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Cognitive Function Tests: Application of MMSE and MoCA in Various Clinical Settings - a Brief Overview

Piotr Oleksy[1], Karol Zieliński[2], Bartosz Buczkowski[3], Dominik Sikora[4], Ewa Góralczyk[5], Adam Zając[6], Magdalena Mąka[7], Łukasz Papież[8], Jakub Kamiński [9]

[1] Medical University of Silesia in Katowice, Faculty of Medical Sciences in Katowice, ul. księcia J. Poniatowskiego 15, 40-055 Katowice, śląskie, Poland
ORCID https://orcid.org/0009-0008-0567-0317 email poleksy99@gmail.com

[2] Medical University of Silesia in Katowice, Faculty of Medical Sciences in Katowice, ul. księcia J. Poniatowskiego 15, 40-055 Katowice, śląskie, Poland
ORCID https://orcid.org/0009-0009-6069-8053 email karolz2001@interia.pl

[3] Medical University of Silesia in Katowice, Faculty of Medical Sciences in Katowice, ul. księcia J. Poniatowskiego 15, 40-055 Katowice, śląskie, Poland
ORCID https://orcid.org/0009-0001-8065-632X email bartosz.buczkowski.26@gmail.com

[4] Medical University of Silesia in Katowice, Faculty of Medical Sciences in Katowice, ul. księcia J. Poniatowskiego 15, 40-055 Katowice, śląskie, Poland
ORCID https://orcid.org/0009-0006-8604-1605 email sdominik808@gmail.com

[5] Medical University of Silesia in Katowice, Faculty of Medical Sciences in Katowice, ul. księcia J. Poniatowskiego 15, 40-055 Katowice, śląskie, Poland
ORCID https://orcid.org/0009-0006-9573-0381 email egoralczykk@gmail.com

[6] Medical University of Silesia in Katowice, Faculty of Medical Sciences in Katowice, ul. księcia J. Poniatowskiego 15, 40-055 Katowice, śląskie, Poland
ORCID https://orcid.org/0009-0003-1131-8700 email azajac677@gmail.com

[7] Medical University of Silesia in Katowice, Faculty of Medical Sciences in Katowice, ul. księcia J. Poniatowskiego 15, 40-055 Katowice, śląskie, Poland
ORCID https://orcid.org/0009-0002-8702-9406 email midzia1773@gmail.com

[8] Medical University of Silesia in Katowice, Faculty of Medical Sciences in Katowice, ul. księcia J. Poniatowskiego 15, 40-055 Katowice, śląskie, Poland
ORCID https://orcid.org/0009-0000-1235-0057 email lukaszpap14@gmail.com

[9] Medical University of Silesia in Katowice, Faculty of Medical Sciences in Katowice, ul. księcia J. Poniatowskiego 15, 40-055 Katowice, śląskie, Poland
ORCID https://orcid.org/0009-0006-4725-5977 email kaminskijakub34256@gmail.com

Abstract:

Introduction:

Cognitive impairment can emerge as part of aging or from conditions affecting brain function, such as stroke, brain tumors, delirium, and neurodegenerative diseases. Effective cognitive assessment in clinical practice requires brief, reliable tests that evaluate specific cognitive domains. The MMSE (Mini-Mental State Examination) and MoCA (Montreal Cognitive Assessment) are among the most frequently used tools for these evaluations, each offering unique insights.

Purpose of Research:

This study aims to compare the effectiveness of MMSE and MoCA in diagnosing cognitive impairment and determining their suitability in various clinical settings and patient profiles.

Materials and Methods:

The analysis includes 61 articles from databases such as PubMed and Scopus, identified using keywords: Neuropsychological Tests, Cognitive Function Tests, MMSE and MoCA.

Basic Results:

The results indicate that MMSE, while effective for initial dementia screening, is less sensitive to mild cognitive impairment and influenced by education and age. MoCA offers higher sensitivity for MCI and early Alzheimer's stages, making it valuable as a complementary tool to MMSE.

Conclusions:

Combining MMSE and MoCA assessments can enhance diagnostic accuracy across diverse clinical contexts. Each tool’s unique strengths contribute to a more comprehensive cognitive assessment approach, optimizing diagnostic strategies for specific patient needs.

Keywords: Neuropsychological Tests; Cognition; Mental Status and Dementia Test; Cognition Disorders; Dementia

Introduction

Cognitive assessment entails the examination of numerous mental abilities, particularly learning and memory, attention, concentration, language, sensation, perception of stimuli, and executive functioning (Harvey 2019). Impairment in these functions may manifest in any disease process resulting in structural or metabolic brain disorders, such as head injury, brain tumor, stroke, delirium, or dementia. The cornerstone of reliably diagnosing cognitive impairment lies in integrating three components: patient complaints and observations, a reliable informant account, and the results of cognitive tests (Slater and Young 2013). In 1975, Folstein introduced the first comprehensive test for assessing cognitive abilities. Since then, the Mini-Mental State Examination has remained one of the fundamental instruments for the assessment of cognitive function (Ismail et al. 2010).

To date, numerous tests evaluating cognitive function have been developed, providing healthcare professionals with a diverse array of instruments for conducting accurate cognitive assessments. Each of these tests assesses different domains of cognitive function, including temporal and spatial orientation, attention, concentration, calculation abilities, short-term memory, and language abilities. The sensitivity and specificity of different tests in detecting impairment across cognitive domains may vary. In different clinical scenarios, certain cognitive domains may be affected while others remain relatively intact. These differences underscore the varied clinical utility of cognitive tests across multiple contexts (Velayudhan et al. 2014). This review aims to compare three widely used cognitive assessment tools - the Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) - focusing on their advantages, limitations, and effectiveness in different clinical applications.

Mini-Mental State Examination

The MMSE, first published by Folstein in 1975, represented a significant advancement over prior cognitive function assessment tools, which mainly assessed spatial orientation and short-term memory. The MMSE remains a fundamental tool for evaluating cognitive function and is still widely used in clinical practice as a screening and diagnostic tool for cognitive impairments and dementia. It also serves as a reference point for comparing other cognitive function assessment tools. The MMSE comprises five parts that evaluate the following cognitive functions: orientation in place and time (10 points), registration (3 points), attention and calculation abilities (5 points), short-term memory (3 points), and language skills (9 points), with a maximum score of 30 points (Ismail et al. 2010). Table 1 summarizes the characteristics of each test, with their pros and cons in the context of clinical settings.

Table 1. Comparison of Cognitive Assessment Tools: MMSE and MoCA.

Feature	**MMSE**	**MoCA**
Primary Use	Screening and diagnosing cognitive impairment and dementia	Initial assessment of mild cognitive impairment (MCI)
Domains Assessed	Visuospatial orientation, registration, attention, calculation, short-term memory, language	Short-term memory, attention, concentration, working memory, orientation, language, executive functions, visuospatial abilities
Sensitivity	High for moderate-to-severe cognitive impairments, sensitivity ~81.1% for dementia	High for MCI (80.48%) and early Alzheimer's disease (100%)
Specificity	Specificity ~82.8% for dementia; lower for mild cognitive impairments	Specific for MCI (81.19%) and early Alzheimer's disease (87%)
Reliability	High test-retest reliability (Pearson correlation ~0.887)	Consistent and more reliable for MCI detection than MMSE
Limitations	Sensitive to education and intelligence; limited detection of executive function impairments	Less effective in schizophrenia and HIV-related cognitive impairment
Scoring Complexity	Simple scoring, max score of 30	Standard cutoff of 26 points; can adjust cutoffs based on specific conditions
Administration Time	Short, widely used in outpatient settings	Slightly longer than MMSE but more detailed

Advantages	Widely accepted; good for moderate-severe impairment; suitable as a benchmark	High diagnostic accuracy for MCI and early dementia; broad assessment range
Best Suited For	Dementia and cognitive impairment screening, particularly moderate-severe cases	Early diagnosis of MCI and mild Alzheimer's disease, post-stroke assessment
Limitations in Specific Disorders	Limited for Parkinson's disease (PD) and delirium detection	Less effective in HIV and schizophrenia
Utility for Predicting Progression	Limited in predicting MCI progression to dementia; poor correlation with MCI conversion risk	High prognostic value in detecting post-stroke cognitive impairment

An analysis of 149 studies on the use of the MMSE in dementia diagnosis confirmed that it has a high average sensitivity of approximately 81.1% and specificity of 82.8%. The area under the receiver operating characteristic (ROC) curve was 92%, confirming the high diagnostic utility of this test (Tsoi et al. 2015). The MMSE also exhibits high test-retest reliability, with a Pearson correlation coefficient of 0.887, indicating its accuracy in repeated use. It demonstrates high internal consistency, with a Cronbach's alpha value of approximately 0.86 and a kappa value around 0.97, signifying that the MMSE is a reliable tool for repeated assessments of cognitive function (Harvan and Cotter 2006). However, the MMSE has limitations. It is sensitive to the patient's level of education and intelligence, which may lead to skewed results. Higher education and intelligence levels often produce false-negative outcomes, while advanced age, lower education levels, difficulties in processing visual and auditory information, and ethnic background more frequently result in false-positive outcomes (Bravo and Hébert 1997).

Given these differences, MMSE results should be adjusted based on the patient's age and education. The commonly used cutoff scores (24–26 points) may not be appropriate for older individuals with low education levels. According to some authors, a cutoff score of 14–15 is associated with 78.7% sensitivity and 77.8% specificity in diagnosing dementia among participants with low education levels (Scazufca et al. 2009). Additionally, the MMSE's reliance on visuospatial and language executive functions primarily associated with the dominant hemisphere limits its sensitivity in detecting impairments in other regions of the central nervous system. While the MMSE is valuable in detecting dementia and mild

cognitive impairment (MCI), studies comparing it with other tests, such as the Mini-Cog and the Addenbrooke's Cognitive Examination-Revised (ACE-R), have found that these tests achieve higher diagnostic sensitivity in dementia recognition. The Mini-Cog, despite comparable effectiveness, offers greater practical utility due to its speed and simplicity. While other tests also have limitations, these findings suggest the presence of alternative diagnostic
A meta-analysis indicating that the MoCA is a significantly more useful and reliable tool than the MMSE for detecting MCI. In MCI diagnosis, the MoCA demonstrated a sensitivity of approximately 80.48% and specificity of about 81.19%, while the MMSE's sensitivity was around 66.34%, and its specificity was approximately 72.94% (Ciesielska et al. 2016). Other meta-analyses and systematic reviews have confirmed MoCA's superiority over the MMSE in diagnosing MCI (Jia et al. 2021; Pinto et al. 2019). This suggests that in coming years, the MoCA may be a more suitable tool for evaluating patients presenting with MCI compared to the MMSE (Chun et al. 2021). Both tools, however, are subject to education-related bias, which may lead to excessive cases of suspected MCI. Additionally, the MMSE has limited utility in assessing the risk of MCI progression to dementia. An analysis of 11 studies assessing the effectiveness of the MMSE in evaluating the risk of MCI progression to dementia found an average sensitivity of 40% and an average specificity of 88%. For the risk of progression to Alzheimer's Disease (AD) dementia, the MMSE's sensitivity was 54% and specificity was 80%. These results indicate that the MMSE is poorly correlated with MCI progression risk and should not be used as a standalone diagnostic tool (Arevalo-Rodriguez et al. 2015).
The MMSE's use in diagnosing delirium is also limited. An analysis of 13 studies showed that the MMSE is less accurate than other tools in recognizing delirium. It should not be used as a standalone test for confirming delirium diagnosis, although it can be used as an initial screening test to exclude delirium in low-risk patients (Mitchell et al. 2014). In Parkinson's disease (PD), the MMSE also has limited sensitivity for detecting cognitive impairments. Studies have shown that many PD patients scoring >26 points on the MMSE, indicating normal cognitive function, actually exhibit cognitive impairment symptoms consistent with Parkinson's disease dementia according to the International Parkinson and Movement Disorder Society (Burdick et al. 2014). Therefore, the MMSE is likely an unreliable tool for assessing cognitive impairments in PD, and its use in this context should be supplemented with a comprehensive neuropsychological assessment using other tools (Mamikonyan et al. 2009).
In diagnosing cognitive impairments after a stroke, both the MMSE and MoCA have proven effective. The MMSE is most effective in detecting post-stroke dementia (PSD) with a cutoff of 23–24 points. However, its sensitivity is limited in identifying mild cognitive impairment after a stroke (post-stroke MCI or PSCI). The MoCA, in this context, has shown significantly greater sensitivity and diagnostic utility (Suda et al. 2020). Studies have highlighted the MMSE's significant utility in assessing cognitive impairments resulting from damage to the left middle cerebral artery and thalamus, as these brain regions are associated with cognitive functions assessed in the MMSE. However, it is less sensitive to impairments from damage to other brain regions. Here, the MoCA serves as a complementary tool, sensitive to various types of cognitive impairments (Weaver et al. 2021). The MMSE also effectively serves as an

indicator of long-term PSD and PSCI risk, with MMSE scores at one month post-stroke predicting cognitive deficits persisting up to 24 months (Bour et al. 2010).

Despite the utility of both tests, there is no universally defined standard for evaluating post-stroke cognitive impairments, which complicates the diagnosis of PSD and PSCI. Notably, the MMSE and MoCA were designed for screening and outpatient diagnosis of cognitive impairments, not specifically for assessing cognitive dysfunction in post-stroke conditions. As such, a standardized diagnostic tool adapted for PSD and PSCI assessment remains lacking (Kosgallana et al. 2019).

Montreal Cognitive Assessment

The Montreal Cognitive Assessment was developed for the brief initial assessment of mild cognitive impairment. It evaluates cognitive functions including short-term memory, attention, concentration, working memory, temporal and spatial orientation, language abilities, visuospatial executive functions, and general executive functions (Ismail et al. 2010). Unlike the MMSE, most studies have found that age and education level do not significantly affect MoCA scores, though some data suggest that gender may have a notable impact (Wu et al. 2014).

A meta-analysis assessing the sensitivity and specificity of the MoCA in differentiating MCI in individuals over 60 demonstrated that the optimal cutoff score was 24 - 25 points, with a sensitivity of 80.48% and specificity of 81.19%. The ROC analysis for MoCA revealed an AUC of 0.846, indicating it is significantly more effective for MCI diagnosis than the MMSE, which had an AUC of 0.736 (Ciesielska et al. 2016). Other studies confirm MoCA's high utility in diagnosing MCI, making it a more precise diagnostic instrument than the MMSE (Jia et al. 2021; Pinto et al. 2019; Nasreddine et al. 2005). MoCA also proves highly specific in detecting early Alzheimer's disease (AD), with a sensitivity of 100% and specificity of 87% (Nasreddine et al. 2005). Therefore, the authors recommend MoCA as a complementary tool to the MMSE for early MCI and AD diagnosis due to its higher sensitivity in detecting these conditions, while MMSE is better suited for assessing more advanced stages of AD (Nasreddine et al. 2005).

The MoCA is also highly valuable in identifying cognitive impairments in patients with Parkinson's disease, including both mild cognitive impairment in Parkinson's disease (PD-MCI) and Parkinson's disease dementia (PD-D) (Brown et al. 2016). Multiple studies confirm the MoCA's superiority over the MMSE in detecting PD-MCI and PD-D. The optimal cutoff for PD-MCI is 26 points, yielding 90% sensitivity and 75% specificity, while for PD-D, the cutoff is 21 points, with 81% sensitivity and 95% specificity, surpassing MMSE results (Dalrymple-Alford et al. 2010). The authors emphasize that MoCA proves significantly superior in differentiating PD-MCI and PD-D when the optimal cutoff is applied; however, further research and validation are needed for its continued use in this context.

In differentiating cognitive deficits among patients with transient ischemic attack (TIA) and ischemic stroke, the MoCA has shown greater efficacy compared to the MMSE. MoCA effectively distinguishes between cognitive abilities in this patient group, while the MMSE exhibits a ceiling effect in patients with mild cognitive impairments. More than half of patients with MMSE scores above 27 points demonstrated cognitive impairment detectable using MoCA (Pendlebury et al. 2010). MoCA also identifies cognitive disorders that the

MMSE cannot detect, such as attention and executive function impairments. Other studies also support MoCA's superiority over MMSE in post-stroke cognitive impairment assessment, likely due to MoCA's ability to differentiate complex cognitive dysfunctions, such as impairments in executive functions, visuospatial skills, and ideational thinking, while MMSE questions on attention and recall are simpler (Nys et al. 2005). Summaries from numerous studies conclude that MoCA is significantly more accurate than MMSE for post-stroke cognitive impairment assessment, although further research is necessary to determine MoCA's prognostic value for long-term cognitive impairments post-stroke and progression risk from post-stroke cognitive impairment to dementia.

MoCA has also been validated for detecting cognitive disorders in patients with vascular dementia (VaD). MoCA is highly diagnostic in distinguishing VaD symptoms from age-related changes in healthy older adults. For VaD diagnosis, the optimal MoCA cutoff is 17 points, which provides a sensitivity of 77% and a specificity of 97%. In contrast, the MMSE, using a 26-point cutoff, shows significantly lower sensitivity and specificity (62% and 78%, respectively) (Freitas et al. 2012). MoCA's advantages here include its assessment of executive functions and the inclusion of complex tasks that assess short-term memory, language functions, attention, concentration, working memory, and spatial visual perception. Even the abbreviated 5-minute MoCA version, endorsed by the National Institute of Neurological Disorders and Stroke - Canadian Stroke Network (NINDS-CSN) Vascular Cognitive Impairment Harmonization Standards, demonstrates high diagnostic sensitivity in the VaD patient group, with an optimal cutoff below 8 points yielding an 85% sensitivity and 88% specificity (Hachinski et al. 2006). This indicates that both the full and abbreviated MoCA tests are optimal diagnostic tools for detecting VaD, outperforming the MMSE in this context (Freitas et al. 2012).

In patients with schizophrenia, however, MoCA may not be an optimal diagnostic tool. With the standard cutoff for schizophrenia patients, MoCA has relatively low sensitivity (69.2%) and specificity (76.2%) (Belvederi Murri et al. 2020). Lowering the cutoff to 25 or 23 points has been proposed to improve sensitivity and specificity, but further research and validation are required (Gil-Berrozpe et al. 2020; Yang et al. 2018). Despite this, the MoCA is often more effective than the MMSE in detecting cognitive impairments in patients with schizophrenia, as it includes subtests for executive functions and attention, which are specific to disorders found in schizophrenia patients (Pendlebury et al. 2010). Studies further indicate that cognitive impairments detected with MoCA are associated with illness severity and the degree of negative symptoms (Wu et al. 2014). Future MoCA use in schizophrenia patients will require further research to establish an optimal cutoff for this group.

While the MoCA shows promise as a cognitive disorder screening tool in patients with HIV, it is not sufficiently sensitive and specific in its current form. At the standard cutoff of 26 points, the MoCA cannot distinguish between HIV patients with cognitive impairments and those with normal cognitive functions (Rosca et al. 2019). This may be because the MoCA evaluates cognitive function areas rarely associated with HIV-related cognitive impairment (Woods et al. 2009). Lowering the cutoff has been suggested to improve diagnostic accuracy, but this approach requires further validation (Overton et al. 2013). Further research is needed

to identify more suitable cognitive assessment tools for HIV patients and to refine cutoff points to improve sensitivity and specificity.
In Huntington's disease (HD) patients, studies indicate that MoCA is a reliable screening tool for detecting cognitive impairments associated with the disease when using the standard 26-point cutoff (Bezdicek et al. 2013; Ringkøbing et al. 2020). MoCA effectively identifies cognitive impairments across a wide range of severity levels in HD. Moreover, MoCA scores are strongly correlated with the severity of neurodegenerative changes in the caudate nuclei, left amygdala, and alterations in the temporoparietal, occipital, and dorsolateral frontal cortices (Ramirez-Garcia et al. 2022).

Conclusions

The MMSE and MoCA each offer distinct advantages and limitations in assessing cognitive function across various clinical contexts. The MMSE remains a foundational tool for initial dementia screening due to its high reliability, sensitivity, and ease of use. However, its accuracy is affected by factors such as education and age, limiting its utility in detecting MCI and specific cognitive deficits like executive dysfunction. The MoCA addresses many of these limitations, offering higher sensitivity and specificity for MCI and early Alzheimer's disease stages. MoCA is particularly valuable for detecting cognitive impairments that the MMSE may overlook, such as executive functions and complex visuospatial skills. While MoCA is superior for early-stage cognitive decline, it is less effective in advanced dementia compared to the MMSE. In conclusion, while each test has distinct strengths, combining the MMSE and MoCA can enhance diagnostic accuracy and offer a more comprehensive assessment of cognitive function. Tailoring the choice of test based on specific clinical scenarios and patient characteristics is recommended for optimal diagnostic and prognostic outcomes.

Disclosure:

Author Contributions:

Conceptualization: Piotr Oleksy, Dominik Sikora, and Magda Mąka
Methodology: Bartosz Buczkowski, Karol Zieliński, and Łukasz Papież
Validation: Adam Zając, Bartosz Buczkowski, and Jakub Kamiński
Formal Analysis: Jakub Kamiński, Magda Mąka, and Ewa Góralczyk
Investigation: Łukasz Papież, Magda Mąka, and Dominik Sikora
Resources: Jakub Kamiński, Karol Zieliński, and Ewa Góralczyk
Data Curation: Dominik Sikora, Adam Zając, and Piotr Oleksy
Writing – Original Draft Preparation: Piotr Oleksy, Karol Zieliński, and Dominik Sikora
Writing – Review & Editing: Ewa Góralczyk, Łukasz Papież, and Piotr Oleksy
Visualization: Adam Zając, Ewa Góralczyk, and Karol Zieliński
Supervision: Piotr Oleksy, Dominik Sikora, and Bartosz Buczkowski

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