Reliability, validity, and cultural adaptation of the Persian version of the Exercise Adherence Rating Scale (EARS) in patients with knee osteoarthritis

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ABSTRACT

Objectives: The aim of this study was to culturally adapt and assess the validity and reliability of the Exercise Adherence Rating Scale (EARS) in Persian language for patients with knee osteoarthritis.

Methods: The original English version of the EARS was forward-translated to Persian (by an expert and a non-expert in the field of exercise and health science) and then backward-translated to English by two people, and then by a committee of five, pre-final Persian version of EARS was created. Patients were provided with a three-month exercise program, three times a week, through telerehabilitation. After completion of the exercise program, patients filled out the Persian version of EARS and the Scanlan questionnaire. Three weeks later, patients completed the EARS and Scanlan questionnaire again. During the study, patients recorded the number of exercise sessions weekly in a standardized diary form. Face validity was assessed by ten patients, using the item impact method. Content validity was assessed by five experts and quantified using the content validity ratio and content validity index. Agreement between EARS and Scanlan questionnaire was assessed using Spearman test and Bland–Altman plot. The reliability of the Persian version of EARS was assessed using the intraclass correlation coefficient and Cronbach’s α.

Results: A total of 30 patients (3 men, 27 women), with a mean age of 59 years (SD = 10), participated in this study. All items of the Persian version of EARS had item impact method scores above 1.5, indicating acceptable face validity. The scale-content validity index/average for relevancy and simplicity components were calculated as 0.87 and 0.85, respectively, indicating good content validity. Bland–Altman plot showed good agreement between EARS and Scanlan questionnaire at baseline and three weeks later. Cronbach’s alpha was 0.96, indicating excellent internal consistency. The intraclass correlation coefficient (95% CI) was 0.996 (0.991, 0.998), indicating excellent reliability.

Conclusions: The Persian version of EARS demonstrated acceptable cultural adaptation, reliability, and validity in patients with knee osteoarthritis. The use of the Persian version of EARS can be a reliable and valid tool to assess exercise adherence in patients with knee osteoarthritis.

Level of the evidence: II.

Abbreviations: KOA, Knee osteoarthritis; VAS, Visual Analogue Scale; EARS, Exercise Adherence Rating Scale; RCT, Randomized clinical trial; T1, Forward translator 1; T2, Forward translator 2; T12, Forward translator 3 (to integrate the first and second translation); B1, Backward translator 1; B2, Backward translator 2; Pre, Pre-test; Post, Post-test; AUC, area under the curve; ICC, intra-class correlation coefficient; N, Number; CVR, Content Validity Ratio; CVI, Content Validity Index.

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2059-7754/© 2024 The Author(s). Published by Elsevier Inc. on behalf of International Society of Arthroscopy, Knee Surgery and Orthopedic Sports Medicine. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).
What are the new findings?

- The Persian version of the Exercise Adherence Rating Scale demonstrates validity and reliability in accurately measuring exercise adherence among patients with knee osteoarthritis.
- This adapted scale offers a more precise and dependable method for assessing exercise adherence in patients with musculoskeletal disorders compared to traditional methods such as standardized diary forms or researcher-administered questionnaires.
- Given the wide-spread use of the Persian language in Iran, Afghanistan, and Tajikistan, it appears that this scale holds potential for application in research conducted across these three countries.

INTRODUCTION

Exercise, particularly therapeutic exercise, is essential for managing and treating many musculoskeletal disorders [1]. Evidence shows that exercise can statistically significant benefit patients with chronic musculoskeletal conditions like knee osteoarthritis (KOA) by reducing pain, improving function, decreasing fall risk, enhancing psychological well-being, and improving overall quality of life [2-4]. Given the chronic nature of the disorder, home exercise programs and telerehabilitation are affordable and accessible long-term interventions [5,6]. However, for these programs to be effective in changing patients’ lifestyles, patient commitment and consistent adherence are crucial [7].

Adherence to exercise is typically measured in research studies using simple tools such as questionnaires, exercise diaries, and self-administered scales [8,9]. The Exercise Adherence Rating Scale (EARS) is a six-item patient-reported outcome measure that assesses adherence behavior directly. Patients rate the six items on an ordinal Likert scale of potential responses, with higher scores indicating greater adherence (0 = strongly agree to 4 = completely disagree) (0-24). Eleven items from the EARS measure behavior related to exercise adherence. The total score of EARS is 68. The EARS is completed at the end of treatment to assess adherence behavior retrospectively [10].

To our knowledge, the Persian version of EARS has not been translated, culturally adapted, and validated in Persian-speaking patients with chronic musculoskeletal disorders, particularly KOA. Persian is commonly spoken in Iran, Afghanistan, and Tajikistan. Therefore, this study aims to translate, culturally adapt, and assess the validity and reliability of the Persian translation of the EARS in Iran.

MATERIALS AND METHODS

Participants

The cultural adaptation and measurement of the validity and reliability of the EARS (Persian version) were conducted as part of an ongoing randomized clinical trial that started in June 2022 and will end around May 2023. For the present study, data were collected from 30 out of 129 patients (exercise group) from the randomized clinical trial. Patients were recruited through medical referrals to the rheumatology research center of Shariati Hospital, Tehran University of Medical Sciences. Men and women (age < 40 years) with KOA were included in this study according to the inclusion and exclusion criteria (Table 1). Patients provided written informed consent before starting the study. The ethics committee for research involving human subjects of the Sport Sciences Research Institute of Iran approved the study (IR.SSRC.REC1401.021), which was conducted in accordance with the Declaration of Helsinki [11].

Before the study began, a blind evaluator filled in the demographic information of the patients. The patients were instructed to complete the exercise at home three times a week (36 sessions during three months) and to report completed exercise sessions in a standardized diary form. A sports therapist (a health professional with a master's degree in corrective exercise and therapeutic exercise) taught exercises and checked the patients weekly. After the completion of three months of exercise intervention, the patients filled out the EARS and Scanlan questionnaires. After three weeks [10], the questionnaires were filled out again by the patients to assess reliability. The number of sessions reported by the patients (sessions they exercised and recorded in the diary form) was recorded to assess validity. Before filling out the EARS, the questionnaire was translated into Persian (Fig. 1).

Thirty-two patients were initially enrolled in the study, with two excluded due to their inability to perform exercises (due to a car accident and personal reasons). Consequently, the final sample comprised 30 patients diagnosed with KOA (Fig. 1).

Exercise Adherence Rating Scale (EARS)

The EARS is a reliable and valid patient-reported outcome measure that assesses exercise adherence behavior. It consists of six items that are graded on a Likert scale ranging from 0 to 4, with higher scores indicating better adherence. The EARS includes 11 items related to exercise adherence and has a total score of 68. It is completed at the end of treatment to evaluate adherence behavior retrospectively [10].

Sport Commitment Scanlan Questionnaire

The Sport Commitment Scanlan Questionnaire is a well-established measure that assesses sport enjoyment and exercise adherence, personal investment, social constraints, involvement alternatives, and involvement opportunities. The questionnaire has been translated into the Persian language and is a reliable and valid tool to measure exercise adherence. Six items of this questionnaire directly measure adherence to exercise, and it is scored from 26 to 130 points, with a higher score indicating greater adherence [12].

Table 1
The inclusion and exclusion criteria. KOA: knee osteoarthritis.

<table>
<thead>
<tr>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
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<tbody>
<tr>
<td>Age &lt;40</td>
<td>Severe osteoporosis</td>
</tr>
<tr>
<td>Radiographically KOA (determined by Kellgren and Lawrence grade 1 to 3 on the 1–4 scale)</td>
<td>Clinical history of cancer</td>
</tr>
<tr>
<td>A clinical diagnosis of knee osteoarthritis (defined as knee pain for &gt;3 months, early morning stiffness &gt;30 min, crepitus, bony tenderness, and no palpable warmth)</td>
<td>Submitted to previous physical therapy in the past 6 month</td>
</tr>
<tr>
<td>Ability to use smartphone</td>
<td>Inflammatory joint diseases</td>
</tr>
<tr>
<td>Ability to read and write</td>
<td>Lower extremity joint replacement</td>
</tr>
<tr>
<td>Submitted to previous physical therapy in the past 6 month</td>
<td>Alzheimer diseases and Neurological diseases</td>
</tr>
<tr>
<td>Illiterate patients without caregivers (child, nurse, caregiver)</td>
<td>Patients in the postsurgery period</td>
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</table>
The Standardized Diary Form is a simple and effective tool to assess exercise adherence. Before starting the exercise intervention, patients are instructed to record the number of completed exercise sessions in a weekly diary form. At the end of the exercise intervention, the patients hand over the diary form to the researcher, and the number of exercise sessions completed by the patients is recorded. Previous studies suggest that patients who complete 24 out of 36 training sessions have a high adherence to exercise. As per previous research, good protocol adherence for exercise groups was defined as attendance at a minimum of 24 out of 36 sessions [13].

**Translation**

We adhered to the recommended guidelines for cross-cultural adaptation of self-report measures [14] and the principles outlined in the "Report of the ISPOR Task Force for Translation and Cultural Adaptation" [15] during the process of translating the EARS from British English into Persian. The standard forward-backward translation was employed, beginning with a forward translation stage. Two Persian-speaking translators independently translated the EARS into Persian, resulting in versions T1 and T2 (Fig. 2).

One translator was an uninformed language professional with a Bachelor of Arts degree who was not familiar with the concepts being translated but produced a translation that reflected the language used in the Iranian population. The other translator was a therapist specializing in exercise, a health professional and researcher with a master’s degree in corrective exercises and sports injuries who was knowledgeable about the concepts being translated and provided a clinically informed translation.

In the second stage, a meeting was arranged with the two forward translators and a professional sports biomechanics (assistant professor) to integrate the contents of the translations and synthesize a combined T12 version from the original EARS, the forward translations, and written reports. All issues that arose were documented.

In the third stage, two back translators who were blinded to the original EARS independently translated T12 back into British English, resulting in versions B1 and B2. Two native back translators who were fluent in Persian and lived in Iran and had no clinical experience with patients with KOA also translated T12 into Persian.

![Flowchart of cross-cultural adaptation from the original version to the Persian Exercise Adherence Rating Scale. RCT: Randomized clinical trial, VAS: Visual Analogue Scale, N: Number, EARS: Exercise Adherence Rating Scale.](image-url)
In the next stage, a joint meeting was held in the presence of all four translators and the professional sports biomechanics, during which the original EARS was presented and the backward-translated scale was compared with it. At the meeting, all versions of the scale (T1, T2, T12, B1, and B2) and the corresponding written reports were merged to develop a prefinal version of the scale for field testing. Ultimately, we established the prefinal Persian version of EARS.

In the fifth stage, the prefinal Persian version of the EARS was tested on 30 adult patients with KOA.

**Validity**

After completing the intervention, all 30 patients were asked to complete the EARS and the Sport Commitment Scanlan Questionnaire. In order to examine the construct validity of the EARS, we investigated whether the EARS score was correlated with the number of completed exercise sessions (36 sessions of home exercises) and the subscales of the Sport Commitment Scanlan Questionnaire (exercise adherence score) [16,17]. The patients had already completed the Sport Commitment Scanlan Questionnaire at baseline. Based on the content and evidence [18], we hypothesized that the EARS score would positively correlate with the completed exercise sessions and the Sport Commitment Scanlan Questionnaire.

To assess construct validity, patients were divided into two groups based on their adherence levels derived from standardized diary entries: the “good” group, consisting of individuals completing exercises in more than 24 sessions, and the “not good” group, comprising those completing fewer than 24 sessions. Face validity was evaluated by ten patients and quantified using the item impact method (IIM), calculated as the proportion of responses scoring 5 or 4, multiplied by the mean score for each item.

**Reliability**

As for reliability, one estimate is test-retest reliability [19]. The patients did not receive a new treatment (exercise intervention), but they were asked to continue their exercise program between the first and second completions of the scale. The patients completed the scale for the second time after three weeks of completing the first scale [20]. If the result of the second scale was received more than one week after the scheduled completion date, it was excluded from the study.

**Statistical analysis**

Continuous and categorical variables were summarized as mean ± SD or frequency (percentage), respectively. After assessing normality distribution using Shapiro–Wilk test, the Mann–Whitney test was used to compare mean between groups. The face validity was assessed by ten patients using the IIM. In this method, the comprehensibility of each item was assessed using a 5-point Likert scale ranging from 1 (not understandable at all) to 5 (quite understandable). The item impact score was then calculated using the following formula: “Item Impact Score = percentage of patients who gave a score of 4 and 5 x Importance”, where importance was the average of all responses. If the item impact score was greater than 1.5, the item was considered suitable for further analysis [21]. Content validity was assessed by five experts and quantified using the content validity ratio (CVR) and content validity index (CVI). To determine the content validity ratio, the necessity of each item was assessed based on a three-point Likert scale. The formula for the CVR is CVR = (Ne–N/2)/(N/2), where Ne is the number of expert participants indicating an item as “essential,” and N is the total number of experts. According to the critical values from the Lawshe table, a CVR above 0.99 for 5 participants was considered acceptable and should be retained in the questionnaire [22].

In this study, the content validity index was measured using the scale-level-CVI (S-CVI), which was computed based on the number of items in the questionnaire that achieved a rating of “very relevant,” “very clear,” or “very simple.” The average CVI (S-CVI/Ave) was calculated by summing the individual CVIs and dividing by the total number of items. An S-CVI/Ave value ≥ 0.90 indicates excellent content validity [23].

The agreement between the EARS and Scanlan questionnaires was assessed using the Spearman test and Bland–Altman plot. A Bland–Altman plot is a graphical method used to visualize the differences in measurements between two different instruments or measurement techniques. In this plot, the differences between the two instruments are plotted against the averages of the two instruments. Horizontal lines are drawn at the mean difference and at the limits of agreement, which are defined as the mean difference plus and minus 1.96 times the standard deviation of the differences [24].

The reliability of the Persian version of the EARS was assessed using the intraclass correlation coefficient (ICC) and Cronbach’s α. Additionally, the receiver operating characteristic curve and area under the curve were used to predict the likelihood of completing more than 24 exercise sessions based on the EARS score at baseline. All analyses were conducted using the SPSS statistical package for Windows, version 27, and R 4.2.3 software.

**RESULTS**

The mean age of the patients was 59 ± 10 years, with a predominance of female participants (n = 27, 90%) who were predominantly married (n = 26, 87%). Only 30% of participants had attained an academic education, and 3% reported a history of smoking. The mean Visual Analogue Scale (VAS) and radiographic scores were 7 ± 2 and 2 ± 1, respectively (Table 2).

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**Fig. 2.** Flowchart of the process of cross-cultural adaptation to the Persian of the EARS in six stages. EARS: Exercise Adherence Rating Scale, T1: Forward translator 1, T2: Forward translator 2, T12: Forward translator 3 (to integrate the first and second translation), B1: Backward translator 1, B2: Backward translator 2, N: Number.
First, to assess the face validity of EARS, the IIM score of ten patient responses was 1.5. Additionally, for evaluating content validity, the Scale-CVI/Average was calculated for three components: relevancy, clarity, and simplicity, yielding scores of 0.87, 0.74, and 0.85, respectively. The CVRs for each item were compared against Lawshe’s critical values and exceeded 0.99 for five experts in the field.

Second, the Spearman correlation between EARS and the Scanlan questionnaire was estimated as 0.87 and 0.83 at baseline and three weeks later, respectively. These associations were statistically significant (P-value < 0.001), confirming concurrent validity. Furthermore, based on the Bland–Altman plots (Fig. 3), all data points fell within the 95% confidence interval for the mean difference between the scores of the two instruments. Thus, agreement between the two questionnaires was observed both at baseline and three weeks later.

Finally, to examine construct validity, the mean EARS scores of patients in the committed exercise group (engaging in exercise for more than 24 sessions) were significantly higher compared to the other group (P-value < 0.05) at both baseline (61.5 ± 6 vs. 40.9 ± 10) and three weeks later (61.1 ± 6 vs. 39.6 ± 10). Additionally, the estimated area under the curve by receiver operating characteristic curve analysis was 99.4%, indicating that the EARS score at baseline had a strong predictive ability for engaging in the exercise above 24 sessions (Fig. 4).

To assess reliability, we first estimated Cronbach’s alpha, which was 0.96, indicating high internal consistency among the 17 items in the

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mean ± SD or Number (%)</th>
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<tbody>
<tr>
<td>Age (year)</td>
<td>59 ± 10</td>
</tr>
<tr>
<td>Sex (female)</td>
<td>27 (90%)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>30 ± 4</td>
</tr>
<tr>
<td>Married (yes)</td>
<td>26 (87%)</td>
</tr>
<tr>
<td>Academic education (yes)</td>
<td>9 (30%)</td>
</tr>
<tr>
<td>Housewife (yes)</td>
<td>22 (73%)</td>
</tr>
<tr>
<td>Smoking (yes)</td>
<td>1 (3%)</td>
</tr>
<tr>
<td>VAS score</td>
<td>7 ± 2</td>
</tr>
<tr>
<td>Radiographic score</td>
<td>2 ± 1</td>
</tr>
<tr>
<td>Symptom duration (year)</td>
<td>6 ± 5</td>
</tr>
<tr>
<td>Pain duration (year)</td>
<td>1.2 ± 1.1</td>
</tr>
</tbody>
</table>

Table 2
Characteristics of KOA patients (n = 30) at baseline, data shown as Mean ± Standard deviation and frequency (percentage) for continuous and categorical variables, respectively. BMI: Body Mass Index, VAS: Visual Analogue Scale.

Fig. 3. Bland–Altman plots: the difference (EARS - Scanlan questionnaires) and average scores ((EARS + Scanlan questionnaires)/2) of each patient are shown in vertical and horizontal axis, respectively. Horizontal red dashes are represented 95% confidence interval of difference mean (Most of the points are within 95% confidence interval, which indicates agreement between the two instruments). A) Measurements at baseline B) measurements at three weeks after baseline.
DISCUSSION

In this study, we culturally adapted the EARS [10]; the Persian version of EARS showed excellent acceptability during baseline and post-test and demonstrated acceptable reliability and validity. It is the valid self-report available in the Persian language to assess exercise adherence in patients with KOA (the Persian version of EARS is given in Supplementary File 1). However, due to the small sample size in this study, further evaluation of measurement properties may be needed for future studies.

Previous studies have shown cross-cultural adaptation of the EARS using a similar process in other languages and for other diseases [25–27]. One study evaluated the cross-cultural adaptation of the Danish version of the EARS in 24 patients (22 females; median age 30) with longstanding hip pain due to hip dysplasia prescribed with home exercises [25]. The study results showed a strong correlation between the EARS and completed exercise sessions (p = 0.005), self-reported pain (p = 0.005), and sport/recreation function (p < 0.03) [20]. The results of this study were consistent with our study, where we also found a statistically significant correlation between completed exercise sessions and EARS scores. In another study, the EARS were cross-culturally adapted to Brazilian Portuguese in 108 patients with chronic low back pain using the same forward-backward method [26]. The results of the study demonstrated an acceptable Brazilian Portuguese version of EARS reliability, validity, and responsiveness for patients with chronic low back pain. According to their report, achieving a score of 17 out of 24 on EARS after being prescribed home exercise could be considered as the minimum requirement for acceptable adherence behavior that leads to better patient outcomes [26]. Other studies have reported cross-cultural adaptation of the EARS in the Nepali version, based on Beaton guidelines, and found the reliability and construct validity of the Nepali version of EARS acceptable for evaluating adherence to exercise [27].

EARS questionnaire. We then used a test-retest approach, applying the intra-class correlation coefficient (ICC) to the quantitative items. Using the two-way random effect model and absolute agreement, we found the ICC (95% CI) to be 0.996 (0.991, 0.998), indicating excellent levels of reliability for the Persian EARS questionnaire.

EARS questionnaire. We then used a test-retest approach, applying the intra-class correlation coefficient (ICC) to the quantitative items. Using the two-way random effect model and absolute agreement, we found the ICC (95% CI) to be 0.996 (0.991, 0.998), indicating excellent levels of reliability for the Persian EARS questionnaire.

Fig. 4. The receiver operating characteristic curve (ROC) analysis with high AUC (Area under the ROC Curve: 99.4%) shows that EARS scores at baseline can predict doing the exercise above 24 sessions. ROC: Receiver operating characteristic curve, AUC: Area under the curve.

STRENGTH AND CLINICAL IMPLICATION

The Persian version of EARS is the validated self-report scale in the Persian language that can assess adherence and behavior adherence to exercises in patients with KOA. Considering the acceptable reliability and validity of this scale in the Persian language, it can be used in clinical practice during the follow-up period of patients prescribed home exercise programs or telerehabilitation. The length of the exercise intervention period in this study was long (three months), which is a strength of this study compared to similar studies. This scale can be used to monitor exercise adherence after face-to-face exercise intervention or online exercise intervention in the follow-up period. It can also be used to check behavior adherence. The Persian language is common in Iran, Afghanistan, and Tajikistan. Furthermore, it seems that this Persian version of EARS can be used in these three countries to measure adherence and adherence behavior in patients with KOA.

CONCLUSIONS

This study aimed to culturally adapt the EARS for the Persian version in patients with KOA, following international recommendations. The results suggest that the Persian version of EARS is a reliable and valid scale to assess adherence to exercise in patients with KOA after the prescription of telerehabilitation.

Declarations

Ethics approval and consent to participate

All participants provided written informed consent before enrollment. This study was part of a Randomized clinical trial (RCT). The code of ethics for the original study (RCT study) was obtained from the ethics committee for research involving human subjects of the Sport Sciences Research Institute of Iran (IR.SSRC.REC.1401.021). Also, the code of trial registration of the main study is IRCT20220510054814N1. The main research was reported following CONSORT guidelines, and all experimental conditions conformed to the Declaration of Helsinki.

Consent for publication

Not Applicable.
Availability of data and materials
All the data that support the findings of this study are available from the corresponding author upon understandable request.

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Authors' contributions
ZGh and EM analyzed, interpreted the data, and wrote the paper. ZGh, RM, and STF participated in the data collection. STF and RM reviewed the paper. All authors read and approved the final manuscript.

Declaration of competing interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments
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Appendix A. Supplementary data
Supplementary data to this article can be found online at https://dx.doi.org/10.1016/j.jisako.2024.02.011.

References