

# Transcultural Adaptation and Validation of the Fonseca Anamnestic Index in a Spanish Population with Temporomandibular Disorders.

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## Research article

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## Abstract

**Background.** The Fonseca Anamnestic Index (FAI) offers a simple method to screen temporomandibular disorders (TMD). This study aimed to validate the standard version of the FAI in a Spanish population and to analyze the clinimetric properties of the Spanish version of the FAI in patients with TMD.

**Methods.** The sample consisted of 179 subjects aged over 18 years, of which 119 were diagnosed with TMD and 60 were healthy controls. Construct validity (exploratory factor analysis), internal consistency, test-retest reliability, and concurrent validity were analyzed. To discriminate between patients with and without TMD, Receiver Operating Characteristic (ROC) curve analysis was performed.

**Results.** The Spanish version of the FAI showed construct validity formed by three factors. Cronbach's alpha was 0.820, indicating good internal consistency. The reliability of the items measured with the weighted kappa coefficient was between 0.588 and 0.899, varying between moderate to almost perfect. The intraclass correlation coefficient (ICC) of the total score was 0.938, indicating excellent reliability. The standard error of measurement (SEM) was 6.42, with a minimum detectable change (MDC) of 12.59 points. The concurrent validity showed a significant correlation with headache, neck pain, vertigo and the Mental Component Summary (SF-12 MCS) of the SF-12. However, the relationship with the Physical Component Summary (SF-12 PCS) was not significant. The ROC curve analysis showed a good accuracy of the FAI in differentiating between healthy and TMD patients with an area under the curve (AUC) = 0.869, corresponding to a cut-off point for the FAI of >35 points, with a sensitivity = 83.19% and a specificity = 78.33%.

**Conclusions.** The Spanish version of the FAI is a valid and reliable instrument for diagnosing people with TMD, with appropriate general clinimetric properties. Discrimination between patients with and without TMD is excellent.

## Background

Temporomandibular disorders (TMDs) are defined as a subgroup of craniofacial pain problems that involve the temporomandibular joint (TMJ), masticatory muscles and associated head and neck musculoskeletal structures [1]. TMDs are the most common orofacial pain condition of non-dental origin. Tenderness and pain of the masticatory muscles, pain in the TMJ, limited jaw joint movements, a clicking or crackling sound on the TMJ grinding and wearing of the teeth, headache, associated dizziness, hearing loss and tinnitus are frequent symptoms [2, 3].

The etiology of TMDs is considered multifactorial and is related to parafunctional habits, bruxism, body posture, stress, age, gender, malocclusion, trauma, rheumatic diseases, overload, and other systemic factors such as fibromyalgia, low back pain, spinal pain, chronic fatigue syndrome, irritable bowel syndrome, sleep disorders, tension and migraine headaches and allergies [4, 5].

In the general population, the prevalence of TMDs ranges from 5 to 12% [6], and approximately 50% of affected patients suffer from orofacial pain or will experience it in the future [7]. A greater female prevalence has been described in the scientific literature, with a female-to-male ratio of up to 4:1 [4].

The main generally accepted clinical examination of cranial-mandibular joint dysfunctions is based on the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) protocol [8], which includes an extensive and complex battery of tests and questions. The DC/TMD protocol is a validated tool for diagnosing the most common conditions of orofacial pain related to TMDs; it was derived from the original DC/TMD protocol, which was even more extensive and complex than this latest version. It is a test administered by clinician that consists of 12 items and evaluates muscle and joint pain, measurements of the different movements of opening, closing, right and left lateralization and protrusion made in centimeters, headaches in the last 30 days, type of bite, opening pattern, movements, noises (clicks and crackles), joint blockages, pain on palpation, TMJ and muscle pathologies. However, the DC/TMD protocol is still too complicated and takes a long time to administer, and the examiner needs to have been previously trained.

The Fonseca Anamnestic Index (FAI) was developed and validated by Dr. Dickson da Fonseca in Sao Paulo, Brazil in 1992 [9, 10]. Its structure consists of 10 questions with a three-point scale (0 = no, 5 = sometimes and 10 = yes), with the overall score of the test ranging from 0 to 100. The FAI evaluates the presence or absence of symptoms caused by TMDs and their severity (mild, moderate and severe). Although the DC/TMD protocol is a standardized and widely used test for the diagnosis of TMDs, the complexity of its use has resulted in other, less difficult diagnostic tests, such as the FAI, being used frequently. Additionally, the FAI can be self-

completed by the patient. However, despite its ease of use and application in different countries, the FAI has not been validated for use in the Spanish population.

This study aimed to validate the standard version of the FAI in the Spanish population and to analyze the clinimetric properties of the Spanish version of the FAI in patients with TMDs.

## Methods

### Participants

To meet the objectives of this study, a cross-sectional questionnaire validation study was designed. This study received the approval of the Research Ethics Committee of Jaén, Spain. All participants provided written informed consent to participate in this study, which was conducted in accordance with the Declaration of Helsinki, good clinical practices, and all applicable laws and regulations.

For the calculation of the sample size, the criterion was to recruit a minimum of 10 subjects per item of the questionnaire to be validated [11] with a minimum of 100 patients [12]. In all, 208 people were contacted, but the final sample was composed of 179 participants (119 TMDs patients and 60 healthy controls). The study was developed between March and August 2019. The sample was selected from the patients of the FisiMedic clinic (Dos Hermanas, Sevilla, Spain) who attended the Physiotherapy, General Medicine and Traumatology services and from those of the Doctor Collantes Clinic who attended Stomatology services (Dos Hermanas, Sevilla, Spain). Recruitment was performed by personal interview after a first telephone contact.

Patients 18 years or older who were diagnosed with TMDs were eligible for this study. Patients with severe neurological or psychiatric pathology that prevented the correct completion of the questionnaires and measures provided for in the study were excluded. In addition, a sample of healthy controls without pathology of TMDs among those who did not meet the diagnostic criteria for TMDs was selected to test the ability of the FAI to discriminate between patients and controls.

### Cross-cultural Adaptation

For cross-cultural adaptation of the original Portuguese version of the FAI to the Spanish version, the International Quality of Life Assessment project for cross-cultural translation [13] was followed. First, the Portuguese version of the FAI was independently translated into Spanish by two bilingual experts. A single version of the FAI was developed by consensus between translators and researchers. In the next stage, two bilingual experts translated the Spanish version back into Portuguese. The Portuguese-translated contents were then compared by the investigators with the original Portuguese version of the FAI to verify whether they had achieved semantic, linguistic, conceptual and technical equivalence. Finally, to test its viability, the Spanish version of the questionnaire was completed by 20 participants to verify that they were able to understand the questions, instructions and answering options. The time required to complete the questionnaire was 3–4 min.

### Measurements

Before completing the questionnaires, including the FAI, all the patients were interviewed to collect demographic data such as age, sex, height, weight, BMI, educational level, work situation, smoking habits, alcoholic habits and physical activity.

Compliance with the Diagnostic Criteria for Temporomandibular Disorders was verified using the DC/TMD examination protocol [14]. This protocol consists of 12 different sections evaluating muscle and joint pain, metric measurements of jaw movements such as opening, closing, lateralization and protrusion, whether the patient experienced headache in the last 30 days, type of bite, opening pattern, movements, joint noises, joint blockages, and pain on palpation; finally, by means of a diagnostic tree and a scheme, the protocol determines whether the diagnostic criteria according to the findings found reach a diagnostic conclusion. The study used a simplification of the results to differentiate between patients with TMDs and those without it and to be able to use it as standard gold when compared with the results of FAI.

The Numeric Pain Rating Scale (NPRS) is a self-implemented pain intensity perception scale. In this test, all the possibilities are arranged at the same level, with 0 being the absence of pain and 10 being the maximum pain the patient is capable of imagining,

organized in an increasing manner from left to right; the patient only has to mark with a cross the answer considered correct [15]. In the present study, the patients recorded orofacial pain and neck pain on two independent NPRS pain scales.

In this study, health status was measured with the 12-Item Short-Form Health Survey (SF-12). The SF-12 is a simple and quick questionnaire compared to its predecessor, the SF-36 that is self-administered and evaluates general quality of life from physical and emotional points of view. It consists of 12 questions that are presented with a variable number of answers. The final result of the test is obtained in a more exact way by means of a statistical processing instrument that provides the value of the physical and mental summary scores with values between 0 and 100 [16].

Dizziness and vertigo sensations were measured with the Dizziness Handicap Inventory (DHI), which is a self-implemented scale that identifies vertigo or lack of balance. The instrument consists of 25 questions that can be answered as yes, no or sometimes. The test identifies functional, physical and emotional problems related to balance disorders. Each dimension corresponds to different questions distributed randomly throughout the test. The functionality questions correspond to items 3, 5, 6, 7, 12, 14, 16, 19 and 24, the emotional questions correspond to items 2, 9, 10, 15, 18, 20, 21, 22 and 23, and the questions on the physical dimension correspond to items 1, 4, 8, 11, 13, 17 and 25 [17, 18].

The Headache Impact Test (HIT-6) is a self-administered headache questionnaire that consists of six questions with five possible answers. The possible outcomes are "never", "rarely", "sometimes", "very often" and "always". The numerical result is the sum of the answers. The HIT-6 has been adapted for use in a multitude of languages and cultures, including peninsular Spanish [19].

The Neck Disability Index (NDI) is a questionnaire that assesses disability produced by neck pain. It consists of ten questions with six different answers that are ordered from least to most disability, with 0 corresponding to no disability and 5 corresponding to greatest disability. The result is the sum of the answers, ranging from 0 to 50. The categorization of the final result is as follows: "no disability" if the result is between 0 and 4, "moderate disability" between 15 and 24, and "complete disability" between 35 and 50 [20].

## Statistical analysis

Data management and analysis were performed with the SPSS 20.0 statistical package (SPSS Inc, Chicago, IL) and MedCalc Statistical Software version 19.1.5 (MedCalc Software bv, Ostend, Belgium; <https://www.medcalc.org>; 2020). Descriptive analysis was performed using means and standard deviations for continuous variables and frequencies and percentages for categorical variables. The Kolmogorov-Smirnov test was used for the analysis of the normality of quantitative variables, and the Levene test was used to verify the homoscedasticity of the samples. We worked with a 95% confidence level ( $p < 0.05$ ).

The construct validity was evaluated by exploratory factorial analysis (factorial validity) using Principal Component Analysis (PCA) with varimax-type orthogonal rotation. Bartlett's sphericity test and the Kaiser-Meyer-Olkin test (KMO) [21] were administered.

The Shrout and Fleiss type 2.1 Intraclass Correlation Coefficient (ICC) was used to measure the test-retest reliability of the total test score [22]. Reliability was considered poor when the ICC was  $< 0.40$ , moderate when the ICC was between 0.40 and 0.75, substantial when the ICC was between 0.75 and 0.90, and excellent when the ICC was  $> 0.90$ . From this coefficient, the standard error of measurement (SEM) and the minimum detectable change (MDC) were found. The SEM was calculated as the baseline standard deviation (SD) ( $\sigma_{base}$ ) minus the square root of  $(1-R_{xx})$ , where  $R_{xx}$  is the test-retest reliability index (ICC) [23]. The agreement between the two observations of each item was analyzed using the Kappa coefficient weighted by quadratic weights [24]. The agreement was considered null if  $Kappa < 0.00$ , insignificant if  $Kappa$  was between 0.00–0.20, discreet if  $Kappa$  was between 0.21–0.40, moderate if  $Kappa$  was between 0.41–0.60, substantial if  $kappa$  was between 0.61–0.80 and almost perfect if  $Kappa$  was between 0.81–1.00 [25]. In addition, the MDC was quantified at the 95% confidence level (MDC<sub>95</sub>) from the SEM formula as follows:  $MDC_{95} = 1.96 * \sigma_{base} * \sqrt{(1-ICC)}$ , where 1.96 is the z-value corresponding to the 95% confidence interval (MDC<sub>95</sub>). The MDC provides a good tool for translating the ICC into units of change in the instrument. In addition, Bland-Altman charts were generated to evaluate the limits of agreement [26].

Internal consistency was measured using Cronbach's alpha coefficient. The alpha coefficient is considered poor if it is less than 0.70, and good if it is between 0.70 and 0.90; when it is greater than 0.90, it is interpreted as indicating the existence of redundancy [27].

To analyze the concurrent validity of the FAI with the NDI, DHI, HIT-6, SF-12 and NPRS, Pearson's correlation coefficient  $r$  was used. The correlation coefficient is considered strong if it is  $> 0.50$  and moderate if it is between 0.30 and 0.50 [28].

The ability to discriminate between patients and controls was performed using receiver operating characteristic (ROC) curves. Initially, patients with or without TMDs were classified based on the diagnostic criteria of the DC/TMD protocol, and the score obtained in the FAI was evaluated as the variable. In the ROC curve, the fraction of true positives (sensitivity) is represented as a function of the fraction of false positives for different cut-off points. The area under the curve (AUC) was also calculated as a measure of the parameters abilities to discriminate between the two diagnostic groups (subjects with or without TMDs). The AUC is considered statistically significant when the 95% confidence interval does not include 0.5 [29]. Values between 0.5 and 0.7 indicate low accuracy, values between 0.7 and 0.9 indicate good accuracy, and values greater than 0.9 indicate high accuracy [30].

## Results

One hundred seventy-nine patients met the eligibility criteria and completed the planned evaluations. Of these, 119 presented with TMDs, and 60 were healthy controls. The sociodemographic characteristics of the sample are shown in Table 1.

Table 1  
Sociodemographic characteristics of the sample.

VARIABLES		NO TMD		TMD	
		Mean	SD	Mean	SD
<b>CONTINUOUS</b>					
Weight (Kg)		77.77	18.75	69.20	14.18
Height (m)		1.65	0.09	1.61	0.08
Body Mass Index		28.48	6.98	26.93	6.85
Age (Years)		47.13	14.69	42.82	13.84
<b>CATEGORICAL</b>		<b>F</b>	<b>%</b>	<b>F</b>	<b>%</b>
Gender	Female	36	60.0	110	92.4
	Male	24	40.0	9	7.6
Physical Activity	No	21	35.0	51	42.9
	Yes	39	65.0	68	57.1
Worker out home	No	14	23.3	23	19.3
	Yes	46	76.7	96	80.7
Economic Level	< 20.000	38	63.3	67	56.3
	> 20.000	22	36.7	52	43.7
Academic level	Primary	15	25.0	14	11.8
	Secondary	32	53.3	55	46.2
	University	13	21.7	50	42.0
Smoke habit	No	36	60.0	83	69.7
	Smoker	8	13.3	13	10.9
	Ocasional Smoker	7	11.7	11	9.2
	Exsmoker	9	15.0	12	10.1
Alcoholic habit	No	22	36.7	40	33.6
	Drinker	4	6.7	4	3.4
	Ocasional Drinker	34	56.7	75	63.0
TMD: Temporomandibular Disorders; SD: Standard Deviation; F: Frecuency.					

Construct validity measured by factor analysis showed a structure with three factors (Fig. 1), the first of which included items 1, 2, 3, 6, 7 and 8, the second factor included items 4 and 5, while the third factor included items 9 and 10 (Table 2). This three-factor structure explained 64% of the variance (Table 3). The measure KMO = 0.790 ( $p < 0.001$ ), indicating that the sample can be considered appropriate for factor analysis.

Table 2  
Rotated Component Matrix of the FAI Factor Analysis.

	Component		
	1 <sup>a</sup>	2 <sup>a</sup>	3 <sup>a</sup>
ITEM 1	0.826		
ITEM 2	0.830		
ITEM 3	0.798		
ITEM 4			0.851
ITEM 5			0.856
ITEM 6	0.721		
ITEM 7	0.501		
ITEM 8	0.571		
ITEM 9		0.706	
ITEM 10		0.739	
<sup>a</sup> Factors obtained from FAI Factor Analysis. Item 1–10: questions of the Fonseca Anamnestic Index.			

Table 3  
Percentages of variance explained by the factor analysis performed using Principal Components Analysis.

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance <sup>a</sup>	Cumulative % <sup>b</sup>	Total	% of variance <sup>a</sup>	Cumulative % <sup>b</sup>	Total	% of variance <sup>a</sup>	Cumulative % <sup>b</sup>
1	4.024	40.236	40.236	4.024	40.236	40.236	3.261	32.609	32.609
2	1.309	13.091	53.327	1.309	13.091	53.327	1.596	15.962	48.571
3	1.114	11.143	64.469	1.114	11.143	64.469	1.590	15.899	64.469
4	0.887	8.867	73.337						
5	0.643	6.428	79.764						
6	0.585	5.848	85.612						
7	0.495	4.951	90.562						
8	0.419	4.195	94.757						
9	0.293	2.935	97.692						
10	0.231	2.308	100.000						

<sup>a</sup> Percentage of variance that explains each factor of the questionnaire structure.

<sup>b</sup> Total percentage of variance explained jointly by the factors that compose the questionnaire structure.

The internal consistency analysis showed a Cronbach's alpha = 0.820, indicating good internal consistency. Analysis of the items (Table 4) showed that the elimination of item 10 resulted in a slight improvement in Cronbach's alpha, although in general, all items seem to contribute adequately to the consistency of the test, with decreases in the alpha value observed when each item is deleted.

Table 4  
Item analysis of the Spanish Version of the Fonseca Anamnestic Index.

	Mean of the scale if the element is deleted	Scale Variance if the element is removed	Corrected total-element correlation	Multiple squared correlation	Alfa de Cronbach if element is deleted <sup>a</sup>
ITEM 1	18.24	21.993	0.589	0.532	0.796
ITEM 2	18.22	21.557	0.635	0.607	0.791
ITEM 3	18.60	20.073	0.733	0.645	0.778
ITEM 4	18.81	22.717	0.379	0.349	0.816
ITEM 5	19.10	23.080	0.397	0.368	0.814
ITEM 6	18.67	21.559	0.526	0.399	0.801
ITEM 7	18.61	21.384	0.546	0.390	0.799
ITEM 8	18.95	20.576	0.591	0.462	0.793
ITEM 9	18.60	21.680	0.450	0.347	0.810
ITEM 10	19.08	24.291	0.210	0.114	0.831
<sup>a</sup> Cronbach's alpha value if the item is deleted from the analysis.					
Item 1–10: questions of the Fonseca Anamnestic Index.					

The test-retest reliability analysis (Table 5) showed weighted Kappa values between a minimum of 0.588 in item 1 and a maximum of 0.899 in item 4, indicating a reliability that varied between moderate and almost perfect. The ICC value for the overall scale score was excellent. The SEM was 6.42 points, and the MDC was 12.59 points. The Bland-Altman plot is shown in Fig. 2.



Table 5  
Reliability of the items and Fonseca Anamnestic Index total score.

ITEM	Weighted Kappa	Lower Bound	Upper Bound	Reliability
ITEM 1	0.588	0.415	0.762	Moderate
ITEM 2	0.816	0.715	0.917	Almost perfect
ITEM 3	0.808	0.727	0.889	Almost perfect
ITEM 4	0.899	0.858	0.940	Almost perfect
ITEM 5	0.681	0.543	0.819	Substantial
ITEM 6	0.747	0.659	0.836	Substantial
ITEM 7	0.693	0.580	0.806	Substantial
ITEM 8	0.891	0.827	0.956	Almost perfect
ITEM 9	0.885	0.819	0.951	Almost perfect
ITEM 10	0.688	0.567	0.809	Substantial
<b>TOTAL SCORE <sup>a</sup></b>	0.938	0.915	0.955	Excellent
<sup>a</sup> Intraclass correlation coefficient (ICC) value for the overall Fonseca Anamnestic Index score.				
Item 1–10: questions of the Fonseca Anamnestic Index.				

In the concurrent validity analysis, the Spanish version of the FAI showed significant correlation with the other indices of TMDs assessment as well as with measures of headache and neck pain and the evaluation of vertigo. However, the correlation with the SF-12 PCS was not statistically significant (Table 6). In general, the correlation with the SF-12 components was poor, moderate with the measures of neck pain, headache and vertigo, and strong with the orofacial NPRS score.

Table 6  
Concurrent validity measured by Pearson Correlation

VARIABLE	r coefficient	p-value	Correlation
HIT-6	0.348	< 0.001	Moderate
NDI	0.460	< 0.001	Moderate
SF-12 PCS	-0.077	0.309	Poor
SF-12 MCS	-0.254	0.001	Poor
NPRS cervical	0.466	< 0.001	Moderate
NPRS orofacial	0.702	< 0.001	Strong
DHI functional	0.380	< 0.001	Moderate
DHI emotional	0.361	< 0.001	Moderate
DHI physical	0.378	< 0.001	Moderate
<i>HIT-6</i> : The Headache Impact Test; <i>NDI</i> : Neck Disability Index; <i>SF-12 PCS</i> : Short-Form Health Survey Physical Component Summary; <i>SF-12 MCS</i> : Short-Form Health Survey Mental Component Summary; <i>NPRS</i> : Numeric Pain Rating Scale; <i>DHI</i> : Dizziness Handicap Inventory.			

In the ROC curve analysis, the ability of the Spanish version of the FAI to discriminate between patients with TMDs and healthy subjects was evaluated with the AUC, which had a mean of 0.869 (0.810 to 0.915;  $p < 0.001$ ) (Fig. 3). With a cut-off point of  $> 35$

points, the FAI showed a sensitivity of 83.19%, corresponding to the proportion of TMDs patients detected, and a specificity of 78.33%, corresponding to the proportion of healthy individuals detected. The remaining predictive values are shown in Table 7.

Table 7  
Predictive values of Fonseca Anamnestic Index to diagnostic case of Temporomandibular Disorder.

Criterion	Sensitivity	95% CI	Specificity	95% CI	+LR	95% CI	-LR	95% CI	+PV	95% CI	-PV	95% CI
> 35	83.19	75.2– 89.4	78.33	65.8– 87.9	3.84	2.4– 6.3	0.21	0.1– 0.3	88.4	82.4– 92.5	70.1	60.7– 78.2
<i>95% CI: 95% confidence interval; +LR: positive likelihood ratio; -LR: negative likelihood ratio; +PV: positive predictive value; -PV: negative predictive value.</i>												

## Discussion

The present study evaluated the clinimetric properties of the Spanish version of the FAI, which has been suggested to be a valid and reliable instrument for assessing patients with TMDs and the degree of severity of the condition and for discriminating between patients with or without TMDs. A total of 119 patients with TMDs and 60 controls N = 60 self-administered the test, and the time spent to complete it was approximately 3–4 minutes.

To the best of our knowledge, this is the most complete clinimetric study of any version of the FAI. The FAI test-retest reliability had been previously analyzed for the Chinese version in a study from Zhang et al. [31], but only in terms of the total score, which showed an ICC = 0.823, which is less than the excellent value of the ICC (0.938) that was found in the Spanish version. Additionally, we studied the reliability of each item using the nonparametric statistic corresponding to the ICC, the weighted Kappa. The different items showed a moderate reliability for item 1, although the rest showed a reliability between substantial and almost perfect. From the ICC value, we also calculate the SEM and the MDC. To the best of our knowledge, this contribution from our study is absolutely original.

Another original contribution of our study is the measurement of concurrent validity with measures of quality of life, pain and factors related to TMDs. In the Chinese version, Zhang et al. [31] performed a very original calculation using an FAI cut-off value > 15 points to determine the agreement with the diagnosis from the DC/TMD Axis, arriving at a good Kappa value (0.633).

In our study, we examined the construct validity by exploratory factorial analysis, resulting in a FAI structure compatible with a multidimensional, three-factor structure. The first factor was composed of items 1, 2, 3, 6, 7 and 8. The second factor was formed by 4 and 5 items, while items 9 and 10 corresponded with the third component. Our results are similar to those obtained by Rodrigues-Bigaton et al. [10] by exploratory factorial analysis. In their study, the first factor comprised items 1, 2, 3, 6 and 7, the second items 4, 5 and 10 and the third items 8 and 9. This structure differed from that obtained by Campos et al. [32] via confirmatory factorial analysis.

In our study, we also measured internal consistency using Cronbach's alpha. Our results showed good internal consistency (Cronbach's alpha = 0.820). This result is better than that reported by Campos et al. (Cronbach's alpha = 0.745) [32], which can also be classified as good and, in any case, indicates that there was no redundancy between the items. However, the Chinese version obtained poor internal consistency (Cronbach's alpha = 0.669) [31].

The accuracy of the FAI in identifying myogenic TMDs had been previously analyzed by Berni et al 2015 [33], who obtained high accuracy by taking a cut-off point > 45 points in the FAI (AUC = 0.940). In this study, the RDC/TMD protocol was taken as the gold standard. In our case, with the same methodology, we obtained good accuracy when a cut-off point > 35 points is taken in the FAI (AUC = 0.869). In our study were obtained values of sensitivity and specificity of 83.19% and 78.33%, respectively. However, the validation of the Chinese version shows a higher ability to detect true positives (sensitivity of 95.9%) but a poorer ability to differentiate true negatives (specificity = 71.9%) [31] than the Spanish version.

Some limitations of the present study should be considered. First, as in all previous studies, it includes a very high proportion of female patients due to the higher prevalence of TMDs in the female population. Second, although the sample was sufficient for the respective analyses, the number of participants in our study was lower than in other reference studies. Moreover, there are several

psychometric properties that can be analyzed in the instrument. Although our study analyzed the most common psychometric properties, others remain to be studied, such as the sensitivity to change or the ability to discriminate between different types of populations.

## Conclusions

The findings of this study confirm that the Spanish version of the FAI has good internal consistency, test-retest reliability, and construct and concurrent validity. Moreover, the Spanish version of the FAI has shown very satisfactory general psychometric properties and is able to discriminate between patients with or without TMDs.

## Abbreviations

FAI: Fonseca Anamnestic Index; TMDs: Temporomandibular disorders; TMJ: Temporomandibular joint; DC/TMD: Diagnostic Criteria for Temporomandibular Disorders; NPRS: Numeric Pain Rating Scale; SF-12: Short-form Health Survey 12;

SF-36: Short-form Health Survey 36; SEM: Standard error of measurement; MDC: Minimal detectable change; KMO: Kaiser-Mayer-Olkin; ROC: Receiver operating characteristic; AUC: Area under the curve; ICC: Intraclass correlation coefficient; SD: Standard deviation.

## Declarations

### Ethics approval and consent to participate

The protocol of this study, which was conducted following the standards of the Declaration of Helsinki, was authorized by the Health Research Ethics Committee of Jaén Hospital, Spain (Portal de Ética de la Investigación Biomédica de Andalucía, Junta de Andalucía. Study Code FonsecaUJA and Internal Code 1539-N-19). All participants provided written informed consent.

### Consent for publication

Not applicable.

### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Competing interests

The authors declare that they have no competing interests.

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## Authors' contributions

All authors actively participated in the study and made substantial contributions to this article. RLV conceived the study. RLV, CMST, NZA, RAR, AIV, JLC, DRA, and EOG contributed to the design of this study, interpreted the results, and wrote the manuscript. RLV, CMST, NZA and RAR collected and reorganized the data. RLV performed the data statistics and analysis. All authors read and approved the manuscript.

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Not applicable.

## Authors' information

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## Figures

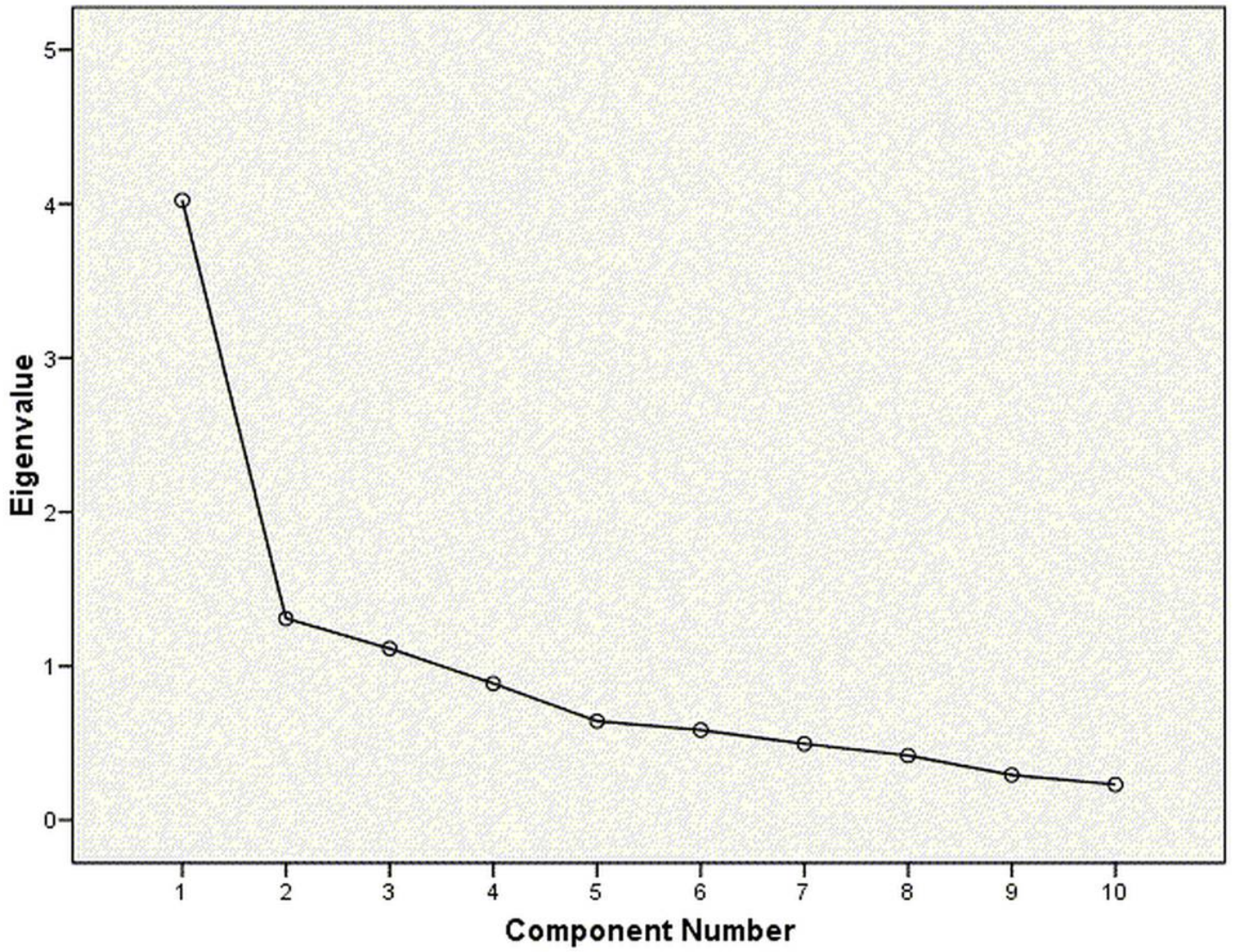
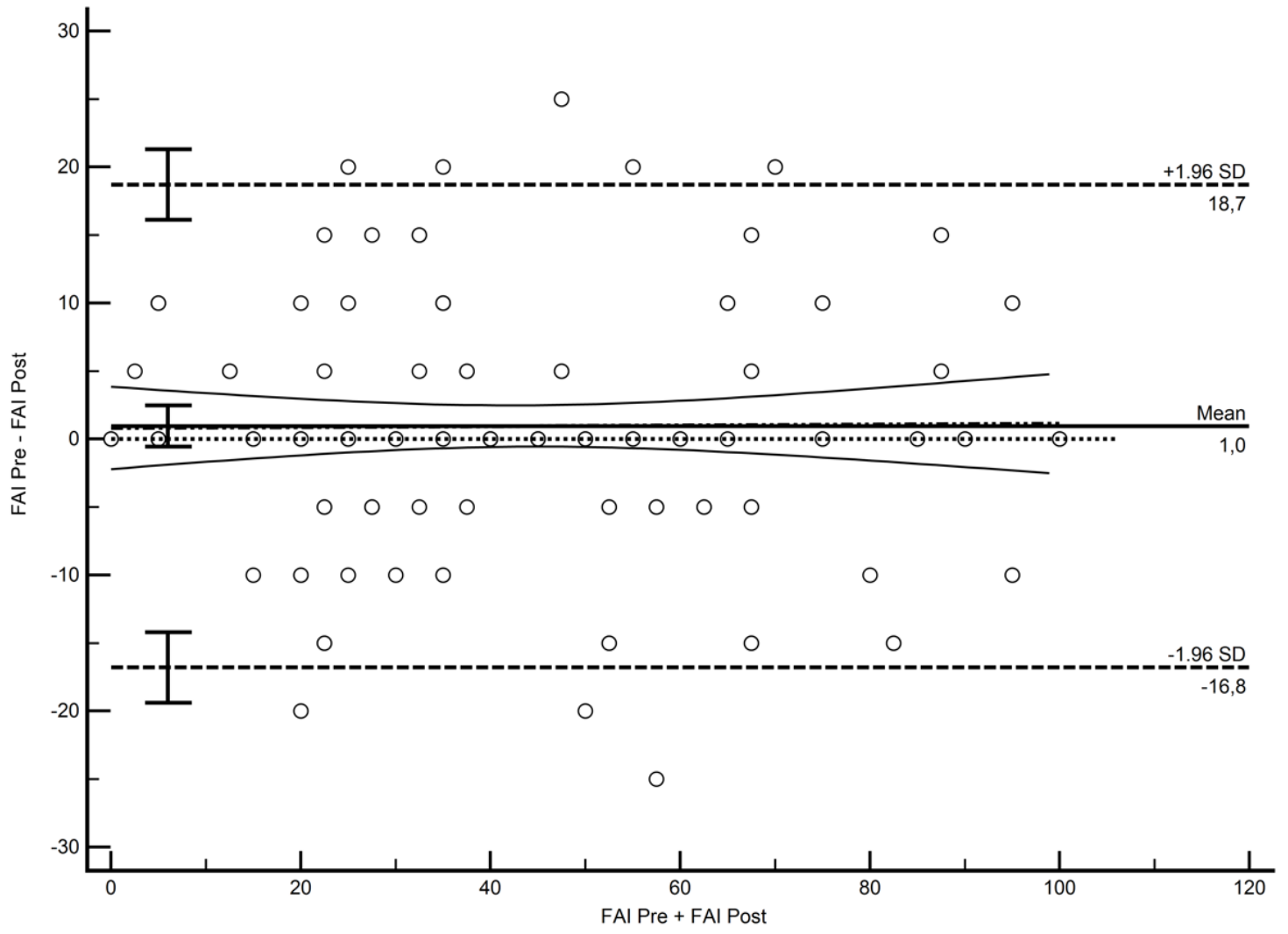


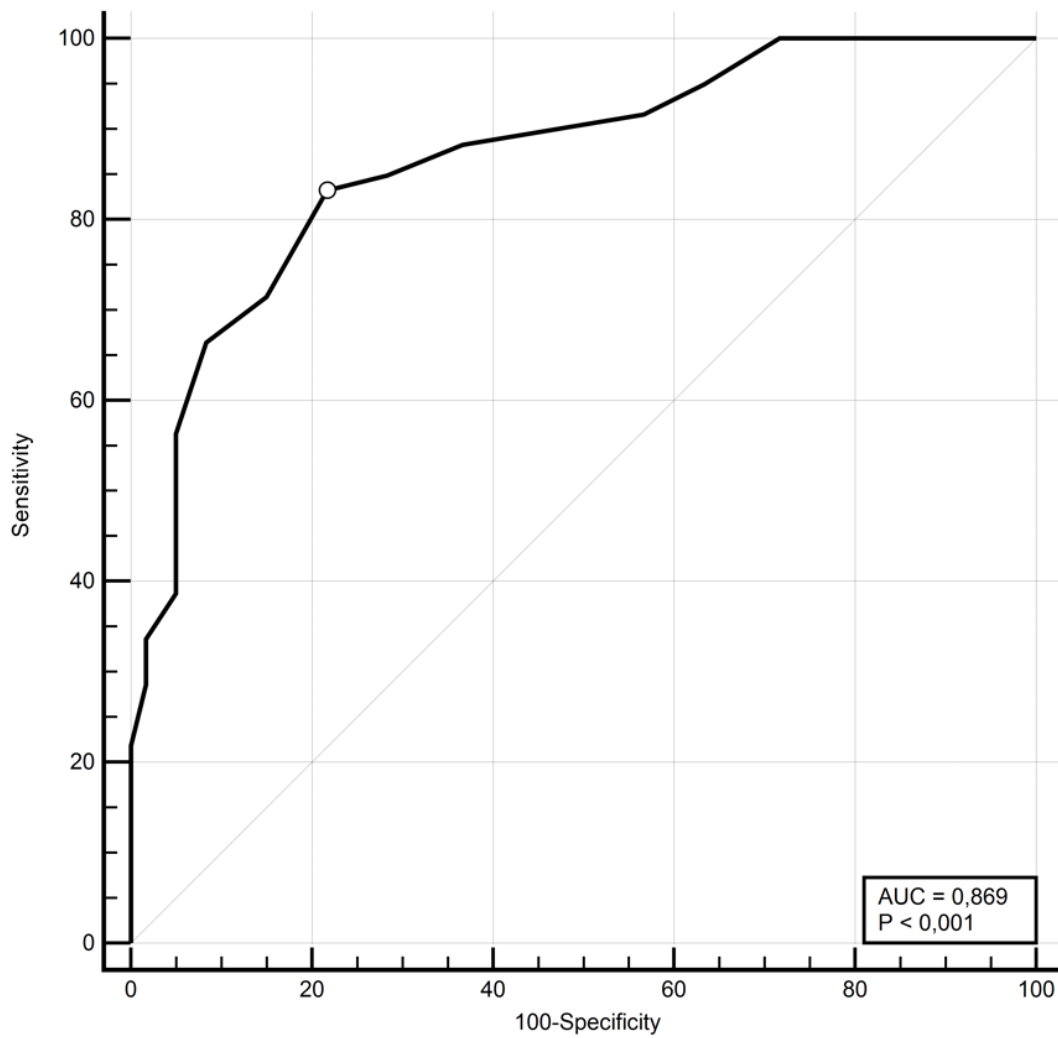
Figure 1

Scree plot for factorial analysis.



**Figure 2**

Bland-Altman plot.



**Figure 3**

ROC curve of the FAI for discriminating between patients and controls.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SpanishversionofFonsecaAnamnesticIndex.docx](#)