

Research Article



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

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ABSTRACT

Introduction: Ankle sprains are among the most common injuries that 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 with ankle sprains is essential. Researchers have developed several measures to determine rehabilitation goals and assess the effects of therapeutic interventions. This study aimed to translate the original English lower extremity motor activity log (LE-MAL) into Persian and investigate the psychometric properties of the Persian version.

Materials and Methods: The LE-MAL was translated into Persian and adapted to Persian culture. A total of 140 patients with ankle sprains completed 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 re-test reliability, and construct validity were assessed.

Results: The Persian LE-MAL exhibited good internal consistency (Cronbach's $\alpha=0.95$) and test re-test reliability (intraclass correlation coefficient [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 the LEFS and LSQ ($0.74 < r < 0.77$). The standard error of measurement was less than 10% of the total instrument score (standard error of measurement [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 measure to assess lower extremity function in individuals with ankle sprains.

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Introduction

Ankle sprains are among the most common musculoskeletal injuries experienced by active young adults at least once during their lifetime, impacting 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 essential following an ankle injury; otherwise, chronic ankle instability may develop [4, 6-8]. Obtaining comprehensive information about lower limb performance 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; however, 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 lower limb performance in individuals with ankle sprains, but these tools have limitations [13].

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

The lower extremity motor activity log (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, and getting into a car) 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 for daily tasks and assesses the level of assistance provided by caregivers. Since there was no accurate scale in the Persian language to assess the real-world use of the

lower limbs in individuals with ankle sprains, this study aimed to translate and investigate the validity and reliability of the LE-MAL.

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, the anterior drawer test, and a figure-of-8 measurement score. Age was restricted to between 18 and 65, with no other reported injuries or concurrent diseases, and the ability to read and write in the Persian language was required. Patients who withdrew from participation for any reason, did not attend follow-up sessions 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](#)).

In this study, the LE-MAL tool was translated into Persian. To assess the construct validity of the Persian LE-MAL, 140 participants completed the lower extremity functional scale (LEFS) and life space questionnaire (LSQ). Both the LEFS and LSQ are self-report measures, have a similar number of items, and assess functional mobility. To assess test re-test 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 project (IQOLA) [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 researcher selected the most accurate translations.

Subsequently, two other bilingual translators who were native English speakers and had no knowledge of the original LE-MAL, performed back-translation. They translated the Persian version back into English. To assess conceptual equivalence, the research team compared the back-translated version with the original and obtained feedback 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). The questionnaires were completed face-to-face, and the 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.

Tools

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. The 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 were scored on a Likert scale ranging from 0 (inability to perform the task) to 10 (fully able). In some studies, the LE-MAL was used to collect data before and after treatment or as an entry criterion for study participants [22-35].

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].

LSQ

This test assesses the extent and frequency of a person's functional mobility in the community [37]. The self-report questionnaire consisted of nine questions evaluating a person's ability to leave their room, house, local community, and regional area. Scores ranged 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 individuals with lower extremity impairments [38]. It has been used in multiple studies to examine quality of life and functional mobility [39-41].

Statistical analysis

Statistical analyses were performed using SPSS software, version 26. Descriptive statistics, including Mean $\pm$ SD, 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 α 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 re-test 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 Equation 1:

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

with acceptable values defined as 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 2:

$$2. MDC_{95\%} = 1.96 \times \sqrt{2} \times SEM [45],$$

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

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

Variables	Category	No. (%)
Sex	Male	57(40.7)
	Female	83(59.3)
Affected side	Right	77(55)
	Left	63(45)
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)

NSAID: Nonsteroidal anti-inflammatory drugs.

Note: Age: Mean±SD 35.2±13.37 years.

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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 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].

Results

Translation, floor, and ceiling effect

The study included 140 patients (57 men and 83 women) with grade 2 ankle sprains. Table 1 presents the participants' demographic characteristics. All data

were normally distributed. 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 of the subscales (assistance, functional performance, and confidence). The Persian LE-MAL showed excellent internal consistency for both the total score ($\alpha=0.97$) and all subscales ($\alpha=0.95-0.97$) (Table 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 re-test reliability. The

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

Construct	ICC (95% CI)	ICC Interpretation	Sig.	SEM	MDC	Mean±SD		Cronbach's α
						Test	Re-test	
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±1.4	8.32±0.96	0.95
Confidence	0.78 (0.62–0.87)	Excellent	0.000	0.54	1.5	7.68±1.53	8.48±1.04	0.97
Total score	0.76 (0.24–0.89)	Excellent	0.000	0.43	1.2	8.13±1.12	8.89±0.75	0.97

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Abbreviations: ICC: Intraclass correlation coefficient; CI: Confidence interval; SEM: Standard error of measurement; MDC: Minimal detectable change.

Table 3. ICC Values for test re-test reliability of each item of the Persian LE-MAL

Items	Test Re-test		
	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 an 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 the bath or shower	0.54	0.000	Moderate
10. Getting in and out of the car	0.66	0.000	Moderate
11. Open a door with a doorknob while 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
13. 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

ICC: Intraclass correlation coefficient; LE-MAL: Lower extremity motor activity log.

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Mean±SD of the total and subscale scores of the 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 re-test assessments ranged from 0.54 to 0.83. Items 1-5 and 8 showed excellent reliability, while items 6, 7, and 9-14 demonstrated moderate reliability (Table 3).

Validity

Table 4 presents the results of construct validity. 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 ($0.74 < r < 0.77$).

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

Tests	Sig.	
	LEFS	LSQ
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)

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Abbreviations: LE-MAL: Lower extremity motor activity log; LEFS: Lower extremity functional scale; LSQ: Life-space questionnaire.

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.

Discussion

This study aimed to translate the LE-MAL into Persian and evaluate its validity and reliability in patients with ankle sprains. The findings were 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]. Similar to the Brazilian version, no ceiling or floor effects were observed, indicating that the Persian LE-MAL is sufficiently sensitive 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 α values reported between 0.80 and 0.95 in previous studies [15, 17-19].

Consistent with the methodology of the Brazilian adaptation, test re-test reliability was assessed by retesting 80 of the 140 participants after a two-week interval [18]. The ICCs for the Persian version ranged from 0.75 to 0.78 for the total score and subscales, indicating excellent test re-test 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 under study. While previous versions focused on individuals with neurological conditions, our study involved patients with orthopedic conditions, specifically those 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 of this subscale.

As shown in Table 2, the SEM for the total score and subscales ranged from 0.43-0.57. These values are comparable to those reported for the Brazilian version, in-

dicating acceptable absolute reliability, as SEM values were below 10% of the total and subscale scores [18]. The MDC for the total score in the Persian LE-MAL was 2.1, indicating that changes exceeding this threshold are likely to reflect true improvements rather than measurement errors. In comparison, MDC values for the Brazilian versions ranged from 0.58 to 3.14 [18, 19], with the differences likely due to variations in sample sizes across studies.

The Persian LE-MAL showed a strong correlation with the LEFS, with the total score ($r=0.77$) and the performance and confidence subscales ($r=0.71-0.73$) showing significant associations. The assistance subscale demonstrated a moderate correlation with LEFS ($r=0.58$). Similarly, the American version reported strong correlations between the LE-MAL and tools assessing lower limb function [15]. 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 LSQ, a tool used to assess functional mobility. The total score ($r=0.77$) and performance and confidence subscales ($r=0.71-0.73$) showed strong relationships with the LSQ, while the assistance subscale 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.

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.

Ethical Considerations

Compliance with ethical guidelines

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

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Authors' contributions

Conceptualization and supervision: Laleh Lajevardi, Ghorban Taghizadeh, Akram Azad, and Amir Seyed Ahmadi; Methodology: Laleh Lajevardi, Ghorban Taghizadeh, and Amir Seyed Ahmadi; Funding acquisition and resources: Laleh Lajevardi; Data collection: Amir Seyed Ahmadi; Data analysis: Ghorban Taghizadeh; Investigation, and writing: All authors

Conflict of interest

The authors declared no conflict of interest.

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