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ORIGINAL ARTICLE

Factor analysis and validation of the Bush Francis catatonia rating scale-Spain version

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Abstract
Background and objectives: The aim of this study was to assess the reliability and validity of the Bush Francis Catatonia Screening Instrument and Bush Francis Catatonia Rating Scale Spain Version (BFCSI-SV and BFCRS-SV) using the ICD-11 and DSM-5 diagnostic criteria as well as other catatonia scales.
Methods: One hundred patients were admitted to the inpatient psychiatry unit at Hospital Universitari Germans Trias I Pujol and two psychiatrists administered the BFCRS-SV to the first 10 patients to assess inter-rater reliability. The BFCRS-SV, BFCSI-SV, Modified Rogers Scale (MRS), Abnormal Involuntary Movement Scales, Barnes Akathisia Rating Scale, and Modified Simpson-Angus Scale were then employed.
Results: The results showed that 27% of patients had catatonia using the DSM-5 diagnostic criteria. Additionally, 51% of patients had 2 or more BFCRSI-SV items (Sensitivity: 100%; Specificity: 67.12%). The alpha coefficient values were 0.80 and 0.84 for the BFCSI-SV and BFCRS-SV, respectively, and the intraclass correlation coefficient values were 0.902 and 0.903. The area under the ROC curve was 0.971 and 0.96, and the instruments had a strong positive correlation with the DSM-5 score, ICD-11 score, and MRS. The study identified a three-factor model comprising the inhibition, excitement, and parakinetic dimensions.

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Conclusions: Overall, the results suggest that the BFCSI-SV and BFCRS-SV are valid and reliable tools for the diagnosis of catatonia, especially when using a cut-off score of 5 or higher for the BFCSI-SV and 7 or higher for the BFCRS-SV.

Introduction

Catatonia is an underdiagnosed and undertreated neuropsychiatric syndrome first described by Kahlbaum in 1874 [1]. During the majority of the 20th century, catatonia was categorized as a subtype of schizophrenia due to its manifestation as a disturbance of volition [2]. However, revisions in nosological systems have unveiled a high incidence of affective disorders in association with catatonia, as well as its overlap with delirium and concurrent presence with other medical conditions [3]. The DSM-5 [4] made changes allowing the recognition of catatonic symptoms in many psychiatric and medical conditions as a specifier, and introducing the term "unspecified catatonia" [5]. On the other hand, the ICD-11 [6] criteria for catatonia included three dimensions: decreased, increased and abnormal psychomotor activity. It should be noted that the ICD-11 criteria for catatonia are broader than the DSM-5 criteria and include a wider range of symptoms. The ICD-11 criteria also include the requirement that the symptoms cause clinically significant distress or impairment in social, occupational, or other areas of functioning. Finally, the ICD-11 criteria categorize catatonia as a separate disorder, not just a specifier, representing a significant advancement compared to previous classification systems [7].

The catatonia syndrome is not infrequent. A systematic review conducted in 2017 determined that the mean prevalence of catatonia in people with psychiatric or medical conditions was 9.2% [8]. Despite the fact that identifying catatonia is not difficult and diagnostic criteria have significantly improved in the last decade, it is often overlooked [9]. It is crucial to note that an early diagnosis of catatonia can prevent complications and significantly improve the prognosis [10]. Some authors argue that there is difficulty for both psychiatrists and psychiatric trainees in identifying the different phenotypes of catatonia and significant inaccuracies in understanding of catatonic features, leading to underdiagnosis of the condition [11,12]. Therefore, it is essential to possess measurement tools that are tailored to the routine clinical practice and encompass the various dimensions of the syndrome.

In order to overcome this important issue, different catatonia scales have been proposed and improved in recent decades [13]. According to a recent systematic review [14], the Bush-Francis Catatonia Rating Scale (BFCRS) [15] was by far the most frequently utilized clinical rating scale for catatonia followed by the Northoff Catatonia Rating Scale (NCRS 40-item version) [16]. The BFCRS was validated in 1996 and it includes the screening tool, the Bush-Francis Catatonia Screening Instrument (BFCSI). A cut-off of two signs from BFCSI has been a controversial topic. Several authors argue the need for at least 3 signs from BFCSI as cut-off to diagnose catatonia [17,18] while others propose the cut-off at 2 signs from the BFCRS [9]. Numerous studies have employed factor analysis of BFCRS to discern the distinct clinical dimensions of catatonia and to differentiate its presentations in mental disorders [19]. To date, as many as seven dimensions of catatonia have been characterized [9,17,20–22], with inhibition and excitement being the most frequently reported in factor analysis [23].

The BFCRS and BFCSI have also been validated in Argentina [24] and Brazil [25]. To the best of our knowledge, the BFCRS and BFCSI, neither the original scales nor subsequent adaptations, have been fully evaluated in acute psychiatric inpatient populations. Furthermore, there are no previous validation studies with such a large sample, using ICD-11 and DSM-5 diagnostic criteria, comparing different catatonia scales or including a factor structure analysis.

This study aims to fill this gap by assessing the psychometric properties of the BFCSI and BFCRS Spain Version (BFCSI-SV and BFCRS-SV) in a large psychiatric inpatient sample using ICD-11 and DSM-5 diagnostic criteria, and other catatonia scales. The properties to be evaluated include reliability, validity, convergent and divergent validity, sensitivity and specificity, and factor structure analysis.

Materials and methods

Study participants

The study was conducted between June 2019 and November 2021 at the acute psychiatric unit of Hospital Universitari Germans Trias i Pujol (Badalona, Spain), a general hospital affiliated with the Universitat Autònoma de Barcelona (UAB). For the initial evaluation of the BFCRS validity among Spanish patients, a convenience sample was used. 100 patients were assessed with the BFCRS-SV. The assessment of catatonia and psychopathological features was carried out within the first 24 h of admission, when catatonic signs are more likely to develop. The evaluators of catatonia were concurrently clinical psychiatrists working in the acute care unit, thus recording the discharge date of hospitalization. Only a language barrier that prevented effective communication was used as an exclusion factor. During catatonia assessment, all patients were receiving their usual psychopharmacological treatment.

The investigation was carried out in accordance with the latest version of the Declaration of Helsinki. Written informed consent from the participants was obtained after the nature of the procedures had been fully explained. All participants were informed that their nonparticipation has no direct or indirect influence or consequence on their usual treatment. Research ethics board approval was from Parc Sanitari Sant Joan de Deu.

Measures

BFCSI-SV and BFCRS-SV

The BFCRS-SV and BFCSI-SV were employed. Catatonic signs were evaluated by JCE and MIG. The BFCRS and BFCSI [15] is one of the most used rating scales in routine clinical practice, to recognize and score catatonic signs and symptoms it comprises 23 items. The first 14 items are used as a screening tool, constituting the BFCSI. Presence of 2 or more BFCRSI items for > 24 h indicates current catatonia. The BFCRS comprises the 14 items of the BFCSI plus 9 other signs to reflect their severity, measured as the sum score of the 23 items (on a 0—3 point scale), with a maximum score of 69 and minimum of 0 points.

DSM-5

The formal diagnosis of catatonia was made using the DSM-5 diagnostic criteria. DSM-5 lists 12 symptoms for catatonia. Three or more items are required in DSM-5 for diagnosing catatonia. The DSM-5 catatonia diagnostic criteria score was used as the gold standard for the criterion validity. Total DSM-5 score was also calculated by adding positive items.

ICD-11

The ICD-11 provides diagnostic criteria for catatonia that include the presence of at least three psychomotor features. These criteria are intended to facilitate accurate and consistent identification and diagnosis of catatonia in clinical practice and research settings. Total ICD-11 score was also calculated by adding positive items.

Modified Rogers scale (MRS)

Extrapyramidal signs (EPS), catatonic signs and other motor abnormalities were rated by means of the Modified Rogers Scale (MRS) [26,27]. This is a 36-item scale that rates, ranging from 0 to 2, clinical signs usually described in catatonic patients. These items are rated 0 (abnormality absent), 1 (abnormality definitely present), and 2 (abnormality pronounced or pervasive).

Abnormal involuntary movement scale (AIMS)

The Abnormal Involuntary Movements Scale (AIMS) [28] is a standardized, clinician-administered assessment tool used to evaluate the presence and severity of abnormal involuntary movements. The AIMS consists of 12 items that assess the occurrence and severity of involuntary movements in different body regions. Each item on the AIMS is scored on a 5-point scale, ranging from 0 (no abnormal movements) to 4 (severe abnormal movements). The total score on the AIMS is calculated by summing the scores across all items.

Barnes akathisia rating scale (BARS)

The BARS [29] is a standardized and validated instrument that assesses the presence and severity of akathisia, as well as the degree of patient distress associated with the condition. The BARS consists of four items that evaluate the presence and severity of subjective and objective symptoms of akathisia. Each item is scored on a 0—4 point scale, with higher scores indicating greater severity of the symptom.

Modified Simpson-Angus scale (MSAS)

The severity of parkinsonism and other movement-related side effects associated with antipsychotic medication use were assessed by means of the MSAS [30]. The MSAS consists of ten items that evaluate the presence and severity of movement-related side effects. Each item is scored on a 0—4 point scale, with higher scores indicating greater severity of the movement-related side effect.

Procedure

The first step consisted in getting authorization for translation from the first author of the original BFCRS (George Bush). The original instrument was translated into Spanish by two Spanish psychiatrists (JCE and LB), who were also fluent in the English language. The items of the scale were culturally adapted and modified if it was necessary. Then the Spanish version was back-translated by a native English speaker. This last version was finally reviewed by two external native Spanish speaker (Spain) psychiatrists. Finally, the BFCRS-SV was sent to the first author of the original publication for approval.

Two trained psychiatrists (JCE and MIG) independently administered the BFCRS-SV to the first 10 patients concurrently, with the purpose of assessing inter-rater reliability. Subsequently, the BFCRS-SV, the BFCSI-SV, the MRS, the AIMS, the BARS and the MSAS were employed to evaluate the entire study population.

Statistical analysis

Data were analysed using the Statistical Package for Social Sciences version 24 (Version 24.0; IBM, Armonk, New York). Descriptive statistics were expressed by frequency or mean and standard deviation (SD), depending on the measurement. Comparisons between catatonic patients and non-catatonic patients (DSM-5 criteria) regarding to sociodemographic, clinical, and psychopathological variables were performed using independent sample t-tests, Mann-Whitney U tests, Fisher's exact test, and chi-square tests, where appropriate. Categorical data were examined by simple contingency tables and the chi-square test or Fisher's exact test when expected cell values were < 5. Normal distribution of the continuous variables was verified using the Kolmogorov—Smirnov test.

Internal consistency of the BFCSI-SV and the BFCRS-SV was tested with Cronbach's alpha coefficient [31]. For further assessment of internal consistency, corrected item-total correlations were computed. Inter-rater reliability was calculated by means of the intraclass correlation coefficient (ICC) [32]. A Receiver Operating Characteristic (ROC) curve for the BFCSI-SV and BFCRS-SV was plotted and the area under each ROC curve (AUC) was estimated. The optimal cut-off point for each scale, according to sensitivity and specificity values, was obtained. The area under the ROC curve was interpreted according to the ranges of diagnostic accuracy [33]. Construct validity was assessed by correlating with Spearman's correlation coefficient the BFCSI-SV and the BFCRS-SV scores with the other three measures of catatonia (DSM-5, ICD-11 and MRS) for convergent, and with the instruments measuring dissimilar constructs (AIMS, BARS, and MSAS) for divergent. Finally, a factor analysis was performed to identify the underlying dimensions and structure of the scales. The factors were extracted using unweighted least squares and Varimax factor rotations. In this study, a significant item was considered to be any with a loading greater than 0.40. If a variable had a loading greater than 0.40 on two or more factors, it was assigned to the factor with the higher loading.

Table 1 Socio-demographic and clinical profile of the study sample.

	Non-Catatonic Patients DSM-5 (*n* = 73)	Catatonic Patients DSM-5 (*n* = 27)
Age (mean, SD)	49.52 (19.29)	48.22 (18.11)
Gender (%, *n*)		
Female	73.6 (39)	26.4 (14)
Male	72.3(34)	27.4 (13)
Marital Status (%, *n*)		
Single	75.7 (28)	24.3 (9)
Married/living with someone	70.5 (31)	29.5 (13)
Divorced	77.8 (7)	22.2 (2)
Widow	66.7 (6)	33.3 (3)
Unknown	100 (1)	0
Living Status (%, *n*)		
Alone	80 (12)	20 (3)
With a partner	68.4 (13)	31.6 (6)
With a partner or children	73.9 (17)	26.1 (6)
Children	80 (8)	20 (2)
Parents	61.9 (13)	38.1(8)
Residency	100 (2)	0
Other	75 (6)	25 (2)
Educational Level (%, *n*)		
Not primary school	73.3 (11)	26.7 (4)
Primary school	70.5 (31)	29.5 (13)
Secondary school	76.1(16)	23.9 (5)
University	87.5 (14)	12.5 (2)
Employment (%, *n*)		
Paid employment	75 (21)	25 (7)
Permanent sick leave	50 (5)	50 (5)
Retired	79.4 (27)	20.6 (7)
Unemployed	70.8 (17)	29.2 (7)
Others	68.7 (2)	33.3 (1)
Days Hospitalization (Mean, SD)	17.77 (15.63)	24.48 (13.56)*
BFCRS score (Mean, SD)	3.14 (4.02)	16.96 (6.88)**

SD: Standard deviation. $^{*}p < 0.05$. $^{**}p < 0.001$
BFCRS: Bush-Francis Catatonia Rating Scale;DSM-5: Diagnostic and Statistical Manual of Mental Disorders (5th edition).

Results

Sociodemographic data

The demographic characteristics of the sample are illustrated in Table 1. Recoded psychiatric syndrome diagnoses are shown in Table 2. Catatonia was present at the time of assessment in 27% of patients, using the DSM-5 diagnostic criteria and in 43% of patients, using the ICD-11 diagnostic criteria. Presence of 2 or more BFCRSI-SV items for > 24 h was detected in 51% of the patients (Sensitivity: 100%; Specificity: 67.12%). Mean of catatonic signs in catatonic and non-catatonic patients diagnosed by means of DSM-5 criteria is shown in Table 3. In the catatonic sample, the signs with the highest means were: Ambitendency (Mean= 1.56; SD=1.52), Automatic Obedience (Mean= 1.48; SD=0.975) and Mitgehen (Mean= 1.44; SD=1.52).

Internal and inter-rater reliability

The complete scale's internal consistency for the BFCSI-SV and BFCRS-SV, as measured by Cronbach's alpha, was 0.80 with a confidence interval (95% CI: 0.735—0.852) for the BFCSI-SV and 0.84 with a confidence interval (95% CI: 0.786—0.879). Removal of any of the BFCRS-SV items did not lead to a significant increase in the scale's alpha coefficient value (Table 3). All corrected item-total correlations were above the minimum cut-off of 0.30. The correlations of the items with the total were significant and their values, quite high in most of the items, ranging from 0.13 (Autonomic abnormality) to 0.60 (Posturing/Catalepsy) for the BFCRS-SV, and 0.23 (Excitement) to 0.57 (Mutism) for the screening scale.

Excellent inter-rater reliability was found among the examined sample. Intraclass correlation coefficient for the BFCSI-SV was 0.903 (95% CI: 0.633—0.975) and 0.902 (95% CI: 0.619—0.976) for the BFCRS-SV. The reliability coefficients between both evaluators for each of both instrument items were high, which is indicative of the clarity and applicability of the scoring procedures set by the scale.

Sensitivity and specificity analysis

The best area under the curve, sensitivity and specificity of the BFCSI-SV and the BFCRS-SV were evaluated comparing it with MRS score, ICD-11 score and DSM-5 diagnosis (Figure 1).

The results showed an AUC (ROC area) of 0.972 for the BFCSI-SV (CI95% = 0.946 — 0.998) and 0.961 for the BFCRS-SV (CI95% = 0.929—0.994), reflecting high accuracy for the tests. On the other hand, ICD-11 total score showed an AUC of 0.966 (CI95% = 0.934—0.997) and the MRS showed an AUC of 0.938 (CI95% = 0.893 — 0.982).

A cut-off point of ≥ 5 score for BFCSI-SV provided good sensitivity (92.3%) and good specificity (90.41%). Predictive values were: positive 78.12% and negative 97.5%. A cut-off point of ≥7 score for BFCRS-SV provided good sensitivity (96.29%) and moderate specificity (80.82%). Predictive values were: positive 64.86% and negative 98.33%.

BFCSI-SV and BFCRS-SV convergent construct validity

The BFCSI-SV and BFCRS-SV had a significant strong correlation with the DSM-5 score (0.891 and 0.862 ($p < 0.01$) and ICD-11 score (0.987 and 0.954 [$p < 0.01$]), the MRS (0.768 and 0.799 [$p < 0.001$]) and the MSAS (0.363 and 0.394 [$p < 0.01$]), and a moderate correlation with the AIMS (0.241 and 0.243 [$p < 0,05$]). There was no correlation between the BFCSI-SV, BFCRS-SV and the BARS (Table 4).

Factor structure analysis

BFCSI-SV

Initially, the 14 items of the BFCSI-SV were included for the factorial analysis. The Kaiser Meyer Olkim and the Bartlett's test of specificity of sphericity measure verified the sampling adequacy for the analysis (KMO= 0.682; Bartlett's = 625.11 [DF = 91, $p < 0.001$]). As per the BFCSI, four factors had eigenvalues over Kaiser's criterion of 1 and in combination explained 66.065% of the variance. The three factor-model accounted for 58.85% of the variance and provided better fit

Table 2 Prevalence of catatonia depending on mental disorder.

	Non-Catatonic Patients DSM-5		Catatonic patients DSM-5	
	N	%	N	%
Psychotic disorder	32	68.1	15	31.9
Affective disorder	32	78	9	22
Eating behavior disorder	2	100	0	0
Substances use disorder	2	100	0	0
Intellectual disability	1	50	1	50
Cognitive disorder	3	100	0	0
Catatonia	0	0	1	1
Other	1	50	1	100
Total	73	73	27	27

Psychotic disorder (Schizophrenia, Unspecified psychotic disorder, delusional disorder and Schizoaffective disorder, Brief pscyhotic disorder); **Affective disorder** (Depression and bipolar disorders); **Eating behavior disorder** (Bulimia, Anorexy); **Substances use disorder** (Alcohol, cocaine and benzodiazepines); **Cognitive disorders** (Unspecified cognitive disorder, dementia); **Catatonia** (Diagnose as disease entity).
DSM-5: Diagnostic and Statistical Manual of Mental Disorders (5th edition).

Table 3 Symptom occurrence with means and standard deviations (SD) of symptom scores.

	Non-Catatonic Patients DSM-5		Catatonic Patients DSM-5		Cronbach's alpha if item is removed
	Mean	SD	Mean	SD	
Excitement	0.25	0.703	0.59	0.844	0.837
Immobility/stupor	0.18	0.385	1.04	0.898	0.826
Mutism	0.07	0.254	0.89	1.05	0.823
Staring	0.19	0.43	1.07	1.035	0.824
Posturing/catalepsy	0.08	0.277	0.96	0.94	0.822
Grimacing	0.01	0.117	0.3	0.542	0.833
Echopraxia/echolalia	0.04	0.2	0.63	1.079	0.826
Stereotypy	0.15	0.462	0.67	0.877	0.833
Mannerisms	0.03	0.164	0.26	0.526	0.834
Verbigeration	0.14	0.451	0.59	0.971	0.833
Rigidity	0.1	0.296	0.63	0.742	0.829
Negativism	0.15	0.569	0.63	0.839	0.83
Waxy flexibility	0.04	0.351	1	1.441	0.826
Withdrawal	0.05	0.229	0.52	0.753	0.829
Impulsivity	0.1	0.446	0.3	0.609	0.834
Automatic obedience	0.33	0.33	1.48	0.975	0.821
Mitgehen	0.25	0.83	1.44	1.528	0.832
Gegenhalten	0.04	0.351	0.44	1.086	0.832
Ambitendency	0.25	0.83	1.56	1.528	0.82
Grasp reflex	0.16	0.687	0.67	1.271	0.83
Perseveration	0.45	1.081	1	1.441	0.845
Combativeness	0.07	0.304	0.19	0.396	0.836
Autonomic abnormality	0.01	0.117	0.11	0.424	0.837

for the data. Component loadings ranged from 0.536 to 0.873 after varimax rotation (see Table 5).

BFCRS-SV

The factor analysis was extended to include all 23 items of the BFCRS-SV. The Kaiser Meyer Olkim measure verified the sampling adequacy for the analysis (KMO= 0.69. Bartlett's = 1231.670 [DF = 253, $p < 0.001$]). The initial factor solution (Eigenvalue greater than 1.0) gave seven factor-solution accounting for 72.10% of the variance. The scree plot showed inflexion that justifies retaining three factors. The three factor-model accounted for 50.51% of the variance and provided better fit for the data. Table 5 shows the factor loadings after varimax rotation. Component loadings ranged from 0.421 to 0.878, except for autonomic abnormality (<0.4). Factor 1 loaded on the items concerned with

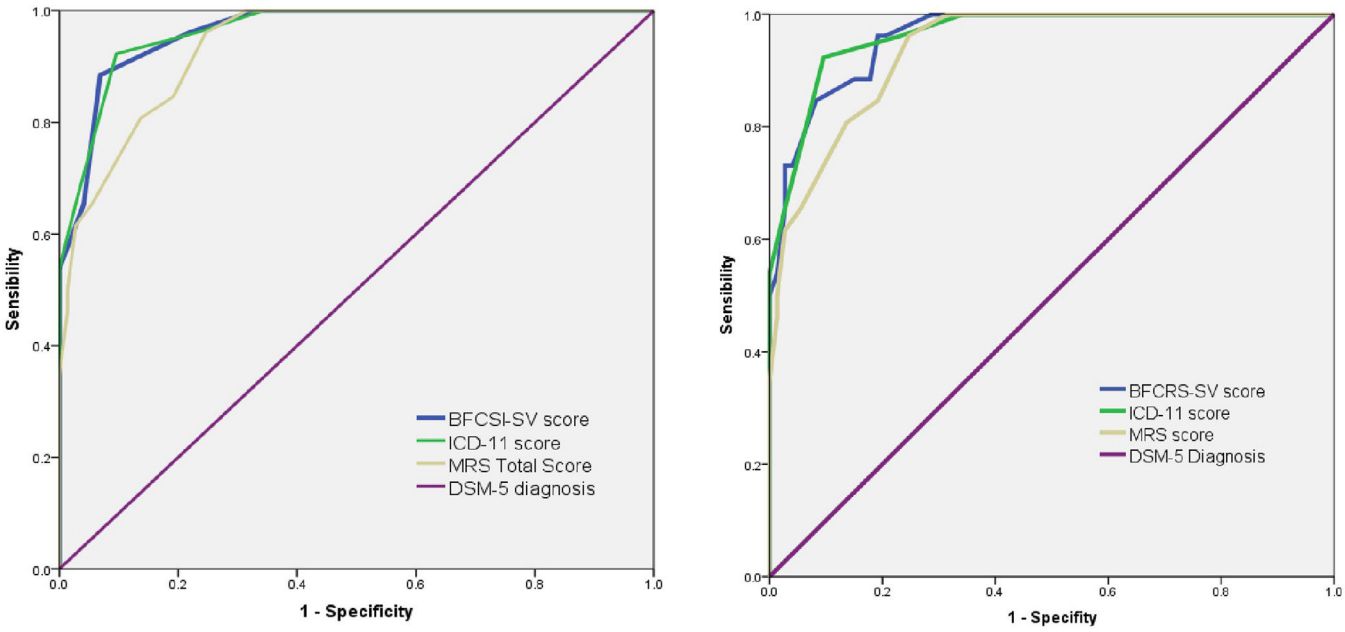

Figure 1 The best area under the curve, sensitivity and specificity of the BFCSI-SV and the BFCRS-SV.

"inhibition" (Immobility, mutism, staring, rigidity, waxy flexibility, withdrawal, automatic obedience), factor 2 on the "excitement" items (excitement, verbigeration, negativism, impulsivity, gegenhalten and combativeness), and factor 3 on "parakinetic" items (posturing/catalepsy, grimacing, echopraxia, stereotypy, mannerism, ambitendency, grasp reflex and perseveration).

Discussion

Catatonia is a neuropsychiatric syndrome characterized by a set of behavioural, motor, and emotional symptoms, which can occur in various psychiatric and medical conditions [34]. The BFCRS is a valid and reliable instrument for the assessment of catatonia being sensitive to changes in catatonia symptoms over time [13,14]. The purpose of this study was to translate and adapt the BFCSI and BFCRS scales into Spanish (BFCSI-SV and BFCRS-SV) and to analyze their psychometric properties. In addition, this study aimed to perform a factor analysis to identify the dimensions of the scale and establish the cut-off points required for an accurate diagnosis of catatonia. The results of our study indicate that the BFCSI-SV and BFCRS-SV are valid and reliable instruments for screening and assessing the severity of catatonia syndrome among Spanish inpatient psychiatry patients. The scales demonstrated good internal validity and inter-rater reliability.

Table 4 Correlations among BFCRS, BFCSI and DSM-5, ICD-11, MRS, BARS, SAS and AIMS.

	BFCSI Score	BFCRS Score
DSM − 5 score	0.891**	0.862**
ICD − 11 score	0.987**	0.954**
MRS	0.769**	0.799**
BARS	0.17	0.174
MSAS	0.362**	0.394**
AIMS (first ten items)	0.241*	0.243*

BFCSI: Bush-Francis Catatonia Screening Instrument; BFCRS: Bush-Francis Catatonia Rating Scale; DSM-5: Diagnostic and Statistical Manual of Mental Disorders (5th edition); ICD-11: International Classification of Diseases 11th Revision MRS: Modified Rogers Scale. BARS: Barnes Akathisia Rating Scale. MSAS: Modified Simpson-Angus Scale. AIMS: Abnormal Involuntary Movement Scale.

* $p < 0.05$.

** $p < 0.01$.

A sample of 100 psychiatry inpatients was evaluated using the BFCSI-SV and BFCRS-SV scales. None of the previous validation studies had been fully conducted on such a large sample of hospitalized psychiatric patients [15,24,25]. The presence of two or more BFCSI-SV items for more than 24 h was detected in 51% of the patients, with a sensitivity of 100% and specificity of 67.12%. These sensitivity and specificity results are similar to those reported in the validation study of the Argentinian version of the BFCRSI, 87.5% and 66.67% respectively [24]. It should be noted that this is not a prevalence study, as patients with a higher likelihood of presenting with catatonic symptoms were selected. This is the reason why the number of patients with catatonia may be higher than in prevalence studies [8].

According to our data, the BFCSI-SV and BFCRS-SV scales have good internal consistency, as measured by Cronbach's alpha. The alpha coefficient values were 0.80 and 0.84 for the BFCSI-SV and BFCRS-SV, respectively, indicating that the scales are consistent and reliable, even when removing any of the BFCSR-SV items. This finding suggests that all items were essential for the performance of the BFCSI-SV and the BFCRS-SV. Previous validation studies of the BFCRS did not provide information on internal consistency [15,24,25]. The intraclass correlation coefficient values for the BFCRS-SV and BFCSI-SV

Table 5 Factor analysis of BFCSI-SV and BFCRS-SV.

	Factor 1	Factor 2	Factor 3	Factor 1 Inhibition	Factor 2 Excitement	Factor 3 Parakinetic
Excitement	−0.035	−0.022	**0.853**	−0.071	**0.792**	0.055
Immobility	**0.873**	−0.055	−0.03	**0.839**	0.008	−0.005
Mutism	**0.848**	0.182	0.061	**0.853**	0.138	0.09
Staring	**0.848**	0.06	−0.076	**0.811**	−0.039	0.097
Posturing	**0.473**	**0.614**	0.059	**0.494**	0.049	**0.558**
Grimacing	0.1	**0.78**	−0.001	0.162	0.109	**0.573**
Echopraxia	0.375	**0.582**	0.123	0.36	0.076	**0.555**
Stereotypy	−0.008	**0.72**	−0.013	0.007	0.01	**0.63**
Mennerisms	−0.073	**0.536**	**0.434**	−0.105	**0.421**	**0.497**
Verbigeration	−0.141	0.144	**0.716**	−0.198	**0.596**	0.373
Rigidity	**0.679**	0.01	0.016	**0.658**	0.012	0.097
Negativism	0.359	0.005	**0.741**	0.346	**0.809**	−0.08
Waxy flexybility	**0.614**	0.254	−0.078	**0.636**	−0.05	0.248
Withdrawal	**0.545**	0.233	0.225	**0.542**	0.205	0.173
Impulsivity				0.043	**0.878**	−0.034
Automatic obedience				**0.565**	−0.042	0.464
Mitgehen				**0.421**	−0.224	0.47
Gegenhalten				0.184	**0.568**	0.141
Ambitendency				**0.464**	−0.069	0.608
Grasp reflex				0.183	0.078	**0.434**
Perseveration				−0.235	0.233	**0.552**
Combativeness				−0.066	**0.814**	−0.005
Autonomic abnormalities				0.094	−0.022	0.146
Cumulative % of variance	31.45%	15.99%	11.40%	25.29%	16.27%	8.93%
Eigenvalues	4.4	2.24	1.59	5.81	3.74	2.05
Kaiser-Meyer-Olkin measure	0.68			0.69		

Note: Factor loadings 0.40 are bold-faced.
BFCSI: Bush-Francis Catatonia Screening Instrument; BFCRS: Bush-Francis Catatonia Rating Scale.

were 0.902 and 0.903, respectively, meaning that the inter-rater reliability was found to be excellent. Even though our results have been slightly lower than in the original validation trial (Kappa= 0.93 and Kappa=0.95) [15] and in the validation of the Brazilian version (Kappa=0.93 and Kappa= 0.96) [25], the scores given by different evaluators were highly consistent and they are concordant with recent studies [35,36], indicating the clarity and applicability of the scoring procedures set by the BFRSI-SV and BFCRS-SV.

The area under the ROC curve (AUC) for the BFCSI-SV was 0.971 and for the BFCRS-SV was 0.96, both with high confidence intervals (CI95%). This suggests that both scales have a high ability to discriminate between patients with and without catatonia. The study also found that the BFCSI-SV had good sensitivity (92.3%) and good specificity (90.41%) with a cut-off point of $\geq$ 5 score, this implies that sensitivity is reduced by almost 8%, while specificity increases by over 23%. In our view, this cutoff point significantly enhances the diagnostic accuracy of the instrument. For the BFCRS-SV, a cut-off point of $\geq$ 7 score provided good sensitivity (96.29%) and moderate specificity (80.82%). Some authors have suggested a cut-off point of 3 signs for BFCSI [21,24] or 2 signs for BFCRS [9]. We hypothesized that a dimensional approach to the catatonic signs could offer greater accuracy by considering not only the occurrence, but also the severity of symptoms in the diagnostic screening of catatonia. Interestingly, working with this approach, a screening of catatonia with the BFCSI-SV would require only two positive signs if at least one of them is severe and the other one is moderate. Conversely, four positive signs in the BFCSI-SV would not be sufficient for a diagnosis of catatonia if they are all of mild severity. Overall, these results support that the BFCSI -SV and BFCRS-SV scales have high accuracy for the diagnosis of catatonia.

The BFCRS-SV and BFCSI-SV showed a strong positive correlation with the DSM-5 score, ICD-11 score, and MRS, which indicates that the scale assesses catatonic symptoms well and therefore represents an appropriate instrument to measure catatonic severity and to diagnose catatonia. In addition, divergent validity was supported by weak correlations with scales measuring dissimilar constructs such as akathisia, tardive dyskinesia and parkinsonism. The present findings, therefore, add more consistency to the validity of BFCSI-SV and BFCRS-SV.

To the best of our knowledge, this is the first validation study of the BFCSI and BFCRS including a factor analysis. Factor analysis of the scales revealed that a three-factor solution best represents the data, namely the inhibition dimension, the excitement dimension and the parakinetic dimension. The results suggest that the BFCSI and BFCRS have well-defined underlying structures, with a relatively clear separation of items into three distinct factors and they were in line with previous studies analyzing factor structure of the BFCSI

and BFCRS [9,21,23,37]. It is worth noting that some of the signs of catatonia included in the various dimensions of the current factor analysis do not conform to the dimensions outlined in ICD-11. For example, ICD-11 includes ambitendency in the dimension of decreased psychomotor activity, whereas in our factor analysis it is included in the parakinetic dimension, even though it also had a high factor loading in the inhibition dimension (0.464). Similarly, ICD-11 includes rigidity, waxy flexibility, and verbigeration in the dimension of abnormal psychomotor activity. Nevertheless, in our factor analysis, the first two signs were included in the inhibition dimension, and the latter was included in the excitement dimension. A relevant finding of our study was that autonomic abnormality did not fit in any of the dimensions. Precisely, ICD-11 considers it as a specifier rather than a diagnostic criterion. As Oldham M. stated in a recent review [38], autonomic abnormality should be included as a specifier in future editions of diagnostic classifications, as it refers to malignant catatonia, the most severe form of catatonia.

Limitations

Methodological caveats of our study must be considered when translating results to clinical work. First, the sample size of 100 subjects was relatively small for a factor analysis of 23-item scale according to current standards [39]. The cohort for the interrater reliability ratings (10 patients) was also small. Second, there is no scale available to measure catatonic syndrome other than the BFCRS. This forced us to use the original English version of the MRS to assess the concurrent validity of the BFCSI-SV and the BFCRS-SV. Third, the patients were assessed for catatonia solely within the first 24 h of admission. Given the potential fluctuation of catatonic symptoms, multiple evaluations throughout the hospitalization period would have been a more appropriate approach. Lastly, we did not systematically control the treatment with benzodiazepines and anti-psychotics. This information would have been of interest, given that the impact of such treatments on the manifestations of catatonia is a controversial topic [40—42].

Conclusions

To summarize, the BFCSI-SV and the BFCRS-SV maintain the metric properties of the original English version. The results of the study suggest that the BFCRS-SV and the BFCSI-SV are reliable, accurate, and valid tools for the diagnosis of catatonia and for measuring severity of the syndrome. This study found that both scales had a high accuracy in identifying catatonia, with good sensitivity and specificity levels, especially when using a cut-off score of 5 or higher for the BFCSI-SV and 7 or higher for the BFCRS-SV. The results also showed that the instrument had a strong correlation with other catatonia rating scales. Finally, this study has identified a three-factor solution that may facilitate clinical evaluation of patients and guide future research in the field of catatonia.

Ethical considerations

N/A.

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Declaration of Competing Interest

The authors have no conflict of interest to declare.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.ejpsy.2023.07.004.

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