

Psychometric Properties of the Persian Montreal Cognitive Assessment in Mild Cognitive Impairment and Alzheimer Disease

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Keywords

Montreal cognitive assessment · Cognitive screening · Psychometric properties · Mild cognitive impairment

Abstract

Introduction: The Montreal Cognitive Assessment (MoCA) is a cognitive screening test widely used in clinical practice and suited for the detection of Mild Cognitive Impairment (MCI). The aims were to evaluate the psychometric properties of the Persian MoCA as a screening test for mild cognitive dysfunction in Iranian older adults and to assess its accuracy as a screening test for MCI and mild Alzheimer disease (AD).

Method: One hundred twenty elderly with a mean age of 73.52 ± 7.46 years participated in this study. Twenty-one subjects had mild AD (MMSE score ≤ 21), 40 had MCI, and 59 were cognitively healthy controls. All the participants were administered the Mini-Mental State Examination (MMSE) to evaluate their general cognitive status. Also, a battery of comprehensive neuropsychological assessments was administered. **Results:** The mean score on the Persian version of the MoCA and the MMSE were 19.32 and 25.62 for MCI and 13.71 and 22.14 for AD patients, respectively. Using an optimal cutoff score of 22 the MoCA test detected 86% of MCI subjects, whereas the MMSE with a cutoff score of 26 detect-

ed 72% of MCI subjects. In AD patients with a cutoff score of 20, the MoCA had a sensitivity of 94% whereas the MMSE detected 61%. The specificity of the MoCA was 70% and 90% for MCI and AD, respectively. **Discussion:** The results of this study show that the Persian version of the MoCA is a reliable screening tool for detection of MCI and early stage AD. The MoCA is more sensitive than the MMSE in screening for cognitive impairment, proving it to be superior to MMSE in detecting MCI and mild AD.

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Introduction

The ageing population has increased in the last few decades, with a corresponding rise in age-associated neurodegenerative disorders [1, 2]. The number of people affected by dementia is increasing rapidly and it has impact on the economy, health, and community resources [3–5]. Cognitive screening measures need to be able to differentiate normal age-related cognitive changes and pathological changes in cognition [6]. Diagnosis pathological changes in cognition require tools that are easy to administer and interpret and have a high diagnostic accuracy.

Table 1. Demographic characteristics of the study sample

Variable	Control (<i>n</i> = 59)	MCI (<i>n</i> = 40)	AD (<i>n</i> = 21)	<i>p</i> value
Age, years	62.55 (6.7)	68.10 (8.8)	73.66 (7.7)	<0.001
Females, % (<i>n</i>)	61 (36)	67.5 (27)	66.7 (14)	0.77
Education, years	11.67 (5.1)	7.67 (5.1)	8.19 (6.1)	<0.001
Subjective memory complains, % (<i>n</i>)	67.8 (40)	80 (32)	95.2 (20)	0.03

Values are presented as means (SD) unless otherwise stated. ADL, activity of daily living.

The most generally used clinical tool for cognitive assessment is the Mini-Mental State Examination (MMSE), which is not adequate for a more subtle cognitive screening, such as for mild cognitive impairment (MCI). Furthermore, the MMSE does not assess abstraction or complicated executive function abilities, which leads to its poor sensitivity in the early stages of cognitive impairment and depends on the integrity of the frontal lobe and associated structures for performing goal-directed behaviors [7, 8]. Besides, it has been proven that executive functioning can be considered as an early subtle deficit in MCI patients before the clinical representation of the disease [9], so the executive functions are an important cognitive domain in light of an early diagnosis of dementia.

The Montreal Cognitive Assessment (MoCA) was developed by Nasreddine et al. [10] and it evaluates several cognitive domains including visuospatial ability/executive functioning, language, recall, attention, and orientation. Compared to the MMSE, the MoCA has a greater variety of subtests; thus it is probably a more sensitive screening tool to assess cognitive impairment as it takes more cognitive domains into account. Evidence shows that the MoCA distinguishes patients with MCI from the cognitively typical population and it is one of the most widely used cognitive screening tools around the world [10].

The aims of the current study were to examine the psychometric properties of MoCA and to compare its diagnostic accuracy with that of the MMSE in terms of detection of MCI in elderly in light of our current study which considers executive function as an early cognitive disturbance in MCI. We analyzed the differences between MoCA and MMSE scores with equivalent scores and cut-off values for MCI versus AD dementia and the contribution of domain subscores in differentiating MCI from the control group in an Iranian population.

Methods

Participants

Of these 120 participants, 21 had a clinical diagnosis of AD, 40 were diagnosed as having MCI, and 59 comprised the control group. The AD patients had to have an MMSE score <22, and the MCI subjects had to have an MMSE score ≥ 22 and no obvious communication problems. Patients were recruited from 2 memory clinics, i.e., the Rehabilitation Hospital (Tehran, Iran) and the Brain and Cognition Clinic (Tehran, Iran). Control subjects were selected from community-dwelling older adults. The inclusion criterion for the controls was cognitive normality, as defined by a performance within 1 SD in all neuropsychological measures (Table 1). The inclusion criteria for the participants were being 60 years or older and having no salient communication problems. The Geriatric Depression Scale-15 (GDS-15) [11] with a cutoff ≤ 7 , neuropsychiatric comorbidities, cognitive therapy <6 months before this study, and motor, visual or auditory deficits that could influence the cognitive assessment were used as exclusion criteria. The participants with MCI were those who had memory complaints and no impairment of basic functional activities of daily living as measured by the Barthel index [12].

Procedure

All the participants underwent a battery of comprehensive neuropsychological assessments. The diagnosis of patients was based on a multidisciplinary team consensus according to the results of the comprehensive assessment and using the Petersen working group criteria for MCI [13]. The MCI group included patients classified as having amnesic MCI (single or multiple domains) with a clinical dementia rating (CDR) of 0.5. The normal controls had a scored ≥ 24 points on the MMSE. The AD group included only mild to moderate cases (CDR ≤ 2 and MMSE ≥ 12). The control subjects had normal activities of daily living and a normal cognitive function (CDR = 0 and MMSE ≥ 22). The AD participants were diagnosed according to the DSM-5 and presented significant cognitive deficits in both the MMSE and Rey Auditory Verbal Learning Test (RVALT) [14]. See Table 1 for full sample descriptive statistics.

All of the participants were recruited between January 2017 and October 2017, and the MoCA and MMSE questionnaires were administered by 2 gerontologists. The MoCA test evaluates: attention/working memory (target detection task, serial sevens, and forward and backward recall of digits) executive functions (Trails B task, phonemic fluency, and verbal abstraction), episodic memory

Table 2. Group comparison of clinical and cognitive performance

Variable	Control (<i>n</i> = 59)	MCI (<i>n</i> = 40)	AD (<i>n</i> = 21)	<i>p</i> value
ADL	99.57 (1.68)	99.12 (2.47)	97.61 (4.06)	0.055
GDS	3.93 (3.31)	6.20 (3.91)	3.00 (2.30)	0.13
CDR	0.09 (0.10)	0.23 (0.19)	0.70 (0.67)	<0.001
RVALT	7.4 (1.4)	5.73 (1.5)	4.22 (1.1)	<0.001
MMSE	28.13 (1.60)	25.62 (3.22)	22.14 (3.13)	<0.001
MoCA	24.50 (2.95)	19.32 (4.02)	13.66 (3.75)	<0.001

Values are presented as means (SD). ADL, activities of daily living.

Table 3. Regression estimates of the relative contributions of age, education, and diagnosis to the MoCA scores

	MCI				AD			
	regression coefficient	<i>t</i>	<i>p</i> value	η^2	regression coefficient	<i>t</i>	<i>p</i> value	η^2
Age (years)	-0.29	-6.36	<0.001	0.46	-0.18	-2.89	0.006	0.34
Education	0.81	3.84	<0.001	0.28	0.22	2.10	0.05	0.25

(recall task), language (naming task and sentence repetition), and visuospatial skills (clock drawing and 3-dimensional figure copy). MoCA scores range from 0 to 30 points (with the highest score indicating better function).

Results

Study Participants

The mean (\pm SD) age of the controls, the MCI patients, and the AD patients was 62.55 ± 6.78 , 68.10 ± 8.81 , and 73.52 ± 7.46 years, respectively (Table 1). The clinical characteristics of the groups are summarized in Table 2. Between groups, no statistically significant difference was found in terms of gender ($p = 0.77$) or age ($p = 0.06$), though the AD group was younger. There were significant differences in educational level ($p < 0.001$) (the AD group had a lower education level)

The Cronbach α of the MoCA was 0.86 and that of the MMSE was 0.74. In this study, age showed a moderate negative correlation with the MoCA score ($r_{118} = -0.47$; $p < 0.001$), and years of education showed a moderate positive correlation with the MoCA score ($r_{118} = 0.36$; $p \leq 0.01$). However, age and education were not significantly correlated with each other ($p = 0.46$). A regression analysis was used to identify which variables had a significant effect on the MoCA, as shown in Table 3.

MoCA Subscores

A one-way ANCOVA controlling for both age and education showed a significant effect of group on MoCA performance (95% CI 1.35–1.79; $p < 0.0001$), and the post hoc analysis showed that performance differed significantly between all patients and healthy controls had a higher performance compared to the MCI and AD groups (95% CI 0.7–0.81%; $p < 0.0001$). Also, a one-way ANOVA for each of the MoCA domains showed statistically significant differences in scores between all 3 groups ($p < 0.001$). The control group had a higher performance (Table 4). The 95% CI of the MoCA subscores for each group are displayed in Figure 1. Post hoc analyses showed that the scores of the control group were significantly higher than those of the patients with MCI and mild AD ($p < 0.001$). ROC curve analysis showed that the MoCA is a more sensitive instrument than the MMSE in distinguishing individuals with MCI from normal controls (AUC = 0.85) and individuals with AD from normal controls (AUC = 0.99). According to the Youden index, the optimal cutoff for distinguishing individuals with MCI from controls for the MOCA was 22 points.

Table 5 shows AUC values for the MoCA and MMSE tests for discriminating controls from patients with MCI and mild AD. According to the AUC, the discriminant potential of the MoCA for MCI was high, with an AUC

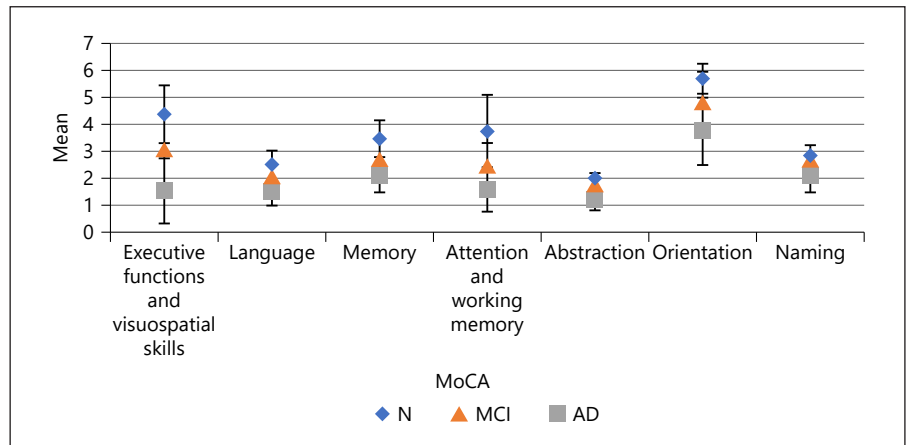


Fig. 1. Point and interval estimates of the MoCA subscore. The 95% CI of the MoCA subscores in the normal controls and MCI and AD patients are shown.

Table 4. Mean MoCA domain scores and SD and results of one-way ANCOVA controlling for age and education with 95% CI

Cognitive domains	Normal (n = 56)	MCI (n = 40)	AD (n = 21)	p value ^a	p value ^b (normal vs. MCI)	p value ^b (normal vs. AD)	p value ^b (MCI vs. AD)
Executive function and visuospatial skills	4.38 (1.08)	3.05 (1.43)	1.52 (1.20)	<0.001	<0.001	<0.001	<0.001
Language	2.50 (0.53)	2.05 (0.59)	1.47 (0.51)	<0.001	<0.001	<0.001	<0.001
Memory	3.47 (0.67)	2.65 (0.76)	2.09 (0.62)	<0.001	<0.001	<0.001	<0.001
Attention and working memory	3.76 (1.34)	2.45 (0.87)	1.57 (0.81)	<0.001	<0.001	<0.001	<0.001
Abstraction	1.98 (0.13)	1.77 (0.42)	1.19 (0.40)	<0.001	<0.001	<0.001	<0.001
Orientation	5.71 (0.55)	4.82 (1.15)	3.76 (1.26)	<0.001	<0.001	<0.001	<0.001
Naming	2.83 (0.37)	2.55 (0.50)	2.09 (0.62)	<0.001	<0.001	<0.001	<0.001

^a ANCOVA. ^b Bonferroni post hoc analysis.

Table 5. Diagnostic properties of the MoCA

Psychometric properties	Cutoff	AUC	Sensitivity, %	Specificity, %	PPV, %	NPV, %
MCI						
MoCA	<22	0.85	86.4	70.0	81	77.8
MMSE	<26	0.73	72.9	67.5	76.8	62.8
AD						
MoCA	<20	0.99	94.9	90.5	96.6	94.9
MMSE	<22	0.95	61.9	38.1	81.9	100

NPV, negative predictive value; PPV, positive predictive value.

of 0.85, and that for AD was excellent, with an AUC of 0.99. In contrast, the corresponding values for the MMSE were 0.73 and 0.95. Figure 2 provides a graphic visualization of the ROC curve analysis.

Discussion

The present study aimed to investigate the psychometric properties and discriminant validity of the MoCA test. This test has been widely used due to its brevity, simplicity, and reliability for diagnosing MCI and AD. In this

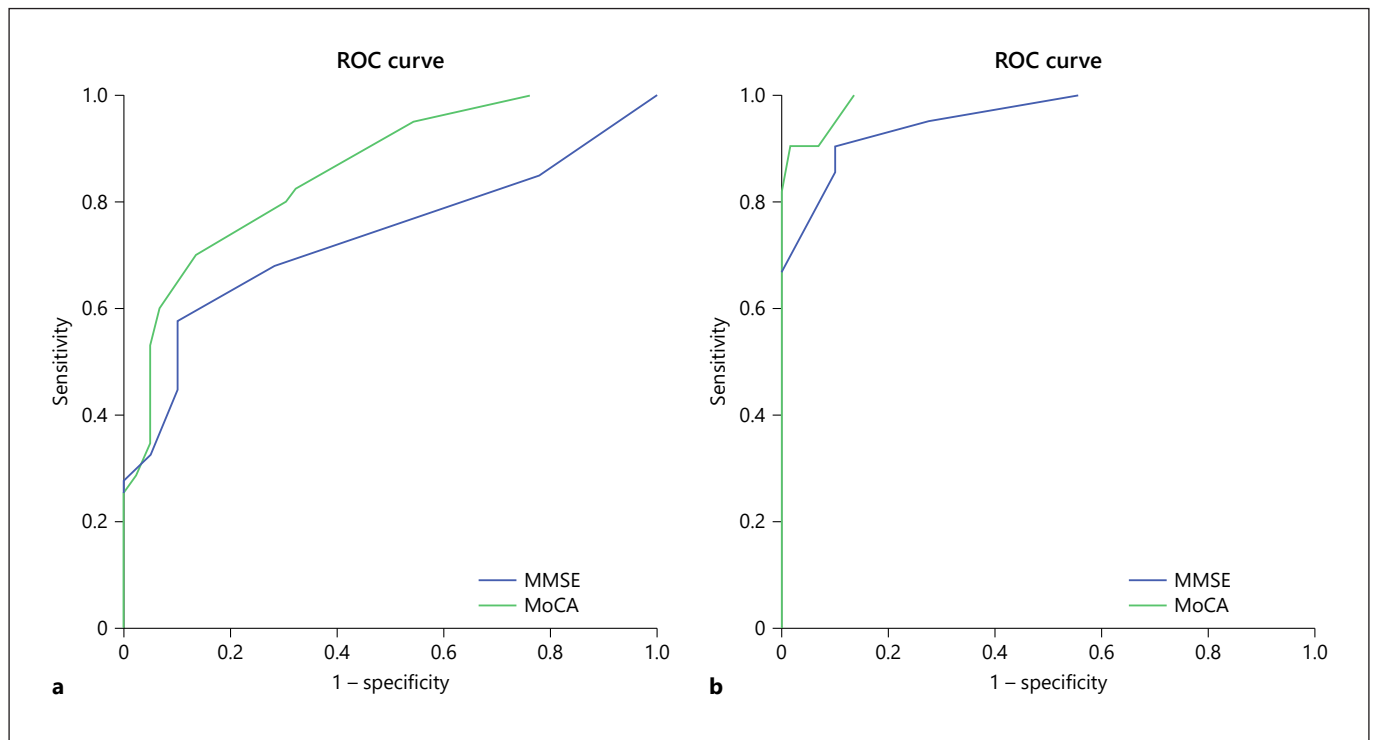


Fig. 2. ROC curves of the MoCA and the MMSE to distinguish MCI patients from normal controls (a) and AD patients from normal controls (b).

study the MoCA was evaluated in a sample of 120 individuals and compared with the MMSE. A comparison between the accuracy of the MoCA and that of the MMSE as a cognitive tracking test revealed that the MoCA has better psychometric properties. In addition to being strongly correlated with the overall MMSE score, the MoCA showed a good internal consistency, with a Cronbach α of 0.74, like in previous studies [15–19]. In the current investigation, a significant statistical difference in the performance on the MoCA was found between cognitively healthy individuals, patients with MCI, and patients with mild AD, compatible with other studies [6, 15, 20, 21].

Our results indicate, in line with previous studies [6, 22, 23], that the Persian version of the MoCA has a high validity for detecting individuals with AD. This result is consistent with the recognized benefits of the MoCA in detection of the early stages of cognitive impairment [18–20, 24], suggesting that the MoCA is a more adequate tool for detection of MCI in the Iranian population. These findings are in consensus with studies from other countries that have revealed that, compared with the MMSE, the MoCA is more sensitive in detecting MCI in different

settings and conditions [18, 22, 24]. In contrast, studies conducted in other countries have shown that the MMSE presents a low accuracy as a tracking test for MCI in the early stage [25, 26]. The ROC analyses of the MoCA revealed its ability to classify patients as cognitively normal controls with acceptable sensitivity (86%) and specificity (70%). Compared with the MMSE, in our study the MoCA was more sensitive in detecting MCI in different settings and conditions, which was in line with previous studies [22, 24]. These findings are in consensus with other studies from different countries that have revealed that, compared with the MMSE, the MoCA test is more sensitive in detecting MCI in different settings and conditions [18] and this justifies its clinical use. However, the cutoffs of 20 for AD and 22 for MCI that we found in the present study are lower than the cutoff of 26 proposed in the study of Nasreddine et al. [10] and similar studies [27–29].

The cutoff point of 26 for detecting MCI proposed in the original MoCA is highly sensitive in distinguishing MCI from normal cognitive aging, but it may increase the risk of falsely classifying cognitively normal subjects as being impaired [30]. Our attained cutoff point is in agreement with studies recommending a lower cutoff point for

the MoCA [31, 32]. Our findings are more similar to those of Luis et al. [28], who proposed 23 as the cutoff score for the US-MoCA test, with a high sensitivity (96%) and specificity (95%) to detect mild cognitive deficits in the aging population. This lower cutoff point may compensate for the lower specificity with the original MoCA cutoff point [18]. Paul et al. [32] also confirmed that the original cut-off score performed normally in MRI brain scanning. Differences in the MoCA cutoff score in different subjects are probably related to age, education, and linguistic factors [33].

The MoCA consists of a few separate tasks that assess different cognitive domains [18]. It is a well-designed objective screening test that assesses different cognitive domains that are important in cognitive screening measures. [18]. More importantly, the MoCA measures an important component of dementia that's not measured by the MMSE, i.e., executive function [34]. Previously we demonstrated that executive function was one of the early domains affected in MCI and it had high sensitivity for early detection of MCI [9]. Within the subdomain evaluation, the control and MCI and AD groups showed statistically substantial differences in all domains. The trail-making subscale of the MoCA evaluates the integrity of a few executive functions including planning, attention, and inhibition that are related to frontal lobe impairments and the prefrontal cortex. Many studies have proven that MCI subjects are characterized by an executive disorder that presents early in the course of the disease, while the pathology does not have a clinical manifestation [9, 21].

Like in other studies [35, 36], the subjects' educational level in our study was positively correlated with the MoCA scores. The MoCA might be biased and people with a higher education would perform better. This may result from a lower cognitive reserve in less educated people and a lessened ability to recruit a neural network to compensate for age-related cognitive changes [33]. Although in some studies the level of education has been positively associated with the total MoCA score, that may be related to the cognitive reserve in more educated persons. To minimize the effect of educational levels on the MoCA score, we used education as a confounding factor in ANCOVA (Table 3). Interestingly, excluding the educational background in the ANCOVA, the mean scores on the MoCA for MCI and AD patients were still significantly different from those of the normal elderly group, which may indicate that the differences between MoCA scores in the MCI patients and controls are not a result of the educational background. Nevertheless, the educational level does not necessarily represent premorbid intellec-

tual functioning, and professional status as an opportunity for many people from past generations to obtain a higher education might have been constrained by psychosocial factors such as family income [37].

Overall, this study is the first to suggest the use of the Persian MoCA for early detection of MCI. Since the MoCA assesses executive function, which is disrupted early in the development of dementia, we strongly suggest the use of the MoCA as a promising test for early detection of MCI, especially combined with other executive function tests.

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Statement of Ethics

This study was approved by the Ethics Committee of the University of Social Welfare and Rehabilitation Sciences of Tehran, Iran (ref. No. IR.USWR.REC.1395.250). Written and informed consent was provided by the participants before the examination.

Disclosure Statement

The authors declare no potential conflict of interests.

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Author Contributions

V.R.: preparation and writing of this manuscript, M.F.: project design. N.C.: writing of this paper, collection of data, and project design.

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