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Article

Cross-Cultural Adaptation and Validation of Fulkerson Knee Instability Scale into Spanish in Patellofemoral Pain

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Abstract

Background/Objectives: The aim of this study was to cross-culturally adapt to Spanish and to analyze the psychometric properties of Fulkerson Knee Instability Scale in Patellofemoral Pain. **Methods:** A Cross-cultural adaptation and validation study has been carried out following the recommendations of COnsensus-based Standards for the selection of health Measurement Instruments (COSMIN). The sample consisted of seventy-five Spanish subjects with Patellofemoral Pain, implying 106 affected knees. Cross-cultural adaptation involved both cultural and linguistic adaptation of the Fulkerson Knee Instability Scale. Psychometric properties evaluated were: validity (construct and external), reliability (internal consistency, test-retest and agreement), discriminant ability and feasibility. **Results:** Construct validity showed *strong* correlation between Fulkerson Scale and both Knee injury and Osteoarthritis Outcome Score for Patellofemoral pain and osteoarthritis ($r=0.83$) and Kujala Patellofemoral Score ($r=0.79$). Correlation coefficients assessing discriminant validity between Fulkerson and descriptive data were all $r<0.4$. Cronbach α evaluating internal consistency and Intraclass correlation coefficient assessing test-retest reliability were both 0.618 (CI95%: 0.534-0.692). Standard error of the mean and Smallest detectable change were 10.13 and 8.82, respectively. Bland-Altman plots showed that >90% of the cases were within the limits of agreement. No floor or ceiling effects were found. Assessing feasibility, Fulkerson was understandable in general and completed by all participants. **Conclusions:** The Spanish version of Fulkerson Knee Instability Scale is a valid, reliable and feasible functional assessment tool for Spanish subjects with patellofemoral pain according to its psychometric properties.

Keywords: patellofemoral pain syndrome; knee; patient-reported outcome measures; diagnostic self evaluation; validation study

1. Introduction

Patellofemoral pain (PFP) is a common condition characterized by pain behind or around the patella [1] resulting from a biomechanical dysfunction between patella and femur [2]. The pain is associated to activities such as: ascending or descending stairs, running, jumping, sitting with knee flexion, squatting or kneeling on the floor for a period of time [3]. The annual prevalence of PFP is approximately 25% based on a review that included diverse population groups (USA, UK, Belgium, Denmark, etc.) [4].

PFP pathogenesis is multifactorial. Thus, quadriceps vastus medialis and vastus lateralis imbalances [5], dynamic valgus [6], decreased hip muscle strength [7], excessive foot pronation [8] or hamstring stiffness [9], among others, can lead to patella maltracking [6] and, consequently, to the

onset of this disorder [6]. This results in PFP to continue to be a challenging musculoskeletal dysfunction in physiotherapy and sports medicine in general [10].

Anamnesis and physical examination of patients are essential for proper diagnosis and treatment [11]. Imaging tests do not always correlate with the subject's symptomatology in PFP [11,12]. For this reason, well-known patient reported outcome measures (PROMs) are particularly useful as they enable, from the initial evaluation, learning about patients' self-assessments of their health and quality of life [13,14].

PFP specific questionnaires are the only ones that provide detailed and accurate information about this joint [15]. Among them, we can find Fulkerson Knee Instability Scale [16] (FKIS), Kujala Patellofemoral Score [17] (KPS) and Knee injury and Osteoarthritis Outcome Score for Patellofemoral pain and osteoarthritis [18](KOOS-PF), three self-administered questionnaires created and validated specifically for patellofemoral issues.

These questionnaires were originally created and validated in English. Their clinical application across various countries since their inception [19–23] has led to numerous cross-cultural adaptations into different languages, a procedure that encompasses both linguistic translation and cultural adaptation [24]. Recent adaptations include KOOS-PF into Spanish [25], KPS into Indonesian [26] y FKIS into Italian [11]. Despite Spanish is the second most widely spoken language globally [27], FKIS is not yet adapted to this language. In addition to expanding worldwide the use of PROMs in clinics, it would enable the scientific community to learn about the properties of this instrument in Spanish [27] and to make prospective comparisons among different population groups [28].

Therefore, the aim of this study was to cross-culturally adapt to Spanish and to analyze the psychometric properties of Fulkerson Knee Instability Scale [16] in Patellofemoral Pain.

2. Materials and Methods

Study Design

This study addressed the cross-cultural adaptation and validation of the FKIS into Spanish. The Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) reporting guideline for studies on measurement properties of patient-reported outcome measures [29] and the Guidelines for Reporting Reliability and Agreement Studies (GRRAS) [30] were used.

The main creator of the original questionnaire [16] was previously notified and gave his approval.

Cross-cultural adaptation involved both cultural and linguistic adaptation (forward-backward translation) of FKIS, as well as the assessment of its psychometric properties concerning reliability and validity. This process was carried out following the international guidelines established by Beaton et al. [24]:

1. Translation from English into Spanish by two bilingual people, whose mother tongue was Spanish, independently. One with extensive clinical experience in musculoskeletal disorders and the other with a degree in English and experience in translation and interpreting. Emphasis was placed on the need for translations to be semantic rather than literal, focusing on conceptual equivalence. Two translated Spanish versions of the original FKIS scale were obtained.
2. Synthesis: Three PFP experts assessed the two versions and agreed on the final version with the translators.
3. Back-translation: It was conducted independently by two native English speakers fluent in Spanish, one of them with a specialization in musculoskeletal pathology but without prior knowledge of FKIS. Both reached an agreement on the back-translated version.
4. Review by an expert committee, consisting of the translators involved and the three clinical experts mentioned in the previous phases, for the assessment of the agreed back-translation. Additionally, the new version was compared with the original.

5. Pretest: A pilot test of the final Spanish version with a sample of 10 subjects with PFP was conducted. Comprehension and/or clarity, appropriateness of vocabulary and relevance of expressions in the Spanish culture were assessed.
6. Validation of the Spanish version of FKIS.

Participants and Sample

Participants were recruited using a non-random consecutive sampling method in Seville and surrounding areas. Various outreach strategies were employed to engage potential participants, including social media, private clinics, sports clubs, and University dissemination through posters, emails, and direct contacts. Inclusion criteria were: individuals with symptomatic PFP with or without cartilage defect (bilateral or unilateral); aged between 16-55 years, to avoid the appearance of late symptoms of apophysitis (Osgood-Schlatter or Sinding-Larssen-Johansson) and early symptoms of osteoarthritis [31]; and with Spanish as their mother tongue. Subjects with severe cognitive impairment or with symptomatology or dysfunction of the knee suffering from PFP due to other causes (e.g. joint effusion, degenerative disease, neurodegenerative pathology, tumor process, among others) were excluded.

Except for the descriptive ones, where the participants were considered, the study considered the affected knees as the sample.

Functional Assessment Tools Used

- Questionnaire to be adapted into Spanish: FKIS.

FKIS is a specific functional assessment scale for patellofemoral disorders or ligamentous instability of the knee developed by Fulkerson et al. (1990) [16], derived from the Lysholm Knee Score [32]. It was first validated by Paxton et al. [33]. It consists of 7 items with variable scores assessing limp, need for support, stair climbing, squatting, instability, pain, and swelling. Scoring ranged from 0-100 points, where 100 is considered optimal.

- Questionnaires used for validation and already adapted to Spanish: KOOS-PF and KPS.

KOOS-PF, created by Crossley et al. (2018) to assesses PFP and/or osteoarthritis [18], consists of 11 questions related to the pathology: stiffness (1 item), pain (9 items) and quality of life (1 item). Each question has 5 possible answers and is graded on a Likert scale from 0 points (none/never) to 4 points (extreme/always). The KOOS rating scales collection uses a formula [34] that transforms the score obtained into a range from 0 (maximum impairment) to 100 (optimal state).

KPS, a questionnaire developed by Kujala et al. (1993) to evaluate patellofemoral pathologies [17], consists of 13 questions, of which 3 refer to pain and physical alterations, 8 refer to a possible functional limitation in different activities, and 2 describe the difficulty in participating in sport activities. Each question has several possible answers (between 3 and 5), and is scored from 0 to 10 points except for some questions which are scored from 0 to 5. The maximum score, 100 points, corresponds to a healthy and asymptomatic state.

Protocol for Action

This study was conducted following the guidelines outlined in the Declaration of Helsinki and received approval from the Research Ethics Committee of the Virgen Macarena-Virgen del Rocío Hospitals of the Andalusian Public Health System (C.I.0162-N-21) on December 3, 2021. All patients agreed to the Informed Consent after reading the User Information Sheet.

Once the content validity intrinsic to the translation and cultural adaptation process had been carried out, two researchers (FE and CR) experienced in the management of knee PROMs administered the questionnaires over the course of almost a year (March – December, 2023), after having shared the instructions. After collecting anthropometric and pathology data, each participant

completed KOOS-PF, KPS and FKIS questionnaires, in that order. It was carried out over two separate sessions spaced 7-10 days apart to prevent participants from recalling their responses, while ensuring they weren't too distant to avoid potential clinical changes in PFP [25,28], as the study did not aim to evaluate intervention effects. Participants with both knees affected answered for each one where applicable. All subjects had the opportunity to ask the researchers any questions they might have had.

Construct validity (convergent and discriminant), external validity, internal consistency, test-retest reliability, agreement, discriminant ability (floor and ceiling effects) and feasibility were analyzed. Note that criterion validity has not been addressed in this research as it is a PROMs study based on COSMIN's recommendations, where gold standards are not considered [35].

Construct validity. Concerning convergent validity, the overall FKIS and, KPS and KOOS-PF scores were correlated. Based on previous findings [11,33], clinical expertise, and the research team's knowledge of PROMs, it was hypothesized that, given the nature of these PROMs, the Spanish FKIS would show the highest correlation ($r \geq 0.8$) with the condition-specific KOOS-PF and a high correlation ($r \geq 0.7$) with the body-part-specific KPS. For discriminant validity, the overall FKIS score was correlated with the variables: age, weight (kg), height (cm), body mass index (BMI), time since the onset of pain (months), Q-angle and hours of physical activity of the participants; as they were not determinants in the development or severity of the pathology [36].

The external validity of FKIS was analyzed to evaluate its applicability and effectiveness in the assessment of PFP in various populations (age and anthropometric, occupational characteristics and amount of physical activity) and contexts (urban/rural areas and meteorological characteristics).

The reliability of the Spanish version of the FKIS was evaluated by assessing internal consistency, temporal stability or reproducibility using the test-retest method, and agreement parameters.

Discriminant ability. Floor and ceiling effects were analyzed for the overall scores and for each item as long as the items included more than 3 response options in order to have at least a 50% chance of the responses not being within the floor/ceiling effect. These effects were considered in the overall scores if at least 15% of the subjects obtained the lowest or the highest scores [37]. For the items, this would be 75% of the subjects [27].

For the feasibility of the questionnaire, unanswered items, questions raised by the participants and the time they spent filling in the questionnaire were considered.

Statistical Analysis

The sample size was calculated with G*Power 3.1.9.2 based on the FKIS Italian adaptation study [11]. A confidence level of 95% was considered, i.e. an α error of 5%, and a precision of 7%, resulting in the need for at least 101 knees. The final sample size included a few more subjects to cover possible dropouts.

As for the descriptive data of the participants and the sample, absolute (N) and relative (%) frequencies were considered for qualitative variables. For quantitative variables, normality was assessed using the Kolmogorov-Smirnov test when $n > 50$ or Shapiro-Wilks test when $n < 50$. Depending on the sample size, the mean and standard deviation were used for parametric variables, while the median and interquartile range were reported for non-parametric variables.

Construct Validity. Convergent and discriminant validity were assessed using the Spearman correlation coefficient (r). Its interpretation was according to Martínez-Ortega RM et al. [38]: $r > 0.7$, strong; $0.7 \geq r > 0.5$, moderate; $0.5 \geq r > 0.25$, weak; and $r \leq 0.25$, rare correlation.

Reliability. Internal consistency was evaluated with Cronbach α coefficient. Values between 0.6-0.9 were considered adequate [39,40]. Intraclass correlation coefficient (ICC) was used for test-retest reliability. The interpretation matches that provided for the correlation coefficients [41]. Agreement was calculated using the smallest detectable change (SDC), defined as $1.96 \times \sqrt{2} \text{SEM}$ [42]. Standard error of the mean (SEM) was previously calculated: $\text{SD} \times \sqrt{1 - \text{ICC}}$ (SD, Standard Deviation) [42]. Bland-Altman plots were included to assess homoscedasticity, showing the difference between FKIS

and KOOS-PF on the one hand, y FKIS and KPS, on the other; against the mean of FKIS and each questionnaire in each plot.

Ceiling and floor effects were calculated with the percentage of participants with lower and higher scores (10th and 90th percentiles, respectively) [37].

IBM SPSS STATISTICS 25® software was used for statistical analyses. The $p<0.05$ values were considered statistically significant.

3. Results

The Spanish version of the FKIS carried out in this study can be found at Supplementary Digital Material 1 (Supplementary Text File 1).

3.1. Participants and Sample

The sample consisted of 106 affected knees, exceeding the 70 knees that Hair et al. [43] suggest (10 subjects per item) for translations, cultural adaptations and validations; and even exceeding COSMIN recommendations [44] (optimum ≥ 100). Seventy-five subjects were involved, of whom 31 were bilaterally affected. Tables I and II show the descriptive data of the participants and the sample (knees).

Table 1. Descriptive characteristics of the participants.

Participants			Men (n=24)	Women (n=51)	Total (n=75)
Age (years)			33.7	33.5	33.6
		SD	12.3	13.1	12.8
		Med	30.0	30.0	30.0
		IQR	21-45	22-48	21-46
Weight (kg)			87.4	66.9	73.5
		SD	12.5	12.2	15.5
		Med	87.5	65.0	74.0
		IQR	77-98	57-75	61-84
Height (cm)			181.0	166.0	170.8
		SD	5.7	6.3	9.4
		Med	180.5	165.0	170.0
		IQR	178-184	162-170	163-179
BMI			26.6	24.3	25.0
		SD	3.7	4.4	4.3
		Med	25.5	23.0	24.3
		IQR	23-30	21-26	22-29
Impairment	Unilateral	N	15	29	44
		%	20%	39%	59%
	Bilateral	N	9	22	31
		%	12%	29%	41%
Impaired limb*	Dominant	N	10	17	27
		%	23%	39%	62%
	Non-dominant	N	5	12	17
		%	11%	27%	38%

Physical activity (hours per week)			6.5	5.1	5.5
		SD	3.9	4.7	4.5
		Med	5.5	5.0	5.0
		IQR	4-10	1-7	3-7
Area of origin	Urban	N	11	31	42
		%	15%	41%	56%
	Rural	N	13	20	33
		%	17%	27%	44%
Occupation	Management / Professional	N	3	14	17
		%	4%	18.5%	22.5%
	Service	N	8	15	23
		%	10.5%	20%	30.5%
	Office work	N	6	5	11
		%	8%	7%	15%
	Student	N	7	17	24
		%	9.5%	22.5%	32%

Abbreviations: , media; SD, standard deviation; Med, median; IQR, interquartile range; BMI, body mass index.
*Only unilateral affected subjects considered.

Table 2. Descriptive characteristics of the sample.

Knees (sample)		Men (n=33)	Women (n=73)	Total (n=106)
Time with pain (months)		95.0	65.4	74.6
	SD	76.4	56.7	64.6
	Med	72.0	54.0	60.0
	IQR	39-144	24-84	24-98
Affected knees Q-angle (degrees)		16.0	20.0	18.8
	SD	3.2	4.5	4.5
	Med	16.0	19.0	18.0
	IQR	14-18	17-24	16-22
FKIS		78.7	74.4	75.8
	SD	11.5	18.0	16.4
	Med	80.0	82.0	80.5
	IQR	69-89	62-89	67-89
KPS		76.7	71.1	72.8
	SD	11.4	19.7	17.7
	Med	78.5	78.0	78.0
	IQR	73-85	55-87	62-86
KOOS-PF		59.8	53.8	55.7
	SD	19.0	23.7	22.4
	Med	61.4	59.1	59.1
	IQR	48-68	34-73	36-73

Abbreviations: , media; SD, standard deviation; Med, median; IQR, interquartile range; BMI, body mass index; FKIS, Fulkerson Knee Instability Scale, KPS, Kujala Patellofemoral Score; KOOS-PF, Knee injury and Osteoarthritis Outcome Score for Patellofemoral pain and osteoarthritis. Note: the two measurement moments were considered for the questionnaires statistics.

3.2. Validity

Table III shows correlation analysis between FKIS, KPS and KOOS-PF to assess convergent validity.

Table 3. Correlation among FKIS, KOOS-PF and KPS.

<i>r</i>	KOOS-PF	FKIS
FKIS	0.825 (<i>p</i> <0.001)	
KPS	0.851 (<i>p</i> <0.001)	0.788 (<i>p</i> <0.001)

Abbreviation: *r*, correlation coefficient; FKIS, Fulkerson Knee Instability Scale, KPS, Kujala Patellofemoral Score; KOOS-PF, Knee injury and Osteoarthritis Outcome Score for Patellofemoral pain and osteoarthritis. Note: all coefficients were analyzed using Spearman’s Rho.

Statistically significant correlation among the 3 questionnaires was obtained (*p*<0.05). In fact, all were *p*<0.001. All their correlation coefficients were>0.78, confirming the hypotheses.

Correlation coefficients among FKIS and the descriptive variables (age, weight, height, BMI, time with pain, Q-angle and physical activity) to evaluate discriminant validity were *r*<0.4 in all cases. Age, BMI and time with pain showed *weak* correlations (0.4>*r*>0.25), while weight obtained *rare* correlation (*r*=0.2). Height, Q-angle and physical activity were non-significant.

3.3. Reliability

Internal consistency and reproducibility: Cronbach α and ICC were 0.618 (IC95%: 0.534-0.692). The test-retest analysis was statistically significant (*p*<0,001).

Agreement: Overall mean FKIS, KOOS-PF and KPS scores were 75.75 (\pm 16.39 SD), 55.71 (\pm 22.44 SD) and 72.84 (\pm 17.72 SD), respectively. SEM and SDC were 10.13 and 8.82, respectively. The mean of the differences between FKIS and KOOS-PF were -20.03 (\pm 13.72 SD), with upper limit, 6.86, and lower limit, -46.93; while those between FKIS and KPS were -2.91 (\pm 10.18 SD), with limits of 17.04 and -22.85. Bland-Altman plots (Figures 1 and 2) showed, in both analyses, that the differences between the 2 evaluations were within the limits of agreement (93.9% of the cases), except for some outliers. No systematic bias was detected, i.e. the zero line was within the 95% CI.

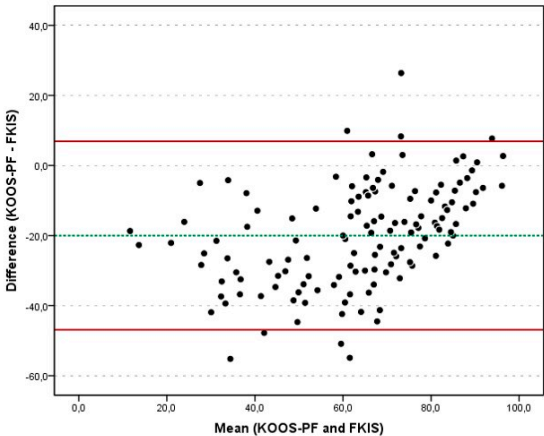


Figure 1. Bland-Altman plot between FKIS and KOOS-PF measurement. Limits of agreement: mean difference (green dots line) \pm SDx1.96 (red solid lines) in points for a 100-point scale.

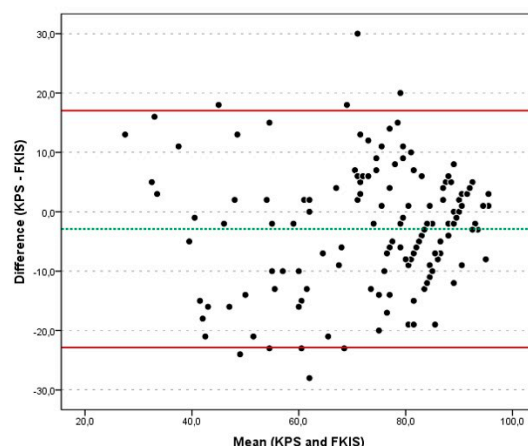


Figure 2. Bland-Altman plot between FKIS and KPS measurements. Limits of agreement: mean difference (green dots line) \pm SD \times 1.96 (red solid lines) in points for a 100-point scale.

3.4. Discriminant Ability

No participant was below the 10th percentile, while 9.5% were above the 90th percentile. Regarding the items, the percentage of subjects who reached either the lowest or highest scores were: item-3, 49.5%; item-4, 35.9%; item-5, 46.2%; item-6, 4.3%; item-7, 60.4%. No floor or ceiling effects were found.

3.5. Feasibility

The mean time (seconds) to complete FKIS was 236 (\pm 27 SD); KOOS-PF, 270 (\pm 23 SD); and KPS, 299 (\pm 17 SD).

FKIS was completed by all participants, although 17 of them raised questions about item-5. All the participants completed the full FKIS, resulting in a maximum response rate.

4. Discussion

This study approached the cross-cultural adaptation and validation of the Spanish version of the FKIS questionnaire. The most relevant findings were *strong* validity, *adequate* internal consistency, *moderate* test-retest reliability; as well as agreement and discriminant ability analysis showed excellent results, making FKIS an adequate tool for assessing PFP in Spanish population.

Translation Process

Regarding the language adaptation process, the two translations of the questionnaire went without difficulty and both back-translations matched the original English version. In item-6 ("Pain"), answer options number 5, "*Severe after walking 1 mile*", and number 6, "*Severe after walking less than 1/2 mile*" required a modification of the units of measurement, i.e. miles are not commonly used in Spain. The choice was to use "...1 kilómetro" (1 kilometer = 0.62 miles) and "...medio kilómetro" (1/2 kilometer = 0.31 miles).

Validity

Our findings showed *strong* correlations among FKIS and both KPS ($r=0.79$) and KOOS-PF ($r=0.83$), being similar to those obtained by Paxton et al. [33] when correlating FKIS with KPS ($r=0.85$) and with Lysholm Knee Score ($r=0.93$). The latter value is the highest, probably due to the fact that Lysholm score, although designed for knee disorders in general [45], is the precursor of the FKIS, and subsequently they have numerous similarities. The Italian adaptation of FKIS [11], shows a *strong* correlation as does our study, but with the Oxford knee score ($r=0.93$). The latter was created for

arthroplasties and replacements [45], although it is also used in osteoarthritis [46]. The high correlations between Lysholm and Oxford with FKIS are striking, since the latter is a specific questionnaire for patellofemoral disorders or ligament instability, i.e. the assessment purpose of each questionnaire is different. In addition, statistically significant correlations between FKIS and descriptive data (*weak*: age, BMI and time with pain; and *rare*: weight), were not clinically relevant, demonstrating good discriminant validity.

In terms of external validity, three dimensions were taken into account: population, circumstances/settings and times [47]. Thus, the sample was heterogeneous in terms of age, anthropometric characteristics, amount of physical activity and professional characteristics, taking into account urban and rural areas, as well as different time periods (cold, hot and wet seasons). All this in order to avoid biases mainly in the perception of pain [48–50].

Reliability

The results obtained showed an *adequate* internal consistency and *moderate* test-retest reliability. Relative to internal consistency (Cronbach $\alpha = 0.618$), the appropriate correlation between items indicated that all items provided useful information [51], as in the original validation by Paxton et al. [33] (Cronbach $\alpha = 0.7$). This result did possibly not score better because FKIS is a questionnaire for patellofemoral disorders or ligamentous instability, but with some items that are more related to instability. As our sample was only PFP, and therefore with numerous cases of patellar hypomobility, i.e. patellar hyper-pressure and limited movement, the tendency was towards the maximum score (stability intact) in item-5 “*Instability*”. Furthermore, the difficulty in standing without additional support (item-2) is more typical in ligamentous instability, so this item tended to have the highest score (99% of the participants), and, consequently, a lower inter-item correlation. This data differs from that observed in the Italian adaptation [11], which obtained a very high internal consistency (Cronbach $\alpha = 0.91$), indicating redundancy between items.

The ICC for FKIS (0.618) indicated a *moderate* test-retest reliability, and therefore, a *moderate* temporal stability, in contrast to its original validation [33] (ICC=0.88) and the Italian adaptation [11] (ICC=0.94). It should be noted that the latter study [11] considered a washing period of 5 days. A washing period lower than 8 days would increase the recall effect [37] and therefore the reliability.

Discriminant Ability

Ceiling and floor effects were not observed in our study, proving that the questionnaire distinguished severe cases from mild ones. This finding supports the validity and reliability of the Spanish version of FKIS. Similarly, the Italian version did not show floor or ceiling effects [11]. However, Paxton et al. [33] obtained a ceiling effect (21%) in their study.

Feasibility

FKIS was easily completed by all participants in general, considering that the questionnaire was pertinent to their pathology. However, some participants did not understand being asked about instability (item-5), as they did not associate it with PFP, as previously discussed. In terms of content comprehension, no participant needed clarification, unlike with KOOS-PF and KPS, where some items gave rise to confusion as stated by Chamorro-Moriana et al. in their study [14]. The average completion time was about 4 minutes. Thus, FKIS was the fastest to complete compared to KOOS-PF and KPS. Finally, the calculation of the final score was simple for the researchers, in contrast to KOOS-PF, where a complex formula is required [34].

These advantages would justify the use of FKIS as an assessment tool in physical therapy, as well as for evaluating the effectiveness of different surgical techniques affecting the patellofemoral joint, as was already done in patellofemoral autologous osteochondral transplantations [19,20,52], Elmslie-Trillat procedures for dislocation of the patella [22,53–56] or tibial derotation osteotomies [23].

Regarding the limitations of the study, responsiveness could not be measured because the applications of the Fulkerson Scale did not aim to analyze the effectiveness of any intervention, i.e. our study did not include any treatment. Moreover, the sample consisted solely of affected knees, preventing comparisons between affected and non-affected subgroups. These could be the subject of prospective studies. Furthermore, future studies might explore the cross-cultural validity of new versions of FKIS to enhance its clinical applicability and establishing itself as a recognized benchmark outcome measure in PFP research.

In relation to the strengths of this study, we considered a heterogeneous and large sample, which exceeded: 10 subjects per item recommended by Hair et al. [43], and even 100 subjects, considered optimal by COSMIN recommendations [44]. All this provided robustness to the results obtained. Moreover, the appropriate validity and reliability data evidenced by this study make it possible to extend the availability of a useful tool for the assessment of PFP, both at a clinical and research level. The latter idea is the main strength and clinical implication.

5. Conclusions

A cross-cultural adaptation of the Fulkerson Knee Instability Scale into Spanish and an analysis of its psychometric properties in patellofemoral pain subjects were successfully conducted. The Spanish version showed appropriate measurement properties based on its validity, reliability, discriminant ability and feasibility. The results on construct, including convergent and discriminant, and external validity; agreement; and discriminant ability were positively highlighted. Consequently, the validated version of this Scale seems an adequate functional assessment tool for Spanish subjects with patellofemoral pain in clinical and research purposes enlarging its application to new populations.

This study suggests that the questionnaire is especially useful in PFP with instability due to hypermobile patella, as opposed to PFP with patellar stiffness.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org.

Author Contributions: Conceptualization, Fernando Espuny-Ruiz and Gema Chamorro-Moriana; Data curation, Fernando Espuny-Ruiz, Carmen Ridao-Fernandez, Rocio Aldon-Villegas and Gema Chamorro-Moriana; Formal analysis, Fernando Espuny-Ruiz and Carmen Ridao-Fernandez; Investigation, Fernando Espuny-Ruiz and Carmen Ridao-Fernandez; Methodology, Gema Chamorro-Moriana; Project administration, Gema Chamorro-Moriana; Resources, Rocio Aldon-Villegas; Supervision, Gema Chamorro-Moriana; Writing – original draft, Fernando Espuny-Ruiz and Gema Chamorro-Moriana; Writing – review & editing, Fernando Espuny-Ruiz, Carmen Ridao-Fernandez, Rocio Aldon-Villegas and Gema Chamorro-Moriana.

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Abbreviations

The following abbreviations are used in this manuscript:

PFP	Patellofemoral pain
PROMs	Patient reported outcome measures
FKIS	Fulkerson Knee Instability Scale
KPS	Kujala Patellofemoral Score
KOOS-PF	Knee injury and Osteoarthritis Outcome Score for Patellofemoral pain and osteoarthritis
COSMIN	Consensus-based Standards for the selection of health Measurement Instruments
GRRAS	Guidelines for Reporting Reliability and Agreement Studies
BMI	Body mass index
ICC	Intraclass correlation coefficient
SDC	Smallest detectable change
SEM	Standard error of the mean
SD	Standard Deviation

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