

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

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Running title: Assessing MBI with the MBI-C in people with MCI

ABSTRACT:

Background: Neuropsychiatric Symptoms (NPS) are non-cognitive, behavioral or psychiatric symptoms that include disturbances of mood, perception, and behavior related to a neurocognitive disorder. NPS are frequent in Mild Cognitive Impairment (MCI) and associated with a higher risk of dementia. The Mild Behavioral Impairment (MBI) is a new diagnostic entity, that describes the emergence of later life NPS in pre-dementia states. The Mild Behavioral Impairment Checklist (MBI-C) is the first measure developed to assess MBI.

Objectives: To estimate the prevalence of MBI in people with MCI, score distribution, sensitivity, specificity, diagnostic utility and correlations with neuropsychological tests.

Methods: One hundred eleven MCI participants were evaluated with the Questionnaire for Subjective Memory Complaints (QSMC), Mini Mental State Examination (MMSE), Cambridge Cognitive Assessment-Revised (CAMCOG-R), Neuropsychiatric Inventory-Questionnaire (NPI-Q), Geriatric Depression Scale-15 items (GDS-15), Lawton and Brody Index and the MBI-C, which was conducted by phone to participants' informants. Descriptive, logistic regression, ROC curve, and bivariate correlations analyses were performed.

Results: MBI diagnosis prevalence was 14.2%. The total MBI-C scoring differentiated people with MBI at a cutoff-point of 6.5, optimizing sensitivity and specificity. MBI-C total scored correlated positively with NPI-Q, QSMC, GDS-15 and Lawton and Brody Index.

Conclusion: The phone application of the MBI-C is useful for detecting MBI in people with MCI. MCI participants present NPS that were correlated to their subjective memory complaints reported by informants, depressive symptoms and negatively with Instrumental Activities of daily Living. Further research should be done to clarify the predictive role of NPS in MCI.

Keywords: Behavioral and psychological symptoms of dementia, dementia, mild behavioral impairment, mild cognitive impairment, neuropsychiatric symptoms, preclinical dementia, prodromal dementia.

Footnotes:

Abbreviations

NPS: Neuropsychiatric Symptoms of Dementia; BSPD: Behavioral and Psychological Symptoms of Dementia; MCI: Mild Cognitive Impairment; MBI: Mild Behavioral Impairment; PIA: Professional Interest Area; ISTAART: International Society to Advance Alzheimer Research and Treatment; AA: Alzheimer Association; NIA-AA: National Institute on Ageing-Alzheimer's Association; MBI-C: Mild Behavioral Impairment-Checklist; DSM-5: Diagnostic and Statistical Manual of Mental Disorders, 5th edition; AD: Alzheimer Disease; NINCDS-ADRDA : National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association; QSMC: Questionnaire for Subjective Memory Complaints; SCC: Subjective Cognitive Complaints; MMSE: Mini Mental State Examination; CAMCOG-R: Cambridge Cognitive Assessment-Revised; IADL: Instrumental Activities of Daily Living; GDS-15: Geriatric Depression Scale; NPI-Q: Neuropsychiatric Inventory Questionnaire; NPI: Neuropsychiatric Inventory.

Background

Neuropsychiatric symptoms in Mild Cognitive Impairment

Neuropsychiatric Symptoms (NPS), also known as Behavioral and Psychological Symptoms of Dementia (BPSD), are non-cognitive, behavioral or psychiatric symptoms that include disturbances of mood, perception, and behavior related to a neurocognitive disorder [1].

NPS are associated with greater functional impairment [2], accelerated progression to dementia [3], higher burden of neuropathologic markers of dementia [4], greater caregiver stress [5] and poorer quality of life [6].

Two previous systematic reviews [7,8] have shown that NPS are common in Mild Cognitive Impairment (MCI), with prevalence rates from 35% to 85%. This variability can be explained by differences in demographics, study setting, MCI criteria, and behavioral instruments used [7,8]. People with MCI and NPS have a greater impairment in global, cognitive and functional scores than those who have MCI without NPS [9]. These symptoms also increase the likelihood of developing dementia in people with MCI at baseline [3,10,11].

Mild Behavioral Impairment Diagnosis

Mild Behavioral Impairment (MBI) [12] is a neurobehavioral syndrome characterized by later life acquired, sustained, and meaningful NPS of any severity as an at-risk state for incident cognitive decline and dementia. MBI identifies individuals at an increased risk of developing dementia, but who do not necessarily exhibit overt cognitive symptoms. In addition to occurring after cognitive impairment (the traditional lens through which NPS have been viewed), MBI can occur in concert with, or in advance of MCI, thus potentially identifying earlier stage disease.

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 [13], resulting in inappropriate, delayed or suboptimal care [14]. 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.

In 2016, the NPS Professional Interest Area (PIA) of the International Society to Advance Alzheimer's Research and Treatment (ISTAART), a subgroup of the Alzheimer's Association (AA) addressed this gap in knowledge by developing diagnostic criteria for MBI [12] (Table 1). The MBI construct is in keeping with the inclusion of behavioral symptoms in the 2011 National Institute on Aging–Alzheimer's Association (NIA-AA) consensus recommendations for diagnosis of all-cause dementia [15]. The basis of these criteria is the assumption that neurodegeneration may manifest with changes in personality, behavior or psychiatric symptoms, prior to cognitive impairment, depending on the type, location and impact of the underlying pathology. The ISTAART-AA MBI criteria addressed explicitly the relationship between MBI and MCI, and were intended to standardize research into early non-cognitive markers of dementia by stipulating later life emergence of symptoms and a minimum six-month duration to minimize the inclusion of transient and reactive states, and increase signal detection. Within the ISTAART-AA MBI criteria, symptoms are divided into the following domains: apathy [16,17], emotional dysregulation [18,19], agitation/aggression [4,20], social disinhibition [21,22], and psychotic symptoms [23–25]. The ISTAART NPS group further operationalized the measurement of MBI with the development of the Mild Behavioral Impairment-Checklist (MBI-C) [26], designed to elicit emergent NPS in a community dwelling, functionally independent,

older population, in accordance with the ISTAART-AA MBI criteria. The explicit goal of the MBI-C is case ascertainment, but further validation of its performance is required.

INSERT TABLE 1.

Some recent studies have estimated the prevalence of MBI symptoms, using only criterion one of the ISTAART-AA criteria and a transformation algorithm of the Neuropsychiatric Inventory (NPI) [27] to generate prevalence of MBI with a one month symptom duration. In a memory clinic population [28], the prevalence of MBI in MCI was 85.3% whereas in a population-based study [29] it was 48.9%. However, early research using the MBI-C, which mandates six months of emergent symptoms, have generated a much lower MBI prevalence. In a primary care clinical sample of people with MCI and SCC, the prevalence estimated using the MBI-C and the full ISTAART-AA MBI criteria was 11.6%, potentially providing a specificity of diagnosis useful for detection and intervention [30].

Objectives

To the best of our knowledge, this is the first study to use the MBI-C by phone interview in people with MCI to estimate: 1) the prevalence of MBI diagnosis and score distribution; 2) the sensitivity and specificity of the MBI-C and its utility for diagnosing MBI; and 3) the relationships between NPS, cognitive status, and functional performance in instrumental activities of daily living.

The phone application of the MBI-C could be highly beneficial in populations very dispersed, where the residents have difficulties to travel to the health care centers, or when the informants are not able to go there due to health reasons or agenda.

Methods

Setting

One hundred eleven participants aged ≥ 50 years with MCI were recruited from patients attending Primary Care Health Centers in Santiago de Compostela (Spain).

MCI was diagnosed according to Petersen's criteria [31,32].

Exclusion criteria were: prior diagnosis of depression or other psychiatric disturbances, according to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria [33], following the medical records data provided by general practitioners; prior diagnosis of neurological disease, including probable Alzheimer's Disease (AD) or other types of dementia, according to the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA) [15] and DMS-5 criteria [33]; previous brain damage or brain surgery; undergoing chemotherapy; prior diagnosis of diabetes type II; sensory or motor disturbances; and consumption of substances that might affect normal performance of the tasks. The participants underwent clinical, neurological and neuropsychological examination.

Study protocol approvals, registrations and patient consents

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 patient anonymity and privacy has been preserved.

Sociodemographic, cognitive and functional evaluation

A questionnaire on sociodemographic data was used to obtain information from the patients.

A short Spanish version of the Questionnaire for Subjective Memory Complaints (QSMC) [34], was administered to participants and to a family member in order to assess Subjective Cognitive Complaints (SCC).

The general cognitive functioning of participants was evaluated by the Spanish version of the Mini Mental State Examination (MMSE) [35,36], and with the Spanish version of the Cambridge Cognitive Assessment-Revised (CAMCOG-R) [37–39], both with norms for age and education.

Functional assessment was done using the Spanish version of the Lawton and Brody Index, to evaluate Instrumental Activities of Daily Living (IADL) [40].

Measurement of Neuropsychiatric Symptoms

To assess NPS we used: the 15-item Spanish version [41] of the Geriatric Depression Scale (GDS-15) [42]; the Spanish version [43] of the Neuropsychiatric Inventory Questionnaire (NPI-Q) [44], a brief form of the NPI [27]; and the Spanish version of the MBI-C [45].

The MBI-C [26] includes observations of symptoms being later life in onset, and sustained for six months, requirements that are not explicit in many NPS rating scales. The questionnaire includes 34 items organized in five domains: 1) apathy (six items including assessments of cognitive, behavioral and emotional apathy); 2) affect (six questions including low mood, anhedonia, hopelessness, and guilt, and one question each for worry and panic); 3) impulse (12 questions describing agitation, aggression, impulsivity, recklessness, and abnormal reward and reinforcement); 4) social inappropriateness (five questions assessing sensitivity, empathy, and tact); 5) abnormal thought and 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 represent a meaningful change from baseline behaviors.

The Spanish version of the questionnaire [46] was administered by phone interview to a relative of the patient, to minimize travel to the health center and optimize retention.

Diagnosis of MBI was made via a series of semi-structured interviews in addition to medical records, in accordance with the ISTAART-AA diagnostic criteria [12] (Table 1). To determine criterion one, we asked for the presence of symptoms over the last six months in the initial phone interview and then confirmed it using the NPI-Q (administered to informant on the patient’s assessment session). For the NPI-Q, both 1 month (proper measure of the instrument) and six-month symptom duration were queried (as required in the criteria). For criteria two and three (Table 1), information was obtained from the phone interview. Criterion four (Table 1) 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.

Statistical analyses

Data were analyzed using SPSS v.20. Total scores were calculated for each questionnaire as well as domain scores for the MBI-C. Exploratory analyses were performed to detect any errors in the data. The prevalence of MBI diagnosis and the distribution of the scores in MBI-C were determined using frequency and descriptive analyses. Binary logistic regression was used to determine the predictive value of the MBI-C, being MBI diagnosis the outcome variable and the MBI-C total score the predictor variable. To determine the utility of the MBI-C total score for

diagnosing MBI and the sensitivity and specificity of the cut-off point, a ROC curve analysis was performed, being the total score on the MBI-C the contrast variable and the MBI diagnosis the state variable. The ROC curve analysis was made on a non-parametric assumption since the distribution of the scores was not normal. The relationships between the total score on the MBI-C and cognitive measures (QSMC, 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

Descriptive parameters of the sample

Of the 111 participants, five were excluded due to their outlier MBI-C scores. These participants did not have MBI diagnosis and represented the 4.71% of their group.

Sixty-eight participants were women (64.2% of the sample). Descriptive parameters of the sample (age, years of education, QSMC of the patient, QSMC of the informant, MMSE, CAMCOG-R, GDS-15, NPI-Q and IADL) are shown in Table 2.

INSERT TABLE 2.

Descriptive parameters of the scoring in each of the five domains and total MBI-C are shown in Table 3. Percentile 25 was .00 for all domains, except for total scoring, which was .75. Percentile 50 was between .00 and 1, except for total scoring, which was 3.5. Percentile 75 and 90 were between .00 and 12.00 (maximum possible for total scoring, 102) (Table 3).

INSERT TABLE 3.

The total MBI-C scoring was low, 25 participants (23.6%) scored 0.00 and 12 participants (11.3%) scored 1.00 (Figure 1). The prevalence of MBI according to ISTAART-AA diagnostic criteria was 14.2%.

INSERT FIGURE 1.

MBI diagnosis

The logistic regression analysis showed that MBI-C score is a significant predictor of MBI diagnosis ($\beta = -4.81$; ST. E = .13; $Wald=14.22$; $df=1$, $p < .0001$; $OR=.62$ CI (95%) = .48 - .79. Nagelkerke R^2 showed that the model explains 64% of the variance. The Hosmer-Lemeshow test indicated a good fit for the regression model ($X^2 = 10.71$, $df=8$, $p=.22$).

ROC analysis indicated that MBI-C total scoring differentiated people with MBI diagnoses and the cutoff point 6.5 reached sensitivity= 1.00, specificity=78.2 and $AUC= .93$, $p < .001$ (Figure 2).

INSERT FIGURE 2.

Spearman correlations between measures

MBI-C total scoring correlated positively with NPI-Q ($\rho = .62$; $p < .05$), QSMC from the informant ($\rho = .46$; $p < .05$), GDS-15 ($\rho = .23$; $p < .01$) and negatively with IADL ($\rho = -.26$; $p < .05$). Not correlation was found between the MBI-C and QSMC from the patient ($\rho = -.03$ $p = .77$), CAMCOG-R ($\rho = -.08$ $p = .40$) or MMSE ($\rho = -.14$ $p = .16$) (Table 4).

INSERT TABLE 4.

Discussion

In summary, we assessed the performance of the MBI-C for case ascertainment compared to a gold standard, that is MBI diagnosis following the ISSTART-AA diagnosis criteria made after an extensive clinical assessment and cognitive and neuropsychiatric testing in a clinical sample. According to those criteria, we found that the prevalence of MBI in our MCI sample was 14.2%, and that a cut-off point of 6.5 on the MBI-C best differentiated patients with MBI and those without. The MBI-C, detected subtle NPS that were correlated with functional (Lawton IADL), emotional (NPI-Q and GDS-15) and subjective cognitive (QSMC from the informant) performance. These findings suggest that the phone administration of the MBI-C is useful for detecting MBI in people with MCI. Future studies should determine the predictive value of these NPS in MCI and their relation to incident dementia over time. These results have significant implications for prevention and treatment of cognitive impairment by providing a better understanding of the behavioral, cognitive and functional manifestations of neurocognitive diseases.

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 MCI. This phone validation has clinical advantages in populations very dispersed, where the participants have complications to travel to the health centers, or when the informants are not able to go there due to health reasons or agenda.

In our study, the prevalence of MBI, according to ISTAART-AA diagnosis criteria [12], was 14.2% in people who attended primary care centers and were diagnosed as MCI. Previous studies, using traditional NPS rating scales such as the NPI-Q, indicated that the NPS prevalence in MCI populations ranges from 35% up to 85% [7,8]. Using a transformation algorithm of the NPI score to capture criterion one of MBI, the prevalence estimated in two

recent studies was 85.3% in a clinical sample [28] and 48.9% in a community sample [29]. These percentages are significantly higher than in our sample, possibly due to the short frame of reference of 1 month of symptoms, required by the NPI, compared to the more rigorous expectation of six months of symptom duration and later life onset of symptoms in the MBI-C. Thereby, the MBI-C minimizes the inclusion of transient and reactive states [12] which may cloud the diagnosis. Additionally, our diagnosis was made in a stricter way by incorporating all the four ISTAART-AA criteria. Importantly, many patients from our study did not meet criterion two, because NPS were not of sufficient severity to produce at least minimal impairment in interpersonal relationships, other aspects of social functioning or ability to perform in the workplace. This requirement speaks to the clinical relevance of the ISTAART-AA MBI criteria, and may increase diagnostic specificity by excluding symptoms with no functional impact. In another study [30], in a clinic sample in people with MCI and SCC, the prevalence estimated using all the four ISTAART-AA criteria was 11.6%. Nevertheless, this prevalence was estimated in both in SCC and MCI population. We consider the 14.2% prevalence found in our research constitutes an enriched sample at risk for dementia, and an accurate representation of this high-risk group. Further work needs to be done to analyze the prevalence of MBI in different populations and study settings.

The findings of this study indicated that MBI-C total scoring, taken through a phone interview, was a significant predictor of MBI diagnosis. The cutoff point of 6.5 significantly classified people with MBI diagnoses with a sensitivity of 100% and a specificity of 78.2%. In a pilot study [30], a cutoff point of 7.5 discriminated people with MBI, but this analysis was performed in a sample of people with MCI and SCC. However, the present research was performed in a uniform sample of MCI patients and therefore we consider that the cutoff point of 6.5 is more

accurate to distinguish people with MBI and MCI to those with MCI but without MBI, since MCI [47] and SCC [48] are two different diagnostic entities.

Further work 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 dementia. Moreover, 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.

The MBI-C total score showed a mean significant positive correlation with NPI-Q and with GDS-15, indicating the validity of the MBI-C to assess NPS. In agreement with systematic reviews [7,8], NPS are common in the early clinical stages of neurocognitive disorders, with prevalence rates from 35 up to 85%, due to differences in study setting, demographics, MCI diagnosis and instruments used. Depression is one of the most common symptoms, with a prevalence estimated of 32% in MCI, being higher in clinical than in community samples [49].

The mean significant negative correlation between MBI-C and Lawton and Brody IADL Index also suggest that the presence of first NPS may be related to an early functional impairment. This result is in accordance with criterion two of the MBI diagnosis [12], which assesses if the NPS produce minimal impairment in interpersonal relationships, other aspects of social functioning or ability to perform at the workplace. Commonly, people with MCI have problems to perform complex functional tasks which they used to perform in the past [47]. In MBI diagnosis, these impairments in social, occupational or interpersonal function must be related to changes in personality and behavior, not to cognitive decline [12]. This result highlights the importance of an early assessment of functionality in people at risk of cognitive impairment. While the expectation that functional impairment is due to NPS, and increases diagnostic specificity, the

converse argument also applies. It is possible that awaiting functional impairment may result in diagnostic delays, missing the mildest or earliest of symptoms, and chances for early intervention and clinical trial enrollment [29].

The significant positive correlation between MBI-C and QSMC from informants is relevant taking into account that SCC are an important criterion for the diagnosis of MCI [47]. These results highlight the importance of testing NPS in people with MCI because they may be early markers of cognitive impairment and therefore early indicators of dementia.

No correlation was found between the MBI-C and QSMC from the patient. Juncos-Rabadán et al. [50], concluded that memory difficulties reported by the informant, not the participants themselves, have a greater prognostic value predicting objective performance. Further studies are needed to determine the relationship between SCC and NPS, and with the type of SCC (reported by the patients themselves or by the informants) are more accurate.

Hence, no correlation was found between the MBI-C and the cognitive measures (CAMCOG-R and MMSE). Although MBI and MCI can co-occur, some authors have suggested that they are different syndromes, (neurobehavioral and cognitive) and that both increase the likelihood of dementia [12]. The absence of correlation found in this research supports this hypothesis. Future investigations on the current topic are recommended.

Our study is characterized by several strengths. A detailed neurocognitive assessment, including tasks with norms for age and education, was performed. To assess cognitive deficits, not only the MMSE, a screening test, but also the CAMCOG-R, and extensive battery, was conducted.

Hence, classification of participants was made by diagnostic criteria, instead of cutoff points in screening tasks. Further, we used the MBI-C, an instrument specially designed to detect NPS in pre-dementia populations and the all the four MBI ISTAART criteria.

Notwithstanding the strengths, there are also some limitations. Our study provides prevalence estimates for MBI in those with MCI, but not in those with SCC or dementia. While the cross-sectional design has provided validation of the MBI-C for measuring MBI in MCI patients, it is not possible to make any conclusions in relation to changes in prevalence over time, nor risk factors for evolution to dementia. Longitudinal data is needed to determine the prognostic utility of the MBI-C.

All the results together suggest that the Spanish version of the MBI-C is especially useful for assessing NPS in people with MCI. Recent literature has suggested that, due to poor signal detection and poor recruitment and retention in the early phase of the cognitive impairment, the disease modifying agents have been unsuccessful in improving dementia outcomes [26]. The MBI-C can be beneficial in neurobiological and pharmacological research in case detection, biomarker screening and clinical trial enrollment [26] since the evidence has shown that later life NPS emergence is related to dementia risk [10,11].

Further, 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 [26].

Further investigations are ongoing to address the utility of the MBI and MBI-C.

Disclosure statement

The authors have no conflicts of interest to report.

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Table 1

ISTAART-AA MBI criteria [12]

-
- 1) Changes in behavior or personality observed by patient, informant, or clinician, starting later in life (age ≥ 50 years) and persisting at least intermittently for ≥ 6 months. These represent a clear change from the person's usual behavior or personality as evidenced by at least one of the following:
 - a) decreased motivation
 - b) affective dysregulation
 - c) impulse dyscontrol
 - d) social inappropriateness
 - e) abnormal perception or thought content;
 - 2) Behaviors are of sufficient severity to produce at least minimal impairment in at least one of the following areas:
 - a) Interpersonal relationships
 - b) Other aspects of social functioning
 - c) Ability to perform in the workplace.

The patient should generally maintain his/her independence of function in daily life, with minimal aids or assistance.
 - 3) Although comorbid conditions may be present, the behavioral or personality changes are not attributable to another current psychiatric disorder, traumatic or general medical causes, or the physiological effects of a substance or medication
 - 4) The patient does not meet criteria for a dementia syndrome. (e.g., Alzheimer's disease,
-

frontotemporal dementia, dementia with Lewy bodies, vascular dementia, other dementia). MCI can be concurrently diagnosed with MBI.

Abbreviations: MBI: Mild Behavioral Impairment; MCI: Mild Cognitive Impairment

Table 2

Descriptive parameters of the sample

Variables	Mean (SD)	Standard Error			
		Standard Error	Range	Skew	Kurtosis
Age	70.04 (8.33)	.81	50-84	-.68	-.312
Years of Education	7.89 (4.07)	.39	1-25	1.33	.19
QSMC (patient)	16.00 (3.97)	.38	8-29	.42	.31
QSMC (informant)	16.59 (4.33)	.42	7-26	-0.50	-.57
MMSE	26.39 (2.47)	.24	18-30	-1.11	1.18

CAMCOG-R	82.20 (9.63)	.93	55-102	-.22	-.41
GDS-15	3.16 (2.50)	.24	0-11	.88	.20
NPI-Q	3.73 (3.25)	.32	0-12	.75	-.243
IADL	7.20 (1.25)	.12	2-8	-1.83	.23

Abbreviations: SD, Standard Derivation; QSMC, Questionnaire for Subjective Memory 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 3

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

MBI domains	Mean (SD)	SE	Range	Skew	Kurtosis	Quartile 25	Quartile 50	Quartile 75	Quintile 90
Interest, Motivation & Drive	1.27 (2.06)	.20	0-11	2.31	6.37	.00	.00	2.00	4.00
Mood or Anxiety	1.70 (2.45)	.24	0-11	1.88	3.38	.00	1.00	2.00	5.70
Delay Gratification & Control	.15 (.49)	.05	0-3	4.29	20.84	.00	.00	00	1.00
Societal Norms	1.92	.24	0-11	1.69	2.64	.00	1.00	3.00	6.00

	(2.50)								
Held Beliefs & Sensory Experiences	.04 (.19)	.02	0-1	4.81	21.64	.00	.00	.00	.00
Total Scoring	5.08 (5.45)	.53	0-23	1.30	1.46	.75	3.50	9.00	12.00

Abbreviations: SD, Standard Derivation; MBI-C, Mild Behavioral Impairment-Checklist.

Table 4

Spearman correlations between MBI-C total scoring and scoring in NPI-Q, CAMCOG-R, MMSE, QSMC from the patient, QSMC from the relative, GDS-15 and IADL

Neuropsychological tests	NPI-Q	CAMCOG-R	MMSSE	QSMC (patient)	QSMC (relative)	GDS-15	IADL	MBI-C
NPI-Q	1							
CAMCOG-R	-.09	1						
MMSE	-.14	.65**	1					
QSMC (patient)	.02	-.02	-.06	1				
QSMC (relative)	.35**	-.24*	-.24*	-.32**	1			

GDS-15	.38**	-.10	-.02	-.207*	.174	1		
IADL	-.24*	.17	.13	.10	-.14	.09	1	
MBI-C	.62**	-.08	-.14	-.03	.46**	.23*	-.26**	1

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

NOTE: **the correlation is significant at $p < .05$ (bilateral), * the correlation is significant at $p < .01$.

Figures

Figure 1. Distribution of the total score in the MBI-C, determined using frequency analyses.

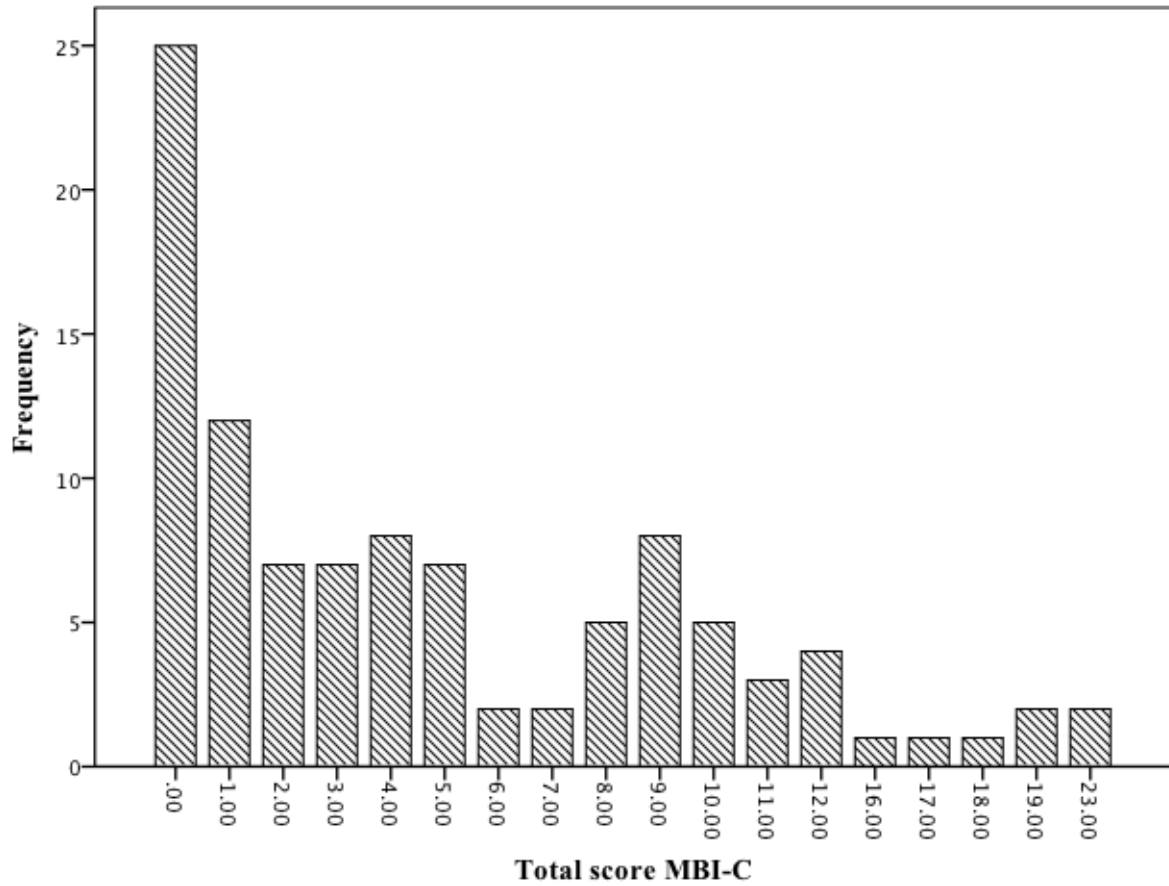


Figure 2. ROC curve, with the total score on the MBI-C as the contrast variable and the MBI diagnosis as the state variable.

