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CONVERTING MOCA-J TO MMSE-J IN COMMUNITY-DWELLING JAPANESE OLDER ADULTS: A PILOT STUDY

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This study aimed to develop a conversion table for the Japanese version of the Montreal Cognitive Assessment (MoCA-J) to the Japanese version of the Mini-Mental State Examination (MMSE-J) to facilitate prediction of the MMSE-J score from the MoCA-J score. Participants (N = 121) were community-dwelling older adults (M = 74.12, SD = 4.73, age 61–84) who were able to visit the university laboratory alone, having no diagnosis of dementia. Their cognitive performance was assessed by MoCA-J and MMSE-J. We developed the MMSE-J conversion table from the row MoCA-J scores using the equipercentile equating with log-linear smoothing. A Bland-Altman plot displayed a nonsignificant systematic bias between the raw and converted MMSE scores. The conversion table presented high accuracy, with 85.8% of converted MMSE-J scores falling within two points of raw scores. In addition, our conversion table demonstrated the advantage of using the MoCA-J for early detection of cognitive decline.

Key words: cognitive assessment, screening, early detection of cognitive decline, mild cognitive impairment

Introduction

As the global population ages, the number of people with cognitive decline increases. A recent focus on this challenge has been to slow the progression from the early stages of cognitive decline, including subjective cognitive decline (SCD) and mild cognitive impairment (MCI), to dementia (Petersen et al., 1999; Reisberg et al., 1988).

Data supporting the findings of this study are available upon request from the corresponding author.

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Therefore, early detection of cognitive decline is necessary for early treatment and prevention (Cruz-Oliver & Morley, 2010). Reports of family members or caregivers often play an important role in detecting cognitive decline, as indicated by current clinical criteria (e.g., Clinical Dementia Rating [CDR], Diagnostic and Statistical Manual of Mental Disorders [5th ed.; DSM-5]; Johansson et al., 2015). However, with an increasing need for detecting cognitive decline at an early stage, it is important to establish simplified and objective methods for the assessment of MCI (Liss et al., 2021).

The Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) are the most widely used cognitive assessment tools for detecting cognitive impairment, including MCI and dementia, in both clinical and research fields (Ciesielska et al., 2016; Liss et al., 2021; Nasreddine et al., 2005). Although many studies have reported using the MMSE to predict cognitive impairment, such as MCI and dementia (Anthony et al., 1982; Sugishita, 2018), limitations in the utilization of the MMSE have been recognized. It has been observed that MMSE scores tend to be relatively high among not only healthy individuals but also those with MCI (Ciesielska et al., 2016; Creavin et al., 2016). This trend is more prominent among individuals with higher educational backgrounds (Bravo & Hébert, 1997; O'Bryant et al., 2008; Sakuma et al., 2017). In contrast, MoCA scores tend to be lower than MMSE scores, suggesting that MoCA is more feasible for detecting early cognitive decline (Abd Razak et al., 2019; Ciesielska et al., 2016; Creavin et al., 2016; Larner, 2012; Nasreddine et al., 2005). Additionally, several previous studies have reported that the MoCA is an appropriate measurement for cognitive decline with different years of education (Kim et al., 2016; Yancar Demir & Özcan, 2015). In this context, the MoCA has been translated into various languages and is gaining attention as a screening tool for early signs of cognitive decline. Moreover, many studies and clinicians are interested in predicting MMSE scores based on MoCA scores (Fasnacht et al., 2023; Roalf et al., 2013; Siqueira et al., 2019). Although previous studies have converted MoCA to MMSE scores (Aiello et al., 2022; Bergeron et al., 2017; Chen et al., 2021; Fasnacht et al., 2023; Lawton et al., 2016; Roheger et al., 2022; van Steenoven et al., 2014; Yang et al., 2021) and vice versa (Bergeron et al., 2017; Roheger et al., 2022; Wong et al., 2018), no study to date has attempted such conversion for the Japanese version. Therefore, it is important to establish a conversion table between Japanese versions of the MoCA (MoCA-J) and MMSE (MMSE-J) although the MoCA is not mainstream in Japan.

Goal and Scope

The purpose of this study was to develop a conversion table from the MoCA-J to the MMSE-J and assess whether the conversion table for the Japanese versions align with previous findings in other languages. Previous studies have reported reliable and simple conversion tables for the conversion of the MoCA to the MMSE. For instance, Roalf et al. (2013) reported that a raw MoCA score of 18 was equivalent to a score of 24 on the converted MMSE among healthy controls and patients with MCI or Alzheimer's disease (AD, a major cause of dementia). The primary objective of this study was to develop and apply a straightforward conversion table from the MoCA-J to the MMSE-J for healthy

older adults and individuals with self-reported SCD. The second objective was to investigate the relationship between MoCA scores and the corresponding converted MMSE scores, with a specific focus on identifying patients with MCI.

Method

Participants

The participants (N = 121, 82 females, 66.9%) were community-dwelling older adults with no diagnosis of dementia, aged 61–84 years (M = 74.12, SD = 4.73), who were able to visit the university laboratory alone, mostly using public transportation. Fifty-two participants were part-time workers, recruited from the Japanese National Silver Human Resources Centers Association (area: Kyoto-city; 2013–2014). Sixty-nine participants were recruited from advertisements in a dance research project for those who have subjective memory complaints (2022–2023). Given that certain participants were recruited from the Silver Human Resources Center, our sample age threshold was 61 years and older. All the participants were Japanese speakers with no clinical diagnosis of dementia. The participants' demographics, sex proportion, age, and education are presented in Table 1. All procedures were approved by the local Research Ethics Committee (2013-E-1666 and 2022-C-1545). Written informed consent was obtained from each participant before commencement of the study.

Measures

Participants underwent testing in the following order: MMSE-J (Folstein et al., 1975; Sugishita, 2012, 2019), followed by MoCA-J (13 participants only completed the MoCA-J; Fujiwara et al., 2010; Nasreddine et al., 2005) on the same day except for a few participants. A trained examiner administered both the MMSE-J and MoCA-J. The scores on both tests ranged from 0 to 30. The MMSE-J assesses orientation, memory, recall, naming objects, attention, following verbal and written commands, writing a sentence, and copying a figure. The MoCA is divided into 6 domains: memory, executive function, attention, language, and orientation (Julayanont et al., 2014; Nasreddine et al., 2005). We adjusted the MoCA-J scores by adding 1 point for individuals with 12 years of education or less. Traditionally, cutoff scores of 23/24 for the MMSE, differentiating dementia from healthy controls (Folstein et al., 1975), and 25/26 for the MoCA, differentiating MCI from healthy Japanese individuals with no educational adjustment (Fujiwara et al., 2010; Nasreddine et al., 2005), have been employed to diagnose neurocognitive decline, respectively.

Data Analysis

We conducted a correlation analysis to analyze the relationship between each test and age or education. Spearman's rank correlation analysis was employed because neither test's scores statistically followed a normal distribution. In addition to this simple correlation analysis, a partial Spearman's rank correlation analysis was adapted to test the association between MMSE-J and MoCA-J. The covariates

Table 1. Demographics

Characteristic (n = 121)	Mean (SD)	Range
Age (years)	74.12 (4.73)	61–84
Education (years)	13.31 (2.55)	8–20
MMSE-J (score)	27.22 (2.11)	19–30
MoCA-J (score)	23.99 (3.21)	12–30

Note. MMSE-J = Mini-Mental State Examination-Japanese version; MoCA-J = Montreal Cognitive Assessment-Japanese version.

included age and educational level. The statistical threshold was set at $p < .05$, and the Benjamini-Hochberg method was used to control the false discovery rate (FDR) for multiple hypothesis testing. For the conversion of the MMSE-J score from the MoCA-J score, we employed the equipercentile equating method with log-linear smoothing using the "equate" library in R (Albano, 2016). This equation method defines 2 different test scores as equivalent if their percentile ranks in each test are equal (Kolen, 1984). Importantly, log-linear smoothing improves the accuracy of the converted scores while maintaining raw data characteristics (Livingston, 1993). A Bland-Altman analysis was conducted to investigate the reliability of the converted table. In this analysis, we investigated the acceptable limit between raw and converted MMSE scores. Additionally, we investigated systematic bias (fixed and proportional bias). The limits of agreement (LOA) lie between mean difference ± 1.96 × standard deviation, considered to be within 95% of the acceptable range of difference (Bland & Altman, 1986). To investigate the accuracy of the conversion table, we evaluated the proportion of participants whose score differences fell within ± 1–2, and ± 3 (Chen et al., 2021; Yang et al., 2021). Statistical analyses were performed using IBM SPSS version 25 and R version 4.2.3.

Results

Demographic Characteristics and Their Associations

The demographic characteristics are presented in Table 1. Additionally, Fig. 1 illustrates histograms for 5-year age groups and their corresponding mean cognitive test scores. As shown in Fig. 2, both cognitive tests significantly correlated with age and education. Age was negatively correlated with cognitive scores (MMSE-J: *rho*(105) = –.256, 95% CI [–.42, –.07], FDR, $p = .00942$, MoCA-J: *rho*(118) = –.369, 95% CI [–.51, –.20], FDR, $p < .001$), while longer educational experiences were linked to elevated cognitive test performance (MMSE-J: *rho*(105) = .236, 95% CI [.05, .41], FDR, $p = .01445$, MoCA-J: *rho*(118) = .263, 95% CI [.09, .42], FDR, $p = .00561$). Additionally, the correlation between MMSE-J and MoCA-J was significant (Fig. 3; *rho*(104) = .384, 95% CI [.21, .54], FDR, $p < .001$). The partial correlation coefficient between the 2 tests, controlling for age and education, was significant (Fig. 3; *rho*(102) = .292, 95% CI [.13,

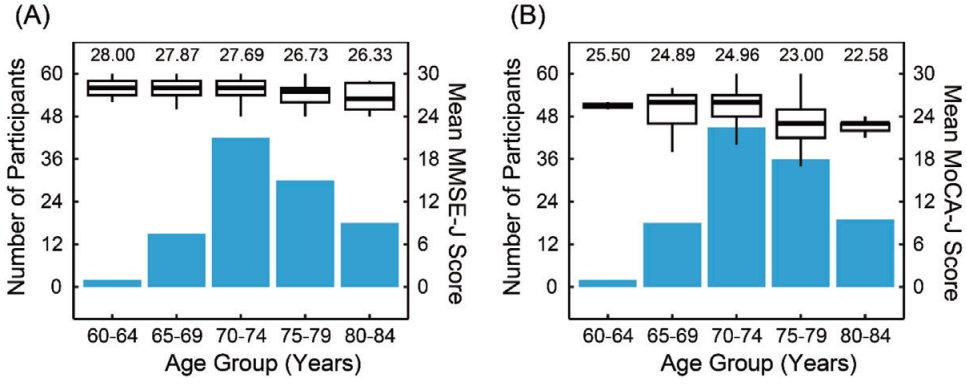

Fig. 1. Histograms for 5-Year Age Groups and Their Corresponding Mean Cognitive Test Scores

Note. (A) Mean MMSE-J score and (B) mean MoCA-J score. MMSE-J = Mini-Mental State Examination-Japanese version; MoCA-J = Montreal Cognitive Assessment-Japanese version.

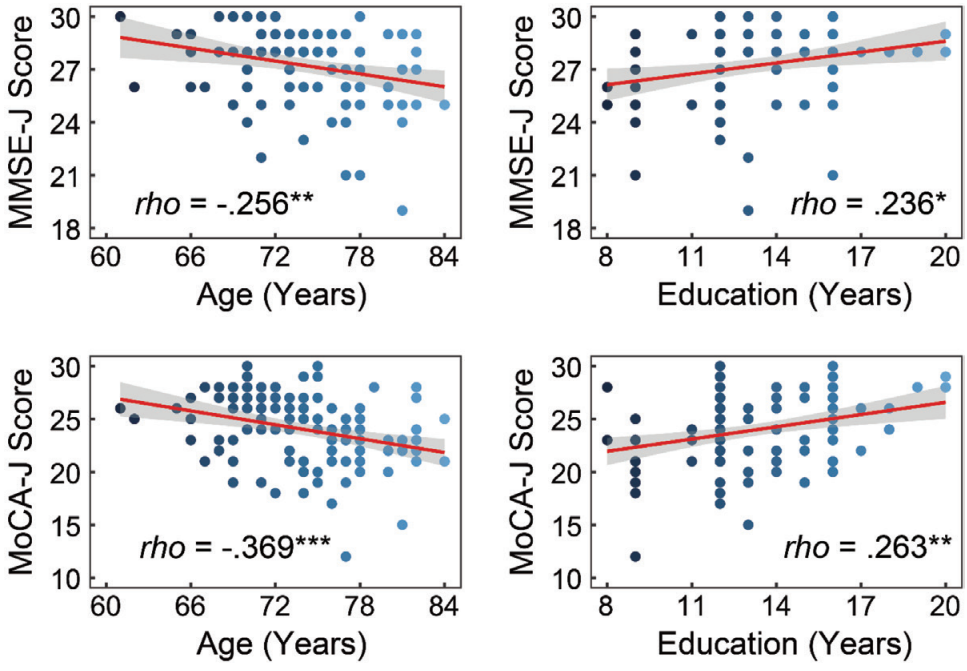

Fig. 2. The Correlation Between MMSE-J or MoCA-J and Age or Education

Note. The MMSE-J ($y = 36.23 - .12x$, 95% CI [25.11, 29.98], RMSE = 2.03, AIC = 460.9, BIC = 468.9) and MoCA-J ($y = 40.23 - .22x$, 95% CI [20.54, 28.49], RMSE = 3.02, AIC = 612.0, BIC = 620.4) scores were negatively correlated with age, whereas their cognitive tests were positively correlated with education (MMSE-J: $y = 24.49 + .21x$, 95% CI [25.24, 29.71], RMSE = 2.04, AIC = 462.1, BIC = 470.1; MoCA-J: $y = 18.85 + .39x$, 95% CI [20.66, 28.13], RMSE = 3.04, AIC = 613.3, BIC = 621.7). MMSE-J = Mini-Mental State Examination-Japanese version; MoCA-J = Montreal Cognitive Assessment-Japanese version; CI = confidence interval; RMSE = root mean squared error; AIC = Akaike information criterion; BIC = Bayesian information criterion.

*$p < .05$, **$p < .01$, ***$p < .001$.

.48], FDR, $p = .00528$).

MoCA-J to MMSE-J Conversion

Table 2 presents the conversion results for the potential MMSE-J scores based on the MoCA-J scores in our study. The raw score range of the MoCA was 12–30. To estimate the equivalent MMSE-J score for MoCA-J scores < 12, we used the estimated scores calculated from a single regression equation. The observed MoCA-J scores (12–30) corresponded to a range of converted scores (19–30) on the MMSE-J (Fig. 4), indicating that the MoCA-J scores tended to be lower than the MMSE-J scores. For instance, the suggested cutoff of 23/24 on the MMSE-J corresponds to 18/19 on the MoCA-J.

Validity of the Converted MMSE-J

A Bland-Altman plot is presented in Fig. 5 to examine the reliability of the

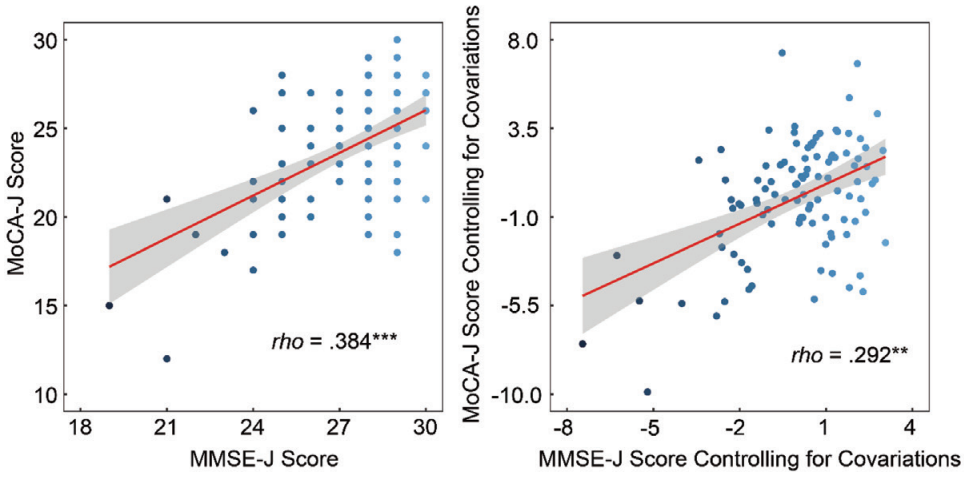

Fig. 3. The Relationship Between MMSE-J and MoCA-J Score Changes

Note. In the simple Spearman correlation analysis, the MMSE-J score was positively correlated with the MoCA-J score (y = 18.73 + .36x, 95% CI [21.67, 30.19], RMSE = 1.79, AIC = 429.8, BIC = 437.8). After controlling for covariates (age and education), these cognitive tests revealed a positive correlation (y = .00 + .32x, 95% CI [–4.37, 3.27], RMSE = 1.77, AIC = 427.3, BIC = 435.3). MMSE-J = Mini-Mental State Examination-Japanese version; MoCA-J = Montreal Cognitive Assessment-Japanese version; CI = confidence interval; RMSE = root mean squared error; AIC = Akaike information criterion; BIC = Bayesian information criterion.

**p < .01, ***p < .001.

converted MMSE-J. The mean difference between the raw and converted MMSE scores was .047, with LOA upper 3.81 and lower –3.72. Neither fixed, t(105) = –.252, 95% CI [–.42, .32], p = .802, nor proportion bias, r(104) = –.058, 95% CI [–.24, .13], p = .553, was present. The scores of 91.5% (97 participants' scores) of the sample fall within the LOA. To investigate the accuracy of the conversion table, our current study focused on analyzing the error ratio within the range of 0 to 3 points, following the methodology described by Yang et al. (2021). They evaluated the error between the raw and converted score of MMSE and reported the following accuracy levels: within 2 points error range for 59%–70%, within 3 points error range for 72.6%–84.5% (for details, see Yang et al., 2021). Our results indicated that 85.8% of the converted MMSE-J scores fell within 2 points of the raw MMSE-J scores, and 91.5% of the converted MMSE-J scores were within 3 points of the corresponding raw scores.

Discussion

The primary goal of the current study was to develop a corresponding table of conversion scores from the MoCA-J to the MMSE-J for community-dwelling older adults in Japan. This conversion table facilitates a comparison between the two cognitive tests, the MoCA-J and MMSE-J. To our knowledge, this is the first report on the conversion of

Table 2. Conversion Table for MoCA-J to MMSE-J Based on a Japanese Sample of Community-Dwelling Older Adults Who Were Able to Visit the University Laboratory

Raw MoCA-J	Equivalent MMSE-J
1	11
2	12
3	12
4	13
5	14
6	14
7	15
8	16
9	16
10	17
11	18
12	19
13	19
14	20
15	20
16	21
17	22
18	23
19	24
20	25
21	26
22	26
23	27
24	28
25	28
26	29
27	29
28	29
29	30
30	30

Note. The MMSE-J 1–11 were the estimated scores. MMSE-J = Mini-Mental State Examination-Japanese version; MoCA-J = Montreal Cognitive Assessment-Japanese version.

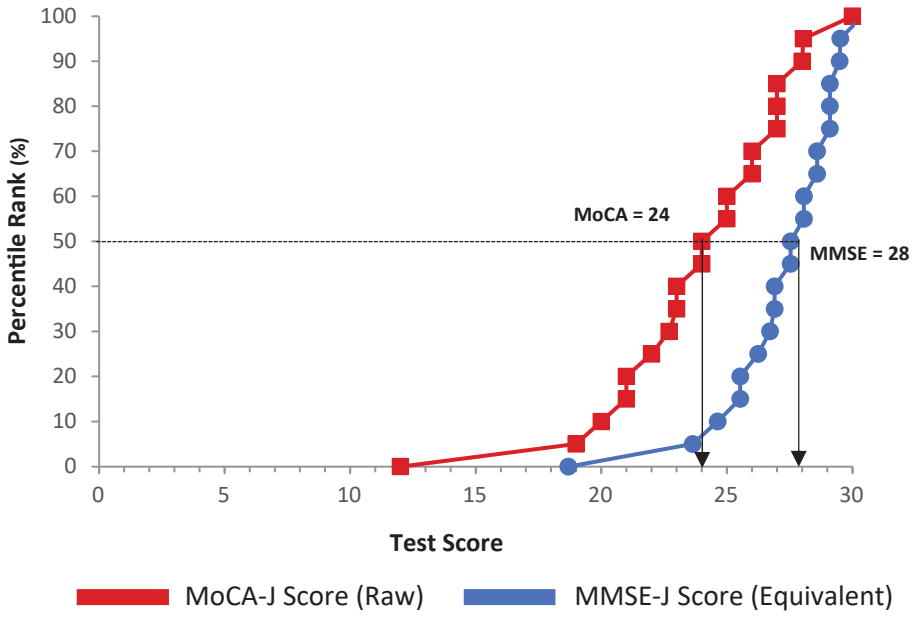

Fig. 4. Corresponding Raw Scores and Percentile Ranks for the MMSE-J and MoCA-J

Note. For example, the MoCA-J score of 24 is equivalent to the MMSE-J score of 28. MMSE-J = Mini-Mental State Examination-Japanese version; MoCA-J = Montreal Cognitive Assessment-Japanese version.

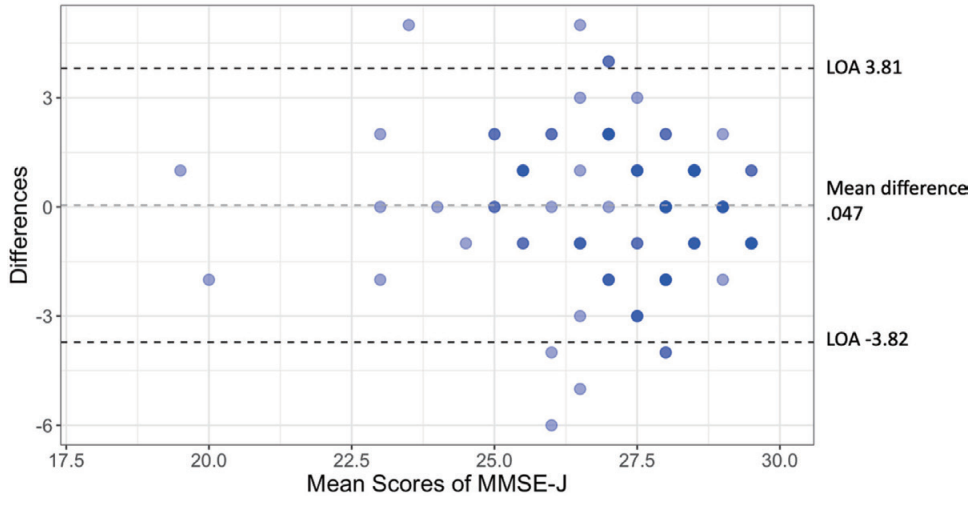

Fig. 5. Bland-Altman Plot of the Difference in the Raw and Converted MMSE-J Scores

Note. The central dot line indicated the mean difference between the raw and converted MMSE-J scores. The upper and lower dot lines represent the LOA, where 95% of the differences between the 2 scores are expected to fall. LOAs are determined by mean difference ± 1.96 × standard deviation. The darker color indicates a higher data density. MMSE-J = Mini-Mental State Examination-Japanese version; LOA = limits of agreement.

scores from the MoCA-J to the MMSE-J.

To assess the relationship between the raw scores of MoCA-J and MMSE-J, we examined the correlation between the two tests. Our result from the Spearman's correlation coefficient indicates a significant relationship. However, it should be noted that our correlation is likely to be smaller than those reported in previous MoCA-MMSE conversion studies (Roheger et al., 2022; Yang et al., 2021). This discrepancy in test relationships was likely associated with the score distribution in the current study, particularly in the MMSE-J, where higher scores were observed in the current sample. Our participants had relatively preserved cognitive function and no diagnosis of dementia. However, the previous study included not only healthy controls but also individuals with MCI or AD. Yang et al. (2021) reported a stronger relationship between MMSE and MoCA scores in individuals with MCI or AD than in normal controls.

To validate the conversion table, we examined the differences between the raw and converted MMSE-J scores (Chen et al., 2021; Yang et al., 2021). In our results, we observed a similar accuracy level for the conversion correspondence table, with no difference noted in 18.9% of cases and a difference within the range of 1–3 points in 62.2%–91.5% of cases. These findings are consistent with those of previous reports (for more details, see Yang et al., 2021).

Regarding the differences between the MMSE-J and MoCA-J in the accuracy of assessing each individual, our conversion table clearly indicates the possibility of a more accurate assessment using the MoCA-J. An advantage of the MoCA-J was observed in those with higher cognitive function. As depicted in Table 2, MMSE-J scores between 25 and 30 corresponded to a wider range of MoCA-J scores (between 20 and 30). Moreover, the inaccuracy owing to the ceiling effect was milder for the MoCA-J. Therefore, our conversion table demonstrates the advantage of using the MoCA-J for the early detection of cognitive decline.

Our results in the conversion table suggest a cutoff score for differentiating AD from MCI or differentiating MCI from healthy controls. For example, a cut-off score of 25/26 of MoCA has been proposed to differentiate individuals with MCI (Nasreddine et al., 2005). Our converted score of 28 on the MMSE-J was equivalent to a MoCA-J score of 25. Additionally, we observed that a converted MMSE-J score of 23/24, considered the dementia cutoff (Folstein et al., 1975), was equivalent to a raw MoCA-J score of 18/19. Here, we report the cutoff score for differentiating MCI from AD on the MoCA-J, although interpreting the screening criteria is an ongoing challenge (Fujiwara et al., 2010).

It is crucial to consider the participant's background such as language, culture, education, and gender when screening for cognitive function (Engedal et al., 2021; Gómez et al., 2013; Kaul et al., 2022; Luo et al., 2018; O'Driscoll & Shaikh, 2017). In fact, a screening cutoff score on MoCA for cognitive function levels varies across countries and participant backgrounds. For examples, MCI < 24 and Dementia < 22 in an African American sample (Goldstein et al., 2014), MCI < 22 and Dementia < 19 in Hong Kong (Yeung et al., 2020), MCI < 24 and Dementia < 19 in Portugal (Magierska et al., 2012), and MCI < 19 and Dementia < 15 in Tanzania (Masika et al., 2021). A recent

study summarized cutoff scores ranging from 13 to 26 to distinguish MCI from healthy individuals and from 15 to 25 to distinguish between dementia and MCI (Liss et al., 2021). Our study provides insights into additional criteria for MCI and AD detection using MoCA scores in Japan.

The current study has several limitations. First, our sample only included community-dwelling older adults without a clinical diagnosis of dementia. A previous study reported that the relationship between the MMSE and MoCA varies depending on the diagnosis of cognitive function (Bergeron et al., 2017). Interpretation of the results should be limited to a specific context; that is, our results are based on a Japanese sample without a diagnosis of AD. Future studies should examine the relationship with a larger sample with wider range of cognitive statuses. Second, in Japan, the Revised Hasegawa Dementia Scale (HDS-R) is widely used in clinical settings to identify dementia (Imai & Hasegawa, 1994). In addition, the HDS-R demonstrated higher accuracy in detecting AD than the MMSE (Kim et al., 2005). Therefore, it is necessary to examine the conversion from HDS-R to MMSE-J or MoCA-J.

To the best of our knowledge, this is the first study to apply a conversion method to major cognitive tests in Japan, focusing on the MoCA-J and the MMSE-J. Recent studies have indicated the global importance of the MoCA over the MMSE in the early detection of cognitive decline. We anticipate that our findings will enhance the versatility of the test for long-term screening and provide insights into the utility of MoCA for screening neurocognitive decline.

AUTHOR'S CONTRIBUTION

K.S. was involved in conceptualization, supervision, participant recruitment, writing-review and editing; S.I. was involved in participant recruitment, acquisition of data, analysis, writing-original draft; M. Yamashita was involved in conceptualization, analysis, writing-original draft; R.T., A.T., S.N. and M. Yamada were involved in participant recruitment, acquisition of data, writing-review and editing. All authors revised and confirmed the final version of the manuscript.

CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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