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Short Report

Bridging cognitive screening tests in neurologic disorders: A crosswalk between the short Montreal Cognitive Assessment and Mini-Mental State Examination

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Abstract

Introduction: To provide a crosswalk between the recently proposed short Montreal Cognitive Assessment (s-MoCA) and Mini-Mental State Examination (MMSE) within a clinical cohort.
Methods: A total of 791 participants, with and without neurologic conditions, received both the MMSE and the MoCA at the same visit. s-MoCA scores were calculated and equipercentile equating was used to create a crosswalk between the s-MoCA and MMSE.
Results: As expected, s-MoCA scores were highly correlated (Pearson $r = 0.82$, $P < .001$) with MMSE scores. s-MoCA scores correctly classified 85% of healthy older adults and 91% of individuals with neurologic conditions that impair cognition. In addition, we provide an easy to use table that enables the conversion of s-MoCA score to MMSE score.
Discussion: The s-MoCA is quick to administer, provides high sensitivity and specificity for cognitive impairment, and now can be compared directly with the MMSE.

Keywords: s-MoCA; MMSE; Cognitive screening; Test equating; Brief cognitive test

1. Introduction

The need for adequate and effective cognitive screening is essential given the rapid growth of the elderly population and the increasing prevalence of Alzheimer's disease (AD) and related disorders. Unfortunately, those with, or developing, dementia often go undiagnosed and many are not even evaluated [1]. In fact, more than 40% of older adults with cognitive impairment are often not identified as impaired [2]. The failure to assess cognitive abilities likely hampers the diagnosis and treatment of neurodegenerative and nonneurodegenerative dementia and may significantly affect patients' and family members' well-being. Yet, most current memory and cognitive screening measures remain too lengthy for regular use in community and primary care settings. Consequently, despite widespread attention given to the growing economic costs of treating and caring for people with AD and other neurodegenerative diseases [3], the availability of time- and cost-effective cognitive screening tests are limited. To serve this demand, well-validated and efficient cognitive screening tests are needed for administration as part of routine clinical visits and check-ups [4].

Many cognitive screening measures exist; the Mini-Mental State Examination (MMSE) [5] and Montreal Cognitive Assessment (MoCA) [6] are two of the most common. Recent work [7] confirms and extends prior findings on the diagnostic

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utility of the MMSE and MoCA. Although the MMSE has a long history of use in clinical and research settings for the assessment and monitoring of acute neurocognitive impairments, it has limited utility in detecting subtle changes in cognition that may signal pending impairment in at-risk individuals [8,9]. In addition, the MMSE has large ceiling effects [10]—even when corrected for education[11]—and relatively poor accuracy in the identification of patients with mild cognitive impairment (MCI) or mild AD [12]. The MoCA overcomes some, but not all, of the limitations of the MMSE, and evidence is accumulating that the MoCA may eventually supplant the MMSE as the gold standard in cognitive screening for AD dementia [7,13]. Specifically, the MoCA includes more robust measures of visuospatial and executive function [6], which likely reduces ceiling and practice effects, but enhances the potential for floor effects. Indeed, comparisons of these two measures find that the MoCA has better sensitivity and specificity in AD, MCI, [7] and Parkinson's disease [13]. Thus, the MoCA may be most informative when attempting to differentiate mild forms of dementia from typical age-related decline. However, one of the most significant limitations of the MoCA is the 10- to 15-minute administration time.

Recently, using a scale-shortening method first described in a study by Moore et al. [14], we established and validated a short form of the standard MoCA (s-MoCA) composed of eight items, which takes approximately 5 minutes to administer [15]. Item response theory and computerized adaptive testing simulation were used to derive the s-MoCA in 1850 well-characterized community-dwelling individuals with and without neurodegenerative disease. The s-MoCA was highly correlated with the original MoCA, exhibited robust diagnostic classification, and cross-validation procedures substantiated the selected items. Thus, the s-MoCA is highly comparable to the standard MoCA, generalizable to healthy individuals and those with neurologic conditions and, most importantly, can be administered more quickly.

Yet, we acknowledge that adoption of the s-MoCA within the primary care setting, neurology clinics, and specialized research settings may be difficult given the historical importance and ubiquity of the MMSE in clinimetrics, research programs, and randomized clinical trials. Thus, in the present study, we provide a straightforward method for converting s-MoCA scores to MMSE scores. The results will facilitate the adoption of the s-MoCA within the clinic by providing continuity in cognitive assessment scores in the clinic and comparability of data in the research setting that will ensure valid longitudinal assessment.

2. Methods

2.1. Participants

All participants (n = 791) were recruited from the Penn Memory Center and Clinical Core of the University of Pennsylvania's Alzheimer's Disease Center. One hundred thirty-eight healthy older adults (HOAs) and 653 individuals with a neurologic condition were assessed. AD (n = 340) and MCI (n = 109) diagnoses accounted for most individuals. To increase generalizability of equated scores, participants with the following neurologic conditions were also included: frontotemporal dementia (n = 15), corticobasal syndrome (n = 5), dementia with Lewy bodies (n = 25), dementia, unspecified (n = 19), hydrocephalus (n = 26), multiple clinical diagnoses (n = 16), indeterminate neurologic condition (n = 56), Parkinson's disease (n = 2), posterior cortical atrophy (n = 4), primary progressive aphasia (n = 7), progressive supranuclear palsy (n = 2), psychiatric illness (n = 13), traumatic brain injury (n = 2), and vascular dementia (n = 12). Note that individuals with multiple clinical diagnoses were individuals with at least two neurologic or psychiatric clinical diagnoses. Clinical assessments included history, physical, and neurologic examinations conducted by experienced clinicians, including the review of neuroimaging, psychometric, and laboratory data. A consensus diagnosis was established using standardized clinical criteria for AD, MCI, or other neurologic or psychiatric conditions presenting with cognitive impairment [16–18]. Additional details on subject recruitment and evaluation have been previously published [7,15].

All 791 participants were administered the MMSE and MoCA during the same visit. The MMSE result was available during consensus diagnosis, but the MoCA was not. Informed consent for the use of all data was obtained from all persons, in accord with the University of Pennsylvania Institutional Review Board.

2.2. s-MoCA scores

Combining sophisticated approaches of item response theory and computerized adaptive testing analytics in 1850 individuals, we previously established an approach for generating s-MoCA scores [15]. This short form consists of eight items from the original MoCA, including the following items: (1) clock draw, (2) serial subtraction, (3) orientation (place), (4) recall, (5) abstraction (watch), (6) naming (rhino), (7) trail-making, and (8) language fluency (see [15] and Supplementary Data). The scores range from 0 to 16, are comparable to the standard MoCA, and outperforms another short version of the MoCA [19]. Correct responses on these eight items are summed to generate the total s-MoCA score.

2.3. Statistical analysis

Between-group comparisons of MMSE and s-MoCA scores were performed using independent sample t tests. s-MoCA scores were equated to MMSE scores using the equipercentile equating method [7,20], which has been used to equate numerous standardized tests [13,15,21]. This statistical method allows for the determination of

comparable test scores from two different measures on the basis of their corresponding percentile ranks. The advantage of the equipercentile equating method is that the equated scores always fall within the range of possible scores. Log-linear smoothing was applied to avoid an irregular distribution of scores [22]. Polychoric correlations between items were used to estimate internal consistency of the s-MoCA. Equipercentile equating with log-linear smoothing was performed using the "equate" library in the R statistical package (v3.2.2. "Fire Safety").

3. Results

Demographic characteristics and test performance are displayed in Table 1. Individual performance on the s-MoCA encompassed all possible scores from 0 to 16. s-MoCA and MMSE scores were highly correlated (Pearson $r = 0.82$, $P < .001$). On average, HOAs scored significantly higher on both the MMSE = 29.34 (0.92) and s-MoCA = 13.53 (1.93) relative to individuals with any type of neurologic disorder—MMSE = 21.77 (6.27) and s-MoCA = 6.23 (3.81), and higher than individuals with MCI—MMSE = 26.09 (3.34) and s-MoCA = 8.64 (2.85) or AD—MMSE = 19.53 (5.81) and s-MoCA = 4.79 (3.22). For comparison, standard MoCA scores are presented in Table 1 and Supplementary Fig. 3. Those with neurologic conditions (age = 74.36 (8.88)) were slightly but significantly older than HOAs (age = 70.29 (8.98); $t\,(790) = -4.71$, $P = 1.26 \times 10^{-6}$). Internal consistency of the items of the s-MoCA was high, Cronbach's $\alpha = 0.90$, and Clinical Dementia Rating Sum of Boxes scores were inversely associated with s-MoCA scores (Pearson $r\,(677) = -0.74$, $P < 2.20 \times 10^{-16}$). Sensitivity, specificity, Youden index, positive and negative predictive value, clinical cutoff score, and classification accuracy are presented in Table 2. As expected, the s-MoCA had high sensitivity and specificity and performed similarly to the full MoCAs typically outperforming the MMSE at identifying individuals with cognitive dysfunction. s-MoCA scores correctly classified 90% of individuals when differentiating individuals with neurologic conditions from HOAs, which was 2% better than performance of the standard MoCA and 7% better than the MMSE.

A plot of the equipercentile equivalent scores on the MMSE and s-MoCA is presented in Fig. 1A. For example, a score of 7 on the s-MoCA is equivalent to a score of 25 on the MMSE, as both of these scores fall at the 50th percentile. Fig. 1B provides the mean, median, and range for MMSE scores for each score on the s-MoCA, and their respective equipercentile equivalent score on the MMSE. Equated scores for only AD dementia, including MCI, are presented in Supplementary Fig. 2 and Supplementary Table 1.

4. Discussion

Early and accurate detection of cognitive impairment in older adults that indicates transition to AD dementia can enhance clinical management and lead to better understanding of individual differences in disease progression. Thus, there is a need for time- and cost-effective approaches that allow for the identification of prodromal disease stages, particularly in primary care clinics. As early detection becomes more necessary, well-validated and brief measures of cognitive performance, such as the s-MoCA, can provide clinicians an efficient tool with which to routinely screen patients and efficiently identify those in need of specialized care or more comprehensive neuropsychological assessment. Here, we show that in general the s-MoCA outperforms that MMSE in identifying older individuals with mild cognitive dysfunction, provide additional evidence of the clinical utility of the s-MoCA and present a crosswalk between s-MoCA and MMSE scores. This crosswalk will enable the widely recognized cutoff scores on the MMSE to be reliably linked with scores on the s-MoCA.

We believe that the s-MoCA is an ideal screening tool for physicians, nurse practitioners, and physician assistants in primary care practice, as these practitioners are often the first to hear patient's complaints. We are

Table 1
Participant demographics and cognitive screening performance

Diagnostic group	N	Age mean (SD) years	Gender F/M	% Caucasian	Education mean (SD) years	Total CDR	MMSE score (range 0–30)	MoCA score (range 0–30)	s-MoCA score (range 0–16)
All neurologic diagnoses	653	74.37 (8.89)	381/272	74%	13.95 (4.26)	4.22 (3.36)	22 (6)	16 (7)	6 (4)
AD	340	75.89 (8.24)	220/120	71%	13.39 (4.27)	5.38 (3.27)	20 (6)	14 (6)	5 (3)
MCI	109	72.95 (8.64)	57/52	78%	14.71 (3.96)	1.68 (1.26)	26 (3)	21 (4)	9 (3)
HOA	138	70.28 (8.99)	92/46	79%	16.95 (2.74)	0.06 (0.22)	29 (1)	27 (2)	14 (2)

Abbreviations: AD, Alzheimer's disease; CDR, Clinical Dementia Rating Scale (sum of boxes); HOA, healthy older adult; MCI, mild cognitive impairment; MMSE, Mini-Mental State Examination; MoCA, Montreal Cognitive Assessment; s-MoCA, short MoCA; SD, standard deviation.

NOTE. All significant pairwise comparisons $P < .01$. Age: HOA < all neuro, AD, MCI; AD > MCI. Sex: HOA ≠ all neuro; HOA = AD; AD ≠ MCI; MCI ≠ HOA. Race: HOA = all neuro, AD, MCI. Education: HOA > all neuro, AD, and MCI; MCI > AD. MMSE: HOA > all neuro, MCI, AD; MCI > AD. MoCA: HOA > all neuro, AD, MCI; MCI > AD. s-MoCA: HOA > all neuro, AD, MCI; MCI > AD.

Table 2
Diagnostic parameters for the MoCA and s-MoCA in the full sample, AD, and MCI

Screening test	Full sample versus HOA	AD versus HOA	MCI versus HOA	AD versus MCI
MoCA				
AUC (± 95% CI*)	0.97 (0.95–0.98)	0.99 (0.99–1.00)	0.95 (0.93–0.98)	0.83 (0.79–0.87)
Sensitivity/specificity	0.86/0.96	0.94/1.00	0.94/0.80	0.76/0.78
Youden index	0.82	0.94	0.74	0.54
Cutoff score	23	22	25	24
PPV/NPV	0.99/0.59	1.00/0.88	0.78/0.94	0.92/0.51
Classification accuracy	88%	96%	86%	77%
s-MoCA				
AUC (± 95% CI)	0.95 (0.94–0.97)†	0.99 (0.98–0.99)†	0.93 (0.90–0.96)†	0.81 (0.76–0.85)†,‡
Sensitivity/specificity	0.91/0.85	0.96/0.91	0.87/0.85	0.67/0.79
Youden index	0.76	0.87	0.72	0.46
Cutoff score	11	10	11	6
PPV/NPV	0.97/0.68	0.96/0.91	0.87/0.85	0.91/0.44
Classification accuracy	90%	95%	86%	70%†,‡
MMSE				
AUC (± 95% CI)	0.94 (0.92–0.96)†	0.98 (0.98–0.99)†	0.88 (0.84–0.92)†,§	0.85 (0.81–0.89)
Sensitivity/specificity	0.81/0.96	0.94/0.96	0.75/0.85	0.79/0.79
Youden index	0.77	0.90	0.60	0.58
Cutoff score	27	27	28	18
PPV/NPV	0.99/0.52	0.98/0.88	0.80/0.81	0.92/0.55
Classification accuracy	83%§	95%	81%§	79%

Abbreviations: AD, Alzheimer's disease; AUC, area under the curve; CI, confidence interval; HOA, healthy older adults; MCI, mild cognitive impairment; MMSE, Mini-Mental State Examination; MoCA, Montreal Cognitive Assessment; NPV, negative predictive value; PPV, positive predictive value; s-MoCA, short MoCA; SD, standard deviation.

*CIs estimated using the DeLong method and $n = 2000$ bootstraps.

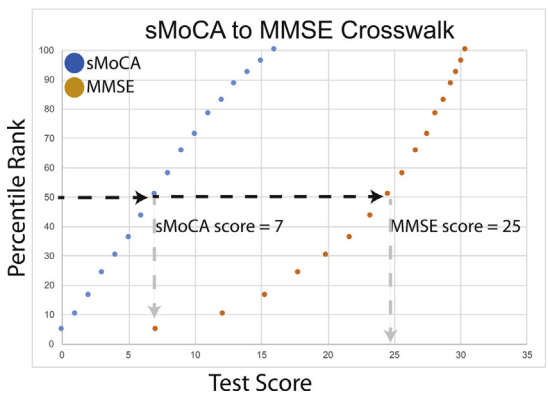
†Significantly lower than the standard MoCA in permutation testing of AUC using roc.test function in R package pROC ($P < .05$).

‡Significantly lower than the MMSE in permutation testing of AUC using roc.test function in R package pROC ($P < .05$).

§Significantly lower than the s-MoCA in permutation testing of AUC using roc.test function in R package pROC ($P < .05$).

encouraged by the performance of the s-MoCA and that it works in many instances better than the MMSE, in particular at differentiating MCI from normal healthy aging. In this respect, the s-MoCA can provide a much-needed quick screen in the primary care setting. The s-MoCA can be quite useful in this setting because the assessment of cognitive functioning is a required element of the Medicare Annual Wellness visit [23]. Other early screening questionnaires or tests that are available and recommended by the National Institute of Aging include the General Practitioner Assessment of Cognition, the Mini-Cog, and the Memory Impairment Screen [23].

A



B

sMoCA score	Equivalent MMSE score	Average MMSE score Mean (+/- SD)	Median MMSE score	MMSE range	N
0	7	9 (5)	9	0-21	37
1	12	13 (5)	13	2-24	44
2	15	16 (4)	16	6-23	50
3	18	19 (3)	19	13-25	61
4	20	21 (4)	21	10-29	46
5	22	21 (3)	21	14-28	48
6	23	23 (3)	23	16-29	57
7	25	24 (3)	23	14-30	59
8	26	25 (3)	25	17-30	57
9	27	26 (3)	26	19-30	59
10	27	27 (2)	27	21-30	46
11	28	28 (2)	28	23-30	54
12	29	28 (1)	28	25-30	37
13	29	29 (1)	30	25-30	45
14	30	29 (1)	30	24-30	31
15	30	29 (1)	30	27-30	29
16	30	30 (1)	30	28-30	31

Fig. 1. (A) Equipercentile equating of the s-MoCA and MMSE corresponding test scores and percentile ranks allow for conversion of s-MoCA scores to MMSE scores. For example, an s-MoCA score of 7 (50th percentile) is equivalent to an MMSE score of 25 (50th percentile). All neurologic conditions were included in the crosswalk. (B) Equivalent, average, median, and the range of MMSE scores are shown for each possible score on the s-MoCA. Equivalent MMSE scores were generated using equipercentile equating method. The number of individuals that achieved a given s-MoCA score is shown in the final column. Abbreviations: MMSE, Mini-Mental State Examination; s-MoCA, short Montreal Cognitive Assessment.

However, the s-MoCA expands on these by covering more cognitive domains, and thus may have broader appeal and utility. We add the s-MoCA to the clinician's toolbox for consideration as a quick and reliable cognitive screen that meets many of the attributes considered necessary for routine use in primary care settings and that can now be directly compared with MMSE performance.

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Author contributions: D.R.R. contributed to drafting and revising the manuscript, study concept and design, analysis and interpretation of data. He accepts responsibility for the conduct of research and gave final approval, did acquisition of data, statistical analysis, and study supervision. His role was of Principal Investigator, had access to all the data, and took responsibility for the data, accuracy of data analysis, and the conduct of the research. T.M.M. contributed to drafting and revising of the manuscript, study concept and design, analysis and interpretation of data, and accepts responsibility for conduct of research. He gave final approval and performed acquisition of data and statistical analysis. D.M.-H. contributed to revising of the manuscript, study concept and design, and accepts responsibility for the conduct of research and gave final approval. He also did study supervision. David A.W., S.E.A., and Daniel A.W. contributed to study concept and design, and accept responsibility for the conduct of research and gave final approval. They also did study supervision and obtained funding. P.J.M. contributed to drafting and revising the manuscript, study concept and design, analysis and interpretation of data, and accepts responsibility for the conduct of research and gave final approval. He also did study supervision.

Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jalz.2017.01.015.

RESEARCH IN CONTEXT

1. Systematic review: The need for adequate, effective, and efficient cognitive screening is essential given the rapid growth of the elderly population and the prevalence of Alzheimer's disease and other cognitive disorders. Unfortunately, dementia screening in the community setting is often overlooked because cognitive assessments are time consuming; this hampers dementia diagnosis and treatment.
2. Interpretation: The short form of the Montreal Cognitive Assessment (s-MoCA) outperforms the Mini-Mental State Examination, indicating that more time efficient cognitive screening inventories can be implemented in clinical and research settings.
3. Future directions: We hope that prospective studies of dementia will implement the s-MoCA, as this shorten version provides an efficient, valid estimate of cognitive function. We are eager to see the s-MoCA implemented in primary care settings as these practitioners are often the first to hear patient's complaints, and we believe it can aid in the assessment of cognitive functioning.

References

[1] Kotagal V, Langa KM, Plassman BL, Fisher GG, Giordani BJ, Wallace RB, et al. Factors associated with cognitive evaluations in the United States. Neurology 2015;84:64–71.
[2] Chodosh J, Petitti DB, Elliott M, Hays RD, Crooks VC, Reuben DB, et al. Physician recognition of cognitive impairment: evaluating the need for improvement. J Am Geriatr Soc 2004; 52:1051–9.
[3] Wimo A, Winblad B, Jönsson L. An estimate of the total worldwide societal costs of dementia in 2005. Alzheimers Dement (Amst) 2007;3:81–91.
[4] Brayne C, Fox C, Boustani M. Dementia screening in primary care: is it time? JAMA 2007;298:2409–11.
[5] Folstein MF, Folstein SE, McHugh PR. "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189–98.
[6] Nasreddine ZS, Phillips NA, Bedirian V, Charbonneau S, Whitehead V, Collin I, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc 2005;53:695–9.

[7] Roalf DR, Moberg PJ, Xie SX, Wolk DA, Moelter ST, Arnold SE. Comparative accuracies of two common screening instruments for classification of Alzheimer's disease, mild cognitive impairment, and healthy aging. Alzheimers Dement (Amst) 2013;9:529–37.
[8] Ravaglia G, Forti P, Maioli F, Servadei L, Martelli M, Brunetti N, et al. Screening for mild cognitive impairment in elderly ambulatory patients with cognitive complaints. Aging Clin Exp Res 2005;17:374–9.
[9] Slavin MJ, Sandstrom CK, Tran TT, Doraiswamy PM, Petrella JR. Hippocampal volume and the Mini-Mental State Examination in the diagnosis of amnestic mild cognitive impairment. AJR Am J Roentgenol 2007;188:1404–10.
[10] Zadikoff C, Fox SH, Tang-Wai DF, Thomsen T, de Bie R, Wadia P, et al. A comparison of the mini mental state exam to the Montreal cognitive assessment in identifying cognitive deficits in Parkinson's disease. Mov Disord 2008;23:297–9.
[11] Franco-Marina F, García-González J, Wagner-Echeagaray F, Gallo J, Ugalde O, Sánchez-García S, et al. The Mini-mental State Examination revisited: ceiling and floor effects after score adjustment for educational level in an aging Mexican population. Int Psychogeriatr 2010;22:72–81.
[12] Hoops S, Nazem S, Siderowf A, Duda J, Xie S, Stern M, et al. Validity of the MoCA and MMSE in the detection of MCI and dementia in Parkinson disease. Neurology 2009;73:1738–45.
[13] van Steenoven I, Aarsland D, Hurtig H, Chen-Plotkin A, Duda JE, Rick J, et al. Conversion between Mini-Mental State Examination, Montreal Cognitive Assessment, and Dementia Rating Scale-2 scores in Parkinson's disease. Mov Disord 2014;29:1809–15.
[14] Moore TM, Scott JC, Reise SP, Port AM, Jackson CT, Ruparel K, et al. Development of an abbreviated form of the Penn Line Orientation Test using large samples and computerized adaptive test simulation. Psychol Assess 2015;27:955–64.
[15] Roalf DR, Moore TM, Wolk DA, Arnold SE, Mechanic-Hamilton D, Rick J, et al. Defining and validating a short form Montreal Cognitive Assessment (s-MoCA) for use in neurodegenerative disease. J Neurol Neurosurg Psychiatry 2016;87:1303–10.
[16] Morris JC, Edland S, Clark C, Galasko D, Koss E, Mohs R, et al. The Consortium to Establish a Registry for Alzheimer's Disease (CERAD) Part IV. Rates of cognitive change in the longitudinal assessment of probable Alzheimer's disease. Neurology 1993;43:2457.
[17] Petersen RC. Mild cognitive impairment as a diagnostic entity. J Intern Med 2004;256:183–94.
[18] Association AP. Diagnostic and statistical manual of mental disorders. 4th ed. Washington, DC: American Psychiatric Association; 2000. text revision (DSM-IV-TR).
[19] Horton DK, Hynan LS, Lacritz LH, Rossetti HC, Weiner MF, Cullum CM. An abbreviated Montreal Cognitive Assessment (MoCA) for dementia screening. Clin Neuropsychol 2015;29:413–25.
[20] Kolen MJ, Brennan RL. Test equating: methods and practices. New York, NY: Springer Science & Business Media; 2013.
[21] Fong TG, Fearing MA, Jones RN, Shi P, Marcantonio ER, Rudolph JL, et al. Telephone interview for cognitive status: creating a crosswalk with the Mini-Mental State Examination. Alzheimers Dement (Amst) 2009;5:492–7.
[22] Moses T, vonDavier AA. An SAS macro for loglinear smoothing: applications and implications. Montreal: American Educational Research Association; 2005.
[23] Cordell CB, Borson S, Boustani M, Chodosh J, Reuben D, Verghese J, et al. Alzheimer's Association recommendations for operationalizing the detection of cognitive impairment during the Medicare Annual Wellness Visit in a primary care setting. Alzheimers Dement (Amst) 2013;9:141–50.