MoCA cutoff score in relation to the functional assessment of seniors living in a rural Canadian community

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Introduction: Research suggests that the Montreal Cognitive Assessment (MoCA) normal cutoff score of 26 may not be appropriate for all populations and ages. We sought to determine an appropriate MoCA cutoff score for community-dwelling seniors living in a rural Canadian community.

Methods: We conducted a retrospective chart review at a health centre in rural northern Ontario. The sample included community-dwelling seniors presenting between Dec. 1, 2013, and July 31, 2015. We generated a receiver operating characteristic curve to evaluate MoCA cutoff scores in relation to functional assessment, using the dichotomous categories of "no deficiencies in activities of daily living/instrumental activities of daily living (ADL/IADL) and "deficiencies in ADL/IADL."

Results: A total of 95 charts were included in the chart review. We identified MoCA scores of 20 (sensitivity 85%, specificity 62%) and 21 (sensitivity 77%, specificity 77%) as cutoff scores for the identification of impairment in this rural population.

Conclusion: Our results suggest the normal range in MoCA score for the community-dwelling rural senior to be between 22 and 30. Although the MoCA demonstrated satisfactory performance as a screening measure, the importance of including ADL and IADL functional assessments before making clinical decisions cannot be overemphasized.

Introduction : Des études semblent indiquer que le seuil habituellement utilisé dans la Montreal Cognitive Assessment (MoCA), soit un score de 26, pourrait ne pas convenir à tous les groupes et à toutes les tranches d'âges. Nous avons cherché à déterminer un seuil approprié pour l'évaluation des personnes âgées habitant dans la communauté d'une région rurale canadienne.

Méthodes : Nous avons mené un examen rétrospectif des dossiers dans un centre de santé d'une région rurale du Nord de l'Ontario. Notre échantillon était composé des personnes âgées habitant dans la communauté qui se sont présentées au centre entre le 1er décembre 2013 et le 31 juillet 2015. Nous avons généré une courbe caractéristique de la performance afin d'évaluer la validité des scores MoCA par rapport à une évaluation fonctionnelle reposant sur des catégories dichotomiques, soit « aucune déficience dans les activités de la vie quotidienne (AVQ)/activités instrumentales de la vie quotidienne (AIVQ) » et « déficiences dans les AVQ/AIVQ ».

Résultats : En tout, 95 dossiers ont été examinés. Nous avons conclu que des scores MoCA de 20 (sensibilité de 85 %, spécificité de 62 %) et de 21 (sensibilité de 77 %, spécificité de 77 %) seraient des seuils appropriés pour détecter la déficience chez cette population rurale.

Conclusion : Nos résultats indiquent que la plage normale de scores MoCA chez les personnes âgées habitant dans la communauté en milieu rural est de 22 à 30. Bien que la MoCA se soit révélée d'une efficacité satisfaisante comme outil de dépistage, nous nous devons d'insister sur l'importance capitale de tenir compte de l'évaluation fonctionnelle des AVQ et des AIVQ dans la prise de décisions cliniques.

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INTRODUCTION

The Montreal Cognitive Assessment (MoCA) is a screening instrument designed to assist primary care providers in the detection of mild cognitive impairment. There is evidence to suggest that diminished cognitive ability can be a predictor of functional deficiencies in activities of daily living (ADL) and instrumental activities of daily living (IADL).[1,2] Thus, the assessment of cognitive impairment has a role to play when appraising the functional ability of older adults to meet self-care needs and handle tasks involved in independent living. This is especially important for older adults living in rural communities, as they may live farther away from services and may have transportation issues. This study examines the association between MoCA scores and the presence of any or no functional deficiencies in ADL and IADL in a sample population of community-dwelling seniors in northern rural Ontario.

The MoCA was designed by Nasreddine and colleagues[3] as a rapid screening instrument for mild cognitive impairment; it assesses multiple cognitive domains, including attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculation and orientation.[4] Julayanont and colleagues[4] further emphasize that the MoCA should be used as a cognitive screening instrument and not a diagnostic tool; hence, clinical judgment, based on thorough clinical evaluation, is important in interpreting MoCA results. The original normative sample involved a healthy control group (*n* = 90), recruited from an urban sample, compared with a group of individuals who met the clinical criteria for mild cognitive impairment (*n* = 94) and a group with mild Alzheimer disease (*n* = 93) diagnosed using gold standard neuropsychological testing. The control group achieved an average MoCA score of 27.4 (range 25.2–29.6), and Nasreddine and colleagues[3]

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used a receiver operating characteristic (ROC) curve to illustrate that the optimal cutoff score for identifying cognitive impairment was 26 for this population (i.e., urban-dwelling seniors).

The MoCA cutoff score of 26 may not be appropriate for every community owing to differences in settings. To allow for cultural differences, the MoCA has been translated into more than 36 languages. The test is freely available at www.mocatest.org, and no permissions are needed for clinical or educational use.[4]

Functional assessment of ADL (Box 1) has been used as a framework for assessing daily function in the aging population and for evaluating rehabilitation and recovery from illness,[7] and provides an overview of a person's ability to meet self-care needs. Healthy aging requires a balance of accessing external resources, such as family and friends, health care providers, health centres and community services.

The Lawton IADL Scale includes domains of function that reflect a person's ability to live independently.[6] The IADL assessment reflects the moment-in-time functioning and can be used to track progress or deterioration over time. The 8 domains of function are listed in Box 1. Historically, men were not scored on food preparation, housekeeping and laundering, but it is now recommended that all 8 domains be assessed for both sexes.[8]

Waldron-Perrine and Axelrod[9] studied the results of the MoCA, alongside neurologic testing of veterans, and found that the optimal cutoff score for detecting mild cognitive impairment was 20 or less, which is substantively lower than the suggested cutoff score of less than 26. Waldron-Perrine and Axelrod[9] also note that the higher cutoff score "may overpathologize neurologically intact individuals," causing anxiety and distress to the individual and family, and placing an undue burden on the health care system. These authors recommended further research aimed at identifying cutoff scores in other populations.

To date, few studies have evaluated the MoCA in a rural setting. Zhou and colleagues[10] investigated the performance of the Chinese MoCA (C-MoCA) in relation to education. The authors stated that more than 38% of the population of China lives in rural areas. They found that the C-MoCA was better suited for individuals with 7–12 years of education (area under the ROC curve [AUC] 0.79; sensitivity 0.89, specificity 0.64 at cutoff 22/23), and was poorer for individuals with 0–6 years of education (AUC 0.60; sensitivity 67%, specificity 49% at cutoff 18/19).

> **Box 1. Activities included in the functional assessment of activities of daily living and instrumental activities of daily living**
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> Activities of daily living[5]
> - Bathing, dressing, grooming, mouth care, toileting, transferring in and out of a bed/chair, walking/walking outside, climbing stairs, eating
>
> Instrumental activities of daily living[6]
> - Shopping, cooking, managing medications, using the phone/looking up numbers, doing housework, doing laundry, driving/using public transportation, managing finances

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Freitas and colleagues[11] examined MoCA performance within a Portuguese sample and found that the mean educational level of their sample was 8.16 (standard deviation [SD] 4.72) years. This is much lower than the mean of 13.33 (SD 3.40) years identified by Nasreddine and colleagues.[3] Freitas and coauthors[11] found that the correction point for education was not applicable because of these educational differences between the 2 samples. They found that, for all educational levels, a MoCA cutoff score of 22.71 (SD 3.60) was appropriate for identifying cognitive impairment in a sample (n = 650, age range 25 to > 65 yr) from a population of rural and urban Portuguese individuals.[11]

Health care providers in rural communities of northern Ontario have used the MoCA and functional assessments of ADL and IADL as part of health assessments of seniors. There is, however, substantial equivocation as to how these measures should be integrated within assessments of this population — specifically with regard to an appropriate cutoff score that may be used to guide interpretation of the MoCA. The purpose of this study was to determine an appropriate MoCA cutoff score for community-dwelling seniors living in a rural Canadian community.

METHODS

We conducted a retrospective chart review at the health centre of a rural small town with a population of about 5000 (2011 Census of Canada). This northern Ontario town is located within 70 km of a metropolitan area with a population of more than 100 000, which defines this rural community as a moderate metropolitan-influenced zone.[12] The main industry of the rural community is a pulp and paper mill.

The review of our consecutively sampled charts (representing all individuals with a MoCA assessment [version 7.1] between Dec. 1, 2013, and July 31, 2015) was done in 2 separate data-collection events. All data were coded by the hospital staff clinician, and no identifiable data were recorded or retained. In the first data-collection event, the same nurse practitioner (B.A.P.) extracted MoCA scores from the charts, adhering to the administration of the MoCA (www.mocatest.org). For individuals with 12 or fewer years of education, the MoCA scores were adjusted by adding 1 point.[3] Screening with the MoCA was for cognitive impairment solely and independently from functional assessment.

After 1 week, the same nurse practitioner, who was unaware of the MoCA scores, categorized functional assessments of ADL[5] and IADL[6] by levels of deficiencies (no deficiencies, mild deficiencies, moderate deficiencies and severe deficiencies). Box 1 summarizes the ADL and IADL criteria used in these assessments.

All charts were reviewed by the same nurse practitioner, who knew each of the individuals through clinic visits, home visits and chart reviews. All charts were reviewed in the same manner to determine whether or not each individual could safely complete each of the 9 ADL tasks and the 8 IADL tasks. Each task was evaluated as "independent" (i.e., able to perform the task) or "not independent" (i.e., not able to perform the task).

The functional assessment of ADL and IADL for each chart was separately categorized by level of deficiencies. Individuals at level 1 demonstrated no functional limitations in ADL and IADL. Functional deficiencies were defined as mild (level 2), moderate (level 3) and severe (level 4).

Data analysis

We plotted an ROC curve to compare cutoff scores for MoCA total scores with levels of functional deficiency on measures of ADL and IADL. We used a 95% confidence interval (CI) for the AUC calculation. All data were analyzed using SPSS (version 23), and NCSS (version 10).

Sample size calculations using an α level of 0.05 and β level of 0.20 determined that a sample size of at least 30 per group was sufficient to conduct ROC comparison analyses (NCSS version 10, PASS version 14). We considered $p < 0.05$ significant for all analyses.

This study was approved by the Health Sciences Research Ethics Board at Western University.

RESULTS

One hundred charts were reviewed; 3 charts were excluded because the MoCAs were performed by another health care provider, 1 MoCA used a version other than 7.1 and 1 MoCA was a duplicate. A total of 95 charts were included in the retrospective chart review.

The sample had good representation from both sexes and had a wide age range. Relevant characteristics are summarized in Table 1. In terms of age and sex, this sample is representative of the region in which the data were collected: data for this community from the 2011 Census of Canada report a senior population of 435 men and 520 women, which suggests that the study sample (37 men and

58 women) has a similar sex composition and includes 9.5% of the population. The age distribution is presented in Figure 1.

The mean educational level was 10.33 (SD 2.99) years, with values ranging from 5 to 18 years. Of the participants, 17.9% completed more than 12 years of education (Fig. 2). Per the MoCA instructions, an additional point was added to the score of individuals who had 12 or fewer years of education.

The mean MoCA score for the sample was 21.25 (SD 4.57), with a wide range of scores (4–30). In terms of the impact of demographic variables and performance on the screening instrument, sex was not associated. Age was found to be weakly associated (Pearson $r = -0.22$, $p = 0.03$), and education was not significantly correlated (Pearson $r = 0.19$, $p = 0.07$).

Sixty-one participants (64%) showed no deficiencies in ADL and IADL (level 1), 16 (17%) showed mild functional deficiencies (level 2), and 18 (19%) showed moderate (level 3) or severe (level 4) functional deficiencies. The deficiency categories were split into 2 groups, level 1 (64%) with no deficiencies and levels 2, 3 and 4 (total of 36%) with deficiencies in ADL and/or IADL. The AUC was 0.81 (95% CI 0.72–0.91). Evaluation of the coordinates of this curve suggests 2 cutoff scores that would be useful adjuncts to clinical assessment. A cutoff score of 20 showed a sensitivity of 85% and a specificity of 62% within this sample, whereas a cutoff score of 21 suggested a sensitivity and specificity of 77%. This ROC curve is depicted in Figure 3.

DISCUSSION

We evaluated cutoff scores for the identification of mild cognitive impairment (in relation to functional deficiencies in ADL and IADL) using the MoCA within a rural sample. A large representative sample was employed within a retrospective chart review, and evaluators were unaware of MoCA scores when evaluating functional deficiency levels based on chart information. Our results suggest that the normal
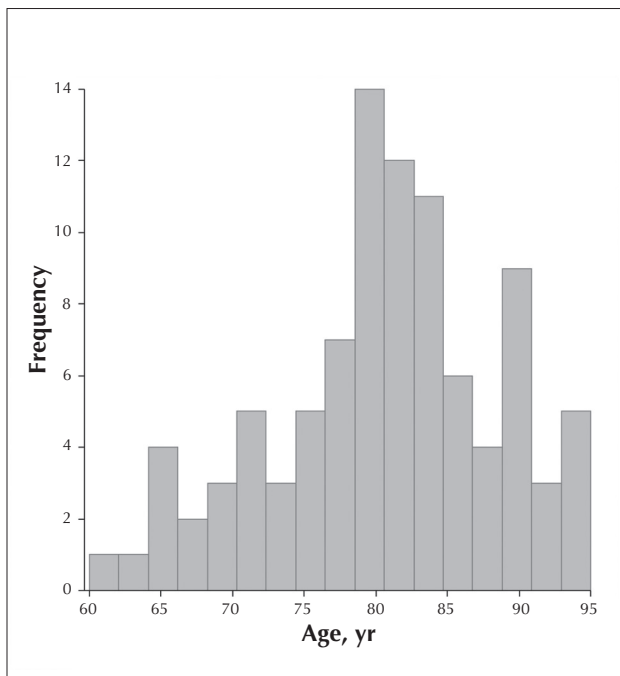
Table 1: Characteristics of patients included in the chart review (n = 95)	
Characteristic	No. (%)*
Age, yr	
Mean (± SD)	80.59 ± 7.50
Range	62–94
Sex	
Female	58 (61.1)
Male	37 (38.9)
Years of education	
Range	5–18
5–8	32 (33.7)
9–12	46 (48.4)
> 12	17 (17.9)
Living alone or with others	
Alone	38 (40.0)
With others	57 (60.0)

SD = standard deviation.
*Unless stated otherwise.

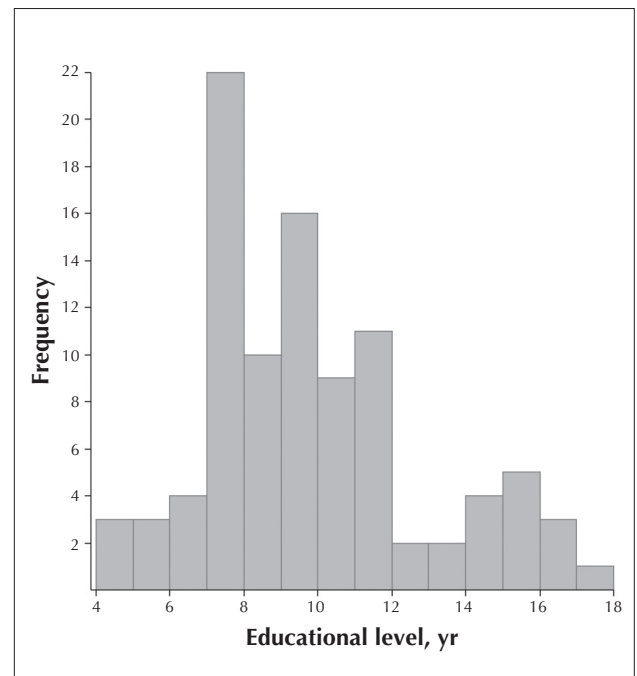Fig. 1. Age distribution of the study sample (n = 95).

Fig. 2. Education distribution of the study sample (n = 95).

range of MoCA scores based on functional assessment within a rural population is likely 22 to 30.

Nasreddine and colleagues[3] identified a MoCA cutoff score of 26 based on an urban sample (*n* = 90) with a mean age 72.84 (SD 7.03) and an average of 13.33 (SD 3.40) years of education, and a reference measurement that was based on neuropsychiatric evaluation and the Mini Mental State Examination. Since this initial publication, there have been a number of studies that have suggested alternative cutoff scores: Rossetti and colleagues[13] reported a MoCA cutoff score of 23, again based on an urban sample; Freitas and coauthors[11] included individuals from Portuguese rural and urban samples, and suggested a cutoff score of 22; and Waldron-Perrine and colleagues[9] reported a cutoff of 21 based on a ROC analysis of an American urban sample. There is, therefore, substantial agreement within the literature about the need for population-specific determination of MoCA cutoff scores. Furthermore, the specific cutoff scores identified within these studies support the cutoff score of 20 or 21, which is consistent with our findings.

Few studies have analyzed MoCA scores in relation to functional assessments of ADL and IADL, and so the inclusion of this mode of assessment is a critical strength of our study. In rural northern Ontario, there are limited resources and limited access to occupational therapists, and so nurse practitioners in small communities frequently become experts in performing these assessments.
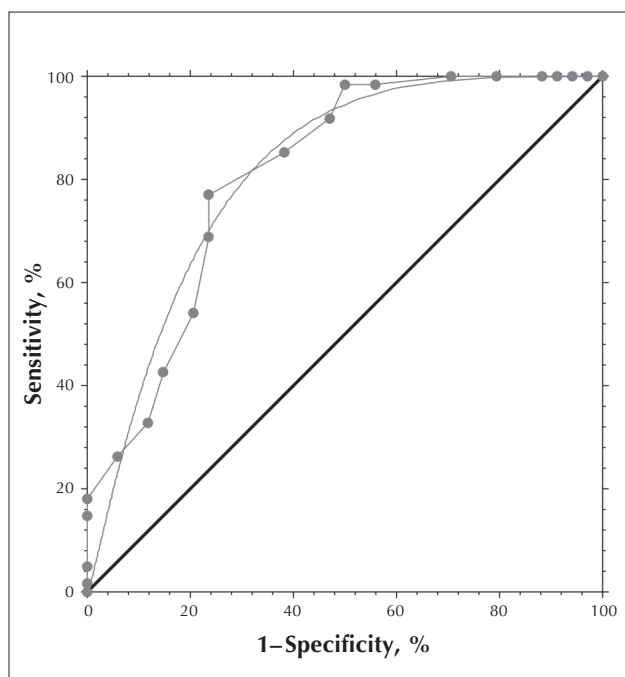

Fig. 3. Receiver operating characteristic curve.

Thus, the present research has substantial ecological validity with regard to the manner in which functional assessments are typically done within rural communities.

A recent study in a Turkish rural community included participants with fewer than 5 years of education, and the results emphasized the need to adapt the language sections of the MoCA.[14] Participants in the current retrospective chart review had between 5 and 18 years of education (mean 10 yr). Although the demonstrated association between years of education and MoCA score was very small in the present study, further investigation of MoCA items in relation to total score is needed. In particular, detailed item response theory analyses would substantially add to the growing literature surrounding implementation of the MoCA.

Limitations

It is important to consider several limitations of the present research. Although the sampling frame included a wide variety of educational backgrounds and a reasonable balance of men and women, and demonstrated good ecological validity, it was conducted in a single health centre. Furthermore, we did not have detailed information on lifestyle habits that have been implicated in cognitive impairment (e.g., smoking and alcohol use), and so it is impossible to draw conclusions about the extent to which these precipitating factors are related to participants' scores on the MoCA. Future research might consider additional demographic factors that may affect MoCA scores.

CONCLUSION

A cutoff score of 20 produces a sensitivity of 85% and a specificity of 62%, and a cutoff score of 21 produces a sensitivity of 77% and an improved specificity of 77%. This indicates that mild cognitive impairment, in relation to functional performance of ADL and IADL, is suggested for individuals within a rural population who score 21 or lower.

These results support the use of the MoCA as an assessment tool for screening for mild cognitive impairment and underscore the potential for overpathologizing rural individuals with the cutoff score of 26 suggested by Nasreddine and colleagues.[3] Furthermore, although the MoCA demonstrated satisfactory performance as a screening measure, the importance of including functional assessments of ADLs and IADLs before making clinical decisions cannot be overemphasized.

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