VALIDATION AND CUT-OFF SCORES OF MONTREAL COGNITIVE ASSESSMENT FOR ELDERLY VISUALLY IMPAIRED

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Abstract

This study aims to determine the reliability and validity and optimal cut-off scores of the Malay version of Montreal Cognitive Assessment for visually impaired (MoCA-BM-blind) among older adults with cognitive decline. Participants for this study were recruited from the population-based longitudinal study on neuroprotective model for healthy longevity (LRGS TUA) among Malaysian older adults. A total of 220 participants, aged 60 years and above, from Selangor were included in this study. Cognitive functions were assessed using MoCA-BM-blind and Malay version of Mini-Mental State Examination for visually impaired (M-MMSE-blind). Habitual distance VA was measured monocularly using the Early Treatment Diabetic Retinopathy Study chart. Cronbach's alpha and Pearson correlation coefficient were used to determine reliability and validity of MoCA-BM-blind, respectively. Receiver operating characteristic (ROC) analysis was conducted to determine the optimal cut-off score for MoCA-BM-blind. Reliability (Cronbach's alpha: 0.76) and validity (Pearson correlation: r = 0.77) of MoCA-BM-blind were high. The optimal cut-off for MoCA-BM-blind in detecting cognitive decline was 9 with 86.8% sensitivity and 72.7% specificity. With this cut-off, 35.0% visually impaired participants were classified as having cognitive decline. MoCA-BM-blind is a valid and reliable screening tool to assess cognitive function among visually impaired older adults.

Keywords: Aging, Cognition, Montreal Cognitive Assessment, Visual Impairment

Introduction

Aging is associated with decline in visual acuity (VA), motion perception, temporal resolution and changes in color perception (1). Aging also causes yellowing and hardening of crystalline lens, reducing the ability to focus at near distances, a phenomenon known as presbyopia. In addition, aging is linked to eye diseases, including cataract, glaucoma, diabetic retinopathy and age-related macular degeneration (ARMD), which may cause visual impairment (VI) (2). Global prevalence of VI among older adults aged 50 years and above was reported to be 20.4%. A National Eye Survey II (NES II) found that VI among Malaysian older adults (aged ≥ 50) was 7.6% (2, 3). A previous study in a rural area at Sepang, Selangor, found a higher prevalence of VI: 21.8% among residents aged 40 years and above (4).

A normal aging process is also associated with decline in cognitive domains, which include memory, processing speed, language, visuospatial and executive function (1). The worldwide overall prevalence of mild cognitive impairment (MCI) among older adults was 16.0% (5). However, the prevalence of MCI ranged from 3.0% to 42.0% (6). In Malaysia, the prevalence of MCI among older adults (aged ≥ 60) was reported to be 38.9% and 29.7% in a more recent study (7, 8).

Association between reduced vision and cognitive decline has been reported in previous studies (9-12). Harrabi et al. (13) reported significant lower scores on Mini-Mental State Examination for visually impaired (M-MSE-blind) among participants with age-related eye diseases (glaucoma, Fuch's corneal dystrophy and ARMD). Reduced vision has been postulated to affect cognitive performance due to lesser involvement in physical and cognitive activities (14). Thus, reducing brain stimulation over time causes gradual neural degradation and cognitive decline as stated in the sensory deprivation hypothesis (15). In addition, Hussin et al. (16) found that the risk of MCI among older adults was reduced with increased cognitive activities.

The Montreal Cognitive Assessment (MoCA) is a cognitive screening tool developed by Nasreddine et al. (17) for detecting MCI. The cut-off scores of MoCA in several studies among Asian older adult populations ranged from 17 to 28 (8, 18-20). The optimal cut-off score for a Bahasa Malaysia version of MoCA (MoCA-BM) was 17, with 68.2% sensitivity and 61.3% specificity, in detecting MCI among Malaysian older adults (8). The MoCA-BM has lower cut-off scores compared to other Asian countries due to adjustment of several co-variates (education level, age, gender, etc.) (8). However, the original MoCA test consists of vision-dependent items which affect evaluation of cognition among VI population (21). Wittich et al. (21) reanalyzed MoCA for visually impaired (MoCA-B) among Caucasian population by omitting those items and found that the optimal cut-off score for MoCA-B was 18, with 63% sensitivity and 98% specificity, in detecting MCI.

To our knowledge, only one study has been published on the cut-off score of MoCA for the visually impaired (21). The cut-off score was not derived from a visually impaired population, but instead was determined by reanalyzing data from the study by Nasreddine et al. (17) through elimination of vision-dependent items. Furthermore, no study was done on a Malay version of MoCA among the visually-impaired in the Malaysian population. It has been reported that language and cultural difference may affect the performance on the MoCA test (22). In conjunction with the increasing population of Malaysian older adults (23) and high percentage of VI among this population (3), this study was carried out to determine the validity and reliability, and optimal cut-off score of the Malay version of MoCA for visually impaired (MoCA-BM-blind) among older adults with cognitive decline in Selangor.

Methods

Ethical approval

The study adhered to the Declaration of Helsinki and was approved by the Medical Research and Ethics Committee of Universiti Kebangsaan Malaysia (UKM1.21.3/244/NN-2018-145). Signed informed consent was obtained from all participants prior to data collection.

Study design

This cross-sectional study was performed on Malaysian older adults recruited from the population-based longitudinal study on neuroprotective model for healthy longevity (LRGS TUA Project) (24). Twelve places were randomly selected from the state of Selangor (Keramat, Klang, Tanjung Sepat, Kuala Langat, Tanjung Karang, Kuala Selangor, Sekinchan, Petaling Jaya, Kelana Jaya, Sungai Pelek, Batu 9 Cheras and Kajang). This study was carried out from August 2018 until May 2019.

Participants

In this study, sample size was calculated using MedCalc Statistical Software version 18.2.1 (MedCalc Software, Ostend, Belgium). Area under the curve (AUC) of 0.80 and a null hypothesis value of 0.50 were used (25). For the ratio of sample sizes in negative to positive cases, a value of 2 was chosen (26). The sample size required from the calculation was 30. Participants aged 60 and above, with no documented major psychiatric illness or mental disorders, were included. Participants with moderately severe or severe cognitive impairment as determined by MMSE (score ≤ 14) were excluded (24).

Cognitive function assessment

Cognitive function tests were administered using MoCA-BM (8) and Malay version of MMSE (M-MMSE) (27). MoCA-BM has eight domains including visuo-constructional skills, executive functions, language, attention and concentration, calculations, memory, orientation and conceptual thinking. For the purpose of determining the cut-off score for MoCA-BM-blind, four visually-dependent items (trail-making task, copy-cube task, clock-drawing task and confrontational naming of animal pictures) were omitted and thus, the total score for MoCA-BM-blind is 22.

M-MMSE consists of 11 items which test for orientation, working memory, concentration, memory recall, language and visuospatial skills (27). The Malay version of MMSE for visually impaired (M-MMSE-blind) was calculated by omitting items requiring vision (naming, performing a three-stage command, following a written instruction, writing a sentence and copying), thus, leaving the total score of 22. The cut-off score 17 was used for M-MMSE-blind (10).

Vision assessment

Habitual distance VA of both eyes was measured monocularly using the Early Treatment Diabetic Retinopathy Study chart (Precision Vision, USA) at 3 m. The testing distance was reduced if participants failed to identify any letter at 3 m (28). VA of the better eye was used for categorization of visual impairment (VI) and analysis. Participants were classified into no visual impairment (NVI) and VI based on International Classification of Diseases for Mortality and Morbidity Statistics, 11th revision (ICD-11) (29). NVI was defined as VA ≤ 0.30 logMAR and VI as VA > 0.30 logMAR.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, N.Y., USA). The normality tests showed that all the parameters were normally distributed (p > 0.05). Reliability of the MoCA-BM-blind was determined using Cronbach's alpha. Pearson correlation coefficient was carried out to determine the concurrent validity between MoCA-BM-blind with M-MMSE-blind. Binary logistic regression was carried out to determine the predicted probability of each MoCA-BM-blind score and was adjusted for age, gender and education level. Receiver operating characteristic (ROC) analysis was carried out to determine the area under the curve (AUC) for sensitivity and specificity for the MoCA-BM-blind. The score with the maximal sensitivity and specificity was determined as the optimal cut-off score for MoCA-BM-blind.

Results

A total of 230 participants participated in this study. Ten were excluded due to M-MMSE score less than 15, hence only data of 220 participants were analyzed. Among 220 participants, 60 participants (27.3%) have VI and 160 participants (72.7%) have NVI. The age of the visually impaired participants ranged from 65 to 89 years, with a mean of 73.97 ± 5.73 years. Female participants (56.7%) slightly outnumbered male participants (43.3%). There highest number of participants was of Chinese (65.0%) ethnicity, followed by Malays (25.0%) and Indians (10.0%). The score for M-MMSE-blind ranged between 5 to 22, with a mean of 17.53 ± 3.95. Mean score for MoCA-BM-blind was 12.17 ± 5.02, with lowest score of 1 and highest score of 22. The sociodemographic characteristic mean score for M-MMSE-blind and MoCA-BM-blind among participants with VI and NVI are summarized in Table 1.

Table 1: Sociodemographic characteristic and cognitive functions of participants

	VI (n=60)	NVI (n=160)
Age	73.97±5.73 (Range: 65-89)	71.84±5.27 (Range: 64-88)
Gender		
Male	26 (43.3%)	68 (42.5%)
Female	34 (56.7%)	92 (57.5%)
Race		
Malay	15 (25.0%)	59 (36.9%)
Chinese	39 (65.0%)	75 (46.9%)
Indian	6 (10.0%)	26 (16.2%)
M-MMSE-blind	17.53±3.95 (Range: 5-22)	18.76±3.28 (Range: 5-22)
M-MoCA-blind	12.17±5.02 (Range: 1-22)	14.54±4.33 (Range: 2-22)

NVI: No visual impairment; VI: Visual impairment; n: number; M-MMSE-blind: Malay version of Mini-Mental State Examination for visually impaired; M-MoCA-blind: Malay version of Montreal Cognitive Assessment for visually impaired

It was found that the internal consistency of MoCA-BM-blind was high with Cronbach's alpha score of 0.76 among the visually impaired participants. The concurrent validity of MoCA-BM-blind with M-MMSE-blind was high (Pearson correlation: r = 0.77, p < 0.05). The optimal cut-off for MoCA-BM-blind in detecting cognitive decline was 9 with 86.8% sensitivity and 72.7% specificity (Table 2; Figure 1). With this cut-off score, 35.0% of the visually impaired participants were classified as having cognitive decline.

Table 2: Sensitivity, specificity, Youden index and AUC for relevant cut-off score of M-MoCA-blind

Cut-off scores	Sensitivity	Specificity	Youden Index	AUC
8	97.4	63.6	0.61	85.0
9*	86.8	72.7	0.60	81.7
10	78.9	72.7	0.52	76.7
11	73.7	77.3	0.51	75.0
12	65.8	81.8	0.48	71.7

Optimal cut-off score.
AUC: Area under the curve; M-MoCA-blind: Malay version of Montreal Cognitive Assessment for visually impaired

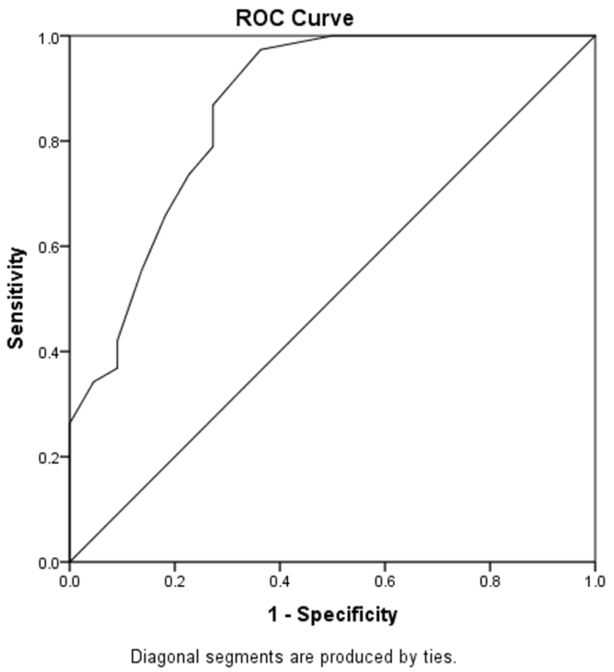

Figure 1: ROC curve of M-MoCA-blind among visually impaired subjects

Discussion

With elimination of visually dependent items, MoCA-BM-blind still retained its high internal consistency (Cronbach's alpha = 0.76) compared to 0.83 in the full MoCA (17) and 0.69 in MoCA-BM (8). The sensitivity (86.8%) and specificity (72.7%) of MoCA-BM-blind in this current study in differentiating participants with cognitive decline from normal were higher compared to MoCA-BM (sensitivity 68.2% and specificity 61.3%) (8). This may be because MoCA-BM was not adjusted for vision status although there are some items in MoCA-BM that require good vision. The prevalence of VI globally is high (20.4%) (2) and in Malaysia, the prevalence of VI among elderly was also high (10.4% in central region: Selangor, Negeri Sembilan and Kuala Lumpur) (3). Thus, it is important to determine the visual status among elderly before administration of MoCA.

To our knowledge, there was only one previous study that reported on the cut-off score for MoCA-B (21). The optimal cut-off of MoCA-BM-blind found in this study was 9, which is lower as compared to Wittich et al. (21). In their study, the cut-off score for MoCA-B was 18 with 63.0% sensitivity and 98.0% specificity. The difference in the findings could be due to the difference in methodology. In the study conducted by Wittich et al. (21), all participants were included regardless of visual status. However, in this study, only participants with VI were included in the analysis.

The elimination of visually dependent items in this study may result in some of the cognitive domains not being tested. Therefore, it could lead to under-estimation of cognitive function in determining cognitive decline (30). However, this can be overcome by using validated verbal or tactile version of MoCA for the visually dependent items in future study (31).

Conclusion

In conclusion, MoCA-BM-blind is a valid and reliable screening tool to assess cognitive function among visually impaired older adults.

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Competing interest

The authors declare no conflict of interest.

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