The Montreal Cognitive Assessment—Basic: A Screening Tool for Mild Cognitive Impairment in Illiterate and Low-Educated Elderly Adults

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OBJECTIVES: To assess the validity of a newly developed cognitive screening tool, the Montreal Cognitive Assessment—Basic (MoCA-B), in screening for mild cognitive impairment (MCI) in elderly adults with low education and varying literacy.

DESIGN: Cross-sectional.

SETTING: Community hospital in Bangkok, Thailand.

PARTICIPANTS: Cognitively normal controls (n = 43) and individuals with MCI according to the National Institute on Aging-Alzheimer's Association work group criteria (n = 42) aged 55 to 80 with less than 5 years of education.

MEASUREMENTS: MoCA-B scores.

RESULTS: Mean MoCA-B scores were 26.3 ± 1.6 for illiterate controls and 21.3 ± 3.8 for illiterate participants with MCI ($P < .001$) and 26.6 ± 2.0 for literate controls and 23.0 ± 2.1 for literate participants with MCI ($P < .001$). MoCA-B scores did not differ significantly according to literacy, and multiple regression suggested no association with age or education. The optimal cutoff score of 24 out of 25 yielded 81% sensitivity and 86% specificity for MCI (area under the receiver operating characteristic curve = 0.90, $P < .001$). Test–retest reliability was 0.91 ($P < .001$), and internal consistency was 0.82. Administration time was 15 to 21 minutes.

CONCLUSION: The MoCA-B appears to have excellent validity and addresses an unmet need by accurately screening for MCI in poorly educated older adults regardless of literacy. **J Am Geriatr Soc 2015.**

Key words: Montreal Cognitive Assessment; mild cognitive impairment; mild cognitive impairment; screening

Mild cognitive impairment (MCI) is conceptualized as a transitional stage between normal aging and dementia. Detecting MCI is important because it allows affected individuals to receive additional support, early intervention, and close monitoring. To facilitate the detection of MCI, many health professionals around the world are using the Montreal Cognitive Assessment (MoCA) because it has been well accepted as a sensitive and efficient screening tool.[1]

The MoCA was originally validated in a sample of individuals with a high level of approximately 13 years of formal education.[2] Several MoCA subtests incorporate tasks that formal education or literacy levels may influence, and as a result, bias may be introduced when illiterate older adults or those with low levels of education effectively underperform. Similar educational biases have been observed, such as with the Mini-Mental State Examination (MMSE), a widely used measure of global cognitive function.[3] Because education and literacy may influence cognitive test performance, dissociating cognitive impairment from normal aging remains challenging when screening for MCI in these groups.

Accurate and well-designed screening measures are needed to support the detection of MCI in illiterate and low-educated individuals. This is an important problem because approximately 16% of the global population, or 773 million adults, were estimated to be illiterate according to a large United Nations Educational, Scientific

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and Cultural Organization survey in 2011.[4] The MoCA—Basic (MoCA-B) was therefore developed to facilitate the detection of MCI in illiterate and low-educated individuals. The present study aimed to establish the validity of the MoCA-B in Thai older adults with limited education and varying literacy levels.

METHODS

MoCA-B Development

The MoCA-B was developed as a collaborative project between the MoCA Clinic and Institute in Canada and the Prince Mahidol Award Foundation and Faculty of Medicine of Chulalongkorn University in Thailand.

Several features were considered in designing the MoCA-B to optimize its ability to detect MCI in individuals with limited education. Literacy-dependent tasks were eliminated, and literacy-independent tasks that measured the same cognitive function were substituted. For example, a fruit fluency task replaced the letter F fluency task to measure lexical storage and mental flexibility, abilities engaging temporal and frontal lobe functions.[5] The Trail-Making Test was simplified by changing the letter–number trail to a number-dot trail, still assessing planning and mental flexibility, which involve frontal lobe circuits.[6] Tasks that education is known to heavily influence, including clock drawing and cube copy, which require planning, constructional skills, and three-dimensional perception, were removed, and a recognition task involving superimposed objects, assessing visuoperceptual skills, was substituted. A problem-solving task that describes a scenario that pertains to daily life replaced serial 7 calculation. The abstraction and similarity task was adapted using pairs of words that require a subordinate degree of abstract thinking to solve. Finally, the animal naming task was simplified by incorporating greater detail regarding the animals to facilitate recognition because literacy affects the process of recognition more than word generation.

A pilot study, using a French-language version of the MoCA-B, was conducted in 10 cognitively intact and 17 cognitively impaired subjects with 12 years of education or less at MoCA Clinic and Institute (Montreal, Canada). The initial results of this pilot suggested that the MoCA-B is likely to be acceptable to clinicians and patients and accurate in screening for MCI in older adults with low levels of education (unpublished data).

Participants

Individuals aged 55 to 80 with less than 5 years of education (N = 85) were recruited at the Sukumarn Anamai Thai Red Cross Health Station 2, a community hospital in Bangkok, Thailand. The ethical review board of the Faculty of Medicine, Chulalongkorn University, approved the study protocol.

The MCI group consisted of 42 subjects who fulfilled the core clinical criteria for MCI due to Alzheimer's disease (AD) according to the National Institute on Aging—Alzheimer's Association criteria[7] The criteria included cognitive decline reported by the individual, an informant, or a physician, with preserved activities of daily living and the absence of dementia. Cognitive and functional decline was objectively determined in a clinical interview with the individual and a caregiver that found a significant change in cognitive and functional skills from previous abilities using the Clinical Dementia Rating Scale (CDR).[8] Individuals with medical, neurological, or psychological conditions having possible cognitive repercussions were excluded. Depression was excluded using the Thai Geriatric Depressive Scale (TGDS). Individuals were excluded if they scored 13 or more on the TGDS,[9] as were individuals currently taking medication with possible cognitive side effects, based on the Anticholinergic Cognitive Burden list. Neuropsychological tests intended for illiterate and low-educated individuals are limited, so the CDR, administered by certified physician who was blinded to MoCA-B score, was the main assessment used to establish the MCI diagnosis.[10] All individuals with MCI had a score of 0.5 out of 3 on the global CDR, with at least 0.5 points for the memory domain. (Higher scores indicate greater impairment.)

The cognitively normal group consisted of 43 healthy subjects who did not have memory complaints. All subjects were screened for medical, neurological, and psychological conditions affecting memory or cognitive functioning. Control participants had a global CDR score of 0 out of 3, which was supported by participant and caregiver interview.

Cognitive Testing

Two well-trained nurses with expertise in cognitive assessment administered the MoCA-B and MMSE according to standard instructions. The nurses were blinded to CDR results and the established clinical diagnosis. The MoCA-B, MMSE, and CDR were administered on the same day or in the same week. To evaluate test–retest reliability, 25 participants (12 controls, 13 MCI) were randomly selected to repeat the MoCA-B within 2 months of the first test.

Montreal Cognitive Assessment—Basic

The MoCA-B is a 30-point test that evaluates six cognitive domains: visual perception (superimposed objects, 3 points), executive functioning (simplified alternating trail making, 1 point; word similarity, 3 points; problem-solving task, 3 points), language (fruit fluency, 2 points; animal naming, 4 points), attention (modified digit Stroop, 3 points), memory (five-word delayed recall, 5 points), and orientation (time and place, 6 points). The MoCA-B (Copyright Z. Nasreddine, MD) is freely available for clinical use in Thai, English, Chinese, and French (www.mocatest.org, visit Basic section).

MMSE Thai Version

The Thai version consists of the same tasks as the original MMSE.[11] The original 0- to 30-point total scale was used for literate participants (controls and MCI). The MMSE tasks that are literacy dependent (attention and calculation, written command and writing were omitted for

illiterate participants, yielding total scores that ranged from 0 to 23.

Statistical Analysis

Chi-square statistics and *t*-tests were calculated to assess possible group differences between controls and participants with MCI on demographics and cognitive test performance.

The accuracy of the MoCA-B in discriminating between controls and participants with MCI was calculated by calculating the area under the receiver operating characteristic (ROC) curve (AUC). This was also calculated for the MMSE to aid in comparison and more specifically to determine whether the MoCA-B is more accurate than the MMSE in participants with low education.

Linear regression analysis was used to investigate whether MoCA-B scores were associated with education, age or cognitive group. Statistical significance was prespecified as a two-tailed test with $P < .05$. All analyses were conducted using SPSS (SPSS, Inc., Chicago, IL).

RESULTS

The demographic characteristics of controls and participants with MCI are shown in Table 1. Multivariable linear regression analysis identified education level to be a predictive factor of MoCA-B total score. To correct for any residual educational bias, if their score was less than 30, 1 point was added to the total score of participants with less than 4 years of education. To correct for literacy, if their score was less than 30, 1 additional point was added to the score of participants considered illiterate, regardless of their education level. Illiteracy was defined as the inability to read or write fluently in daily living. For example, if the participant had 2 years of education but could not read or write, 2 points were added to the total score (1 point for having an education level of less than 4 years and 1 point for meeting the illiteracy criteria). A second multiple regression analysis was conducted after score adjustments. Accordingly, education did not affect MoCA-B total score in this analysis. Moreover, average MoCA-B score did not differ between the literate and illiterate groups (Table 1).

The group with MCI scored significantly lower on all MoCA-B components with the exception of attention, which was the same (2.7 vs 2.9 points, $P = .11$). MoCA-B adjusted totals were significantly lower for the group with MCI than controls in literate and illiterate participants ($P < .001$ for both comparisons). Total MoCA-B score did not significantly vary on the basis of literacy in the MCI ($P = .09$) or control group ($P = .68$).

With a test–retest time frame of 63.9 ± 17.6 days, the difference in MoCA-B total score between the first and second administration was 1.24 ± 1.33 points. The intraclass correlation coefficient between the two evaluations was 0.909 ($P < .001$). The internal consistency of the MoCA-B was also good (Cronbach alpha = 0.816).

ROC analysis of the MoCA-B revealed an AUC of 0.900 ($P < .001$, 95% confidence interval (CI) = 0.836–0.964) to distinguish participants with MCI from controls (Figure 1). The sensitivity and specificity of the MoCA-B at different cutoff scores are shown in Table 2. Using a cutoff score of 25 out of 30, the MoCA-B provided good to excellent sensitivity (86%) and specificity (86%) in detecting individuals with MCI. The positive (85%) and negative (82%) predictive values of the MoCA-B were also satisfactory. Overall accuracy, defined as the ability of the MoCA-B to correctly identify participants with MCI and controls, was 84%.

ROC analysis of the MMSE reported an AUC of 0.702 ($P = .001$, 95% CI = 0.591–0.812), with a sensitivity of 33% and a specificity of 88% for identifying individuals with MCI and 61% overall accuracy.

Table 1. Demographic Characteristics and Performances of Participants with Mild Cognitive Impairment (MCI) and Cognitively Normal Controls

Characteristic	Controls, n = 43	MCI, n = 42	*P*-Value
Demographic			
Female, n (%)	36 (84)	35 (83)	.96
Age, mean ± SD	66.6 ± 6.7	70.2 ± 6.6	.01
Education, year, mean ± SD	3.6 ± 1.1	2.9 ± 1.7	.02
Illiterate, n (%)	7 (16)	21 (50)	.001
Thai Geriatric Depression Scale score, mean ± SD	4.4 ± 3.7	4.8 ± 3.2	.63
Mini-Mental State Examination score, mean ± SD (range)			
Illiterate participants (0–23)	20.3 ± 1.5	18.9 ± 3.0	.24
Literate participants (0–30)	28.0 ± 1.7	26.4 ± 2.6	.01
Montreal Cognitive Assessment—Basic performance, mean ± SD			
Modified Trail-Making Test Part B (0–1 points)	0.56 ± 0.50	0.19 ± 0.40	<.001
Fruit fluency (0–2 points)	1.65 ± 0.53	1.00 ± 0.66	<.001
Orientation (0–6 points)	6.00 ± 0.00	5.52 ± 0.92	.002
Problem-solving task (0–3 points)	3.00 ± 0.00	2.88 ± 0.33	.02
Similarity (0–3 points)	2.12 ± 1.03	0.86 ± 1.07	<.001
Delayed recall (0–5 points)	3.60 ± 1.05	2.55 ± 1.25	<.001
Superimposed object recognition (0–3 points)	2.49 ± 0.67	1.88 ± 0.74	<.001
Animal naming (0–4 points)	4.00 ± 0.00	3.74 ± 0.59	.006
Attention (0–3 points)	2.88 ± 0.32	2.71 ± 0.60	.11
Total score (0–30 points)			
Illiterate participants	26.3 ± 1.6	21.3 ± 3.8	<.001
Literate participants	26.6 ± 1.9	22.9 ± 2.1	<.001
Time used, minutes			
Illiterate participants	16.4 ± 3.1	20.9 ± 5.6	.05
Literate participants	14.6 ± 3.4	17.4 ± 5.7	.05

SD = standard deviation.

DISCUSSION

These results demonstrate the ability of the MoCA-B to differentiate between older Thai adults with and without MCI regardless of literacy. The MoCA-B was found to have good test–retest reliability and internal consistency and could be administered in 15 to 21 minutes.

Literacy and education level have consistently been found to affect cognitive performance on existing tests. Older adults considered to have normal cognition who are illiterate or have few years of education may therefore be misclassified as having MCI because of poor cognitive test performance.[12] A false diagnosis of MCI may engender

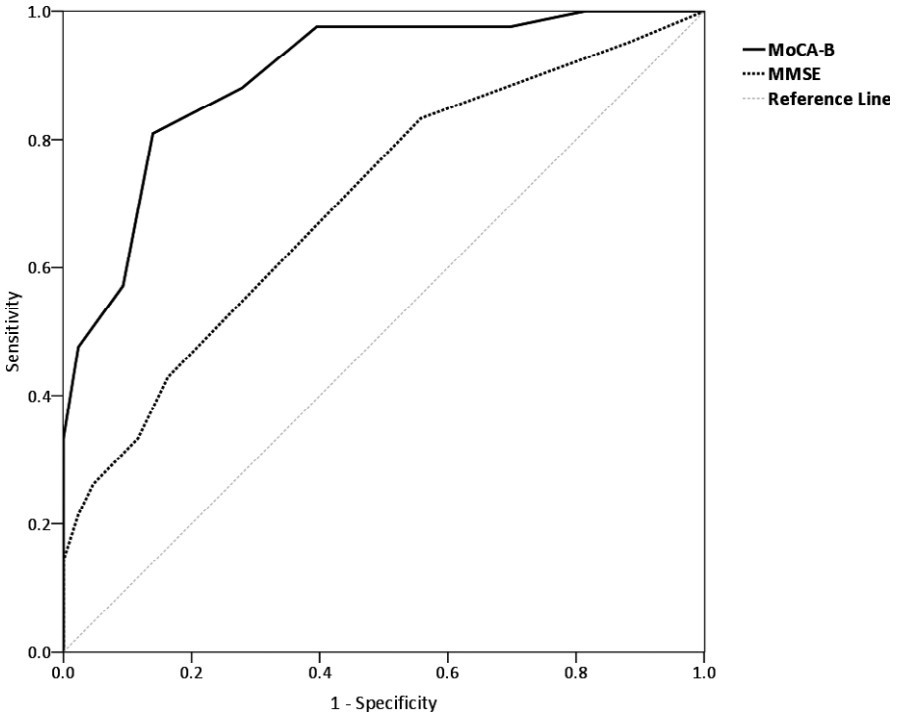

Figure 1. Receiver operating characteristic curves of the (MoCA-B) and Mini-Mental State Examination (MMSE) in detecting mild cognitive impairment.

Table 2. Sensitivity and Specificity of the Montreal Cognitive Assessment—Basic in Detecting Mild Cognitive Impairment Using Different Cutoff Scores

Cutoff score	Sensitivity (%)	Specificity (%)
21/22	33	100
22/23	48	98
23/24	57	91
24/25	81	86
25/26	88	72
26/27	98	60
27/28	98	30
28/29	100	19

stigmatization and lead to social withdrawal.[13,14] Moreover, it may increase clinicians' workloads by triggering unnecessary follow-ups.

Prior attempts to develop cognitive assessments for populations with low levels of education have been reported. Different cutoff scores based on education level were proposed for the MMSE when screening for dementia.[15] The Chinese have adapted the MMSE by modifying literacy-dependent items for subjects with 3 to 4 years of education.[16] The Literacy Independent Cognitive Assessment was recently developed to screen for dementia in an illiterate population.[17,18] The Prueba Cognitiva de Leganés, which assesses memory and orientation, has also shown good validity in detecting dementia.[19] Some studies have used the Informant Questionnaire on Cognitive Decline to screen dementia[20–22] as a stand-alone test or in combination with other cognitive tests. The aim of the above-mentioned tests is to screen for dementia, not MCI. To the knowledge of the authors, the MoCA-B is the first cognitive screening instrument that demonstrates satisfactory validity in detecting MCI in illiterate and low-educated individuals.

The MoCA-B correctly identified cognitively normal participants with a specificity (86%) similar to that of the MMSE (88) but, it had 81% sensitivity to detect MCI, compared with 33% for the MMSE. The MoCA-B's better sensitivity may be attributed to its content, which is more comprehensive than that of the MMSE and is designed to be less dependent upon education and literacy. As a result, the MoCA-B misclassified only 16% of participants, in comparison with 39% for the MMSE. This large difference in accuracy would clearly have important consequences when screening for MCI in populations with high levels of illiteracy and low levels of education, which is important given that two-thirds of individuals with AD reside in middle- to low-income countries, where there is a high rate of illiterate and poorly educated individuals.[23]

Limitations of the present study should be considered. Participants were not followed prospectively to investigate the MoCA-B's ability to predict future cognitive decline or incident dementia or to monitor cognitive decline. Despite strict exclusion criteria to exclude other possible causes of cognitive decline, biomarker testing was not performed. For example, some subjects with MCI due to AD might have had mixed pathology of AD and small vessel disease because neuroimaging was not done. Individuals with AD or other forms of dementia were not included because the primary purpose of the MoCA-B study was to detect individuals with MCI. The CDR has limitations in terms of detecting non-Alzheimer's type pathology, and disease prevalence in the target population can affect test validity. MoCA-B was validated in a clinic of a community hospital in Bangkok and may not perform as well when screening

for MCI in the general population, where MCI prevalence may be lower than in this study population. The results of this study are applicable only to the Thai population. Further studies are needed before the test can be widely recommended for different populations.

In conclusion, the MoCA-B is the first assessment developed to screen for MCI in illiterate elderly adults and those with low levels of education. The MoCA-B assesses multiple cognitive domains in 15 to 21 minutes, is freely available, and has been designed to be easy to administer and interpret. It has excellent sensitivity and specificity and high test–retest reliability and internal consistency. The MoCA-B should assist physicians in a wide range of settings to identify MCI at an early stage, improving access to appropriate support and targeted interventions for dementia prevention.

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