RESEARCH

Anterior Knee Pain Scale (AKPS): structural and criterion validity in Brazilian population with patellofemoral pain

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Abstract

Purpose To identify the best internal structure of the Brazilian version of the Anterior Knee Pain Scale (AKPS), comparing different instrument structures (structural validity) and correlating the scores of the versions (criterion validity).

Methods We included Brazilian volunteers, aged ≥ 18 years, with patellofemoral pain (PFP) for at least 3 months. We used the confirmatory factor analysis and considered the following fit indices: chi-square/degrees of freedom (DF), comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA). We considered the structure with the lowest values of the Akaike information criterion (AIC), sample size adjusted Bayesian information criterion (SABIC), and assessed criterion validity using Pearson correlation coefficient (r) to correlate the long and short versions.

Results The study included 101 participants, mostly women (65.3%), young adults (~ 31 years old), overweight (BMI > 25 kg/m^2), incomplete higher education (37.6%), and physically active (64.4%). The original 1-domain, 13-item structure showed adequate fit indices (chi-square/GL < 3.00, TLI and CFI > 0.90, and RMSEA < 0, 08). However, items 11 and 12 had a factorial load of less than 0.23. Therefore, we excluded items 11 and 12 and found adequate fit indices (chi-square/GL < 3.00, TLI and CFI > 0.90, and RMSEA < 0, 08) and lower AIC and SABIC values. We observed a correlation coefficient above the acceptable cutoff of 0.70 (r = 0.966, p-value < 0.001) between the versions.

Conclusion The 11-item AKPS (without items 11 and 12) is the version with the most adequate internal structure and correlates satisfactorily with the long version of the instrument.

Keywords Musculoskeletal disorders, Functional status, Factor analysis, statistical

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Introduction

Patellofemoral pain (PFP) is a common patellofemoral condition that is characterized by an insidious onset of poorly defined pain, localized to the anterior retropatellar and/or peripatellar region of the knee [1]. The onset of symptoms may be slow or acutely develop with a worsening of pain accompanying lower-limb loading activities [2].

The Anterior Knee Pain Scale (AKPS), or Kujala score, was developed by Kujala et al. [3] in Finland (in English, in 1993) to measure aspects of disability [4] caused by patellofemoral disorders (e.g., PFP, patellar subluxation, and patellar dislocation). The authors validated the construct by finding significantly lower scores in patients with patellofemoral disorders when compared to a control group.

The original instrument has 13 items and scores ranging from 0 to 100, with lower scores indicating greater disability. Since the development of the instrument [3], several studies have been conducted to adapt the AKPS to other cultures, including Turkish [5], Chinese [6], Persian [7], Spanish [8], Dutch [9], Thai [10], Greek [11], Arabic [12], Indonesian [13], Norwegian [14], Italian [15], German [16], and French [17].

In Brazil, two studies translated and adapted the AKPS for the population with PFP. Firstly, Aquino et al. [18] performed the translation and cross-cultural adaptation and did not investigate any other measurement properties. Subsequently, a more robust study translated and adapted the AKPS for the Brazilian population and identified the instrument with adequate internal consistency and reliability, with a valid construct, and with satisfactory responsiveness [4]. However, no validation studies have examined the internal structure of the AKPS through factor analysis, thus reducing its relevance to clinical or research settings.

A systematic review examined the measurement properties of scales and questionnaires for patients with PFP and found that only the Activities of Daily Living Scale (ADLS) and the International Knee Documentation Committee (IKDC) had an internal structure confirmed by factor analysis [19]. Furthermore, according to Hoglund et al. [1, 20], most patient-reported outcome measures used to measure pain and function in patients with PFP have inadequate content validity.

The evaluation of condition-specific patient-reported outcomes is highly recommended by experts [21], with the AKPS being one of the most commonly used instruments and correlating with many physical and non-physical factors [22, 23]. However, the assessment of the measurement properties of AKPS and other patient-reported outcome measures for knee disorders is scarce, as shown by systematic reviews [1, 19, 20].

Therefore, considering this gap in the literature, the objective of the present study was to identify the best internal structure of the Brazilian version of the AKPS, comparing different instrument structures (structural validity) and correlating the scores of the versions (criterion validity) whose measurement provides an adequate indication of the dimensionality of the construct, attribute or factor being measured.

Methods

Study design and ethical aspects

A cross-sectional study to examine the structural validity of the AKPS. Data collection for the study was done using an online form (Google Forms, Mountain View, CA, USA)®. Participants were recruited through advertising in the university community, rehabilitation clinics, and gyms in São Luís (Maranhão, Northeastern Brazil). Social media advertising was also used. The study procedures were approved by the Institutional Research Ethics Committee (protocol number 3.995.226).

Sample size

The sampling was based on the recommendations of the COnsensus-based Standards for the selection of health Measurement INnstruments (COSMIN) [19]. Namely, seven times the number of items of the scale, provided that this value is not less than 100. In this sense, considering 13 items, the present study was composed of at least 100 individuals with PFP.

Eligibility criteria

We included only participants with PFP [2] and adopted the following exclusion criteria: history of trauma, fracture, or acute injury to the knee joint; knee surgery; use of analgesics in the past seven days; physiotherapy treatment for PFP in the past three months; and presence of other chronic pain. The diagnosis was made asynchronously and remotely.

Assessments

Participants reported whether they engaged in physical activity (yes or no), the number of times per week, the duration, and the type of exercise. Afterward, a bachelor of physical education (AP-S) evaluated the reports and classified them according to relevant recommendations for physical activity levels [24].

In addition to the Numerical Pain Rating Scale (NPRS), which assesses the mean pain intensity of the participants, and an initial assessment of personal,

sociodemographic, anthropometric and clinical aspects (Table 2), we used the AKPS, a scale adapted to Brazilian Portuguese [4] with 13 items and different response possibilities for each item, corresponding to a specific score, as shown in Table 1. The final score of the scale is obtained by adding the score of each item, ranging from 0 to 100. Lower scores indicate greater disability.

Therefore, participants of both sexes, sedentary or active, aged between 18 and 60 years, and with reports of PFP [2] for at least 3 months were included. In addition to the participant's verbal report, the NPRS was used to characterize the participant's pain intensity: a unidimensional scale from 0 to 10 points, where 0 represents "no pain" and 10 represents "worst pain imaginable", with adequate validity for the Portuguese population [25].

Statistical analysis

We performed descriptive analysis and presented data as means and standard deviations or relative and absolute frequencies. We used confirmatory factor analysis (CFA) to identify the best structure of the AKPS through R Studio software (Boston, MA, USA)®, using the lavaan and semPlot packages. We used the implementation of a polychoric matrix and the robust diagonally weighted least squares (RDWLS) extraction method [26, 27]. We considered appropriate values of fit indices for the following cut-offs: chi-square/degrees of freedom (DF) < 3; comparative fit index (CFI) and Tucker-Lewis index (TLI) > 0.90; and root mean square error of approximation (RMSEA) < 0.08 [28, 29].

For model comparison, the structure with the lowest Akaike Information Criterion (AIC) and Sample Size Adjusted Bayesian Information Criterion (SABIC) values was considered most appropriate [30]. Factor loadings were considered adequate if they were greater than 0.40 [31]. Finally, we assessed validity criteria using the 13-item long version of the AKPS as the gold standard. Therefore, we used the Pearson correlation coefficient (r) to correlate the long and short versions (data with normal distribution according to the Kolmogorov–Smirnov test). A correlation coefficient > 0.70 was considered an appropriate cut-off point for criterion validity [32].

Results

The AKPS proposed in this study consists of 11 items with separate categories related to different levels of knee function. Categories within each item are scored and responses are summed to produce a global index where

Table 1 Score of responses for each item on the Anterior Knee Pain Scale (AKPS)

Item	Score
1. Limp	a) 5 b) 3 c) 0
2. Support	a) 5 b) 3 c) 0
3. Walking	a) 5 b) 3 c) 2 d) 0
4. Stairs	a) 10 b) 8 c) 5 d) 0
5. Squatting	a) 5 b) 4 c) 3 d) 2 e) 0
6. Running	a) 10 b) 8 c) 6 d) 3 e) 0
7. Jumping	a) 10 b) 7 c) 2 d) 0
8. Prolonged sitting with the knees flexed	a) 10 b) 8 c) 6 d) 4 e) 0
9. Pain	a) 10 b) 8 c) 6 d) 3 e) 0
10. Swelling	a) 10 b) 8 c) 6 d) 4 e) 0
11. Abnormal painful kneecap (patellar) movements (subluxations)[a]	a) 10 b) 6 c) 4 d) 2 e) 0
12. Atrophy of thigh[a]	a) 5 b) 3 c) 0
13. Flexion deficiency	a) 5 b) 3 c) 0

[a] Excluded items

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Table 2 Personal and anthropometric characteristics of the sample (*n* = 101)

Variable	Mean (standard deviation) or n (%)
Age (years)	31.77 (12.21)
Body mass (kg)	71.07 (15.19)
Stature (m)	1.65 (0.08)
Body mass index (kg/m^2)	25.75 (4.39)
Sex	
Male	35 (34.7%)
Female	66 (65.3%)
Education	
Incomplete primary education	1 (1%)
Complete primary education	1 (1%)
Incomplete secondary education	1 (1%)
Complete secondary education	12 (11.9%)
Incomplete higher education	38 (37.6%)
Complete higher education	26 (25.7%)
Incomplete post-graduate	5 (5%)
Complete post-graduate	17 (16.8%)
Lower limb dominance	
Right	79 (78.2%)
Left	13 (12.9%)
Both	9 (8.9%)
Physical activity	
Yes	65 (64.4%)
No	36 (35.6%)

a score of 85 represents "no deficit" and a score of 0 represents "the highest possible deficit". Response scores for each item on the AKPS are shown in Table 1.

The majority of the sample consists of women (65.3%), young adults (~31 years old), overweight (body mass index > 25 kg/m2), with incomplete higher education (37.6%), and practitioners of physical activity (64.4%) (Table 2). Reading the pain characteristics (Table 3), we observed that the majority of the sample has pain in the sitting position (82.2%) or crouching (67.3%), mean pain duration greater than 39 months, and mean pain intensity greater than 4 points on the NPRS. Regarding the side of greater pain, there was a similar distribution between unilateral pain on the right (32.7%), on the left (36.6%), and bilateral (30.7%).

Regarding the internal structure of the AKPS (Table 4), the structure with 1 domain and 13 items showed adequate fit indices (Chi-square/GL < 3.00, TLI and CFI > 0.90, and RMSEA < 0.08). However, items 11 and 12 had a factorial load of less than 0.23, indicating that they were poorly explained by the domain (Fig. 1). Therefore, we excluded items 11 and 12 and found adequate fit indices (chi-square/GL < 3.00, TLI

and CFI > 0.90, and RMSEA < 0.08) and lower AIC and SABIC values (Table 4), in addition to factor loadings greater than 0.40 (Fig. 2). Thus, the AKPS structure with 1 domain and 11 items is more appropriate (Additional file 1).

In terms of criterion validity, the correlation between the 11-item and 13-item versions of the AKPS showed a correlation coefficient above the acceptability cutoff of 0.70 (*r* = 0.966, *p*-value < 0.001). Thus, even with the reduction of two items, the final scores remain highly correlated.

Discussion

This study showed that the 11-item AKPS, excluding items 11 and 12, is the version with the most adequate internal structure and satisfactorily correlated with the long version of the instrument. Although AKPS has been adapted for Turkish [5], Chinese [6], Persian [7], Spanish [8], Dutch [9], Thai [10], Greek [11], Arabic [12], Indonesian [13], Norwegian [14], Italian [15], German [16], and French [17], the authors did not analyze the internal structure of the AKPS. To date, this is the first validation study to examine the internal structure of the AKPS using factor analysis.

We emphasize that the clinical and scientific relevance of the AKPS is still limited because important measurement properties (e.g., reproducibility, responsiveness, and interpretability) of the AKPS still need to be investigated [1, 20]. Therefore, we suggest that further

Table 3 Sample pain characteristics

Variables	Mean (standard deviation) or n (%)
Pain presence	
Sitting (yes)	83 (82.2%)
Crouched (yes)	68 (67.3%)
Running (yes)	62 (61.4%)
Jumping (yes)	62 (61.4%)
Up or down stairs (yes)	66 (65.3%)
Time of pain (months)	39.04 (50.38)
Knee in pain	
Right	33 (32.7%)
Left	37 (36.6%)
Both	31 (30.7%)
AKPS	
13 items (score, 0–100)	76.00 (13.09)
11 items (score, 0–85)	63.74 (12.21)
NPRS at rest (score, 0–10)	4.51 (1.99)

AKPS Anterior Knee Pain Scale, *NPRS* Numerical Pain Rating Scale

Table 4 Confirmatory factor analysis of the versions of the Anterior Knee Pain Scale (AKPS)

Structure	Chi-square/DF	CFI	TLI	RMSEA (90% CI)	AIC	SABIC
13 items	1.35	0.965	0.958	0.059 (0.019 to 0.089)	4824.880	4810.754
11 items	1.45	0.970	0.962	0.067 (0.024 to 0.101)	4043.385	4031.432

DF Degree of freedom, *CFI* Comparative fit index, *TLI* Tucker-Lewis index, *RMSEA* Root mean square error of approximation, *CI* Confidence interval, *AIC* Akaike information criterion, *SABIC* Sample-size adjusted Bayesian information criterion
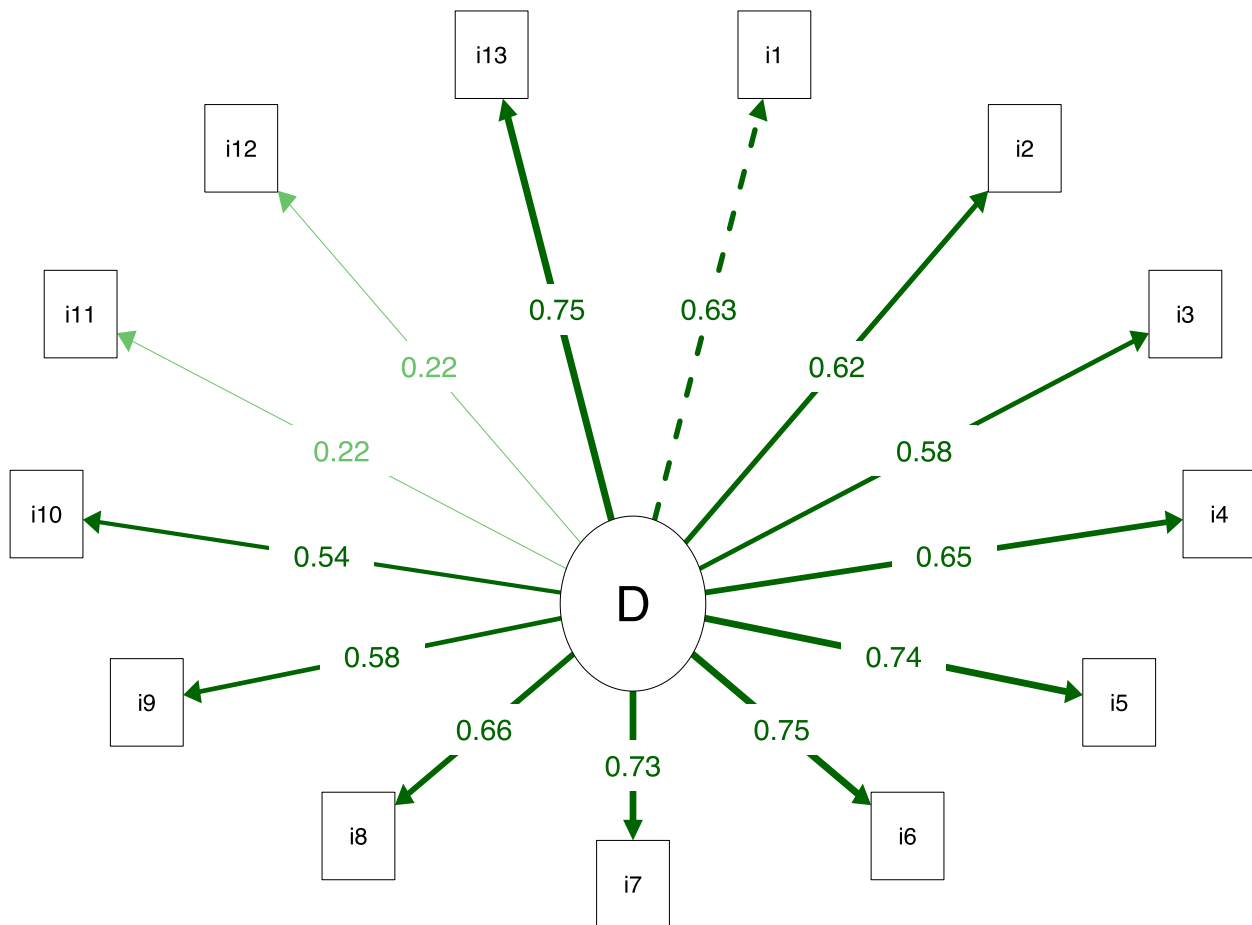

Fig. 1 Path diagram of the Anterior Knee Pain Scale (AKPS) with 13 items. All factor loadings above 0.40, except items 11 and 12. The dotted line indicates the first factor item. The thicker the line, the greater the factor loading. D: Disability

studies are needed to determine whether this instrument should be added to or removed from the scientific community.

This study has important limitations. First, according to the American College of Rheumatology [33], clinical symptoms related to degenerative lesions in the knee joint begin to appear at 38 years of age, with radiographic evidence becoming detectable at 40 years of age or older; thus, generalizability to the PFP population, which consists primarily of young individuals [34], may be compromised.

Second, although the results support the 11-item AKPS as the version with the most adequate internal structure and satisfactory correlation with the long version of the instrument, we know that the 11-item AKPS has adequate measurement properties only for the Brazilian population. Since this is the first validation study to examine the internal structure of the AKPS through
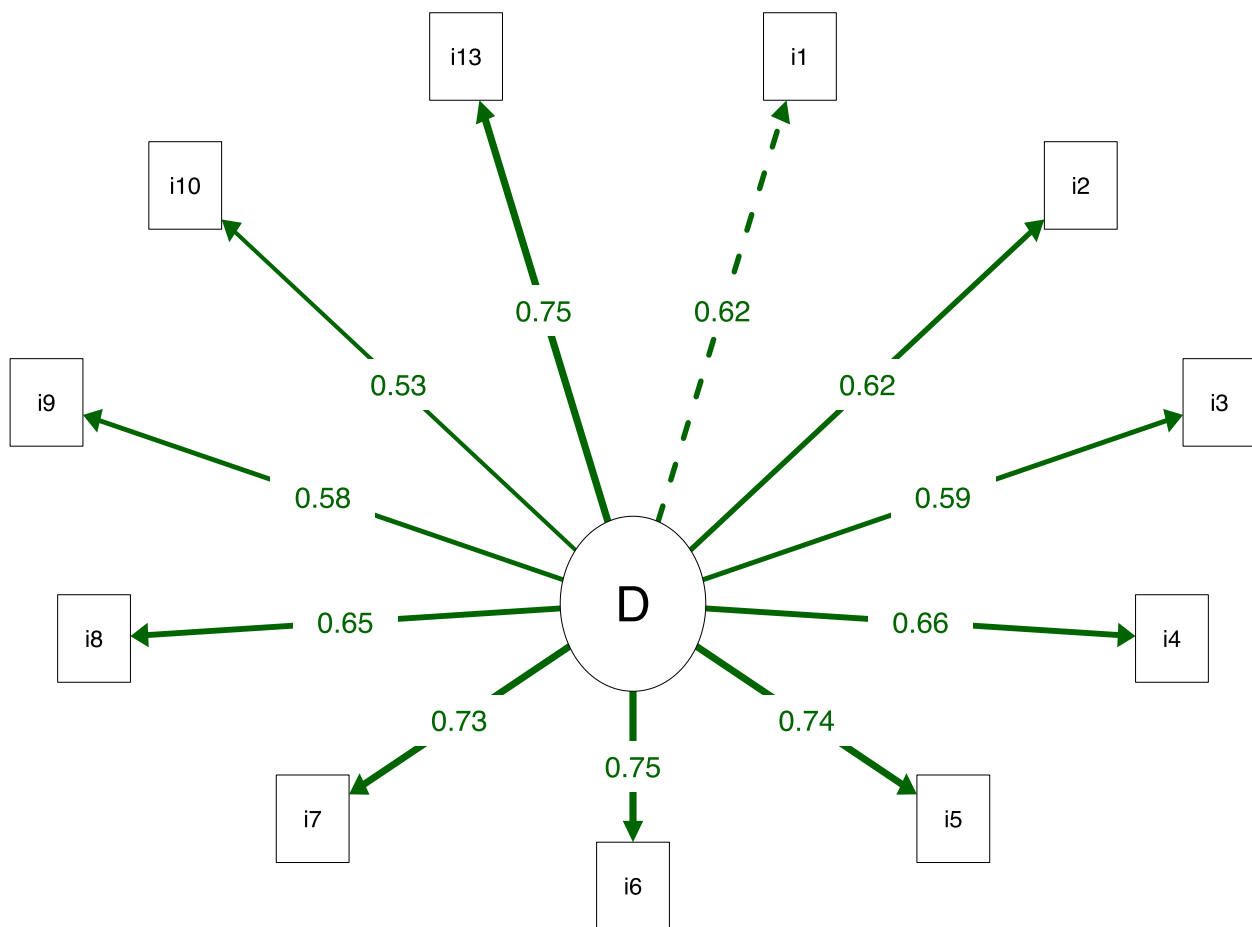
Fig. 2 Path diagram of the Anterior Knee Pain Scale (AKPS) with 11 items. All factor loadings above 0.40. The dotted line indicates the first factor item. The thicker the line, the greater the factor loading. D: Disability

factor analysis, we propose its reproducibility in other countries and its comparison with other instruments. Finally, the sample was predominantly female, and future studies should balance the number of participants by gender.

Conclusion

The 11-item AKPS (without items 11 and 12) is the version with the most adequate internal structure and correlates satisfactorily with the long version of the instrument.

Abbreviations

AIC	Akaike Information Criterion
AKPS	Anterior Knee Pain Scale
SABIC	Sample-Size Adjusted Bayesian Information Criterion
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
COSMIN	COnsensus-based Standards for the selection of health Measurement INstruments
DF	Degree of freedom
NPRS	Numeric Pain Rating Scale
PFP	Patellofemoral pain
RDWLS	Robust Diagonally Weighted Least Squares
R	Pearson correlation coefficient
RMSEA	Root Mean Square Error of Approximation
TLI	Tucker-Lewis index

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12891-024-07164-z.

Additional file 1. The 11-item Anterior Knee Pain Scale (AKPS). Anterior Knee Pain Scale (AKPS) com 11 items.

Availability of data and materials

The data and materials in this paper are available from the corresponding author on request.

Declarations

Ethics approval and consent to participate

This study was approved by the Research Ethics Committee of the Universidade Federal do Maranhão (protocol number 3.995.226), whose guidelines have been in accordance with the Declarations of Helsinki. All respondents participated in this study freely and signed an informed consent form.

Consent for publication

Not applicable.

Competing interests

AVDF, CAFPG, and AP-S are Associate Editors of the BMC Musculoskeletal Disorders. The other authors declare that they have no competing interests.

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