SEM, Standard Error of Measurement; MDC, Minimal Detectable Change.

3.2. Reliability

As shown in Table 2, the total score (ICC = 0.76) and the subscales of LE-MAL (0.78 > ICC > 0.44) demonstrate moderate to excellent test-retest reliability. The means and standard deviations of the total score and subscale scores of LE-MAL are also reported in Table 2 (as well as the values of ICC, SEM, and MDC). The ICC values for the 14 items of the Persian LE-MAL in test-retest assessments ranged from 0.54 to 0.83. Items 1 to 5 and item 8 showed excellent reliability, while items 6, 7, and 9 to 14 demonstrated moderate reliability (Table 3).

Table 3. ICC values for test-retest reliability of each item of the Persian LE-MAL

Items	**Test-retest**		
	ICC	**Sig.**	**Interpretation of reliability**
1.Walking indoors	0.80	0.000	Excellent
2.Walking Outdoors	0.75	0.000	Excellent
3.Climbing stairs (up and down)	0.76	0.000	Excellent
4.Stepping over object	0.82	0.000	Excellent
5.Turning around when standing (whole body with movement of feet)	0.83	0.000	Excellent
6.Come to stand from a chair	0.61	0.000	Moderate
7.Come to stand from a toilet	0.67	0.001	Moderate
8.Getting in and out of bed	0.75	0.000	Excellent
9.Getting in and out of bath or shower	0.54	0.000	Moderate
10.Getting in and out of car	0.66	0.000	Moderate
11.Open a door with a door knob in standing and walking through the doorway	0.58	0.000	Moderate
12.Wash hands/grooming at the sink in standing	0.57	0.000	Moderate
12.Wash hands/grooming at the sink in standing	0.63	0.000	Moderate
14.Retrieving object from floor (from standing position)	0.58	0.000	Moderate

Abbreviations: ICC; Intraclass Correlation Coefficient, LE-MAL; Lower Extremity Motor Activity Log

3.3. Validity

The results of construct validity are presented in Table 4. The hypothesis of this study was supported by the presence of positive correlations between the total and subscale scores of the Persian LE-MAL and the total scores of both the LEFS and LSQ. Specifically, strong correlations were observed between the total score of the Persian LE-MAL and the LEFS and LSQ ($0.74 < r < 0.77$).

Among the subscales, the Confidence and Functional Performance subscales showed strong correlations with the LEFS and LSQ ($0.68 < r < 0.77$), while the Assistance subscale

demonstrated moderate correlations with both instruments ($0.54 < r < 0.58$). These findings support the construct validity of the Persian version of the LE-MAL.

Table 4. Correlation coefficients (significance levels) between the total and subscale scores of the Persian LE-MAL and the LEFS and LSQ

Tests	LEFS (sig.)	LSQ (sig.)
Assistance	0.54 (0.000)	0.58 (0.000)
Functional Performance	0.68 (0.000)	0.73 (0.000)
Confidence	0.77 (0.000)	0.71 (0.000)
Total Score	0.74 (0.000)	0.77 (0.000)

Abbreviations: LE-MAL, Lower Extremity Motor Activity Log; LEFS, Lower Extremity Functional Scale; LSQ, Life-Space Questionnaire.

4. Discussion

This study aimed to translate the LE-MAL into Persian and evaluate its validity and reliability in individuals with ankle sprains. The findings are consistent with those of the Brazilian versions in terms of content validity, with all activities in the questionnaire deemed culturally appropriate for Iranian participants, and no modifications to the items were necessary(18, 19). As with the Brazilian version, no ceiling or floor effects were observed, indicating that the Persian LE-MAL is sensitive enough to detect changes across a range of functional levels (19).

The Persian LE-MAL demonstrated high internal consistency, comparable to both the Brazilian and American versions, with Cronbach's alpha values reported between 0.80 and 0.95 in previous studies (15, 17-19).

Consistent with the methodology of the Brazilian adaptation, test-retest reliability was assessed by retesting 80 of the 140 participants after a two-week interval (18). The intraclass correlation coefficients (ICCs) for the Persian version ranged from 0.75 to 0.78 for the total score and subscales, indicating excellent test-retest reliability. These values align with those reported in the Brazilian and American versions, where ICCs for the total score ranged from 0.76 to 0.96, and ICCs for the performance and confidence subscales ranged from 0.80 to 0.97(15, 17-19).

However, unlike the Brazilian version, which reported ICCs ranging from 0.81 to 0.91 for the assistance subscale, the Persian version demonstrated only moderate reliability for this subscale (ICC = 0.44). This difference may be attributed to the population studied. While previous versions focused on individuals with neurological conditions, our study involved orthopedic patients with ankle sprains. The two-week interval may have allowed these participants to recover and become less reliant on assistance, leading to variability in their responses and, consequently, lower reliability for this subscale.

As shown in Table 2, the standard error of measurement (SEM) for the total score and subscales ranged from 0.43 to 0.57. These values are comparable to those reported for the Brazilian version, indicating acceptable absolute reliability, as SEM values were below 10% of the total and subscale scores (18). The minimum detectable change (MDC) for the total score in the Persian LE-MAL was 2.1, suggesting that changes above this threshold likely reflect true improvements rather than measurement error. In comparison, MDC values for the Brazilian versions ranged from 0.58 to 3.14 (18, 19), with the differences likely due to variation in sample sizes across studies.

The Persian LE-MAL showed a strong correlation with the Lower Extremity Functional Scale (LEFS), with the total score (r = 0.77) and the performance and confidence subscales (r = 0.71–0.73) showing strong associations. The assistance subscale demonstrated a moderate correlation with the LEFS (r = 0.58). Similarly, the American version reported strong correlations between the LE-MAL and tools assessing lower limb function (15), while another U.S. study involving stroke patients found moderate to strong correlations between LE-MAL scores and functional assessments (17). In contrast, the Brazilian versions reported weaker correlations (18, 19).
Additionally, strong correlations were observed between the Persian LE-MAL and the LSQ, a tool used to assess functional mobility. The total score (r = 0.77) and the performance and confidence subscales (r = 0.71–0.73) showed strong relationships with the LSQ, while the assistance subscale again showed a moderate correlation (r = 0.58). These findings are consistent with the American version, which also reported strong correlations with measures of functional mobility (15), in contrast to the weaker relationships observed in the Brazilian versions(18, 19).
The Persian LE-MAL may serve as a useful tool for clinicians and researchers to monitor the functional outcomes of rehabilitation and treatment interventions in individuals with ankle sprains. Although this study did not specifically assess the responsiveness of the Persian LE-MAL, future research should evaluate its sensitivity to change, particularly in the context of post-surgical or rehabilitative interventions.

5. Conclusion

The findings of this study indicate that the Persian version of the LE-MAL is a valid and reliable instrument for evaluating lower limb function in individuals with ankle sprains. It demonstrates strong psychometric properties, is culturally appropriate for Persian-speaking populations, and is suitable for clinical and research applications.

Acknowledgements:
The authors sincerely thank the University of Alabama at Birmingham for granting permission to use and translate the LE-MAL questionnaire, and are deeply grateful to all participating patients for their valuable contributions to this study.

Disclosure statement

Funding:
This research was supported by rehabilitation research center of Iran university of medical sciences (project code: 1401-3-6-24015).

Conflicts of interest:
The authors declare no competing interests.

Ethics approval:
The execution of the project was approved by the Ethics Committee of the Iran University of Medical Sciences (IR.IUMS.REC.1400.1238), and all study participants signed an informed consent form to participate in the study.

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