Original Article

PORTO BIOMEDICAL JOURNAL
WHERE SCIENCE MEETS KNOWLEDGE

OPEN

Normative data of the Portuguese version of the Mini-Addenbrooke's Cognitive Examination

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Abstract

Introduction: Mini-Addenbrooke's Cognitive Examination (M-ACE) is a screening neurocognitive test with diagnostic accuracy for mild cognitive impairment and dementia. The present study aims to determine the construct validity, concurrent and divergent validity and to determine the normative equation for the Portuguese version of M-ACE.

Method: The sample is composed by 130 participants without any subjective complaint of memory loss and completely independent in daily life activities, recruited in health units, day care centers and religious and civic associations, from several districts of Portugal. The ACE-III, from which the M-ACE was extracted, and the Geriatric Depression Scale (GDS) were administered to all participants.

Results: Reliability is considered good ($\alpha = 0.844$) and the item-total correlations of the M-ACE were highly significant. M-ACE showed a positive correlation with ACE-III and a negative correlation with GDS. Schooling and age were the only variables related to M-ACE performance. The obtained model from the multiple regression was significant. A normative equation was extracted from this model.

Conclusions: The Portuguese version of M-ACE has solid psychometric properties enabling its clinical use. The availability of M-ACE normative equation based on a healthy sample according to age and education enables the use of a brief screening tool for cognitive functioning. M-ACE does not require formal specialized training, it is a quick test which can be an advantage, for instance, in primary health care consultations.

Keywords: cognitive dysfunction, dementia, mental status and dementia tests, primary health care, psychometrics

Introduction

Dementia and cognitive impairment are a serious worldwide problem. Dementia is at the top 10 of the leading causes of burden of disease in high-income countries.[1] In Western Europe the prevalence of dementia over the age of 60 is estimated at 7.3% and the prospects are for an increase in this number.[2] In Portugal, the estimated prevalence of dementia is 1.71%[3] and in the north of the country a prevalence rate of 2.7% was determined among people aged 55 to 79.[4] Population ageing will place Portugal by 2070 as the European country with the highest total age-dependency ratio (89.7%).[5]

In this context, international guidelines recommend surveillance using neurocognitive screening tests in populations with suspected or high risk of cognitive impairments.[6,7]

In primary care settings, dementia and cognitive impairment are often underdiagnosed because of the high number of patients by physician and the limits of the available instruments.[8–10] The use of screening tests with high diagnostic utility, simplicity, celerity and with normative data for the target population is central in a time-constrained practice.[11]

Recently a third version of the Addenbrooke's Cognitive Examination (ACE-III) was developed in order to improve previous versions.[12] ACE-III is scored out of 100 and assesses 5 cognitive domains: Attention, memory, verbal fluency, language and visuospatial functioning. Despite being an instrument widely used with proven diagnostic utility in identifying dementia and cognitive impairment in a variety of clinical situations it takes about 15 to 20 minutes to be administered.[12–14]

Using a data driven scaling model, a shorter version of the ACE-III, the Mini-Addenbrooke's Cognitive Examination (M-ACE) was developed.[15] The M-ACE is composed by 5 tasks (Temporal orientation, learning and recall of a name and address, animal fluency and drawing of a clock with time specified) with a maximum score of 30 and a time of administration of 5 minutes.[15]

Several studies have pointed to the M-ACE diagnostic accuracy for mild cognitive impairment and dementia with high levels of sensitivity and specificity even when compared to more extensive tests.[15–19]

Considering the fact that the clinical value of a test is limited without the possibility to compare the individual performance with a reference group, this work aims to: determine the construct

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Porto Biomed. J. (2021) 6:5(e138)

Received: 7 April 2020 / Received in final form: 11 October 2020 / Accepted: 13 February 2021

http://dx.doi.org/10.1097/j.pbj.0000000000000138

validity of M-ACE through the internal reliability (Cronbach's alpha) and correlations between the 5 subtasks and M-ACE; concurrent and divergent validity; the influence of sociodemographic variables on the test's performance and to produce the normative equation for the Portuguese version of M-ACE.

Methods

Participants

The sample is composed by 130 participants, from both genders, with ages ranging between 60 and 91 years ($M = 70.93$; SD = 8.07) and with schooling raging between 1 and 17 years ($M = 5.74$; SD = 4.3), without any subjective complaint of memory loss and completely independent in daily life activities. Individuals with a prior history of neuropsychiatric or other medical diagnosis liable to interfere directly on neurocognitive functioning were excluded. A sociodemographic questionnaire specially made for this study and a health status inventory with 4 questions regarding daily activities and memory complains were used at this stage. Individuals with results equal or lower than 1 standard deviation on the ACE-III were excluded from the sample to ensure that participants were cognitively intact. Participants were recruited in health units, day care centres and religious and civic associations, from several districts of Portugal, enabling the collection of data in an easily accessible and representative sample. Table 1 shows the characteristics of the sample.

Neuropsychological assessment

The following tests were administered: the ACE-III, from which the M-ACE was extracted, and the Geriatric Depression Scale (GDS).[20]

ACE-III was used to characterize the general level of cognitive functioning, to include participants, and to determine the concurrent validity of M-ACE. GDS was used to determine divergent validity of M-ACE.

Table 1

Characteristics of the sample

	n	%
Sex		
Male	59	45
Female	71	55
Type of profession		
Blue collar	100	77
White collar	30	23
Professional status		
Retired	125	96
Working	3	2
Unemployed	2	2
District of origin		
Porto	22	16.9
Braga	15	11.5
Viana do Castelo	14	10.8
Vila Real	14	10.8
Aveiro	13	10
Coimbra	13	10
Viseu	10	7.7
Guarda	8	6.2
Castelo Branco	8	6.2
Évora	7	5.4
Bragança	6	4.6

The Portuguese version of the GDS has a high psychometric accuracy (sensitivity of 100% and specificity of 83%) as a screening instrument to detect depression, both in the general and clinical population settings.[21]

As stated the M-ACE is composed by 5 tasks: Temporal orientation, composed by 4 questions (max. score 4); Immediate learning and delayed recall of a name and address (max. score 14); Animal fluency during 1 minute (max. score 7); Drawing of a clock marking 10 past 11 (max. score 5).[15,18] The maximum score is 30 points. The Portuguese version has high sensitivity (100%) and specificity (72.1%), for the detection of dementia.[18]

Scoring criteria of M-ACE, followed the norms of the English version of the test (https://sydney.edu.au/brain-mind/resources-for-clinicians/dementia-test.html)

Procedure

The instruments were administered on the context of this study to all subjects, individually in 1 session in a closed room. Besides the neuropsychological assessment a sociodemographic questionnaire specially made for this study and a health status inventory were administered.

In the institutions with ethical committee, the approvals for the study were obtained. All the participants gave their informed consent.

Statistical analysis

Statistical analysis was carried out using the program IBM *Statistics* version 23 for Windows.

Frequencies, central tendency and deviation measures were first employed to characterize the sample and to report the assessment results. Internal reliability was determined through Cronbach's alpha, and the internal structure was analyzed by the correlations between the 5 subtasks and the total scale correlations (Pearson's correlations). Concurrent validity was determined by correlating the score on the instrument of interest, the M-ACE, with the score on a reference measurement tool that is known to accurately measure that same construct, the ACE-III; divergent validity was obtained by correlating it with an instrument associated to a different construct, the GDS (Pearson's correlations).

Kolmogorov–Smirnov (KS) test was used to test the normal distribution of the M-ACE scores. Once the normal distribution was not verified, multiple linear regression (enter method) was performed in order to determine the predictive model of M-ACE score. Normative equation was extracted from the multiple linear regression (method enter) to determine the expected result of a given individual according to the predictive variables of M-ACE.

Significance was determined with $P \leq .05$.

Results

The results obtained by the participants on neuropsychological tests are presented in Table 2.

The value of Cronbach's alpha for the M-ACE is considered good ($\alpha = 0.844$). The item-total correlations of the M-ACE 5 tasks were all positive and highly significant (Table 3).

M-ACE showed a positive correlation with ACE-III ($\rho = 0.862$; $P < .001$) and a negative correlation with GDS ($\rho = -0.258$; $P = .01$). Schooling ($\rho = 0.461$; $P < .001$) and age ($\rho = -0.478$; $P < .001$) were significantly related to the results on M-ACE. Sex ($U = 1063$; $P = .237$), type of previous/actual profession ($U =$

Table 2

Results obtained by the sample on the tests

	M	SD	[Min.–Max.]
ACE-III	89.8	6.59	[69–99]
M-ACE	25.37	3.27	[17–30]
Temporal orientation	3.93	0.29	[3–4]
Learning name and address	6.85	0.54	[4–7]
Animal fluency	5.08	1.04	[2–7]
Clock drawing	3.92	1.43	[0–5]
Recall name and address	5.59	1.77	[0–7]
GDS	7.97	4.39	[1–19]

359.5; $P=.068$) and professional status (KW = 13.668; $P=.544$), and district of origin (KW = 1.2219; $P=.135$) were not related to M-ACE performance.

Since M-ACE scores did not follow a normal distribution (KS = 0.171; $P<.001$), a multiple linear regression was performed including schooling and age as predictors of M-ACE scores. The obtained model is significant ($R^2=0.597$; $P<.001$) and includes both variables (Table 4). From this model the following normative equation was extracted:

M-ACE = (−0.160 * AGE (years)) + (0.297 * SCHOOLING (years)) + 34.816.

Discussion

The mean score of M-ACE in our normative sample (25.37), is similar to the ones in the Malaysian (25.5)[22] and Thai (24.3)[23] studies, and slightly lower than the Chinese (27.4)[24] and Brazilian (28)[25] samples, a fact that may be related to higher schooling in those 2 samples (11.8 and 12 years, respectively).

M-ACE proved to have construct validity with good reliability and significant correlations between its components and the total score indicative of a satisfactory internal structure. The good level of internal reliability is a common denominator to all M-ACE versions.[15,17,23,25]

M-ACE results are highly correlated to the extended version (ACE-III). This aspect, already reported in the clinical validation study of the Portuguese version,[18] is indicative of its concurrent validity and it is highly suggestive that findings on the diagnostic utility of ACE-III may be extended to M-ACE. The negative correlation with the GDS was expected, since the inverse relation between depressive mood and cognitive functioning is well established.[26]

Results on M-ACE were influenced by schooling and age. Although some studies report low correlation with age,[23,24,27] others report education as having a significant impact.[23,24,28] This variability can be explained by the distinct characteristics of the samples. Our study comprised participants with a mean schooling of approximately 6 years, while most of the studies reported an average of education ranging between 10 and 18 years.[15,24,27] However, this is in line with the Portuguese reality, where the majority of the population with more than 65 years of age only has the first cycle of education (4 years).[28] The observed variability reinforces the need to determine normative data specific to the population in which the instrument will be used.

Table 3

Correlations between the subtasks and M-ACE

	M-ACE
Temporal orientation	0.322
Learning name and address	0.359
Animal fluency	0.52
Clock drawing	0.702
Recall name and address	0.812

Values presented correspond to Pearson's correlations.
All values are significant at $P\leq.001$.

Table 4

Multiple linear regression model for M-ACE

Model	B	SE B	β	t	*P*
(constant)	34.816	2.566		13.57	<.001
Age	−0.160	0.034	−0.391	−4.66	<.001
Education	0.297	0.067	0.369	4.409	<.001

The model extracted from the multiple linear regression accounts age and schooling for 59.7% of the variance observed in M-ACE scores. This means that besides the fact that age and schooling may be correlated with each other,[29] these variables maintain an independent influence on the performance of the test. Therefore, to compare the performance of an individual to the normative sample it is necessary to compute the formulas in order to obtain the expected results according to age and schooling. Afterwards, the *z* score for the total of M- ACE is calculated according to the following formula:

$$\text{z Score} = \left(\frac{\text{Obtained result} - \text{Expected result}}{\text{Standard Deviation}}\right)$$

In Table 5, an example of a 79 years old subject with 6 years of education it is given. The expected result is calculated by using the normative equation and then the *z* score can be obtained using the standard deviation of our sample.

However, the present study holds some limitations. First, by excluding participants with results inferior to 1 standard deviation on ACE, we may have eliminated normal individuals with lower cognitive performance, therefore normative means could have been overvalued; second, not all Portuguese districts are represented in our sample; however, the most recent demographic data[30] show that the majority of the Portuguese population lives in the districts selected for sample recruitment.

Few studies of ACE in normal populations have been reported. This is, to our knowledge, the first study reporting normative data of M-ACE. The availability of M-ACE normative equation based on a healthy sample according to age and education enables the use of a brief screening tool for cognitive functioning. M-ACE does not require formal specialized training, it is a quick test which can be an advantage, for instance, in primary health care consultations.

As stated by Hsieh and coleagues,[15] another major benefit is the fact that the M-ACE was empirically determined and is comprised of items which are within the ACE-III and also in its

Table 5

Example of *z* scores calculation for a 79 years old person with 6 years of education

Formula	Expected result	Obtained result	SD	*z* score
M-ACE (−0.160*79) + (0.297*6) + 34.816	24	21	3.27	−0.9

predecessor, the ACE-R. This fact may enable clinicians to derive M-ACE scores from pre-existing patient data.

In conclusion the Portuguese version of M-ACE has solid psychometric properties enabling its clinical use.

Acknowledgments

None.

Conflicts of interest

The authors declare no conflicts of interest.

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