ORIGINAL RESEARCH

Association Between the Japanese Version of Montreal Cognitive Assessment Tasks and Driving as the Primary Mode of Transport Among Community-Dwelling Older Adults

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ABSTRACT

Background

Deciding whether to continue driving or transition to alternative means of transportation is a challenging issue for older adults in preventive care settings. This study aimed to identify potential associations between the Japanese version of the Montreal Cognitive Assessment (MoCA-J) and driving as the primary mode of transport among older adults.

Methods

The participants of this cross-sectional study were community-dwelling older adults participating in a long-term preventive care program. Participants were divided into two groups (DRIVING or OTHER) based on their questionnaire response regarding the main mode of transport used when going out, where the OTHER group included all participants who selected any other mode than a car driven by themselves. Cognitive function was measured using 13 MoCA-J tasks. Binary logistic regression analysis was used to identify associations between MoCA-J results and inclusion in the DRIVING group.

Results

Among the 199 participants, 156 were categorized into DRIVING group and 43 into OTHER group. The DRIVING group showed significantly higher task achievement rates than the OTHER group in trail-making, digit span, and phonemic verbal fluency tests. Of these, only the trail-making test results were associated with inclusion in the DRIVING group (odds ratio, 2.82; 95% confidence interval, 1.22–6.51; p =.016).

Conclusions

The trail-making task of MoCA-J may assist health-care professionals in providing driving guidance to older adults.

Key words: health promotion, mobility, preventive care, screening tool, cognition, frontal lobe, transportation mode

INTRODUCTION

Transport is essential for allowing community-dwelling older adults to participate in social activities.(1) Driving is the most common mode of transportation among older adults residing in both urban and rural areas; however, as people age, they gradually transition to alternative modes of transportation.(2,3) This is attributed to the increased risk of older adults developing dementia and mild cognitive impairment (MCI), conditions that impair the cognitive functions required for driving, such as attention, executive function, visuospatial cognition, and memory.(4-9) Cognitive decline is an important contributing factor in accidents involving older drivers.(4,5,9,10)

The Mini-Mental State Examination[11] and the Japanese version of the Montreal Cognitive Assessment (MoCA-J)[12] are part of cognitive tests commonly used to assess the driving fitness of community-dwelling older adults. The MoCA-J predicts driving fitness and risks among older drivers more effectively than the Mini-Mental State Examination.[9,10,13,14] Many previous analyses are based solely on the total MoCA-J score.[13] However, when diagnosing dementia and MCI, the scores obtained for each cognitive domain of the MoCA-J may be more useful than the MoCA-J total score.[15] We hypothesize that the results of specific MoCA-J domains and tasks may also yield new insights into the driving fitness of community-dwelling older adults.

In Japan, individuals renewing their driver's license after age 75 are required to undergo cognitive function testing, with the results determining whether they may continue driving.[16] Furthermore, physicians may voluntarily report examination findings to the Public Safety Commission if a licensed driver diagnosed with dementia or other specified conditions refuses to heed advice to refrain from driving.[17] However, assessments of driving fitness based on cognitive function and the selection of appropriate screening tools remain challenging.[14,18,19] Health-care professionals can also provide driving guidance in relation to cognitive function,[20] and are often involved in the process of helping individuals in dementia care settings to stop driving.[21] Therefore, a better understanding of the cognitive tasks that can inform driving decisions among older adults is crucial for healthcare professionals.

The study aims to identify MoCA-J-based screening tools for informing driving decisions among older adults. To achieve this purpose, we analyze the associations between individual MoCA-J task results and driving as the primary mode of transportation among community-dwelling older adults. The results of this study provide a more scientific basis for driving guidance in primary care and health promotion settings.

METHODS

This cross-sectional study is based on survey data from a wider study analyzing the effect of remote exercise classes on preventing frailty and frailty-related issues among community-dwelling older adults.[22] The wider study was conducted in collaboration with local governments in Sakai City and Katsuyama City, Fukui Prefecture, Japan. Participants in the exercise classes underwent regular physical and cognitive function assessments, as well as medical interviews, to understand their living conditions. The survey data were obtained from an initial assessment conducted prior to participation in the exercise classes.

Participants

Participants were recruited for the exercise classes through public information magazines and websites in each municipality. Residents who wished to participate applied directly to their respective municipality. From April 2022 to March 2024, 209 older adults participated in the exercise classes. Ten participants were excluded due to incomplete medical interviews or difficulties conducting the cognitive assessments, resulting in a final sample of 199 participants.

All participants were provided with written explanations of the risks of participation and the emergency procedures and medical follow-up required in the event of an accident, with the approval of Sakai City and Katsuyama City municipalities. Written informed consent was obtained from all participants. This study was approved by the Medical Ethics Review Board of Fukui University (20220048) and conducted in compliance with the Declaration of Helsinki (revised in Fortaleza in 2013) and the Ethical Guidelines for Life Science and Medical Research Involving Human Subjects (Notification No. 1 of the Ministry of Education, Culture, Sports, Science and Technology; Ministry of Health, Labour and Welfare; and Ministry of Economy, Trade and Industry on March 23, 2021).

Determining the Primary Mode of Transportation for Participants

The modes of transportation used by the participants were determined during an interview by asking, "What is your main mode of transport when going out?" The answer choices included walking, cycling, motorbike, car (driving yourself), car (driven by someone else), train, bus (local), bus (hospital/facility), wheelchair, electric wheelchair, walker, senior mobility scooters, and taxi. Multiple responses were allowed because older adults gradually transition from driving to alternative modes of transport as they age.[3,23] In this study, participants were categorized into two groups according to the selected mode of transportation. Individuals who included car (driving yourself) among their responses were classified into the DRIVING group, whereas those who selected only other modes of transportation were classified into the OTHER group. This categorization was adopted because driving a car represents the most common mode of transportation among older adults.[2,3]

Cognitive Function Tests

We used the MoCA-J as the cognitive test in this study.[12] The MoCA-J, which is designed to detect MCI, is scored out of 30, with the total score representing a composite of six cognitive function domains: visuospatial, executive, attention, memory, language, and orientation, measured through 13 individual tasks.[12] One point was added if the participant had 12 years or less of formal education.[12] The MoCA-J identifies MCI in participants with a score of 25 points or less, whereas 26 points or more indicates a normal cognitive range (sensitivity, 93%; specificity, 87%).[12] The MoCA-J test was administered by medical and nursing students, physicians, clinical laboratory technicians, nurses, and occupational therapists, all under the supervision of a neurologist and nurse with at least seven years of experience in neuropsychological testing. Physicians, nurses, clinical laboratory technicians, and occupational therapists assisted the medical and nursing students. Nurses

with more than seven years of experience verified the scoring accuracy. In this study, each MoCA-J task was classified as either achieved or not achieved. For tasks with a single point value, receiving a point was considered "achieved." For tasks with multiple point values, obtaining the maximum score was considered "achieved," whereas any score below the maximum was classified as "not achieved."

Statistical Analysis

We compared medical interviews and MoCA-J results for participants in the DRIVING and OTHER groups. The results for sex, chronic disease, and main mode of transport are presented as the number of participants (percentage), whereas those for age and education are presented as the mean (standard deviation [SD]). MoCA-J results are presented as the mean (SD) of the total score and the number (percentage) of participants who achieved each task.

The chi-square test was used to compare the DRIVING and OTHER groups for nominal variables, including sex, chronic disease, and the number of people who achieved each MoCA-J task. The Mann–Whitney U test was used for continuous variables, including age, education, and the total MoCA-J score. We performed binary logistic regression analysis to identify cognitive functions associated with the main transportation mode of older adults. The dependent variable was the primary mode of transportation (DRIVING or OTHER), and the independent variables were the results of each MoCA-J task that differed significantly between DRIVING and OTHER groups in the univariate analysis. The moderating variables included age, sex, and education, which were selected based on previous studies.[10,19,24] A receiver operating characteristic curve was constructed to determine the discrimination ability of the regression model, with model validity determined using the area under the curve.

All statistical data were analyzed using EZR version 1.68 (Saitama Medical Center, Jichi Medical University, Japan).[25] The level of statistical significance was set to $p = .05$.

RESULTS

Among the 199 participants, 162 (81.4%) were female and 37 (18.6%) were male, and the mean age was 74.8 ± 6.2 years. Regarding the main mode of transportation, 156 (78.4%) were assigned to the DRIVING group and 43 (21.6%) to the OTHER group.

Table 1 compares the baseline characteristics and MoCA-J scores between the DRIVING and OTHER groups. No significant difference was noted in sex between the groups. However, participants in the DRIVING group were significantly younger (p=.001) and more highly educated (p<.001). Chronic diseases such as dementia and mental disorders were significantly more common in the OTHER group (p=.032 and p=.043, respectively). The total MoCA-J score was significantly higher in the DRIVING group (p<.001).

Table 2 shows the results of each MoCA-J task (achieved or not achieved) for the two groups. The DRIVING group had a significantly higher proportion of participants who achieved the trail-making, digit span (forward and backward), and phonemic verbal fluency tasks (p<.001, p=.036, p=.017, and p=.025, respectively). Among these tasks, the results of the trail-making task were significantly associated with inclusion in the DRIVING group (odds ratio, 2.82; 95% CI, 1.22–6.51; p=.016; Table 3). The area under the receiver operating characteristic curve was 0.733 (95% CI, 0.644–0.822).

DISCUSSION

In this study, we analyzed potential cognitive functions associated with driving as the primary mode of transport among community-dwelling older adults by examining the results of individual MoCA-J tasks. Older adults who drove themselves had significantly higher achievement rates for trail-making, digit span, and phonemic verbal fluency tasks than those who used other modes of transportation. Multiple regression analysis identified trail-making as a key item associated with older adults who drove as their main mode of transportation.

The trail-making task in MoCA-J involves alternately connecting numbers and hiragana characters, and corresponds to the trail-making test part B (Trails B) in the MoCA. Trails B requires frontal lobe functions such as attention switching, planning, and executive function.[26,27] Although visual information processing and memory are required for driving, executive functioning is particularly important.[5,7,19] Therefore, the observed identified association between the MoCA-J trail-making test and older adults driving themselves indicates that this test sensitively captures the frontal lobe functions necessary for driving.

Older adults who drove themselves also showed significantly higher achievement rates on the digit span and verbal fluency tasks than those who used other transportation methods; however, the results of these tasks were not associated with inclusion in the DRIVING group. Although the digit span and verbal fluency tasks reflect working memory, cognitive flexibility, and executive function in the frontal lobe,[28,29] these tasks were verbally presented, whereas trail-making is a visual task that activates a broad range of brain regions, including the bilateral frontal (executive function), temporal (recollection of numbers and words), and occipital–parietal (visuospatial information processing) lobes, all of which are essential for driving.[8,9,27] Thus, the digit span and verbal fluency tasks only partially capture the brain functions required for driving, whereas the trail-making task comprehensively assesses these functions, which may explain the lack of association. Additionally, driving requires complex visual information processing,[8,9,30] which may not have been effectively captured in the linguistic delivery of the digit span or verbal fluency tasks.

Trail B is considered a useful tool for health-care professionals assessing driving fitness from the perspective of functional impairment in clinical settings.[31] In Japan, Trail B is a required neuropsychological test related to automobile driving when age-related cognitive decline is

suspected.[32] However, Trail B only assesses functional impairment, whereas driving fitness should be determined using comprehensive clinical findings.[31] Although our results demonstrate that the MoCA-J trail-making test is associated with driving as the primary mode of transport among older adults, decisions regarding whether an older adult should continue driving or transition to alternative transportation methods should be based on comprehensive findings, incorporating the insights gained from this study alongside conventional driving aptitude assessments,[31,32] such as driving simulator and road evaluations. Furthermore, the MoCA-J trail-making test is a shortened version of Trail B that evaluates only whether participants have achieved/not achieved the task, unlike the full version that evaluates task completion time and error count. Therefore, caution is required when interpreting the results of this study. However, conducting detailed driving aptitude tests is often impractical in community health promotion settings.[33] Under these circumstances, the MoCA-J trail-making test represents a simple and useful screening tool for measuring cognitive function and assessing driving fitness in community-dwelling older adults.

This study has some methodological limitations. First, we did not obtain detailed information on the participants' driving status. Previous studies have highlighted the limitations of capturing driving as a binary variable (driving/not driving), and recommended collecting more detailed information on driving behaviour, such as driving frequency and distance.[3]

TABLE 1.
Participant characteristics, main mode of transportation, and MoCA-J scores

Variable	*Unit*	*Overall* *n=199*	*DRIVING* *n=156*	*OTHER* *n=43*	*P value*
Sex					
Male	n (%)	37 (18.6)	31 (19.9)	6 (14.0)	.51
Female	n (%)	162 (81.4)	125 (80.1)	37 (86.0)	
Age[a]	year	74.8 ± 6.2	73.9 ± 5.6	77.9 ± 7.1	.001[b]
Education[a]	year	12.6 ± 2.4	12.9 ± 2.4	11.3 ± 2.0	<.001[b]
Morbidity					
Hypertension	n (%)	95 (47.7)	77 (49.4)	18 (41.9)	.40
Diabetes	n (%)	29 (14.6)	24 (15.4)	5 (11.6)	.63
Heart disease	n (%)	19 (9.5)	16 (10.3)	3 (7.0)	.77
Arrhythmia	n (%)	14 (7.0)	9 (5.8)	5 (11.6)	.188
Eye disease	n (%)	44 (22.1)	32 (20.5)	12 (27.9)	.31
Stroke	n (%)	5 (2.5)	4 (2.6)	1 (2.3)	1.00
Epilepsy	n (%)	1 (0.5)	0 (0.0)	1 (2.3)	.22
Dementia	n (%)	4 (2.0)	1 (0.6)	3 (7.0)	.032[b]
Mental disease	n (%)	7 (3.5)	3 (2.0)	4 (9.3)	.043[b]
Main mode of transportation					
Car (driving yourself)	n (%)	156 (78.4)	156 (100.0)	0 (0.0)	—
Walking	n (%)	28 (14.1)	7 (4.5)	21 (48.8)	
Bicycle	n (%)	12 (6.0)	0 (0.0)	12 (27.9)	
Motorbike	n (%)	1 (2.0)	0 (0.0)	2 (4.7)	
Car (driven by someone else)	n (%)	12 (6.0)	3 (1.9)	9 (20.9)	
Train	n (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Bus (local)	n (%)	1 (0.5)	0 (0.0)	1 (2.3)	
Bus (hospital or facility)	n (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Wheelchair	n (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Electric wheelchair	n (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Walker or senior mobility scooter	n (%)	1 (0.5)	0 (0.0)	1 (2.3)	
Taxi	n (%)	1 (0.5)	0 (0.0)	1 (2.3)	
MoCA-J					
Total score[a]	points	23.9 ± 4.0	24.5 ± 3.5	21.7 ± 4.8	<.001[b]
≤25 points[c]	n (%)	113 (56.8)	83 (53.2)	30 (69.8)	.058

[a]Data for age, education, and MoCA-J score are presented as the mean ± standard deviation.
[b] $p<.05$.
[c]Total MoCA-J score of 25 or less indicates mild cognitive impairment.[12]
DRIVING = participants who selected "car (driving yourself)" as the main mode of transportation; OTHER = participants who selected any other mode as the main mode of transportation; MoCA-J = Japanese version of the Montreal Cognitive Assessment.

Driver's license possession is also associated with cognitive function.[34] Therefore, future research should collect more detailed driving data. Second, the MoCA-J trail-making task is a shortened version of Trail B. Consequently, detailed analyses of task completion time and error counts, which are typically used to assess driving fitness, could not be performed.[31] Furthermore, analyzing error types in Trail B can help identify areas of brain function decline.[35] Thus, using the full version of Trail B in future research could provide a more detailed analysis of the relationship between driving decisions and cognitive function among older adults. Third, the generalizability of our findings is limited by differences in the transportation environments between rural and urban areas.[24,36] Future research should include urban-dwelling older adults and data compared with the findings of this study. Nevertheless, driving remains the primary mode of transportation among older adults in both rural and urban areas.[2,3] Therefore, we suggest that this study makes a valuable contribution to assessments of driving fitness among older adults, regardless of whether they reside in rural or urban areas.

TABLE 2.
Comparison of MoCA-J task results between groups[a]

Sub-item	*DRIVING*	*OTHER*	*P value*
	n=156	*n=43*	
Trail-making	132 (84.6)	24 (55.8)	<.001[b]
Copy cube	99 (63.5)	21 (48.8)	.112
Draw clock	122 (78.2)	29 (67.4)	.161
Naming	130 (83.3)	37 (86.0)	.82
Digit span forward	127 (81.4)	28 (65.1)	.036[b]
Digit span backward	137 (87.8)	31 (72.1)	.017[b]
Target tapping	150 (96.2)	40 (93.0)	.41
Serial 7	126 (80.8)	29 (67.4)	.095
Repeat sentences	40 (25.6)	7 (16.3)	.23
Phonemic verbal fluency	89 (57.1)	16 (37.2)	.025[b]
Verbal abstraction	83 (53.2)	19 (44.2)	.31
Delayed recall	22 (14.1)	2 (4.7)	.115
Orientation	132 (84.6)	35 (81.4)	.64

[a]Data are presented as the number of participants who achieved each task (%).
[b]$p<.05$.
DRIVING = participants who selected "car (driving yourself)" as the main mode of transportation; OTHER = participants who selected any other mode as the main mode of transportation; MoCA-J = Japanese version of the Montreal Cognitive Assessment.

CONCLUSION

The results of the MoCA-J trail-making task are associated with driving as the primary mode of transportation in community-dwelling older adults. This finding suggests that the MoCA-J trail-making task represents a useful indicator for older adults considering their daily transportation options, including whether to refrain from driving. This study provides valuable driving guidance support for health-care professionals, as well as older adults and their families in primary care and health promotion settings.

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TABLE 3.
Relationship between inclusion in the DRIVING group and achievement rates for each MoCA-J task

Variable	*OR*	*95% CI*		*P value*	*VIF*
		Lower	*Upper*		
Age	0.95	0.89	1.02	.128	1.27
Sex	1.89	0.64	5.54	.25	1.06
Education	1.20	1.00	1.45	.056	1.23
MoCA-J					
Trail-making	2.82	1.22	6.51	.016[a]	1.15
Digit span backward	1.90	0.76	4.75	.167	1.03
Phonemic verbal fluency	1.14	0.51	2.57	.75	1.18

[a]$p<.05$.
OR = odds ratio; CI = confidence interval; VIF = variance inflation factor; MoCA-J = Japanese version of the Montreal Cognitive Assessment.

CONFLICT OF INTEREST DISCLOSURES

We have read and understood the *Canadian Geriatrics Journal*'s policy on conflicts of interest disclosure and declare the following interests: HO has signed a nondisclosure agreement with Nice METS Inc. and Macnica Inc. The other authors declare no conflicts of interest.

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