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Validation study of the Functional Assessment Scale for Acute Hamstring injuries in Spanish professional soccer players

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Abstract

Objective: To cross-culturally adapt and validate the Functional Assessment Scale for acute hamstring injury for professional Spanish-speaking soccer players.

Design: Clinical measurement study. Cross-cultural adaptation was conducted following international recommendations. Indicators of validity, reliability and responsiveness are provided.

Subjects: The Spanish version of the Functional Assessment Scale for acute hamstring injury scale was administered to 165 participants: 45 professional soccer players with acute hamstring muscle injury diagnosis, 40 healthy subjects, 40 individuals at-risk for a hamstring muscle injury and 40 patients with injuries of the lower limb other than hamstring muscle injury.

Main measures: The Functional Assessment Scale for acute hamstring injury.

Reference measures: Spanish version of the Quality of Life Short-Form 36 questionnaire (SF-36) and the Lower Limb Functional Index (LLFI).

Results: Cronbach's alpha (internal consistency) for the Spanish version of the Functional Assessment Scale for acute hamstring injury scale was >0.8. The intraclass correlation coefficient using the two-way random model ($ICC_{2,1}$) (test–retest) was 0.993 (95% confidence interval (CI): 0.991–0.995; $P < 0.05$). In the exploratory factor analysis, a one-factor solution explained 85% of the variance. Subjects with hamstring muscle injury scored significantly lower than the other groups in the Spanish version of the Functional Assessment Scale for acute hamstring injury scale ($P < 0.001$). The Spanish version of the Functional Assessment Scale for acute hamstring injury scale score within the hamstring muscle injury group showed moderate and significant correlations with SF-36 physical components (Spearman's $r_s > 0.6$; $P < 0.001$), and LLFI score at baseline ($r_s = 0.42$; $P < 0.01$). The standard error of measurement (SEM) and minimum detectable change threshold ($MDC_{95\%}$) were 2.6 and 7.2 points, respectively. The responsiveness indicators have an effect size of 3.62, and the standardized response mean is 3.24.

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Conclusion: The Spanish version of the Functional Assessment Scale for acute hamstring injury scale showed satisfactory psychometric properties. It can be considered a reliable and valid instrument to assess the functional impact of acute hamstring muscle injury in professional Spanish-speaking football players.

Keywords
Muscle injury, patient-reported outcome measure, cross-cultural adaptation, sport

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Introduction

Muscle injuries are responsible for 31% of all injuries in soccer players.[1–3] Hamstring muscle injuries are the most common muscle injuries in male soccer players, and are associated with significant time loss, significant re-injury rates and the high costs.[1,4,5] Epidemiological studies report that hamstring muscle injury comprise between 6% and 30% of all injuries recorded in soccer,[1] with an incidence of 6–9 injuries per 1000 hours played.[1,2,6]

Following a hamstring muscle injury, the main objective of a rehabilitation program is returning an athlete to their sport at the prior level of performance with a minimal risk of injury recurrence.[7,8] Self-reported outcome instruments have become a valuable tool for clinical practice due to the importance of monitoring the severity of symptoms and the effectiveness of treatment, considering the patient's point of view.[9]

Malliaropoulos et al.[10] developed the Functional Assessment Scale for Acute hamstring injuries, a self-reported outcome measure that can measure the impact and severity of symptoms in athletes with acute hamstring muscle injury. It was developed following the recommendations of the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) initiative.[11] Currently, it is the only specific scale for acute hamstring injuries, and it is available in the Greek, English[10] and German[12] languages. To our knowledge, however, a Spanish version of the Functional Assessment Scale for acute hamstring injury is not available.

Considering the large number of potential users of this instrument, the aim of this study was to cross-culturally adapt the Functional Assessment Scale for acute hamstring injury into Spanish and to evaluate its psychometric properties in Spanish professional soccer players.

Methods

The Functional Assessment Scale for acute hamstring injury

The Functional Assessment Scale for acute hamstring injury[10] is a self-administered patient-reported outcome measure (PROM) that consists of 10 items to assess pain and disability (severity of symptoms) of patients with hamstring injuries. A patient's answers are reflected in a 0–10 numerical rating, except for items 2, 9 and 10, which have a categorical rating system with a specific distribution of the 10 points. For each item, 10 represents the high/normal level of physical ability and 0 represents the complete disability. The highest possible score is 100 points, and the theoretical minimum is 0. Lower scores are related to more symptoms, their severity and disability.

Cross-cultural adaptation

Cross-cultural adaptation of the Functional Assessment Scale for acute hamstring injury was performed following the guidelines of the American Association of Orthopedic Surgeons Outcomes committee.[13] Figure 1 depicts the translation process. The subsequent study of psychometric properties was carried out considering the COSMIN recommendations.[11]

Participants

A cross-sectional study was conducted between September 2015 and June 2017. The study protocol

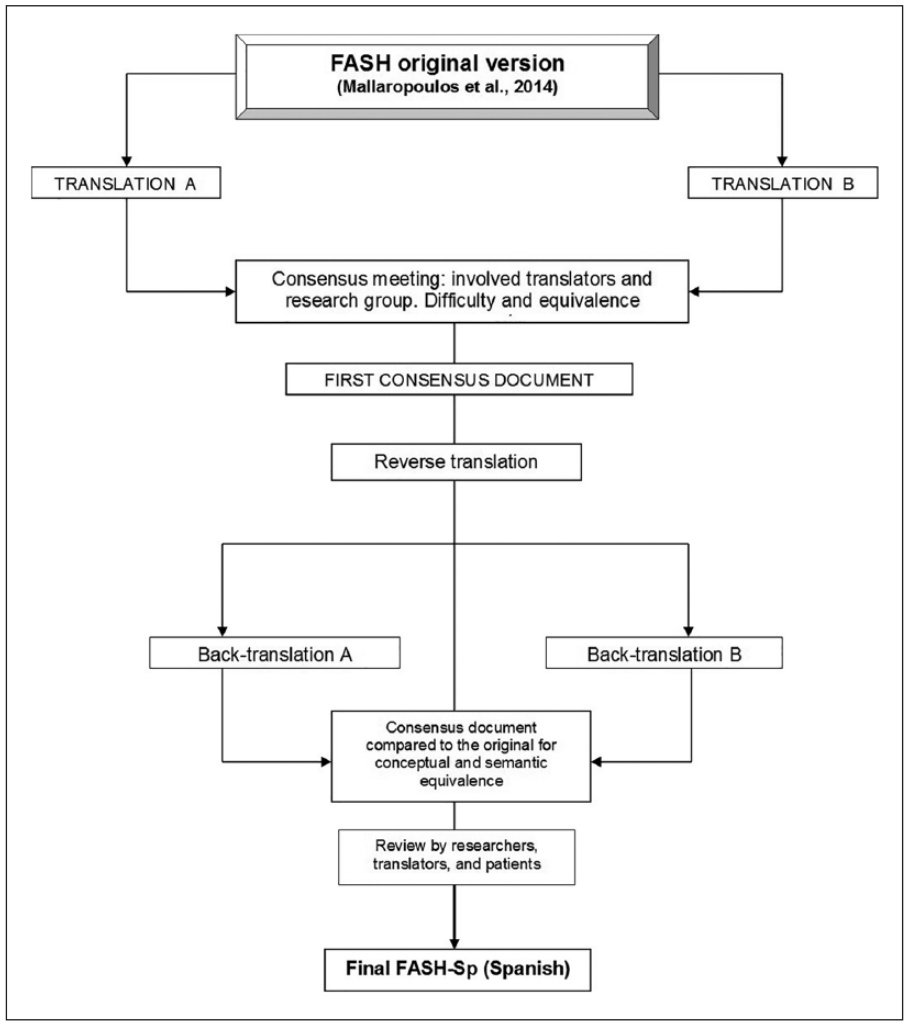

Figure 1. Flowchart of the Functional Assessment Scale for Acute Hamstring injuries scale from English to Spanish.

was approved by the Ethics and Experimental Research Committee of Miguel Hernandez University (DPC.SHS.01.14). In all cases, the Spanish version of the Functional Assessment Scale for acute hamstring injury scale and the other PROMs were self-administered. All participants read and signed an informed consent form before the data collection.

The study sample comprised four groups, but with special focus on soccer players: 45 professional soccer players of the Spanish Professional Soccer League who suffered an acute hamstring muscle injury, 40 healthy and physically active individuals, 40 individuals who practiced disciplines considered as risk for hamstring injury and, finally, 40 patients with lower limb musculoskeletal injuries other than hamstring muscle injury which include knee tendons and ligament injuries, knee meniscus tears, groin pain and ankle injuries among others.

Patients with hamstring muscle injury were recruited from soccer teams that played in the first division of the Spanish soccer league and were selected according to the following inclusion

criteria: adults who agreed to participate voluntarily in the study, giving prior informed consent and with a diagnosis of acute hamstring muscle injury. All hamstring muscle injury had occurred during training or matches, and were diagnosed and classified by the medical staff of the club using the Munich classification system developed by Mueller-Wohlfahrt et al.[14] Hamstring muscle injury was then defined considering the structural injury in the Munich Consensus statement as "any acute indirect muscle Injury 'with macroscopic' evidence, in MRI or ultrasound of muscle tear." Participants were excluded if they did not speak Spanish, if they do not have an acute hamstring muscle injury diagnosis from a physician or if they had concomitant injuries.

Healthy subjects were recruited from among the Sport Sciences and Physiotherapy students of Miguel Hernandez University who undertook regular physical activity for more than 6 hours per week during the 2015–2016 scholar course. The at-risk group data were collected from several sports, including tennis, futsal and speed runners, from six private sports clubs through contact with the staff of the clubs. Patients with injuries other than hamstring strains were contacted from nine private physiotherapy clinics.

Procedure for psychometric properties evaluation

Data collection. The Spanish version of the Functional Assessment Scale for acute hamstring injury scale resulted from the translation process was completed twice for all participants. Within healthy and at-risk groups, a member of the research team administered the questionnaires at all times. For the other injuries group, the scale applications were supervised by the physiotherapist in coordination with the research team. In the hamstring muscle injury group, each physiotherapist collaborator was contacted by the authors to ensure that data collection was being conducted adequately.

Moreover, soccer players who suffered a hamstring muscle injury involved in the study completed other two PROMs, both at baseline and at discharge: the Spanish version of the Quality of Life Short-Form 36 questionnaire (SF-36)[15] that is a generic measure of health status that includes 36 questions, distributed in eight domains. It ranges from 0 to 100 points, where the higher the score, the better the health status. And, the Lower Limb Functional Index (LLFI) is used.[16] It is a lower limb regional and condition-specific PROM with a Spanish adaptation available.[17] It comprises a 25-item questionnaire with a 3-point Likert-type scale. It provides a functional score as a percentage of pre-injury or normal status, from 0% to 100%.

Evaluating psychometric properties

Reliability. Reliability refers to both the degree of homogeneity in a questionnaire (internal consistency), as well as the reproducibility of the scores (temporal stability or test–retest reliability), and the absence of random errors.[18] These properties were studied for the entire sample.

Temporal stability was evaluated by delivering a second administration of the Spanish version of the Functional Assessment Scale for acute hamstring injury scale 48–60 hours after the first assessment to all participants, assuming that the clinical status of the injured players would not change in this time period.[10] Measurement error was assessed by calculating the standard error of measurement (SEM) and the minimum detectable change (MDC) in the hamstring muscle injury group.[19] The MDC represents the minimal change that a patient has to exhibit on a questionnaire to ensure that the observed changes are real. The SEM is an estimate of the expected variation in a set of stable scores, assuming that real change has not occurred.[20] Both indicators are expressed in the same units of the questionnaire, which is an advantage for its interpretability.

Validity. Several facets of validity were examined within the hamstring muscle injury group. Construct validity was studied through analysis of the factor structure, using an exploratory approach. Convergent validity was assessed testing the relationship between the Spanish version of the Functional Assessment Scale for acute hamstring

injury scale score and the SF-36 domains at baseline using correlations coefficients. A priori, we expected that correlations between the Spanish version of the Functional Assessment Scale for acute hamstring injury scale scores and the physical dimensions of SF-36 (physical functioning, physical role, bodily pain and standardized physical component) would be higher than correlations with other non-physical domains of the SF-36 (vitality, mental health, emotional or social role). In addition, correlation with other PROM used for LLFI was calculated. Known-groups validity was tested by comparing the scores of the Spanish version of the Functional Assessment Scale for acute hamstring injury scale among groups, as a form of external validity. The healthy/at-risk and patient groups of subjects are distinct subgroups that were expected to score differently in the Functional Assessment Scale for acute hamstring injury.

Responsiveness. The Spanish version of the Functional Assessment Scale for acute hamstring injury scale and SF-36 were completed by each participant with hamstring muscle injury for the responsiveness assessment, at baseline and again at discharge to assess changes after the physiotherapy treatment. The discharge assessment was applied after completing the return to sports phase. The treatment of hamstring muscle injury included basic analgesic measures, manual therapy, electrotherapeutical modalities and therapeutic exercise.[7,8]

Feasibility. The time that subjects spent filling out the questionnaire was recorded to assess feasibility and acceptability, as well as the percentage of unanswered questions. Ceiling and floor effects were analyzed using descriptive statistics and considered to be present if >15% of the responders achieved the theoretical minimum or maximum possible score of the Spanish version of the Functional Assessment Scale for acute hamstring injury scale. We considered this effect was present if >75% scored the minimum or maximum possible for each item.

Statistical analyses

All statistical analyses were performed with IBM SPSS version 23 (SPSS Inc., Chicago, IL, USA). The Shapiro–Wilk test was applied to assess the normal distribution of the Spanish version of the Functional Assessment Scale for acute hamstring injury scale scores. Statistical significance was accepted at the 5% level. Quantitative variables were presented as the mean ± SD, or median and interquartile range, and qualitative variables using frequencies and percent (%).

Reliability. Cronbach's alpha was calculated for internal consistency. Test–retest reliability was studied via the intraclass correlation coefficient using the two-way random model ($ICC_{2,1}$), with a 95% confidence interval (CI). A Bland–Altman plot was also constructed to show the measurement error assessed by the limits of agreement. Reproducibility was considered to be "excellent" if intraclass correlation coefficient (ICC, >0.75), "good" (ICC, 0.60–0.74), "fair" (ICC, 0.40–0.59) or "poor" (ICC, <0.40).[21]

The parameters of error measurement used in this study were the SEM and MDC, and were measured only in the hamstring muscle injury group. Measurement error is the systematic and random error of a patient's score that is not attributed to real changes in the construct that is being measured.[20] The SEM was calculated as follows: $\mathrm{SEM}_{\mathrm{agreement}} = SD \times \sqrt{(1-R)}$, where SD is the standard deviation of the first assessment and R is the reliability coefficient for the questionnaire. We used the $ICC_{2,1}$ of the hamstring muscle injury group as recommended by Stratford.[18] The following formula was used to calculate the MDC threshold: $\mathrm{MDC}_{95\%} = 1.96 \times \sqrt{2} \times SEM$, where 1.96 is the value associated with the 95% CI and $\sqrt{2}$ accounts for the error associated with taking two measurements.

Validity. Factor analysis was studied from participants' baseline the Spanish version of the Functional Assessment Scale for acute hamstring injury scale scores using maximum likelihood extraction.[22] Three a priori requirements were set for factor extraction: scree plot point of inflection at the second eigenvalue, eigenvalue cutoff > 1.0 and ⩾10% variance.[23]

Known-groups validity and group differences were calculated using the Kruskal–Wallis test, with

Table 1. Descriptive characteristics of the study participants.

	Healthy ($n=40$)	At risk ($n=40$)	Hamstring muscle injury ($n=45$)	Other injuries ($n=40$)
Age	21.0 ± 3.1	24.5 ± 3.1	25.9 ± 5.6	24.5 ± 4.2
Body mass index	23.1 ± 1.5	23.3 ± 1.0	22.8 ± 1.2	23.2 ± 1.5
Days training/week	2.9 ± 0.7	4.2 ± 0.9	5.5 ± 0.9*	2.8 ± 1.6
Hours training/day	1.5 ± 0.4	2.0 ± 0.6	2.4 ± 0.8	1.3 ± 0.6
SF-36 Physical component	55.4 ± 3.9	53.0 ± 5.0	35.3 ± 7.4*	43.9 ± 5.9
SF-36 Mental component	53.3 ± 6.1	52.8 ± 5.7	54.1 ± 11.1	55.9 ± 6.2
Mean Baseline FASH-Sp	95.3 ± 3.4	94.9 ± 4.8	20.6 ± 20.0*	61.6 ± 15.4
Mean Retest FASH-Sp	95.6 ± 3.3	95.3 ± 4.4	32.2 ± 20.1*	62.7 ± 14.7
Median Baseline FASH-Sp	95 (12–88)	96 (83–100)	10 (0–70)*	64 (54–33)
Median Retest FASH-Sp	96 (11–89)	96 (86–100)	31 (2–73)*	66.5 (57–30)

SF-36: Quality of Life Short-Form 36 questionnaire; FASH-Sp: Spanish version of the Functional Assessment Scale for Acute Hamstring injury.
*Significant differences between Hamstring muscle injury group and the other groups, $P < 0.01$.

post hoc comparisons using the Mann–Whitney U test with Bonferroni correction for multiple testing, resulting from the formula $k(k-1)/2$, where k is the number of groups ($p_{adj}=0.017$). Correlations between the Spanish version of the Functional Assessment Scale for acute hamstring injury scale scores and the SF-36 domains were calculated using Spearman's rho (r_s) due to the nonparametric nature of the data.

Responsiveness. Distribution-based indicators to assess responsiveness were used to consider scores at the baseline and at discharge assessments: the effect size and the standardized response mean. The effect size is the mean difference between baseline and discharge scores of the hamstring muscle injury patients divided by the standard deviation of the baseline scores. The standardized response mean was calculated as the mean change scores divided by the standard deviation of the change scores. Both were interpreted using Cohen's thresholds: an effect size of 0.20–0.49 represents a small change, 0.50–0.79 represents a medium change and ⩾0.80 represents a large change.[24]

Ceiling and floor effect. Minimum and maximum scores for individual items and the total score for the Spanish version of the Functional Assessment Scale for acute hamstring injury scale were calculated to assess possible floor or ceiling effects. If more than 15% of respondents achieved the lowest or highest possible score, floor or ceiling effects were considered to be present.

Sample size calculation. Parameters of the reliability study were considered for sample size estimation: for an alpha of 0.05, a statistical power of 0.80, lower limit $\rho_{(0)}=0.7$, upper limit $\rho_{(1)}=0.9$ and an estimated Spearman's rho of 0.85, a total sample of 120 subjects was required.

Results

A total of 165 subjects participated in the study. The characteristics of the participants are summarized in Table 1. For the hamstring muscle injury group, descriptive characteristics of the hamstring-registered injuries appear in Table 2. Scores for the SF-36 and LLFI questionnaires for the hamstring muscle injury group are presented in Table 3.

The translation and back-translation of the questionnaire presented no difficulty either in language or in comprehension of the items. The Spanish version of the Functional Assessment Scale for acute hamstring injury scale can be found in Supplemental Material.

Table 2. Descriptive characteristics of the 45 hamstring-registered injuries.

	Frequencies (%)
Type of injury	
Type 3A	23 (51.1%)
Type 3B	22 (48.9%)
Imaging	
Ultrasound	17 (37.8%)
MRI	28 (62.2%)
Location	
Biceps femoris	27 (60.0%)
Semitendinosus	13 (28.9%)
Semimembranosus	5 (11.1%)
Side of injury	
Right	28 (62.2%)
Left	17 (37.8%)
Recurrence	
New	38 (84.4%)
Recurrent	7 (15.6%)
Exposure	
Training	15 (33.3%)
Competition	30 (66.7%)
Severity	
Minimal (1–3 days)	0 (0%)
Mild (4–7 days)	0 (0%)
Moderate (8–28 days)	33 (73.3%)
Severe (>28 days)	12 (26.7%)
Mechanism	
Sprinting	20 (44.4%)
Kicking	7 (15.6%)
Accelerating/decelerating	9 (20%)
Stretching	4 (8.9)
Other (jump, tackle, etc.)	5 (11.1%)

MRI: magnetic resonance imaging.

Reliability

Cronbach's alpha was 0.971 for the Spanish version of the Functional Assessment Scale for acute hamstring injury scale scores at baseline. When Cronbach's alpha was analyzed for the scale by eliminating each item one at a time, it ranged from 0.966 to 0.970. For test–retest reliability, $ICC_{2,1}$ was 0.983 ($P < 0.001$; 95% CI: 0.977–0.988). A Bland–Altman plot is presented in Figure 2, showing that the mean difference between the two applications of the Spanish version of the Functional Assessment Scale for acute hamstring injury scale was 11.6 points with limits of agreement ranging from 19.6 to −12.4 points, with a few outliers. The values for SEM and MDC were 2.6 and 7.2 points, respectively.

Validity

Factor analysis. The correlation matrix Kaiser–Meyer–Olkin value was 0.913, with a significant Bartlett's sphericity test (2297.01; $P < 0.001$). Both were considered as adequate values for sample adequacy rates to carry out the dimensionality analysis. Factor analysis indicated a single factor structure, reaching 80.4% of the variance explanation. This was a unique factor, with eigenvalues greater than 1. Figure 3 shows the scatter plot in which a clear inflection point can be observed from the first factor. Factor loadings are shown in Table 4.

Criterion related. Mean scores of the Spanish version of the Functional Assessment Scale for acute hamstring injury scale for each group are shown in Table 1. Considering all samples, the normality tests indicated that the scores of the Spanish version of the Functional Assessment Scale for acute hamstring injury scale exhibited asymmetric distribution. The same finding was made for the hamstring muscle injury group scores. Differences in the Spanish version of the Functional Assessment Scale for acute hamstring injury scale scores between the hamstring muscle injury group and the rest of the groups were significant ($P < 0.01$).

Convergent and divergent validity were assessed for the hamstring muscle injury group. A moderate and significant correlation between the Spanish version of the Functional Assessment Scale for acute hamstring injury scale score and the following SF-36 domains was found at baseline: physical function ($r_s = 0.63$; $P < 0.001$), physical role ($r_s = 0.33$; $P < 0.05$), bodily pain ($r_s = 0.55$; $P < 0.001$) and standardized physical component ($r_s = 0.59$; $P < 0.001$); however, the Spanish version of the Functional Assessment Scale for acute hamstring injury scale score did not show significant correlation with vitality ($r_s = 0.10$; $P > 0.05$), mental health ($r_s = 0.22$; $P > 0.05$) or the

Table 3. Mean scores in different patient-reported outcome measures for the hamstring muscle injury group ($n = 45$) at baseline and discharge.

	Baseline	Discharge
FASH-Sp	20.6 ± 20.0	93.1 ± 7.2
LLFI	69.8 ± 22.4	95.5 ± 5.9
SF-36		
Physical functioning	56.7 ± 23.8	99.3 ± 2.5
Pain	33.0 ± 5.3	73.5 ± 14.6
Vitality	62.4 ± 14.3	66.1 ± 8.3
Emotional role	82.5 ± 29.3	98.1 ± 7.9
Physical role	34.0 ± 29.4	77.2 ± 26.4
Social functioning	68.9 ± 26.7	91.1 ± 11.2
Mental health	75.1 ± 16.2	80.0 ± 9.1
General health	82.0 ± 13.4	88.4 ± 10.5
Physical component summary	35.3 ± 7.4	53.1 ± 5.1
Mental component summary	54.1 ± 11.1	53.7 ± 4.2

FASH-Sp: Spanish version of the Functional Assessment Scale for Acute Hamstring injury; LLFI: Lower Limb Functional Index scale; SF-36: Quality of Life Short-Form 36 questionnaire.

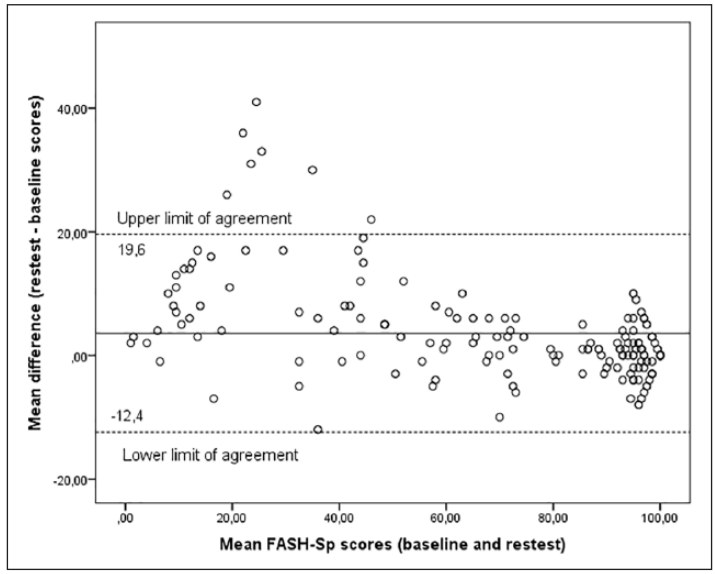

Figure 2. The Bland–Altman plot showing agreement between test–retest measurements, where the limits of agreement are the mean difference ± 1.96SD (dotted lines).

standardized mental component ($r_s = 0.22$; $P > 0.05$). A moderate and significant correlation was found between the Spanish version of the Functional Assessment Scale for acute hamstring injury scale and LLFI scores at baseline ($r_s = 0.42$; $P < 0.01$).

The average number of treatment days for soccer players with hamstring muscle injury was 23.1 ± 8.6 days (range of 8–40). The mean change in the Spanish version of the Functional Assessment Scale for acute hamstring injury scale score for the hamstring muscle injury group between baseline

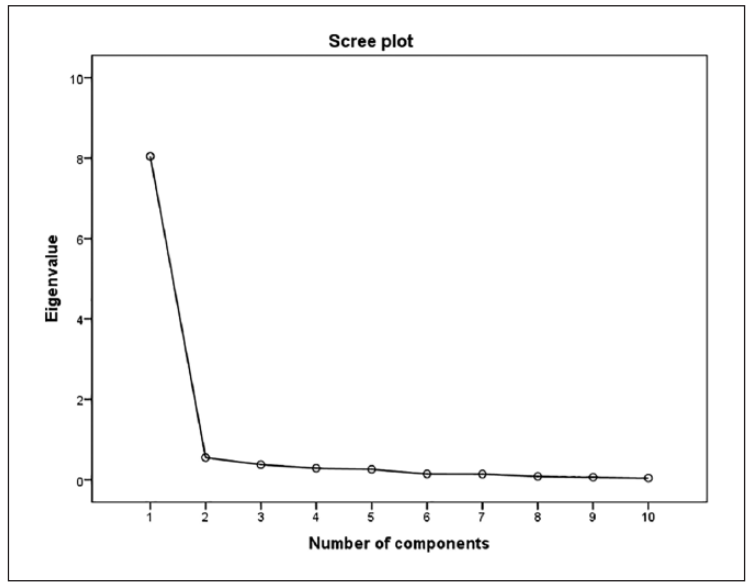

Figure 3. Scree plot for the exploratory factor analysis.

Table 4. Factor loadings for the one-factor solution in the exploratory factor analysis.

Functional Assessment Scale for Acute Hamstring injuries items	Component
	I
1. If you have had an acute hamstrings injury, please rate your current level of pain and/or discomfort.	0.908
2. Are you currently taking part in your sport, training or other physical activity?	0.898
3. How much pain do you have during walking?	0.907
4. How much pain do you have during jogging or slow pace running?	0.943
5. How much pain do you have during accelerating or sprinting for 30 m?	0.926
6. How much pain do you have during static stretching your hamstrings (toe touch in standing).	0.848
7. How much pain do you have during functional stretching of your hamstrings (straight leg kick)?	0.884
8. Do you have pain or discomfort when performing a full weight-bearing lunge?	0.954
9. Can you perform one Nordic exercise (partner exercise where you attempt to resist a forward-falling motion using your hamstrings throughout the whole range of motion to the ground)?	0.820
10. Can you perform three one-legged jumps for distance?	0.873

and at discharge applications was 72.5 points (SD: 22.4, 95% CI: 79.2–65.7). Effect size was 3.62 and standardized response mean was 3.24

Feasibility

The time spent to complete the Spanish version of the Functional Assessment Scale for acute hamstring injury scale by participants in this study was less than five minutes in all cases.

Floor and ceiling effects. Only two patients (4.4%) with hamstring muscle injury achieved the lowest possible score on the Spanish version of the Functional Assessment Scale for acute hamstring injury scale. More than 75% of hamstring muscle injury

atients achieved the lowest score by item, for questions 2 and 9.

Discussion

After the validation process, the Spanish version of the Functional Assessment Scale for acute hamstring injury scale has shown adequate values in the reliability and validity psychometric indexes, similar to those reported in the original study. No difficulties were found in the translation process.

Soccer is a very deeply rooted sport in Spain and is the most dominant sport in Latin American Spanish-speaking countries.[25] This offers the potential for a large number of active players that may suffer hamstring muscle injury and are, therefore, potential users of the Spanish version of the Functional Assessment Scale for acute hamstring injury scale scale.

Lohrer et al.[12] also studied a soccer player population, although there are slight differences in the age of the subjects who had hamstring muscle injury, who were slightly younger, as well as in the competition category. This could have explained the differences in the observed Spanish version of the Functional Assessment Scale for acute hamstring injury scale scores between these versions. In the hamstring muscle injury group, the mean score of the Spanish version of the Functional Assessment Scale for acute hamstring injury scale was 20.6 ± 20.0 points, and for the German injured soccer players, it was 42.7 ± 29.9 points. In the Greek study, the mean score for the hamstring muscle injury group was 25.1 ± 17.6 points.

In the factor analysis (internal validity), just one factor explained 80% of the variance, meeting all three a priori criteria. This confirms that there was a unique dimension as stated by Malliaropoulos et al.,[10] who achieved a unique factor solution that explained 95.8% of the variance. These findings support the presence of construct validity and that the single summated score can be used, since it facilitates its use in clinical practice.

In analysis of the scores for each the Spanish version of the Functional Assessment Scale for acute hamstring injury scale question, we identified a particular behavior for item 3 ("pain during walking"). On one hand, greater, but not statistically significant variability in the score was observed depending on the injured muscular belly, as a tendency for a lower score in biceps femoris injuries. Physical principles demonstrate that the biceps femoris muscle exerts the most force relative to the other hamstring muscles,[26] which could explain this observation. On the other hand, a higher score was observed than in the other items. Lohrer et al.[12] also pointed to this tendency for item 3 to score higher. Impairments of gait may be different depending on the location of the injury in the hamstring muscle, as well as its severity.[27] This, together with the fact that there are other agonist bellies that can compensate for the lost function, could explain these observations.

A floor effect was detected in the hamstring muscle injury group for items 2 and 9. This could be because the scale was administered immediately after the injury, and therefore, functional capacity in most of the injured players was null, scoring 0 in the degree of sport participation (item 2) and in execution of the Nordic exercise of hamstrings (item 9). Nordic exercise is a form of eccentric exercise commonly used to strengthen the hamstrings eccentrically. It is a partner exercise in which hamstrings are used to resist forward falling of the straight trunk from a kneeling position while partner holds the athlete's heels. It is considered as a high-load exercise for hamstring muscle group, and therefore, with an acute muscle injury, most cannot do it.

In other questions, such as 5, 8, 9 and 10, the scores were also very low due to the functional capacity impairment caused by hamstring muscle injury. From our point of view, this finding suggests that the Spanish version of the Functional Assessment Scale for acute hamstring injury scale score has reduced clinical relevance in the acute phase, given the disability of the patients to perform the functional gestures contained in the scale items.[8] The score obtained at this time serves, however, as a baseline point from which to monitor the evolution of symptoms and functional capacity throughout the rehabilitation process.[9]

Significant correlations were obtained between the Spanish version of the Functional Assessment Scale for acute hamstring injury scale score and

other instruments that measure physical functional capacity, showing the expected convergence, which reinforces the criterion validity. We think that the reported moderate magnitudes of the correlations are due to the Functional Assessment Scale for acute hamstring injury-specific orientation to the sport. The LLFI also globally assesses the effect of injury on the lower extremity, using items on psychological and social aspects that Functional Assessment Scale for acute hamstring injury does not possess.[16] For these reasons, we consider the Functional Assessment Scale for acute hamstring injury as an appropriate and specific instrument with which to measure results in cases of hamstring muscle injury in sport.

The reliability of the Spanish version of the Functional Assessment Scale for acute hamstring injury scale scores has proved to be high and well supported. Both indexes, for internal consistency and for reproducibility, match those reported by the German and original versions,[10,12] being excellent (>0.9). As shown in Figure 2, there is more variability in the Spanish version of the Functional Assessment Scale for acute hamstring injury scale scores, especially at lower score ranges. Probably, this may be due to the injured players who have participated in the study, received an basic treatment with ice, rest, elevation, compression (Heiderscheit) in their soccer teams, and they experienced improvements regarding pain in the 48- to 60-h period (retest), being especially marked in players with more symptomatic lesions (lower Functional Assessment Scale for acute hamstring injury scores). As reported by Malliaropoulos et al., the 48- to 60-h period was selected to avoid the occurrence of significant clinical changes and trying to avoid recall bias.

We have, however, obtained higher values for the measurement error indicators (SEM and MDC) than those previously reported.[10,12] This may, in part, be due to the characteristics of the sample. Very-low MDC values for the Functional Assessment Scale for acute hamstring injury score may not constitute a threshold for the detection of real changes in subjects with hamstring muscle injury. The highest MDC value reported for the Functional Assessment Scale for acute hamstring injury up to date is 3 points.[10] From our point of view, considering a low MDC magnitude, there may be a certain risk of bias in the identification of real change. Patients tend to recall the location of pain more accurately than the intensity in a PROM.[28] Considering the recall bias is easy that there may be small oscillations (i.e. one unit/point) on items that involve referred pain intensity (items 3 to 8), and this could reach the MDC threshold in a biased way. For example, if a soccer player improves one level or category in items 2, 9 and 10, they could also reach the MDC threshold. In this case, however, this improvement should generally be accompanied by improvements in other pain-related items, and the clinical change would be greater than 3 points.

The Victorian Institute of Sports Assessment–Hamstrings (VISA-H) scale is a very similar PROM to the Functional Assessment Scale for acute hamstring injury, but used in proximal hamstrings tendinopathy.[29] It was considered in the original Functional Assessment Scale for acute hamstring injury development to assess concurrent validity.[10] Using the results reported by the authors, we have calculated the values of the SEM and MDC for the VISA-H as 3.3 and 9.1, respectively. Considering the similarities between Functional Assessment Scale for acute hamstring injury and VISA-H in their content and 10-point response scale for pain-related questions, a more in-depth study of the MDC is desirable.

Our results suggest that a change score of at least 7 points for the Spanish version of the Functional Assessment Scale for acute hamstring injury scale is needed to declare a real change between repeated measurements. However, this is a statistical threshold, and our study design does not allow a determination of which changes are clinically relevant. In a clinical context, the minimal important difference, which is the degree of a change meaningful to a patient, is more relevant to decision-making.[20] To improve the applicability of the Spanish version of the Functional Assessment Scale for acute hamstring injury scale score in soccer players with hamstring muscle injury, future research to investigate the minimal important difference is therefore required, using a larger sample and a longer follow-up period.

This study has several limitations that must be considered in the interpretation of the results. We did not achieve a large enough sample size to perform a confirmatory factor analysis for validity, which would be the relevant analysis to provide more evidence of the dimensionality of the scale.[23] The results reported by Malliaropoulos et al.[10] and those of this study point to a clear unidimensional structure. It should also be noted that the hamstring muscle injury group sample were male professional soccer players. It would be interesting to compare these findings in women soccer players, as well as in other sports disciplines. Future studies should confirm these findings in other Spanish-speaking participants (South American) since there could be conflicting linguistic information due to the cultural difference with respect to the Spanish-speaking population from Spain, as pointed out by Cuesta-Vargas et al.[17]

The Spanish version of the Functional Assessment Scale for acute hamstring injury scale obtained favorable results in the cross-cultural adaptation process in the capacity of understanding and response for the participant's traits. It can be seen as a practical, valid and reliable PROM with which to assess the severity of symptoms in patients with hamstring muscle injury. This tool may help clinicians and researchers to evaluate the impact of hamstring muscle injury in the functional capacity of Spanish-speaking soccer players and to assess subjective outcomes. In the future, and studying in greater depth the responsiveness of the Functional Assessment Scale for acute hamstring injury, its scores could be used as a further element in the decision-making for the return to play[30] in players who had suffered a hamstring muscle injury.

Clinical Messages

- The Spanish version of the Functional Assessment Scale for acute hamstring injury scale has acceptable measurement properties and may be used to quickly assess subjective outcomes in Spanish-speaking soccer players with hamstring muscle injury.
- Also, it can be used to monitor symptoms and function during a patient's rehabilitation progress, both in clinical and research settings.

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