Title: Assessing Mild Behavioral Impairment with the Mild Behavioral Impairment-Checklist in people with Subjective Cognitive Complaints

Running title: Assessing MBI with the MBI-C in elders with SCC

Authors: Sabela C. Mallo[1], Zahinoor Ismail[2,3], Arturo X. Pereiro[1], David Facal[1], Cristina Lojo-Seoane[1], María Campos-Magdaleno[1], Onésimo Juncos-Rabadán[1].

[1]Department of Development and Educational Psychology, University of Santiago de Compostela, Santiago de Compostela, Spain

[2]Department of Psychiatry and the Mathison Centre for Mental Health Research & Education, Cumming School of Medicine, University of Calgary, Calgary, Alberta, Canada

[3]Department of Clinical Neurosciences and Hotchkiss Brain Institute, and The Ron and Rene Ward Centre for Healthy Brain Aging Research, University of Calgary, Calgary, Alberta, Canada

Addresses:

Sabela C. Mallo, Arturo X. Pereiro, David Facal, Cristina Lojo-Seoane, María Campos-Magdaleno, Onésimo Juncos-Rabadán: Development Psychology, University of Santiago de Compostela, Xosé María Suárez Núñez Street, Campus Sur, Santiago de Compostela, ES–15782, Spain.

Zahinoor Ismail: 3280 Hospital Dr. NW, TRW Building First Floor, Mathison Centre, Calgary, AB, T2N 2Z6, Canada.

Correpondence should be addressed to Sabela C. Mallo, Development Psychology, University of Santiago de Compostela, Xosé María Suárez Núñez Street, Campus Sur, Santiago de Compostela, ES–15782, Spain; phone +34 881-813-949; fax +34 881-813-901; email: sabelacarme.mallo@usc.es

Abstract

Objectives: To estimate the prevalence of Mild Behavioral Impairment (MBI) in people with Subjective Cognitive Complaints (SCC), study the distribution of the scores, determine the sensitivity, specificity, and utility for MBI diagnosis, and to analyze the correlation of the Mild Behavioral Impairment Checklist (MBI-C) scores with other neuropsychological tests.

Design: Correlational study with a convenience sampling. Descriptive, logistic regression, ROC curve, and bivariate correlations analyses were performed.

Setting: Primary care health centers.

Participants: 127 patients with SCC.

Measurements: An extensive evaluation including Questionnaire for Subjective Memory Complaints (QSMC), Mini Mental State Examination (MMSE), Cambridge Cognitive Assessment-Revised (CAMCOG-R), Neuropsychiatric Inventory-Questionnaire (NPI-Q), the Geriatric Depression Scale-15 items (GDS-15), the Lawton and Brody Index and the MBI-C, which was conducted by phone to participants' informants.

Results: MBI diagnosis prevalence was 5.8%. The total MBI-C scoring was low and differentiated people with MBI at a cut-off point of 8.5 (optimizing sensitivity and specificity). MBI-C total scoring correlated positively with NPI-Q, QSCC from the informant and GDS-15.

Conclusions: The phone application of the MBI-C is useful for detecting MBI in people with SCC. The prevalence of MBI in SCC was low. The MBI-C detected subtle NPS that were correlated with scores on the NPI-Q, depressive symptomatology (GDS-15) and memory performance perceived by their relatives (QSCC). Future studies should determine the predictive value of these symptoms in SCC and its relation to incident cognitive decline over time.

Key words: Behavioral and Psychological Symptoms of Dementia, Neuropsychiatric Symptoms, Mild Behavioral Impairment, Cognitive Impairment.

Introduction

Subjective Cognitive Complaints (SCC) (Jessen *et al.*, 2014) is a diagnostic entity that characterizes people with cognitive complaints but without objective cognitive impairment, and an increased risk of Mild Cognitive Impairment (MCI) (Masters *et al.*, 2015) and dementia (Gifford *et al.*, 2014).

Neuropsychiatric symptoms (NPS), also known as behavioral and psychological symptoms, are non-cognitive, behavioral or psychiatric symptoms that include disturbances of mood, perception, and behavior related to a neurocognitive disorder (Lyketsos *et al.*, 2011). In cognitively normal adults, NPS can be present (Ismail *et al.*, 2016) and predict progression to Mild Cognitive Impairment (MCI) (Masters *et al.*, 2015).

Relationships between SCC and NPS have been recently analyzed in some studies. A meta-analysis (Burmester et al., 2016) showed a significant link between SCC and depression. General measures of NPS (Mewton *et al.*, 2014) and specific measures of anxiety (Balash *et al.*, 2013) are also strongly associated with SCC. However, other NPS, as apathy, agitation or delusions, have not been studied yet (Burmester et al., 2016). Thus, the presence of NPS in people with SCC could be a risk factor for MCI and their early identification is fundamental to prevent cognitive impairment and to provide early interventions (Pink et al., 2015).

Mild Behavioral Impairment (MBI) (Ismail *et al.*, 2016) is a neurobehavioral syndrome characterized by later life acquired, sustained and meaningful NPS of any severity that cannot be better accounted for by other formal medical and psychiatric nosology. MBI is an at-risk state for incident cognitive decline, and for some, MBI is the index manifestation of neurodegeneration, observed in advance of cognitive impairment. The MBI assumes that the neurodegeneration may manifest with changes in personality, behavior or psychiatric symptomatology, prior to cognitive impairment, depending on the type, location and impact of the underlying pathology. MBI detects individuals at an increased risk of developing dementia, but who do not necessarily show overt cognitive symptoms. Additionally, the relationship between MBI (the neurobehavioral axis) and MCI (the neurocognitive axis) is explicit, in that MBI can precede, co-occur with, or emerge after MCI. Hence, to diagnosis MBI the symptoms should produce at least minimal impairment in at least one of the following areas: interpersonal relationships, other aspects of social functioning and/or ability to perform at the workplace.

Importantly, MBI distinguishes between formal psychiatric illness and chronic psychiatric symptomatology, vs. new-onset psychiatric symptoms in older adults, the latter of which are core to the MBI construct of the at-risk state. Historically, older adults with later onset NPS, who did not show obvious cognitive impairment would receive a psychiatric diagnosis, and the possibility of neurodegenerative disease was often overlooked (Wooley *et al.*, 2011).

In 2016, the NPS Professional Interest Area (PIA) of the International Society to Advance Alzheimer Research and Treatment (ISTAART), a subgroup of the Alzheimer's Association (AA), developed and published research diagnostic criteria for Mild Behavioral Impairment (MBI) (Ismail *et al.*, 2016). The MBI entity is in keeping with the inclusion of NPS in the 2011 National Institute on Aging–Alzheimer's Association (NIA-AA) consensus recommendations for diagnosis of all-cause dementia (McKhann *et al.*, 2011), highlighting the clinical importance of NPS. Hence, these criteria were intended to standardize research into early non-cognitive markers of dementia by specifying later life emergence of symptoms and a minimum 6-month duration, minimizing the inclusion of transient and reactive states.

Within the ISTAART-AA MBI criteria, MBI has been categorized into the domains of decreased drive/motivation (Sherman *et al.*, 2017), affective/emotional dysregulation (Ismail *et al.*, 2017a), impulse dyscontrol and agitation (Nagata *et al.*, 2014), social inappropriateness (Desmarais *et al.*, 2017), and delusions and hallucinations (Fischer and Agüera-Ortiz, 2017).

Assessment of MBI has been operationalized with the development of the MBI checklist (MBI-C) (Ismail et al., 2017c), which was tailored specifically to the MBI criteria, including explicit observations of symptoms being impactful, later life in onset, and sustained for 6 months, requirements that are not explicit in many NPS rating scales. The MBI-C was designed to detect the emergent of NPS in a community-dwelling, functionally independent, older population, in accordance with the ISTAART-AA MBI criteria.

Recent investigations have estimated the prevalence of the MBI diagnosis, using only criterion one of the ISTAART-AA and a transformation algorithm of the Neuropsychiatric Inventory (NPI) (Cummings *et al.*, 1994). In a memory clinic study (Mortby *et al.*, 2017) the prevalence of MBI in people with SCC was 76.5% and in a population-based study 43.1% (Sheikh *et al.*, 2017). Nevertheless, in a study using the MBI-C in a clinical sample with people with MCI and SCC (Mallo *et al.*, 2017), the prevalence estimated using all the four ISTAART-AA criteria was 11.6%.

The aims of the present investigation were to study in people with SCC: 1) the prevalence of MBI and the distribution of the scores; 2) the sensitivity and specificity of the MBI-C and its utility for diagnosing MBI; and 3) the relationships between NPS, cognitive status, and the performance in activities of daily living. The MBI-C was administrated by phone, since it’s a very useful procedure when the patients are not able to travel to the health centers, especially in dispersed populations.

Methods

One hundred twenty-seven participants aged ≥ 50 years and with SCC were recruited from Primary Care Health Centers in Santiago de Compostela (Spain). Exclusion criteria were: prior diagnosis of depression, psychiatric illness or neurological disease, including probable Alzheimer Disease (AD) or other types of dementia; brain damage or brain surgery; undergoing chemotherapy; diabetes type II; sensorial or motor disturbances; and substances consumption that might affect normal performance of the tasks. The participants underwent clinical, neurological and neuropsychological examination.

The study was approved by the Ethics in Clinical Research Committee of the Galician Government and was carried out in accordance with The Declaration of Helsinki, as revised in Seoul 2008. Written informed consent was obtained from all participants before the study, and anonymity has been preserved.

A questionnaire on sociodemographic and clinical data was used to obtain information from the patients and/or a family member. A short Spanish version of the Questionnaire for Subjective Memory Complaints (QSMC) (Benedet, 1996) was administered to participants and to a family member to assess SCC.

Cognitive functioning of participants was evaluated by the Spanish version of Cambridge Cognitive Assessment-Revised (CAMCOG-R) (Roth *et al.*, 1986; Roth *et al.*, 1998; Roth, 2003) and with the Spanish version of the Mini Mental State Examination (MMSE) (Folstein, *et al.*, 1975), adapted and validated by Lobo et al. (Lobo *et al.*, 1999), both with norms for age and education.

Functional assessment was conducted using the Spanish version of the Lawton and Brody Index, specially designed to evaluate Instrumental Activities of Daily Living (IADL)(Lawton and Brody, 1969).

To assess NPS we used: the Spanish version (Boada *et al.,* 2002) of the NPI-Q (Kaufer *et al.*, 2000); the 15-item Spanish version (Martínez *et al.*, 2002) of the Geriatric Depression Scale (GDS-15) (Yesavage and Sheikh, 1986); and the Spanish version of the MBI-C (Agüera-Ortiz and López-Álvarez, 2017).

The MBI-C (Ismail et al., 2017c) is the first specially developed instrument to assess the MBI construct as described in the ISTAART-AA criteria. The questionnaire comprises 34 items organized according to the five MBI domains: 1) drive/motivation: six questions including assessments of cognitive, behavioral and emotional apathy; 2) affective/emotional regulation: six items including low mood, anhedonia, hopelessness, and guilt, and one question each for worry and panic; 3) impulse control/agitation: 12 questions assessing agitation, aggression, impulsivity, recklessness, and abnormal reward and reinforcement; 4) social cognition: five questions describing sensitivity, empathy, and tact; 5) abnormal thoughts/perception: five questions assessing suspiciousness, grandiosity, and auditory and visual hallucinations. For each item, a “yes” or “no” question is followed by a severity rating scale of 1-mild, 2-moderate, or 3-severe. Symptoms should be at least 6 months persistence and represent a meaningful change from baseline. Due to the population being very geographically dispersed in this region, the Spanish version of the questionnaire (Ismail *et al.*, 2016) was administered by phone interview to a relative of the patient, to optimize participant retention.

Diagnosis of MBI was made via a series of semi-structured interviews in addition to medical records, in accordance with all the four ISTAART-AA criteria (Ismail *et al.*, 2016). To determine criterion one, we asked for the presence of symptoms over the last 6 months in the initial phone interview and then confirmed it using the NPI-Q (Boada *et al.,* 2002) (administered to an informant on the patient's assessment session). For the NPI-Q (Boada *et al.,* 2002), both 1 month (proper measure of the instrument) and 6-month symptom duration were necessary (as required in the criteria). For criteria two and three, information was obtained from the phone interview. Criterion four was obtained from the final assessment and diagnosis. Definite MBI diagnosis was made by the research team after incorporating several sources of information that included extensive clinical assessments, cognitive and neuropsychiatric testing.

Data were analyzed using SPSS v.20. Domain scores for the MBI-C were calculated as well as total scores for each questionnaire. Exploratory analyses were performed to identify any error in the data. The distribution of the scores in MBI-C and the prevalence of MBI diagnosis were determined using frequency and descriptive analyses. Binary logistic regression was used to determine the predictive value of the MBI-C for MBI diagnosis, being MBI diagnosis the outcome variable and the MBI-C total score the predictor variable. A ROC curve was generated to determine the utility of the MBI-C total score for diagnosing MBI and the sensitivity and specificity of the cut-off point. The ROC curve was performed on a non-parametric assumption since the descriptive analyses showed that the distribution of the scores was not normal. The total score on the MBI-C was the contrast variable and the diagnosis of MBI was the static variable. The relations between the total score on the MBI-C and cognitive measures (QSCC, CAMCOG-R, MMSE), NPS scores (NPI-Q, GDS-15), and functional results (IADL) were examined using Spearman bivariate correlations because several measures did not follow a normal distribution. The level of significance was set at $p<$ .05.

Results

Of the 127 participants, six were excluded due to their outlier MBI-C scores; they represented 4.72% of participants and did not have an MBI diagnosis.

Nighty-five participants were female (78.5% of the sample). Descriptive parameters of the sample (age, years of education, QSCC of the patient, QSCC of the informant, MMSE, CAMCOG-R, GDS-15, NPI-Q and IADL) are shown in Table 1.

INSERT TABLE 1.

Descriptive parameters of the scoring in each of the five domains and total MBI-C are displayed in Table 2. Percentile 25 and percentile 50 was .00 for all domains, except for total scoring in percentile 50, which was 1.00. Percentile 75 was between .00 and 4.00 while percentile 90 was between .00 and 8.40 (maximum possible for total scoring, 102) (Table 2).

INSERT TABLE 2.

The total MBI-C scoring was low; 88 participants (76.5%) scored .00 and 11 participants (9.6%) scored 1.00 (Figure 1). The prevalence of MBI according to ISTAART-AA diagnostic criteria was 5.8% (7 participants).

INSERT FIGURE 1.

The logistic regression analysis showed that MBI-C is a significant predictor of MBI diagnosis (β= -1.08; ST. E = .50; *Wald*=4.63; *df*=1, $p<$ .05; *OR*=.34 CI (95%) =.12 - .90). Nagelkerke R^2 indicated that the model explains 85% of the variance. The Hosmer-Lemeshow test revealed a good fit for the regression model (X^2 = 2.50, *df*=4, p =.99). ROC analysis indicated that

MBI-C total scoring differentiated people with MBI diagnoses. The cut-off point was seated at 8.5 with a good sensitivity= 1.00, specificity=91.7 and *AUC*= .99, $p < .001$ (Figure 2).

INSERT FIGURE 2.

MBI-C total scoring correlated positively with NPI-Q (ρ = .57; $p < .01$), QSCC from the informant (ρ = .30 $p < .01$), GDS-15 (ρ = .22 $p < .05$). However, not correlation was found between the MBI-C and IADL (ρ = -.18; p =.06), MMSE (ρ = .09 p = .31), QSCC from the patient (ρ = .02 p =.82) and CAMCOG-R (ρ = -.02 p =.83) (Table 3).

INSERT TABLE 3.

Discussion

To the best of our knowledge, this is the first study of the MBI-C, administered by phone interview, in a sample of people with SCC. The phone validation is highly beneficial in dispersed populations, where the participants have complications to travel to the health centers, or when they are not able to go there due to health reasons or agenda.

In summary, our results indicated that the prevalence of the MBI diagnosis in people with SCC, estimated with the ISTAART-AA diagnosis criteria and the MBI-C, was low (5.8%). The MBI-C detected subtle NPS that were correlated with the NPI-Q, depressive symptomatology (estimated by the GDS-15) and memory performance perceived by the participants' relatives (measured by the QSCC). Therefore, these results suggest that phone administration of the MBI-C is useful for detecting MBI in people with SCC. These findings provide a better understanding of the behavioral, cognitive and functional manifestations of neurocognitive diseases, and have significant implications for prevention and treatment.

The role of NPS in SCC has not been studied as frequently as in MCI and dementia (Sheikh *et al.*, 2017). The prevalence of MBI in people with SCC, according to ISTAART-AA diagnosis criteria (Ismail *et al.*, 2016), was 5.8% in our study. Nevertheless, investigations using traditional rating scales, such as the NPI, have indicated that the prevalence of any NPS in controls ranges from 5 up to 27% (Ismail et al., 2017c). This variability can be explained by the differences in demographics, study setting, terminology, and behavioral instruments selected. Using a transformation algorithm of the NPI to estimate criterion one of the MBI, two recent studies indicated a prevalence of 76.5% in a clinical sample (Mortby *et al.*, 2017) and of 43.1% in a community sample (Sheikh *et al.*, 2017). Some reasons may explain why these prevalence rates are higher. The NPI requires one month of symptoms as the reference frame, whereas the MBI-C involves a more rigorous expectation of six months and a later life onset of symptoms. Thus, the MBI-C minimizes the inclusion of transient and reactive states (Ismail et al., 2017c). Hence, our diagnosis was made in a stricter way, incorporating all the four ISTAART-AA MBI criteria. In a pilot study with a clinical sample of people with MCI and SCC, the prevalence estimated using all the four ISTAART-AA criteria was 11.6% (Mallo *et al.,* 2017). Notwithstanding, this prevalence was established in both SCC and MCI population. We consider that the 5.8% prevalence indicated by the present study constitutes an enriched and accurate sample at-risk for cognitive impairment.

In our investigation, the MBI-C total scoring was a significant predictor of MBI diagnosis. The cut-off point of 8.5 correctly classified 99% of the SCC sample, differentiating people with and without an MBI diagnoses with a sensitivity of 100% and a specificity of 91.7%. A pilot study (Mallo *et al.,* 2017) has reported that a cut-off point of 7.5 best differentiated people with MBI to those without. Nevertheless, the sample included people with SCC and MCI. In the present research, a uniform sample of people with SCC was used. Consequently, we consider that a cut-off point of 8.5 is more accurate since MCI (Albert *et al.*, 2011) and SCC (Jessen *et al.*, 2014) are two different diagnostic syndromes.

MBI-C total scoring correlated significantly and positively with NPI-Q and GDS-15, showing the validity of MBI-C to assess NPS. In agreement with a previous study, broad measures of NPS are related to SCC (Mewton *et al.*, 2014). In the population-based Mayo Clinic Study of Ageing (Geda *et al.*, 2014), symptoms of agitation, anxiety, apathy, irritability, and depression increased the risk of developing MCI in healthy adults. The positive and significant correlation with the GDS is also in concordance with recent studies that showed that depression is a strong indicator of SCC (Chin *et al.*, 2014; Burmester *et al.*, 2016). All the same, this relationship may be limited to clinical samples, because the patients are already concerned about their performance.

Moreover, there was no correlation between MBI-C and Lawton IADL. Importantly, criterion two of the MBI diagnosis asses if the NPS produce at least minimal impairment in interpersonal relationships, other aspects of social functioning or ability to perform at the workplace (Ismail *et al.*, 2016). Commonly, people with MCI have problems to perform complex functional tasks which they used to perform in the past (Albert *et al.*, 2011), in contrast to people with SCC (Jessen *et al.*, 2014). However, in MBI diagnosis, these impairments in social, occupational or interpersonal function must be related to changes in personality and behavior, not to cognitive decline (Ismail *et al.*, 2016). It is important to note that many patients from our study did not meet criterion two because NPS were not of sufficient severity to affect function. This requirement speaks to the clinical relevance of the MBI criteria, and increase specificity by excluding symptoms without functional impact, which may not be risk factors for MCI and dementia. Further research needs to be done in order to clarify this issue.

MBI-C scoring was correlated with QSCC scores from the informant but not with QSCC from the patient. Juncos-Rabadán et al. (Juncos-Rabadán *et al.*, 2012) concluded that memory difficulties reported by the informant, not the participants themselves, have a greater prognostic value predicting objective performance. Further work is required to establish this. It is important to note that SCC (from the informant and/or the patients themselves) constitute a criterion for diagnosing MCI. Our findings highlight the importance of assessing NPS in people with SCC since they could be early markers of decline.

No correlation was found between the MBI-C and cognitive performance measured by the MMSE nor by the CAMCOG-R. Despite the fact that MCI and MBI can co-occur, some authors have suggested that they are different syndromes (cognitive and behavioral) and that both increase the likelihood of dementia (Ismail *et al.*, 2016). The absence of correlation found in this investigation supports this hypothesis. Future research should be done to establish this.

Our study is characterized by several strengths. An extensive neurocognitive assessment, including tests with norms for age and education, was performed. Hence, participants were classified in accordance with diagnostic criteria, instead of cut-off points in instruments like the MMSE. Moreover, the MBI-C, an instrument specially designed to detect NPS in pre-dementia populations (including people with MCI and SCC) (Ismail et al., 2017c), was performed by phone interview to increase retention, since the population is very spread out.

Nevertheless, several limitations should be acknowledged. We provided the prevalence estimates for MBI in those with SCC, but not in those without cognitive complaints nor in people with neurocognitive disorders, such as MCI and dementia. While the cross-sectional design has provided validation of the MBI-C for measuring MBI in people with SCC, it is not possible to make any conclusions in relation to changes in prevalence over time, nor risk factors for evolution to objective cognitive impairment. Longitudinal data is required to determine the predictive utility of the MBI-C for developing cognitive impairment.

This research has thrown up many questions in need of further investigation. In our study, a clinician conducted the MBI-C by phone, but more investigations should be done with face-to-face assessments to generate other validations of the MBI-C. Hence, while our study is focused on the MBI-C total score, differences in prediction of cognitive impairment based on the various aggregate domain scores need to be determined. Different MBI domains may predict different MCI and dementia subtypes, which may have implications for treatment. Furthermore, in future studies, psychometric properties of the MBI-C need to be determined with large and transcultural samples. As this study was performed with a primary care clinical sample, more research is required to determine if the results vary in non-clinical community samples, since prior literature has concluded that NPS are more frequent in clinical versus community samples (Ismail *et al.*, 2017b). Moreover, more research is needed in order to determine if the new MBI criteria can be used to assist the diagnostic process and if the MBI-C is a helpful instrument for the early identification of individuals at risk of cognitive impairment.

Taken together, these findings suggest that the Spanish version of the MBI-C is a valid and reliable tool for detecting MBI in primary care patients with SCC. Recent research has established that disease modifying agents have been unsuccessful in improving dementia outcomes due to poor signal detection as well as poor recruitment and retention outcomes (Ismail et al., 2017c). Since NPS are related to a higher risk of dementia (Pocnet *et al.*, 2015), the MBI-C could be useful in case detection, biomarker screening and clinical trial enrolment (Ismail et al., 2017c).

Conflict of interest

None.

Description of author's roles

Sabela C. Mallo, study concept and design, acquisition of data, analysis and interpretation of data, manuscript writing.

Zahinoor Ismail, study concept and design, critical revision of manuscript

Arturo X. Pereiro, interpretation of the data and critical revision of the manuscript

David Facal, interpretation of the data and critical revision of the manuscript

Cristina Lojo-Seoane, study supervision, preliminary analyses

María Campos-Magdaleno, acquisition of data, preliminary analyses

Onésimo Juncos-Rabadán, study concept and design, study supervision, critical revision of the manuscript

Acknowledgements

The study was funded by the Spanish Ministry of Economy and Competitiveness (ref. PSI2014-55316-C3-1-R) and the Galician Autonomous Government Grant (ref. ED431C2017/27). S.C. Mallo is funded by a fellowship from the Spanish Ministry of Economy and Competitiveness (ref. BES-2015-071253).

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Figure legends

1. Figure 1. Distribution of the total scores in the MBI-C stratified by frequency. MBI-C: Mild Behavioral Impairment-Checklist.
2. Figure 2. ROC curve. Contrast variable: total score on the MBI-C. State variable: MBI diagnosis. Cut-off point: 8.5.

Tables

Table 1 Descriptive parameters of the sample

Characteristics	Mean (SEM)	SD	Range	Skew	Kurtosis
Age	64.75 (.79)	8.75	50-84	-.68	-.93
Years of Education	11.27 (.52)	5.73	2-25	1.33	-.44
MMSE	28.54 (.15)	1.62	21-30	.42	3.93
CAMCOG-R	93.26 (.63)	7.01	67-105	-.50	.75
QSCC (patient)	16.49 (.31)	3.46	8-26	-1.11	.18
QSCC (informant)	14.79 (.36)	3.97	7-28	-.22	.18
GDS-15	2.77 (.22)	2.38	0-11	.88	1.53
NPI-Q	2.59 (.29)	3.23	0-16	.75	2.92
IADL	7.78 (.06)	.62	5-8	-1.83	11.89

Notes: SE: Standard Error of the Mean; SD: Standard Deviation; QSCC: Questionnaire for Subjective Cognitive Complaints; MMSE: Mini Mental State Examination; CAMCOG-R: Cambridge Cognitive Examination-Revised; NPI-Q:

Neuropsychiatric Inventory-Questionnaire; GDS-15: Geriatric Depression Scale-15 items; IADL: Instrumental Activities of Daily Living.

Table 2 Descriptive parameters of scores in the five domains and total of the MBI-C

Domains	Mean (SEM)	SD	Range	Skew	Kurtosis	%ile 25	%ile 50	%ile 75	%ile 90
Interest, Motivation & Drive	.55 (.12)	1.26	0-6	2.61	6.44	.00	.00	.00	2
Mood or Anxiety	.83 (.13)	1.38	0-6	1.92	3.38	.00	.00	1.00	3
Societal Norms	1.24 (.21)	2.26	0-10	2.20	4.71	.00	.00	2	4.40
Delay Gratification & Control	.03 (.02)	.18	0-1	5.14	24.90	.00	.00	.00	.00
Held Beliefs & Sensory Experiences	.04 (.02)	.24	0-2	6.22	41.75	.00	.00	.00	.00
Total Scoring	2.71 (.39)	4.17	0-19	1.91	3.41	.00	1.00	4.00	8.40

Notes: SEM: Standard Error of the Mean; SD: Standard Deviation; %ile: Percentile; MBI-C: Mild Behavioral Impairment Checklist; SD: Standard Deviation.

Table 3 Spearman correlations between the MBI-C and the NPI-Q, CAMCOG-R, MMSE, QSCC from the patient, QSCC from the relative, GDS-15 and IADL

Tests	MMSE	CAMCOG-R	QSCC (patient)	QSCC (relative)	GDS-15	NPI-Q	IADL	MBI-C
MMSE	1							
CAMCOG-R	.45**	1						
QSCC (patient)	-.12	-.08	1					
QSCC (relative)	-.06	.01	.31**	1				
GDS-15	-.15	-.027**	-.30**	-.23**	1			
NPI-Q	.02	-.08	.12	.38**	.39**	1		
IADL	.08	.12	-.16	-.21*	-.03	-.17	1	
MBI-C	.09	-.02	.02	.30**	.22*	.57**	-.18	1

Notes: MMSE: Mini Mental State Examination; CAMCOG-R: Cambridge Cognitive Examination- Revised; QSCC: Questionnaire for Subjective Cognitive Complaints; NPI-Q: Neuropsychiatric Inventory- Questionnaire; GDS-15: Geriatric Depression Scale-15 items; IADL: Activities of Daily Living; MBI-C: Mild Behavioral Impairment Checklist.

**The correlation is significant at *p*<.05 (bilateral), * The correlation is significant at *p*<.01.

Figure 1. Distribution of the total scores in the MBI-C stratified by frequency. MBI-C: Mild Behavioral Impairment-Checklist.

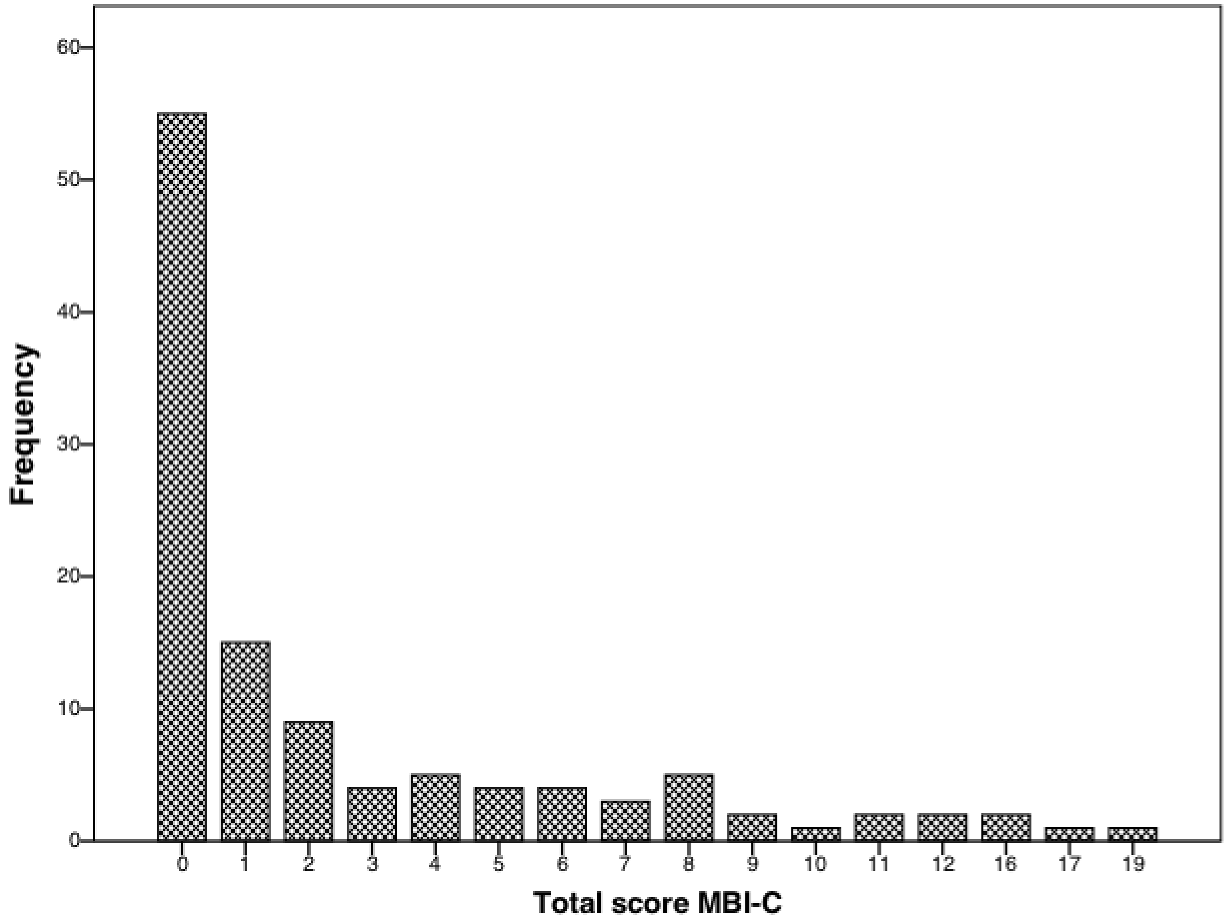

Figure 2. ROC curve. Contrast variable: total score on the MBI-C. State variable: MBI diagnosis. Cut-off point: 8.5.