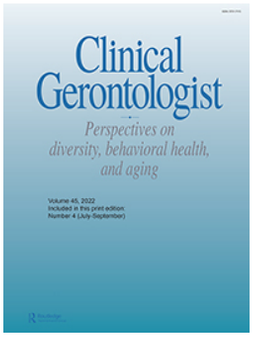

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Reliability and Factor Structure of the Saint Louis University Mental Status (SLUMS) Examination

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ABSTRACT

Objectives: Compared to its alternatives (e.g., Mini-Mental State Examination [MMSE] and Montreal Cognitive Assessment [MoCA]), little is known about the psychometric properties and factor structure of the Saint Louis University Mental Status (SLUMS) Examination. The purpose of the current study is to describe the internal consistency, factor structure, and temporal stability of the SLUMS, a widely used cognitive screening measure.

Methods: We examined the SLUMS of 108 mostly White male Veterans seen for home-based primary care services, 101 of whom had complete data and 28 who completed retesting approximately one year later.

Results: At time one, Veterans averaged 76.44 (*SD* = 9.88) years of age and 13.07 (*SD* = 2.26) years of formal education. Results indicated that the SLUMS had acceptable internal consistency (α = .709) and temporal stability (ρ =.723), with strongest evidence for a one-factor structure.

Conclusions: The SLUMS appears to have adequate reliability and clear one-factor structure in this sample. Additional research with diverse samples is needed to characterize the psychometrics of the SLUMS more comprehensively.

Clinical Implications: The SLUMS appears to be an efficient method for approximating global cognitive functioning among medically complex older adults.

KEYWORDS

Saint Louis University Mental Status Examination; cognitive screening; psychometrics of tests

Introduction

The Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) and the Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005) are commonly used cognitive screening measures that are well established in the literature. Depending on the measure, users must either pay a fee per administration (MMSE) or undergo formal training for a fee (MoCA). These factors may lead users to select a freely available cognitive screening measure, such as the Saint Louis University Mental Status (SLUMS) Examination (Tariq, Tumosa, Chibnall, Perry, & Morley, 2006). Although the measure has wide clinical use (Rabin, Paolillo, & Barr, 2016), little is known about its psychometric properties. A recent review found only 20 studies that provided information regarding at least one psychometric property of the SLUMS (Spencer, Noyes, Bair, & Ransom, 2022). This project aims to examine the internal consistency, factor structure, and temporal stability of the SLUMS.

There are little data pertaining to the reliability of the SLUMS. The SLUMS has been examined in mixed clinical samples using English and Turkish versions of the test. The internal consistencies were .57 (Shwartz, Morris, & Penna, 2019) and .85 (Kaya et al., 2016), respectively. Kaya and colleagues (2016) observed a one-week test-retest coefficient of .68. This estimate exceeds the test-retest reliability of the MoCA, which ranges from .33 to .48 (Cooley et al., 2015). In studies examining SLUMS performances over time in older Veterans, Cruz-Oliver and colleagues (2014) and Howland and colleagues (2016) tracked changes in SLUMS scores over a 7.5-year interval. They established three levels of SLUMS scores to classify

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individuals as being cognitively unimpaired or having mild cognitive impairment (MCI) or dementia. Although the authors did not report parametric statistics, they observed participants' categorical designations often changed considerably over time. Among those in the MCI category at baseline, 48.1% reverted to cognitively unimpaired at follow-up. Some participants may have shifted diagnostic categories because of acute illnesses and not because of progressive neurodegeneration. In the larger literature, so-called "reversion" rates of this magnitude are problematic in that they may indicate that in many instances the initial baseline designation of MCI was artifactual (Bondi et al., 2014).

Within performance-based cognitive tests, factor analytic procedures can help identify underlying theoretical constructs within their pool of items. Practical applications from factor analytic procedures are most apparent in multi-subtest cognitive batteries, such as the Wechsler intelligence scales, where both higher-order total scores and index scores can be computed from subtests. The same data reduction concept can be applied to cognitive screening measures. The authors of the MMSE cautioned against interpreting individual items. To date, no published research has examined the factor structure of the SLUMS. In contrast, several researchers have subjected the MMSE to factor analyses, with varied support for a three-factor (Orientation, Language, and Attention/Calculation; Lopez, Charter, Mostafavi, Nibut, & Smith, 2005) or five-factor structure (Concentration, Language/Praxis, Orientation, Memory, Attention; Jones & Gallo, 2000). Similarly, the MoCA has been examined through factor analyses with authors reporting between two and six underlying cognitive domains (Duro, Simões, Ponciano, & Santana, 2010; Freitas et al., 2012; Moafmashhadi & Koski, 2013).

In this project, we examine the internal consistency, temporal stability, and factor structure of the SLUMS in Veterans receiving home-based primary care (HBPC) services. In lieu of hypotheses, we offer several research questions. First, we will evaluate whether the SLUMS attains adequate internal consistency, as defined by Mitrushina (2009). Second, we will explore the factor structure of the SLUMS.

Methods

All study procedures were approved by the Institutional Review Board at a Midwestern Veterans Affairs hospital (IRB Number 1610672–3). This included a waiver of informed consent and permission to review retrospective data of human subjects.

Participants

We examined archived records for 108 Veterans receiving HBPC services at a Midwestern VA medical center. Veterans are referred to HBPC after poor progress toward designated health care goals in their primary care clinic. These Veterans are medically complex with multiple comorbidities, and experience significant psychosocial burdens. Their multitude of impairments often render them either homebound or with limited ability to access spaces in their communities. As part of routine clinical care, Veterans enrolled in these services completed yearly cognitive screening. Veterans were excluded if they did not complete the full SLUMS. Thus, seven Veterans with visual and/or motor impairments that truncated their SLUMS were excluded. The final sample consisted of 101 Veterans (M_{age} = 76.44 [SD = 9.88], $M_{education}$ = 13.07 [SD = 2.26]), who were mostly male (94.1%) and White (85.2%). Twenty-eight Veterans (M_{age} = 74.86 [SD = 11.08], $M_{education}$ = 13.54 [SD = 2.89]) completed the SLUMS approximately one year later. There were no differences between age, education, or SLUMS scores at Time 1 for participants who completed a second SLUMS and those who did not. All participants had medical illnesses that necessitated home-based care. Based on record review, 45.5% participants had neurocognitive disorders, and 62.4% had a mental health diagnosis. Neurocognitive and mental health diagnoses were established clinically and are only used descriptively in this study to characterize the sample.

Materials and procedures

The SLUMS contains 11-items, 10 of which are scored. The total score ranges from 0 to 30 points, with higher scores reflecting better performances. Items #1-3 (3 points) pertain to orientation, #4 (no points) learning trial of five words, #5 (3 points) mental calculations, #6 (3 points) semantic fluency, #7 (5 points) delayed recall of five words, #8 (3 points) backwards digit span, #9 (4 points) clock drawing, #10 (2 points) object identification, and #11 (8 points) story recall. According to the classifications offered by the original study, among those with at least a high school education, scores above 26 are "Normal," 21–26 "Mild Neurocognitive Impairment," and below 21 suggests "Dementia" (Tariq et al., 2006). Among those not completing high school, scores above 24 are "Normal," 20–24 "Mild Neurocognitive Impairment," and below 20 suggests "Dementia." The SLUMS was administered by HBPC registered nurses who were trained how to administer the SLUMS by the HBPC licensed clinical psychologist.

Data analyses

Descriptive analyses were used for the SLUMS total score and the 10 individually scored items. To examine reliability, we used Cronbach's alpha to measure internal consistency. Cronbach's alpha is the most frequent statistic for internal consistency, which represents the aggregation of all possible split-half correlations of a measure. Typically, when evaluation internal consistency of a measure, values range up to a maximum value of 1.00, with scores exceeding 0.90, 0.80, and 0.70 being considered outstanding, excellent, and acceptable, respectively (Hosmer & Lemeshow, 2000). However, acknowledging that users of cognitive screening tests knowingly sacrifice optimal accuracy for efficiency, Mitrushina (2009) suggests that reliability values exceeding 0.60 and greater are adequate for brief cognitive measures. Items with little to no variance are excluded from reliability analyses. Preliminary analyses demonstrated that Item #10 (object identification) was largely invariant across time points and was not included in subsequent analyses.

Factor analytic research in psychological assessment generally demonstrates a significant range in sample sizes from small (42) to large (>1,000; Henson & Roberts, 2006), with more nuanced understanding that data characteristics have significant bearing on what constitutes an adequate sample for a stable factor structure. For example, strong relationships between items can decrease the sample size needed to conduct a factor analysis (Tabachnick & Fidell, 2013).

We anticipated correlated factors on analyses; therefore, we used oblique (Promax) rotation using principal components extraction. To guard against selecting spurious factors with a small sample, we opted against using the Kaiser-Guttman "rule" of eigenvalues over 1.0, because this method has been criticized for over-selection of factors (Zwick & Velicer, 1986). Instead, we opted to select the number of factors based on a combination of eigenvalues over 1.0 and visual inspection of the scree plot.

Results

Descriptive data

SLUMS scores averaged 20.86 (SD = 5.86) at Time 1 and 20.25 (SD = 6.07) at Time 2, with a mean loss of −0.46 points (SD = 4.16). With the sample of 28 participants that completed the SLUMS both at Time 1 and Time 2, the correlation coefficient across administrations for the total score was .723 (Spearman's Rho). Table 1 includes total and item-level data. SLUMS scores ranged from 8 to 29.

Table 1. SLUMS descriptive statistics.

	Mean	SD	Minimum	Maximum
SLUMS Total Time 1	20.86	5.86	8	29
Items 1–3	2.57	0.85	0	3
Item 4	-	-	-	-
Item 5	1.96	1.17	0	3
Item 6	2.16	0.81	0	3
Item 7	2.59	1.69	0	5
Item 8	1.16	0.70	0	2
Item 9	2.47	1.72	0	4
Item 10	1.88	0.43	0	2
Item 11	2.57	2.41	0	8
SLUMS Total Time 2	20.25	6.07	8	28
Items 1–3	2.57	0.84	0	3
Item 4	-	-	-	-
Item 5	1.93	1.15	0	3
Item 6	2.25	0.97	0	3
Item 7	2.68	1.57	0	3
Item 8	0.96	0.58	0	2
Item 9	2.43	1.75	0	4
Item 10	2.00	0.00	2	2
Item 11	5.43	1.79	2	8

N = 101 at Time 1; N = 28 at Time 2. Item 4 is a non-scorable item.

Internal consistency reliability

Cronbach's alpha coefficients were α = .709 at Time 1 and α = .768 at Time 2. Cronbach's alpha improved from .709 to .716 with the removal of Item #10 (object identification) at Time 1. Item #10 was relatively invariant, as the average score was 1.88/2 points. At Time 2, there was no variance in scores on Item #10, with all 28 participants getting full points on this item. Therefore, it was not included in the calculation of Cronbach's alpha. Time 1 corrected item-total correlations ranged from .105 (Item #10) to .642 (Item #7; remembering five objects) with a mean of .446. Time 2 corrected item-total correlations ranged from .459 (Item #8; backwards digit span) to .636 (Item #7). Table 2 presents the item-total correlations per item and across timepoints.

Factor analyses

Initial factor analyses of all 10 scoreable items suggested that the first 3 items (related to orientation) were best treated as a single score. Factor analysis was subsequently completed on the 8 scorable items of the SLUMS. Two factors emerged with eigenvalues over 1.0. However, visual inspection of the scree plot indicated that there was one stable factor, accounting for 38.29% of the variance. Examination of the second possible factor (eigenvalue = 1.066), accounted for an additional 13.32% of the variance.

Factor loadings were examined to determine the theoretical contribution of the 2-factor solution. All items loaded onto factor 1 with loadings ranging from .433 to .807, except for item #10 which loaded onto the second factor at .877. Additionally, these two-factors were not correlated (r = .069), suggesting that Item #10 may contribute poorly to the overall measure. Indeed, this item had limited variability. Of the 101 participants, only 8 people scored less than perfect (4 people obtained score 0/2, 4 people obtained score 1/2).

Given the invariance of Item #10, we specified the number of factors to 1 to examine the resulting component matrix. The single factor had component matrix scores that ranged from .215 (Item #10) to .789 (Item #7) and are presented in Table 3.

Table 2. Corrected item-total correlations.

	Time 1	Time 2
Items 1–3	.557	.655
Item 5	.321	.496
Item 6	.565	.590
Item 7	.642	.636
Item 8	.374	.459
Item 9	.510	.509
Item 10	.105	–
Item 11	.490	.533

Item 10 had zero variance at Time 2 and was removed from scale.

Table 3. Component matrix scores.

Items 1–3	.709
Item 5	.480
Item 6	.730
Item 7	.789
Item 8	.523
Item 9	.651
Item 10	.215
Item 11	.658

Component matrix when fixed to one-factor solution.

Discussion

In our mixed clinical sample of Veterans receiving HBPC services, SLUMS scores were largely free from floor or ceiling effects, had adequate internal consistency for a cognitive screening measure, and reflected a one-factor structure. There may be growing interest in the SLUMS given that it presents as a free alternative to other commonly used measures, and this study provides helpful information to direct the use of the SLUMS as a cognitive screening measure in clinical settings.

Relative to the reliability of screening measures broadly, the internal consistency of .716 observed in the current study lends support to the SLUMS as an adequately reliable screening measure with Mitrushina's (2009) guidelines in mind. This estimate was more promising than the .57 internal consistently observed by Shwartz and colleagues (Shwartz et al., 2019). Their study examined the SLUMS among 75 patients with dementia with an average score of 22.43 (*SD* = 3.32). Our higher estimate may have resulted from wider variance in SLUMS scores (*M* = 20.86, *SD* = 5.86), consistent with known influence of sample composition on reliability estimates. Our results also suggest that the SLUMS demonstrates temporal stability across a one-year interval; however, scores may have declined due to aging and generally worsening

health over the one-year interval. Conversely, familiarity with the test may have contributed to inflated SLUMS scores at Time 2. Our results support a one-factor solution, suggesting that the SLUMS is best regarded as a measure of global cognition and individual units should not be viewed as capturing domains. However, factor structure often differs as a function of the composition of the population to which they are applied. Consistent with variable factor-structures observed with the MMSE and MoCA, these results pertain to Veterans receiving HBPC services. The factor structure of the SLUMS may differ in other populations.

Portability and ease of administration are desirable qualities for screening instruments. Given its brevity and ease of administration, the SLUMS may be a feasible option to use during a time-limited interdisciplinary intake assessment. Allied health professionals such as trained nurses may find that the SLUMS can seamlessly fit into comprehensive medical appointments, although uses should be aware of the following limitations.

The SLUMS shares general limitations known to all cognitive screening measures. First, the SLUMS is not as reliable as most tests used in neuropsychological assessments, consistent with our modest reliability estimate. Individual SLUMS items may correlate poorly with neuropsychological tests within the same domain, as observed empirically with the MoCA (Moafmashadi & Koski, 2013). Prioritizing brevity, another shared problem of cognitive screening measures is insufficient coverage of cognitive domains. Including both a short word list and story, the SLUMS is heavily weighted toward verbal recall with limited coverage of other cognitive abilities.

However, the SLUMS is uniquely limited in comparison to its cognitive screener counterparts. The MMSE and MoCA have an established research presence, with many studies including well-defined and diverse samples that aim to determine the adequacy of the test. The SLUMS has yet to be characterized with systematic studies in well-defined, diverse groups. Importantly, the adequacy of this test continues to be unclear at this time. For example, recent research suggests that its cutoffs performed poorly in accurately identifying cognitive impairment (Merz & Lace, 2022). Further, the SLUMS lacks well established normative data and reliability has yet to be examined in a healthy sample. Users of the SLUMS should be cautious at this time.

Our study has several limitations and highlights directions for future research. The current study consisted of a sample of HBPC Veterans, which is a relatively unique sample from a demographic and medical complexity standpoint. Reliability and factor structure of the SLUMS should be examined in other samples, including culturally diverse samples, to strengthen these findings. Similarly, larger sample sizes may help strengthen future factor analyses conducted on SLUMS items. Our study was only able to examine temporal stability over a 1-year period in a small subset of the sample. It is important to have statistical guidance for the expected amount of change across administrations included in future research. Test-retest reliability estimates over short time intervals, as well as reliable change indices would be helpful in this regard. Finally, although neurocognitive disorders and mental health diagnoses were established clinically, Veterans did not have a systematic work-up for these diagnoses. As such, information regarding neurocognitive diagnoses was limited and not examined in this study.

This study provides psychometric data of the SLUMS, an increasingly popular cognitive screening test. We found that in this sample of older Veterans receiving HBPC, the SLUMS has one global cognitive factor, adequate internal consistency, and scores are relatively stable across a one-year interval.

Clinical implications

- The SLUMS is best interpreted as a single score and not according to individual items.
- Although clinicians should continue to use the SLUMS with caution, it is a brief and feasible cognitive screener to administer as part time-limited medical appointment.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author, RS. The data are not publicly available due to containing information that could compromise the privacy of research participants.

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