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Detecting Change over Time: A Comparison of the SLUMS Examination and the MMSE in Older Adults at Risk for Cognitive Decline

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SUMMARY

Aims: To directly compare the 1-year stability of Mini-Mental State Examination (MMSE) score and Saint Louis University Mental Status (SLUMS) examination score and correlate score changes with demographic variables, clinical factors, and functional domains. **Methods:** A sample of 304 study participants was recruited from residential and clinical settings in Ohio. Follow-up assessments were administered after 1 year with a retention rate of 92% (n = 281). Functional domains included the Instrumental Activities of Daily Living (IADL) scale. **Results:** MMSE and SLUMS scores correlated with each other ($r = 0.65$, $P < 0.001$) and with two functional measures, including the IADL ($r = 0.27$, $r = 0.24$, $P < 0.001$). However, the MMSE and SLUMS frequently placed the same subject into different categories. Rates of reversion and conversion varied between the two tests. The 1-year changes in MMSE raw score correlated with changes in three functional domains as well as age ($P < 0.05$), while SLUMS raw score changes did not correlate with any functional measures. **Conclusion:** Our large, longitudinal data set allowed us to compare the tests' stability, which differed between the SLUMS and MMSE. The MMSE may be more sensitive than the SLUMS to 1-year cognitive changes influencing functional abilities.

Introduction

With the growth of the over 60-year-old population, the burden of dementia is already pushing the limits of the U.S. healthcare system. Dementing conditions such as Alzheimer's disease (AD) are devastating for patients and families. Although no cures exist, identifying dementia early can empower people to seek treatments that alter the disease trajectory, enroll in clinical trials, and actively participate in crucial decisions about care options and financial and legal matters [1,2].

Detecting mild cognitive impairment (MCI)—the precursor to dementia—provides an opportunity for early interventions and decisions. However, official diagnosis of MCI and dementia requires extensive and rarely reimbursed clinical and psychometric testing at specialized neurological centers. The Mini-Mental State Examination (MMSE) arose from the need for a brief screening tool that could be administered in primary care settings and alert caregivers to the need for comprehensive diagnostic testing. However, the MMSE has significant ceiling effects, reliably detecting dementia but not MCI [1,3–8].

The Saint Louis University Mental Status (SLUMS) examination has recently emerged as a promising alternative to the MMSE. The SLUMS is freely available in the public domain, whereas MMSE use is subject to copyright law [9]. In a large, primarily white, male veteran population, the SLUMS had a significantly better receiver operating characteristic (ROC) curve than the MMSE for MCI in populations with and without high school education; the numbers for dementia were not significant [6]. This higher sensitivity for MCI could be explained by the SLUMS examination's more thorough assessment of executive function, which is often the first ability to decline in older adults [1]. The animal naming and clock drawing items, which both require executive function, enabled the identification of MCI by the SLUMS examination [1,6]. Other cognitive domains assessed by the SLUMS but not the MMSE include logical memory, size differentiation, and verbal fluency [9]. Feliciano et al. [1] validated the

SLUMS in a cognitively healthy, community-dwelling, nonveteran population that included females, finding convergent validities for the MMSE and SLUMS and less skew and a lower mean for the SLUMS than the MMSE, potentially signifying fewer ceiling effects.

Progressing from validation to applicability, Feliciano et al. [1] also correlated both the MMSE and SLUMS with neuropsychological tests and found that the SLUMS explained more variance than the MMSE in a cognitively healthy population. The authors postulated that the SLUMS examination's stronger performance could be attributed to its more extensive evaluation of executive function and working memory. Cruz-Oliver et al. [2] found that both MMSE and SLUMS dementia scores in a large population of male veterans predicted mortality and nursing home placement after seven and a half years. The SLUMS MCI score weakly predicted mortality but not institutionalization, whereas the MMSE MCI score predicted both mortality and institutionalization. Thus, several studies have begun exploring the validity and clinical relevance of the SLUMS, revealing a stronger performance than the MMSE in some domains and a weaker performance in others.

Some patients with MCI can reverse to normal cognitive status over time [10,11], providing even more incentive to identify practical tools that monitor cognitive trajectory. Cruz-Oliver et al. [10] found that nearly a quarter of impaired subjects improved their cognition over seven and a half years, transitioning from dementia to mild impairment or from mild impairment to no impairment on the SLUMS. Reversal of cognitive deficit was associated with improved treatment or the elimination of potentially inappropriate medications. Therefore, cognitive screening scores indicating MCI or dementia can promote necessary re-evaluation of treatment regimens. To determine which screening best alerts examiners to the need for re-evaluation, we aimed to shed more light on both tests' clinical applicability by comparing the 1-year stability of MMSE and SLUMS scores and correlating their stability with demographic variables, clinical factors, and functional domains.

Methods

Sample

A sample of 304 participants was recruited primarily from a neurology and geriatrics outpatient clinic and various community settings in Ohio. A small proportion of participants were recruited during a 5-to-8-day long stay at an in-patient geropsychiatric unit of an academic medical center. Follow-up assessments were administered after 1 year with a retention rate of 92% (N = 281). The local Institutional Review Board evaluated our proposal for potential participant risk and ethical concerns and approved all study procedures. Participants were recruited between May 2011 and September 2013. Individuals administering the neuropsychological assessments were trained by a PhD-level neuropsychologist who was part of the study team.

Inclusion criteria were broad and exclusion criteria minimal to facilitate generalization of study results to community-dwelling and primary care populations. Eligible participants were as follows: (1) age 70 years or older; (2) experiencing mild/moderate dementia, MCI, or no impairment, as defined by an MMSE score of 16 or higher; (3) able to read and speak in English; and (4) able to provide informed consent at the time of the baseline interview. If subjects with cognitive impairment were unable to summarize study procedures after undergoing the consent process, a care partner also signed the consent form. Individuals were excluded if they had: (1) a life expectancy of less than 12 months; (2) planned a nursing home placement or a move from the greater Cleveland area within 12 months of the initial interview; (3) active substance abuse or dependence problems; or (4) a severe, uncontrolled mental disorder that would prevent completion of the study instruments. The latter two exclusion criteria functioned to reduce psychiatric comorbidities that would confound cognitive findings.

Measures

1. MMSE—The MMSE is a widely used, 12-item assessment of cognitive function in the elderly that evaluates an individual's orientation to time and place, registration of words, attention and calculation, recall of words, language, and visual construction [8].
2. SLUMS—The SLUMS is an 11-item screening tool to evaluate cognitive ability in adults. SLUMS items can be divided into three categories: three orientation items, nine reasoning items, and six memory items [12]. We used the "optimized" MMSE and SLUMS cutoffs recommended by Tariq et al. [6] so that both tests accounted for education status, facilitating comparison of MMSE and SLUMS (Table 1).
3. Geriatric Depression Scale (GDS)—The GDS is a 30-item self-report scale used to assess depression in older individuals. The test features yes/no responses, which require less cognitive ability compared to Likert scales [13]. The GDS has demonstrated strong psychometric properties such as robust

Table 1 Cutoffs used for each cognitive category and sensitivity & specificity in Tariq et al. [6]

	MMSE, no high school education		MMSE, high school graduates		SLUMS, no high school education		SLUMS, high school graduates	
	Cutoffs	S&S	Cutoffs	S&S	Cutoffs	S&S	Cutoffs	S&S
Normal	>28.5	–	>29.5	–	>23.5	–	>25.5	–
MCI	26.5–28.5	0.60/0.65	27.5–29.5	0.75/0.48	19.5–23.5	0.92/0.81	21.5–25.5	0.95/0.76
Dementia	<26.5	0.81/0.87	<27.5	0.89/0.86	<19.5	1.00/0.98	<21.5	0.98/1.00

S&S, sensitivity & specificity; MCI, mild cognitive impairment; MMSE, Mini-Mental State Examination; SLUMS, Saint Louis University Mental Status examination.

internal consistency (Cronbach's α = 0.91), split-half reliability of 0.94, and a test–retest correlation of 0.85 over 1 month [14].

4. Instrumental Activities of Daily Living (IADL), Self-Rated Version—The IADL scale consists of 9 multiple-point ratings assessing self-impressions of money management, shopping, travel, telephoning, medication use, housekeeping, meal preparation, handy work, and laundry. The IADL was found to be reliable in patients with AD and sensitive to change in mild to moderately demented patients, as scores changed on average 2.06 (±3.27) points annually in these patients [15].
5. Alzheimer's Disease Cooperative Study-Activities of Daily Living Inventory (ADCS-ADLI)—The ADCS-ADLI consists of 23 items administered by a trained rater to either subjects or their healthcare proxies. This inventory was designed to assess functional performance in individuals with MCI and AD in clinical trials. In a multicenter instrument development protocol, this test demonstrated high test–retest reliability between baseline and one and 2 months, correlated with MMSE scores in patients with AD, and showed a decline in performance from baseline to 12 months. ADL items were identified that captured change in functional ability in patients across the entire range of MMSE scores [16].
6. Neuro-QOL Executive Function—Neuro-QOL is a multisite NINDS-funded project that is intended to serve as a psychometrically robust health-related quality of life (HRQL) assessment tool for adults and children. Many items for the Executive Functions component assess cognitive functioning related to activities of daily living, such as balancing finances, keeping track of personal records and appointments, and managing daily activities.
7. Patient-Reported Outcomes Measurement Information System (PROMIS) Applied Cognition—PROMIS Applied Cognition is a 16-item measure evaluating self-impressions of cognitive function in areas such as mental acuity, concentration, and memory. The measure comprises a positively worded Abilities subscale and a negatively worded Concerns subscale. Studies have demonstrated internal consistency reliability of greater than 0.90 for both subscales, and the Abilities subscale correlated modestly with anxiety and depression [17, 18].

Data Analysis Plan

We used descriptive statistics to characterize participant demographics, including age, gender, race, income level, and high school completion status. We performed Pearson correlations between baseline MMSE and SLUMS raw scores and baseline GDS, IADL, and PROMIS Applied Cognition scores. To categorize subjects as *normal*, *MCI*, or *dementia*, we used the scoring guidelines for the MMSE and SLUMS set forth by Tariq et al. [6] in a study on 705 Veterans Administration (VA) male subjects (Table 1). We created frequency tables for these three categories for both tests at baseline.

We then analyzed stability by taking into account MMSE and SLUMS raw scores and cognitive categories at the 1-year time point. We performed Pearson correlations between change-over-time difference values in raw MMSE and SLUMS scores and quantitative demographic and clinical variables as well as change-over-time difference values in various functional domains, including the GDS, IADL, PROMIS Applied Cognition, Neuro-QOL Executive Function, and ADCS-ADLI. We performed one-way analyses of variance (ANOVAs) with Tukey's HSD post hoc tests using a categorical demographic or clinical variable as the independent variable and the MMSE or SLUMS raw score change as the dependent variable.

We then divided subjects into the following stability statuses: *reversers* (into improved cognitive categories), *stable*, or *converters* (into worse categories). Frequency tables were constructed. We performed a McNemar's test for converters versus nonconverters in relation to MMSE and SLUMS stability statuses to determine whether the distributions between stability were the same. To ensure we were examining cognitively homogeneous populations when performing tests using these stability statuses, we restricted selection to baseline MCI subjects or baseline dementia subjects rather than analyzing the entire reverser, stable, and converter categories. For stability analysis of baseline MCI subjects, we performed one-way ANOVAs with the three stability statuses as factor levels and change-over-time differences of scores on the aforementioned functional domains as dependent variables. Age was considered as a covariate as well. For stability analysis of baseline dementia subjects (two categories only), we performed two-sided, two-sample *t*-tests assuming unequal variance when appropriate. The adopted significance level for hypothesis tests was 0.05. Bonferroni correction was

Table 2 Baseline demographic and clinical characteristics for the original sample and a sample that includes only the subjects who completed the 1-year follow-up assessment

	Percentage (Frequency) or Mean (SD) for the original sample (N = 304)	Percentage (Frequency) or Mean (SD) for the follow-up sample (N = 281)
Age (years)	78.3 (5.7)	78.4 (5.7)
Gender		
Female	71.1% (216)	71.5% (201)
Male	28.9% (88)	28.5% (80)
Education level		
No high school diploma	11.1% (34)	10.7% (30)
High school diploma	25.0% (76)	25.6% (72)
Some college or more	63.8% (194)	63.7% (179)
Race		
Caucasian	78.6% (239)	79.4% (223)
African American	18.8% (57)	18.1% (51)
Other	2.6% (8)	2.6% (7)
Number of medical conditions	3.8 (2.2)	3.8 (2.2)
GDS category		
No depression	82.1% (243)	82.8% (227)
Mild depression	16.2% (48)	16.1% (44)
Severe depression	1.7% (5)	1.1% (3)
Average MMSE score	27.4 (2.6)	27.6 (2.5)
Average SLUMS score	22.0 (4.9)	22.1 (4.8)

SD, standard deviation; GDS, Geriatric Depression Scale; MMSE, Mini-Mental State Examination; SLUMS, Saint Louis University Mental Status examination.

Table 3 Frequency table of baseline cognitive categorization by MMSE and SLUMS

		MMSE categories			
		Normal	MCI	Dementia	Total (% of SLUMS scores)
SLUMS categories	Normal	32	36	12	80 (28.5%)
	MCI	21	45	28	94 (33.5%)
	Dementia	8	37	62	107 (38.1%)
	Total (% of MMSE scores)	61 (21.7%)	118 (42.0%)	102 (36.3%)	281 (100%)

MCI, mild cognitive impairment; MMSE, Mini-Mental State Examination; SLUMS, Saint Louis University Mental Status examination.

Table 4 Correlations between change-over-time differences of MMSE score, SLUMS score, and various functional domains

	MMSE		SLUMS	
	Pearson correlation (N)	2-tailed significance	Pearson correlation (N)	2-tailed significance (N)
MMSE	1 (279)	–	0.20 (279)	0.001**
SLUMS	0.20 (279)	0.001**	1 (281)	–
GDS	0.00 (272)	0.953	0.07 (272)	0.224
IADL	0.12 (267)	0.053	0.06 (267)	0.322
ADCS-ADLI (subject-rated)	0.07 (243)	0.304	0.07 (245)	0.288
ADCS-ADLI (proxy-rated)	0.46 (43)	0.002**	0.17 (43)	0.291
Neuro-QOL Executive Function	0.36 (265)	0.048*	0.09 (266)	0.168
PROMIS Applied Cognition	0.15 (269)	0.013*	0.07 (270)	0.249

MMSE, Mini-Mental State Examination; SLUMS, Saint Louis University Mental Status examination; IADL, Instrumental Activities of Daily Living; GDS, Geriatric Depression Scale; ADCS-ADLI, Alzheimer's Disease Cooperative Study-Activities of Daily Living. Patient-Reported Outcomes Measurement Information System (PROMIS) Applied Cognition. *$P < 0.05$ **$P < 0.01$.

not adopted, as the main objective of these tests was exploratory in nature—we aimed to establish evidence of external validation of cognitive change scores.

All statistical analyses were conducted using SPSS Version 22 released by IBM in 2013 (IBM, Armonk, NY, USA).

Results

Sample Characteristics

Table 2 summarizes the baseline demographic and clinical characteristics of the original study population (N = 304) as well as the portion of the study population reassessed after 1 year (N = 281). Because these numbers were very similar, we focused only on the follow-up sample so we could connect baseline and stability analyses. Participants' mean age was 78.4 (SD 5.7). Most participants were Caucasian (79.4%), female (71.5%), college attendees (63.7%), and not clinically depressed (82.8%). The average number of medical conditions was 3.8 (SD 2.2). The average MMSE score was 27.6 (SD 2.5), and the average SLUMS score was 22.1 (SD 4.8).

Baseline Characteristics of the MMSE and SLUMS

Our sample consisted of 21.7% normal, 42.0% MCI, and 36.3% dementia subjects based on MMSE cutoff scores and 28.5% normal, 33.5% MCI, and 38.1% dementia subjects based on SLUMS cutoff scores (Table 3). However, the MMSE and SLUMS frequently assigned the same subject to different categories. For example, 60% of the subjects classified as normal on the SLUMS were categorized as MCI or dementia on the MMSE.

For Pearson correlations, both MMSE and SLUMS scores correlated with the functional measures IADL ($r = 0.27$, $r = 0.24$, $P < 0.001$, N = 274) and PROMIS Applied Cognition ($r = 0.24$, $r = 0.37$, $P < 0.001$, N = 275). SLUMS scores were also inversely associated with GDS depression scores ($r = -0.13$, $P = 0.04$, N = 274). The MMSE and SLUMS correlated with each other ($r = 0.65$, $P < 0.001$, N = 281).

Stability Characteristics of the MMSE and SLUMS

The mean change-over-time difference in MMSE scores was −0.9 (SD 2.2), while the mean change in SLUMS scores was 0.10 (SD 3.6). For MMSE reversers, the mean change was 2.1 points (SD 1.1). For MMSE converters, the mean change was −2.5 (SD 1.4). The corresponding SLUMS changes were 4.2 (SD 2.0) and −3.8 (SD 2.3), respectively.

For Pearson correlations, 1-year changes in MMSE raw score inversely correlated with age ($r = -0.19$, $P = 0.002$, N = 279) and directly correlated with changes in SLUMS scores ($r = 0.20$, $P < 0.001$, N = 279) and PROMIS Applied Cognition ($r = 0.15$, $P = 0.013$, N = 269), Neuro-QOL Executive Function ($r = 0.12$, $P < 0.05$, N = 265), and proxy-rated ADCS-ADLI domains ($r = 0.46$, $P = 0.002$, N = 43), while SLUMS score changes did not correlate with any functional measures or age

Table 5 (A) Frequency table of MMSE and SLUMS stability statuses. (B) Frequency of MMSE and SLUMS stability statuses, baseline MCI subjects only

	MMSE	SLUMS
(A)		
Reversers	13.5% (38)	22.8% (64)
Stable	57.7% (162)	62.3% (175)
Converters	28.8% (81)	14.9% (42)
Total	100% (281)	100% (281)
(B)		
Reversers	14.4% (17)	34.0% (32)
Stable	50.0% (59)	43.6% (41)
Converters	35.6% (42)	22.3% (21)
Total	100% (118)	100% (94)

MCI, mild cognitive impairment; MMSE, Mini-Mental State Examination; SLUMS, Saint Louis University Mental Status examination. Reversers' cognition improved. Stable subjects remained in the same cognitive category. Converters' cognition declined.

(Table 4). Spearman correlations produced similar results. Gender, race, income, number of medical conditions, and treatment for past or current mental disorders were not significantly associated with change over time in MMSE or SLUMS scores.

The stability status of individuals varied between the MMSE and SLUMS (Table 5A,B). The MMSE identified more converters overall (28.8% vs. 14.9% on the SLUMS, with $P < 0.001$ observed from McNemar's test). Normal subjects converted to either MCI or dementia at rates of 63.9% (MMSE) or 26.3% (SLUMS). Approximately 50% of the baseline MCI subjects remained in the same cognitive category over the 1-year time frame; the MMSE and SLUMS identified different reversion and conversion percentages (Table 5B). Of baseline dementia subjects, 20.6% on the MMSE and 29.9% on the SLUMS reversed to MCI or normal. For scores on the Neuro-QOL Executive Function test of MMSE MCI baseline subjects, we performed a one-way ANOVA using the three possible stability statuses (converter, stable, and reverser). We found a global F-test value of 3.576 ($P = 0.032$, df = 2, 108). Tukey's HSD post hoc tests revealed that Neuro-QOL Executive Function scores of MMSE MCI converters (N = 42) declined compared to stable MCI subjects' (N = 59) scores, even after adjusting for age ($P = 0.023$). A two-sided, two-sample t-test with unequal variance demonstrated that scores on the ADCS-ADLI of MMSE reversers (to either normal or MCI) (N = 21) from dementia baseline declined less compared to stable dementia subjects' (N = 81) scores ($P < 0.01$). We found that the mean age was similar between these two groups of baseline dementia subjects. Similar analyses performed on SLUMS stability statuses yielded no significant results.

Conclusion

Baseline MMSE and SLUMS correlations with the validated functional measure IADL and the newer PROMIS Applied Cognition scale suggest that both cognitive screenings were clinically relevant in our sample. Baseline MMSE and SLUMS correlated with each other, signifying that the tests may assess similar cognitive domains. The SLUMS was inversely associated with the GDS. As neither the SLUMS examination nor the MMSE contain depression items, the correlation of the SLUMS with the GDS suggests that either depression adversely affects cognition [19], or that dementia—particularly early dementia—can present with depressive symptoms [20].

The overall percentage of subjects placed into each cognitive category at baseline was similar—within 10% for all three categories—between the MMSE and SLUMS. However, we replicated previous findings that the MMSE and SLUMS have a low level of agreement for any given individual. Cao et al. [12] determined that 48% of MMSE dementia subjects were categorized as MCI or normal on the SLUMS. This figure was 39% for our sample. Strikingly, we found that 60% of the subjects classified as normal on the SLUMS were categorized as MCI or dementia on the MMSE. We encourage future research to elucidate the reasons for this lack of agreement.

Our large, longitudinal data set allowed us to compare the stability of the MMSE and SLUMS. Within the converter or reverser categories, the SLUMS demonstrated higher magnitude score changes and higher standard deviations than the MMSE. More individuals reversed on the SLUMS compared to the MMSE, which might be explained by the SLUMS examination's superior detection of very mildly impaired cognition [1,3–8]. The higher percentage of converters, overall negative change over time, and more dramatic score change in converters than reversers for the MMSE could suggest that the MMSE is more sensitive than the SLUMS for detecting cognitive statuses that decline into the dementia range. Current evidence on the tests' relative sensitivities for dementia is equivocal [6]; further studies are needed.

We correlated change-over-time differences in MMSE and SLUMS raw scores with baseline participant demographics and change over time in other functional domains. The MMSE was significantly correlated with changes in Neuro-QOL Executive Function, PROMIS Applied Cognition, and proxy-rated ADCS-ADLI (Table 3), while the SLUMS was not associated with changes in any domains, suggesting that the MMSE may be more sensitive to cognitive ability that influences functional capacity over time. Cognitive domains assessed by the MMSE may overlap with or influence activities of daily living and applied cognition. The Neuro-QOL Executive Function test evaluates executive function related to activities of daily living. Our unpublished finding (2015) that Neuro-QOL Executive Function and ACDS-ADLI moderately correlated supports the presence of this activities of daily living component. Although the SLUMS examination may have a stronger executive function component than the MMSE, the MMSE may better assess activities of daily living, as evidenced by the correlation of changes in the IADL with changes in the MMSE but not the SLUMS examination and prior findings of modest correlations between the MMSE and activities of daily living [1,21,22]. The MMSE's relationship with activities of daily living could explain the correlation between changes over time in the MMSE and Neuro-QOL Executive Function. Changes in proxy-rated but not participant-rated activities of daily living measures correlated with MMSE changes, which may suggest that proxies have a better perception of patients' functionality in daily activities. Most demographic measures had no bearing on changes in MMSE or SLUMS scores. However, the MMSE was inversely correlated with age, corroborating results from Tangalos et al. and Tombaugh et al. that age was related to MMSE scores, but gender was not [7,8].

Further, scores on the Neuro-QOL Executive Function test of MMSE converters from MCI baseline declined compared to stable MCI participants' Neuro-QOL scores, even after controlling for age. Scores on the ADCS-ADLI of MMSE reversers from dementia baseline declined less compared to stable dementia subjects' scores (mean age was similar among these two groups). These stability status-specific findings reinforce the MMSE's possible advantage in identification of cognitive deficits that are relevant to functional performance. This could be explained by the MMSE's evaluation of a broader range of cognitive domains compared to the SLUMS.

In contrast to our results that suggest that MMSE-identified impairment has outcome relevance, previous meta-analyses have found validity problems with the MMSE. Mitchell [23] determined that the MMSE was modestly accurate for ruling out dementia in nonspecialist settings but was not sufficiently sensitive for case finding or in these settings. Therefore, in the absence of comprehensive diagnostic testing, MMSE results indicating MCI or dementia might best be verified using other cognitive screening tests. We support the conclusions of other authors that combinations of screening tests could be superior to individual tests and recommend further research to validate the combination of the MMSE and the SLUMS or other screening tests [23].

Another conclusion of our study is that both MMSE and SLUMS cognitive categories were unstable. Our result that only 50% of baseline MCI subjects remained MCI contradicts the findings of Cruz-Oliver et al. [10], who reviewed six studies that used different screening or diagnostic tests on individuals with MCI and determined that 71% remained in the MCI category over one to 5 years. Cognitive decline in SLUMS normal participants rivals previously identified MCI conversion percentages; rate of cognitive decline in MMSE normal subjects far exceeds these MCI conversion percentages [10]. Given that MCI is a transitional state to dementia, cognitive decline in normal subjects was expected to be lower. Additionally, more than 20% of baseline dementia subjects reversed to MCI or normal cognition on either measure, a surprising and novel finding that warrants further study. Perhaps our particular sample of primarily white, female, and highly educated subjects is more susceptible to environmental or lifestyle factors that change cognition. Another possible explanation is that the MMSE and SLUMS cutoffs in Tariq et al. [6] cannot be generalized to non-VA populations. In this case, new cutoffs may be necessary. Tangalos et al. (1994) provided age- and education-based MMSE cutoffs for a community sample that could be better suited for future community-based studies [7]. To our knowledge, no similar cutoffs have been created for the SLUMS. Given that the official SLUMS cutoffs are based on the VA study by Tariq et al. [6], optimized cutoffs for non-VA populations are needed.

Future research should also explore whether these short-term cognitive "switches" persist over several years for both the MMSE and SLUMS. These studies should include gold standard diagnostic measures—comprehensive clinical and psychometric testing—to establish the predictive validity of the MMSE and SLUMS and the combination of both tests.

Limitations

Study limitations include a relatively small sample size for each category of analysis (i.e., MCI converters), little ethnic or racial diversity, and relatively high levels of education. Thus, these study results may not generalize to ethnic minorities or less educated populations. Further, the cognitive category cutoffs we used for the MMSE and SLUMS were inevitably arbitrary and may not generalize to community populations. A third limitation is that we reassessed subjects using the same tests at follow-up, which introduces the possibility of learning effects. These learning effects constitute a confounding cognitive variable that could have overinflated our reversion numbers. Finally, both MCI and dementia subjects are heterogeneous populations, as both cognitive categories consist of multiple subtypes and etiologies. Stratifying by subtype may support different conclusions about the stability and clinical applicability of the MMSE and SLUMS.

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Conflict of Interest

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