



## Comparing the Sensitivity, Specificity, and Predictive Values of the Montreal Cognitive Assessment and Mini-Mental State Examination When Screening People for Mild Cognitive Impairment and Dementia in Chinese Population



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### ABSTRACT

**Background:** The study compared the sensitivity, specificity, and diagnostic value of the Montreal Cognitive Assessment (MoCA) and Mini-Mental State Examination (MMSE) in screening for mild cognitive impairment (MCI) and dementia.

**Methods:** A cross-sectional descriptive design was used, and 142 participants were screened for MCI and mild dementia by using the MoCA and MMSE. The receiver operating characteristic curves and the cutoff scores with the largest area under the curve (AUC) were determined and compared to calculate the sensitivity, specificity, and diagnostic value (positive predictive value [PPV] and negative predictive value [NPV]).

**Results:** The optimal MoCA cutoff scores for MCI and dementia were 24 and 20, respectively. According to these scores, the sensitivities were 0.88 and 0.79, the specificities were 0.74 and 0.80, the AUCs were 0.91 and 0.87, the PPVs were 0.93 and 0.74, and the NPVs were 0.74 and 0.87, respectively. The optimal cutoff MMSE scores for MCI and dementia were 27 and 24, respectively. Hence, the sensitivities were 0.88 and 0.84, the specificities were 0.70 and 0.86, the AUCs were 0.88 and 0.89, the PPVs were 0.94 and 0.80, and the NPVs were 0.81 and 0.88, respectively.

**Conclusion:** In the Chinese population, the MoCA is more efficient in screening for MCI than for dementia, whereas the MMSE is more efficient in screening for dementia than for MCI. The MoCA and MMSE can be used by clinical staffs for quick and accurate cognitive impairment screening, thus facilitating early and appropriate clinical intervention and treatment.

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The prevalence rate of dementia increases as the global population ages. According to the World Health Organization, 36 million people in 2012 had a diagnosis of dementia worldwide (prevalence rate, 4.7%). The prevalence rates in the Americas and Asia are 6.5–8.5% and 4.2–7.0%, respectively. For adults older than 65 years, the prevalence rate nearly doubles every 5 years (*Alzheimer's Disease International, 2009*). Dementia can cause elderly people to become disabled or institutionalized, thereby increasing burdens on caretakers. Therefore, accu-

rate and early diagnosis and proper intervention benefit both patients and family members. Although several screening instruments have been used to detect dementia, the Montreal Cognitive Assessment (MoCA) and the Mini-Mental State Examination (MMSE) are specifically widely used in the early screening for dementia in Chinese population. Dementia is most commonly diagnosed used by the MMSE and is acknowledged as the gold standard for cognitive screening. The major advantage of the MoCA is its sensitivity for both mild cognitive impairment (90% sensitivity) and mild dementia (100% sensitivity) (*Nasreddine et al., 2005*). *Tables 1 and 2* list the findings of previous studies on the reliability, validity, sensitivity, specificity, and predictive value (positive predictive value [PPV] and negative predictive value [NPV]) of multilingual versions of the MoCA and MMSE. According to *Table 1*, the MMSE consists of 7 cognitive domains; orientation, registration, attention, calculation, memory, language, and visual construction. In addition to the aforementioned 7 cognitive domains, executive

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**Table 1**  
MoCA and MMSE for Dementia Assessment.

Tool/author (year)	Items/time	Method	Areas assessed										Reliability			
			Memory	Attention	Orientation	Calculation	Language	Registration	Executive function	Conceptual thinking	Visuospatial structure	Cronbach's $\alpha$	Test-retest	Inter-rater		
MoCA Nasreddine et al.(2005)	12 items/ 15 minutes	✕	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0.72–0.87	0.86–0.96	0.87–0.95
MMSE Folstein et al.(1975)	11 items/ 10 minutes	✕	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0.68–0.96	0.74–0.99	0.83

NOTE "✕": test and interview administered by clinicians or trained professionals; "✓": areas covered; MoCA = Montreal Cognitive Assessment; MMSE = Mini-Mental State Examination.

functions and conceptual thinking domains are added in the MoCA. Both instruments demonstrated good internal consistency, test retest reliability, and inter-rater reliability. According to Table 2, the MoCA has a higher sensitivity, specificity, positive predictive value, and negative predictive value than the MMSE especially for screening people with MCI and mild AD (Nasreddine et al., 2005; Wong et al., 2009). However, because of cultural differences in Eastern and Western countries, it is critical for optimal usage to further examine the sensitivity, specificity, and psychometric properties of the two instruments across a broad range of cognitive dysfunctions in Chinese clinical settings.

**MONTREAL COGNITIVE ASSESSMENT**

The MoCA is a psychiatric instrument developed by Nasreddine et al. (2005) for assessing mild cognitive impairment (MCI). The current version comprises eight cognitive functions: attention and concentration, executive functions, memory, language, visuoconstructional abilities, conceptual thinking, calculations, and orientation. The internal consistency based on Cronbach's  $\alpha$  is 0.72–0.87, the test–retest reliability is 0.86–0.96, and the inter-rater reliability is 0.87–0.95 (Hu et al., 2013; Wong et al., 2009).

The MoCA has been translated into several languages and demonstrates high sensitivity and specificity in assessing MCI (Tables 1 and 2). For assessing MCI, the cutoff score is 26, the sensitivity of the original MoCA version is 0.90, the PPV is 0.89, and the NPV is 0.91 (Nasreddine et al., 2005). For the multilingual MoCA versions, the cutoff score is

22–27, the sensitivity is 0.89–0.92, and the specificity is 0.78–0.85 (Hu et al., 2013; Lee et al., 2008; Tsai et al., 2012).

For assessing dementia, the cutoff score is 21–26, the sensitivity is 0.92–1.00, the specificity is 0.87–0.96 (Hu et al., 2013; Nasreddine et al., 2005; Tsai et al., 2012), the PPV is 0.88–0.89, and the NPV is 1.00 (Nasreddine et al., 2005; Tsai et al., 2012) of the MoCA.

Tsai et al. (2012) translated the MoCA into Chinese, and the translated version (MoCA-T) demonstrates high reliability and validity. For assessing MCI, the optimal cutoff score of the MoCA-T is 23–24, area under the curve (AUC) is 0.91 (95% confidence interval [CI]: 0.86–1.00), sensitivity is 0.92, specificity is 0.78, PPV is 0.88, and NPV is 0.94. The MoCA-T is more efficient than the MMSE for assessing MCI. For assessing dementia, the MoCA-T cutoff score is 21–22, AUC is 0.99 (95% CI: 0.98–1.00), sensitivity is 0.98, specificity is 0.95, PPV is 0.88, and NPV is 1.00.

**MINI-MENTAL STATE EXAMINATION**

The MMSE, the most commonly used instrument for assessing cognitive function, includes orientation, memory, calculation and attention, registration, language, and visuospatial function (Folstein, Folstein, & McHugh, 1975). For assessing MCI, the optimal MMSE cutoff scores ranged 23–28. Some differences have been observed in the sensitivity, specificity, and predictive value. For assessing dementia, the MMSE cutoff score is 24–26, sensitivity is 0.89–0.95, and specificity is 0.87–0.98 (Blesa et al., 2001; Dong et al., 2012; Tsai et al., 2012).

**Table 2**  
Sensitivity and Specificity Analysis of the MoCA and MMSE.

		n	Cut-off point	Sensitivity	Specificity	AUC	PPV	NPV	
MoCA	Hu et al. (2013)	146							
	<Chinese version>								
		Normal	84	26/27	0.92	0.85	–	–	–
		MCI	72	25/26	0.92	0.96	–	–	–
		Dementia	38						
	Tsai et al. (2012)	71	23/24	0.92	0.78	0.91	0.88	0.94	
	<Taiwanese version>								
		Normal	98	21/22	0.98	0.95	0.99	0.88	1.00
		MCI	115						
	Lee et al. (2008)	37	22/23	0.89	0.84	–	–	–	
<Korean version>									
	Dementia	44							
Nasreddine et al. (2005)	Normal	90							
	MCI	94	26	0.90	–	–	0.89	0.91	
	Mild AD	93	26	1.00	0.87	–	0.89	1.00	
MMSE	Dong et al. (2012)	Normal	33						
		MCI	61	23/24	0.72	0.83	0.84	0.72	0.83
		Dementia	136						
	Tsai et al. (2012)	Normal	38						
		<Taiwanese version>							
		MCI	71	27/28	–	0.63	–	–	–
		Dementia	98	25/26	0.95	0.98	–	–	–
	Blesa et al. (2001)	Normal	253						
		MCI	86						
		Dementia	111	24/25	0.89	0.87	–	–	–

MoCA = the Montreal Cognitive Assessment; MMSE = the Mini-Mental State examination; MCI = mild cognitive impairment; AD = Alzheimer's disease; AUC = area under curve; PPV = positive predictive value; NPV = negative predictive value.

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