Normative Data for the Montreal Cognitive Assessment in a Japanese Community-Dwelling Older Population

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Key Words
Cognitive decline • Cognitive screening • Dementia • Cross-sectional study • Community-based study • Elderly • Mild cognitive impairment

Abstract
Background: Although the Montreal Cognitive Assessment (MoCA) is acknowledged as a promising neuropsychological tool, its normative data for older populations have not been established yet. The purpose of this study was to provide normative data for the MoCA in Japanese community-dwelling older people. Methods: In a Japanese town, 1,977 participants aged 65 years or older (mean age 73.6 years; male 41.3\%) completed MoCA tests. After descriptive and regression analyses, normative data were developed for MoCA scores in the population. Results: The mean MoCA score observed (21.8 points) was lower than that for normal controls (27.4 points) in the original validation study of the MoCA. Additionally, 82.6\% of MoCA scores fell below the standard cutoff of 26 points for detecting mild cognitive impairment (MCI). The regression analysis showed that higher age and fewer years of formal education were associated with lower MoCA scores (p < 0.001). Normative data for MoCA scores were presented with respect to age and education. Conclusion: This study provided normative data for the MoCA in a Japanese community-dwelling older population. This research also suggests that conventional use of the MoCA as a screening tool for MCI might be problematic in cultures different from that in which the cutoff was developed.

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Introduction
Mild cognitive impairment (MCI) represents an intermediate clinical state between normal cognitive aging and Alzheimer’s disease or other types of dementia [1]. Although it is not always the case, MCI has been reported to often develop into either Alzheimer’s disease or other forms of dementia and, therefore, recognized as a high-risk state for dementia development [2]. In recent discussions, community-based screening of MCI is considered one of the crucial steps to enable wide-reaching interventions for preventing or slowing the onset of dementia [3].

Montreal Cognitive Assessment (MoCA) is a brief neuropsychological tool designed for screening MCI in community health care [4] and is acknowledged as a promising instrument worldwide [5–7]. Given the need for ethnic-specific versions of neuropsychological tests [8, 9], 38 versions of the MoCA are currently developed in 31 languages (www.mocatest.org). MoCA has also
been reported to have higher sensitivity to a subtle cognitive decline than conventional tools such as the Mini-Mental State Examination [4, 10, 11]. To date, two cohort studies reported normative MoCA data in population-based samples including a multiethnic US population [12] and a Portuguese population [13]. Both studies, however, were conducted with subjects of a wide age range, and thus, the sample sizes were scarce for the older age groups.

Because older people are the primary subjects of MCI screening and subsequent interventions, their scoring characteristics on the MoCA should be examined and demonstrated with a larger sample size. This is an urgent matter, especially for a Japanese society undergoing the world’s fastest aging with the highest life expectancy. Therefore, the aim of the present study was to provide normative MoCA data specific to community-dwelling older people in a Japanese town.

Materials and Methods

Participants

The present study involved analysis of data from the baseline phase of the Sasaguri Genkimon Study (SGS) conducted from May to August 2011. The SGS is an ongoing community-based prospective cohort study in a Japanese local town, Sasaguri, aiming to explore modifiable lifestyle factors causing older people to require nursing care. Subjects of the baseline study (SGS-1) were all residents of the town who were aged 65 years or older and not certified as individuals requiring nursing care by the town in January 2011 (n = 4,979). Sixty-six subjects were excluded due to being dead or moving out by the onset of the study. A set of study information sheets and a questionnaire were mailed to all remaining subjects (n = 4,913), and 2,629 individuals, hereafter referred to as the participants of the SGS-1, responded to the mail by (1) visiting a community center to submit the questionnaire and undergo multiple physical and cognitive tests in one of 31 group-testing sessions of the SGS-1, (2) contacting study coordinators to set up an appointment for an individual home-testing session or (3) visiting the city office to submit the questionnaire (recruitment rate: 53.5%). Of these, 2,129 individuals took part in the MoCA tests. After the testing, we excluded 32 individuals who were unable to complete the MoCA properly, 12 individuals with missing information about their years of formal education, and 108 individuals with self-reported medical histories of stroke, depression, Parkinson’s disease and dementia. Accordingly, data from 1,977 participants (75.2% of the total participants of the SGS-1) were involved in the present study.

Standard Protocol Approvals, Registrations and Patient Consents

All the participants provided written informed consent to participate in the present study. The study protocol and the informed consent form were approved by the Institutional Review Board of the Institute of Health Science, Kyushu University.

Measurements

We used the Japanese version of the MoCA for all measurements. The details of the Japanese version are described elsewhere [5]. Briefly, it was developed and validated by investigators, including the inventor of the original MoCA (Dr. Nasreddine). As in the original one [4], the Japanese version of the MoCA was designed as a 30-point screening instrument administered in about 10 min and consists of the following 12 cognitive tasks: a five-item delayed recall task (5 points), a clock-drawing task (3 points), a cube-copying task (1 point), a trail-making task (1 point), a phono-meric fluency task (1 point), a two-item verbal abstraction task (2 points), a target-tapping task (1 point), a serial subtraction task (3 points), a two-item digits-reading task (2 points), a three-item naming task (3 points), a two-item sentence-repeating task (2 points) and a six-item temporal and locational orientation task (6 points). In the standard procedure of the original as well as the Japanese versions, 1 point is added to the total score of the cognitive tasks if an individual has 12 years or fewer of formal education, and a final total score falling below 26 points is judged to have probable MCI.

Procedures

All MoCA tests were administered to the participants by trained personnel as part of the group-testing and home-testing sessions of the SGS-1. After the testing, MoCA scores were independently evaluated by two authors (K.N. and T.H.) and double-checked between the two before being finally determined. The interevaluator reliability, shown as a percentage of agreement in the MoCA scores, was 93.3% in the initial evaluation. To demonstrate normative data in participants with a wide range of years of formal education, the preferred 1-point correction for education was not adopted.

Statistical Analyses

All statistical analyses were conducted using SAS version 9.2 (SAS Institute Inc., Cary, N.C., USA). The Wilcoxon rank-sum test and the χ2 test were conducted to compare age and sex, respectively, between the participants of the present study and the rest of the subjects (n = 2,936). The Wilcoxon rank-sum test was also performed to assess the difference in years of formal education between the participants of the present study and the rest of the participants of the SGS-1 answering educational history in the questionnaire (n = 608). Descriptive statistics were calculated for MoCA scores and for scores of respective cognitive tasks. A multiple regression analysis was performed with the MoCA score as a dependent variable and age, sex and years of formal education as independent variables. Additionally, to visualize changes in MoCA scores, simple regression analyses were conducted between the MoCA score and age in three education levels (≤9, 10–12, and ≥13 years of formal education). Subsequently, normative data for MoCA scores in the community-dwelling older population were developed with respect to age and education. Overlapping age categories of 65–75, 70–80, 75–85, and ≥80 years, accompanied by the aforementioned three education levels, were adopted in the normative data based on the rationale previously described for practical use of the normative data in community health care [12, 14]. A significance level was set at two-sided α = 0.05.
**Results**

The participants of the present study differed from the rest of the subjects in terms of sex (percentage of males, 41.3 vs. 45.3%; \( p = 0.008 \)), but not in terms of age (median, 72 years for both groups; interquartile range, 68–78 years for both groups; \( p = 0.860 \)). Also, the number of years of formal education was not different between the participants of the present study and the rest of the participants of the SGS-1 answering educational history in the questionnaire (median, 12 years for both groups; interquartile range, 9–12 years for both groups; \( p = 0.216 \)). The mean age of the participants was 73.6 years (standard deviation, SD, 6.2; median, 72; range, 65–96) and the number of years of formal education was 11.0 years (SD, 2.5; median, 12; range, 2–23); 41.3% of the participants were male (\( n = 817 \)). The mean MoCA score was 21.8 points (SD, 3.9; median, 22; range, 5–30), with 82.6% of scores falling below the preferred cutoff of 26 points for probable MCI. Histograms with scores of the respective cognitive tasks are summarized in figure 1.

In the multiple regression analysis, significant associations with the MoCA score were found for age (regression coefficient, –0.21; 95% confidence interval, CI, –0.23 to –0.10). The histogram for each cognitive task is shown in figure 1.
to –0.18; p < 0.001) and education (regression coefficient, 0.42; 95% CI, 0.36–0.49; p < 0.001) but not for sex (regression coefficient, 0.21; 95% CI, –0.10 to 0.52; p = 0.186). Figure 2 demonstrates the results of the simple regression analyses showing significant associations between the MoCA score and age in all three education levels (p < 0.001). Specifically, higher age was associated with lower MoCA scores in all the education levels. Finally, normative data for MoCA, specific to the community-dwelling older people, were determined with respect to the four age categories and three education levels (table 1).

**Table 1.** Normative data for MoCA scores

<table>
<thead>
<tr>
<th>Age category</th>
<th>Education level</th>
<th>Total by age</th>
<th>65–75 years</th>
<th>10–12 years</th>
<th>≥13 years</th>
<th>65–75 years</th>
<th>10–12 years</th>
<th>≥13 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>65–75 years</td>
<td>371 ± 3.7</td>
<td>248</td>
<td>1,278</td>
<td>21.4 ± 3.7</td>
<td>23.3 ± 3.1</td>
<td>24.0 ± 3.0</td>
<td>22.9 ± 3.4</td>
<td></td>
</tr>
<tr>
<td>70–80 years</td>
<td>406 ± 3.8</td>
<td>157</td>
<td>1,034</td>
<td>20.2 ± 3.8</td>
<td>22.1 ± 3.4</td>
<td>23.2 ± 3.0</td>
<td>21.6 ± 3.7</td>
<td></td>
</tr>
<tr>
<td>75–85 years</td>
<td>327 ± 4.0</td>
<td>83</td>
<td>730</td>
<td>19.2 ± 4.0</td>
<td>21.3 ± 3.4</td>
<td>22.6 ± 3.1</td>
<td>20.5 ± 3.9</td>
<td></td>
</tr>
<tr>
<td>≥80 years</td>
<td>161 ± 4.4</td>
<td>35</td>
<td>366</td>
<td>18.0 ± 4.4</td>
<td>20.5 ± 3.5</td>
<td>22.1 ± 4.0</td>
<td>19.6 ± 4.2</td>
<td></td>
</tr>
<tr>
<td>Total by education</td>
<td>692</td>
<td>964</td>
<td>321</td>
<td>1,977</td>
<td>20.1 ± 4.1</td>
<td>22.5 ± 3.4</td>
<td>23.6 ± 3.2</td>
<td>21.8 ± 3.9</td>
</tr>
</tbody>
</table>

Data are expressed as number, mean ± SD and median (with range in parentheses).

**Discussion**

Population-based screening for MCI is recognized as a key step in establishing sound wide-reaching intervention programs for preventing or delaying older people from developing dementia [3]. Although the MoCA has great promise as a screening tool for MCI, knowledge regarding its scoring characteristics in population-based older samples has still been limited. To our knowledge, the present study was the first to demonstrate normative MoCA data specific to community-dwelling older people not only in Japanese society but worldwide. Reflecting the world’s highest population aging rate in Japan, the normative data were formed with a relatively high proportion of old-old and oldest-old samples (table 1), which should be informative for other societies besides Japan. The present study also examined the associations of socio-demographic factors, including age, sex and years of formal education with MoCA scores in the older population.

In an attempt to develop normative data reflecting cognitively normal samples, we excluded individuals from the present analyses if they self-reported medical history of diseases contributing to or reflecting the development of clinical cognitive decline [2, 10, 15, 16]. There exists an argument that normative values should be representative and, therefore, should be developed from samples including both cognitively normal and abnormal individuals [17]. However, we made the exclusion based on the promise that the sensitivity of screening or detecting cognitively impaired individuals can be enhanced by comparing a patient’s score to that of a reference group free of any clinical cognitive decline [18]. The exclusion of individuals requiring nursing care in the subject selection process may also be conducive to enhancing the sensitivity.

The mean MoCA score of 21.8 points observed in the present study was lower than that for the normal controls.
cause multiple population-based studies have also ob-
tained inclusion of patients with undiagnosed dementia. Be-
This percentage is still high even considering the poten-
tions appear to be taken into account during the develop-
though the cross-cultural and cross-linguistic adapta-
the correction) fell below the preferred cutoff of 26 points
of the scores (82.6% without the correction or 75.1% with
points; SD, 3.8). Furthermore, more than three quarters
were unchanged even after the preferred 1-point correc-
tional validity of the cutoff score due to the limited num-
administrative issues in the present study but to a low ex-
possible causes of the discrepancy are some cultural and
ment of the scores in population-based use
be misleading and problematic to count the effects by ad-
cultural and linguistic artifacts occurring in the translation process of
Although the cross-cultural and cross-linguistic adapta-
the validity of the adaptations was examined with a limited number of
clinical-based subjects and, therefore, the possibility of
cannot be ruled out.
As observed in previous population-based studies
among a wide age range [12, 13, 24], this discrepancy may not be attributed to some administra-
the present study but to a low ex-
ternal validity of the cutoff score due to the limited num-
number of samples and/or possible selection bias for the non-
population-based samples in the original study [4]. Other
possible causes of the discrepancy are some cultural and
cross-cultural and cross-linguistic adapta-
tions appear to be taken into account during the develop-
ment process of the Japanese version [5], the validity of
the normative data demonstrated in the present study
population-based samples.
that the current MoCA procedure is somewhat prema-
ture for MCI screening in community-dwelling older
people. However, because we didn’t employ a clinical di-
agnosis of MCI in the research design, the present study
is unable to further propose any alternative criteria for
population-based MCI screening. Instead, at this stage,
the normative data demonstrated in the present study
screening in community-dwelling older samples while taking into account the
influence of age and education. For example, if a 75-year-
old patient with 9 years of formal education scored 12
points on the MoCA test, his or her personal physician
can appreciate that the score was lower than the mean
minus 2 × SD [i.e. 20.2 – (2 × 3.8) = 12.6] for the age-
and education-matched normal group and can suspect
the patient’s clinical cognitive decline. Similarly, the
normative data may be useful for professionals when
monitoring subtle cognitive change within a patient in longitudinal observations. It should be noted here that
the definition of normal or abnormal needs to be care-
fully made in practical use, depending on the context
and circumstances in which the MoCA test is adminis-
tered.
Our report has some limitations which are worth not-
ing here. First, the sample of the present study was af-
fected to some extent by the nonresponse, withdrawal
eclusion of originally designated subjects. Specifi-
cally, the participants of the present study differed from
the rest of the subjects in terms of sex distribution. How-
ever, we believe the influence of this discrepancy on the
present results was not considerable because the regres-
sion analysis showed no association in this discrepancy on the
present study was performed in a single Japanese town, generalizability of the
results is somewhat limited. Nevertheless, the present
normative data can be considered applicable to other
places in Japan because ethnicity and educational system
are almost homogeneous across Japan. Finally, in the norm-
strata were formed with relatively
small numbers of samples and, thus, are probably less re-
liable in terms of age-education relationships.
Associations of MoCA scores with other socio-demo-
graphic factors, such as ethnicity, culture, language, fi-
nancial security and family configuration, remain to be
explored by future investigations in order to generalize
the findings of this research. Obtaining these types of re-

Normative Data for the MoCA in Older
Population

Neuroepidemiology 2013;40:23–29
search findings might be essential before establishing the cutoff for population-based MCI screening. In parallel with exploring the future use of the MoCA as a population-based MCI screening tool, we are going to follow the present participants in prospective observations of the SGS to determine the ability of the test to predict the future onset of dementia in the community-dwelling older population.

**Conclusion**

In summary, the present research reported normative data for MoCA scores derived from a relatively large-scale community-dwelling older population in Japan and proposed practical applications of the normative data in community health care. This research also suggests that conventional use of the MoCA as a screening tool for MCI might be problematic in cultures different from that in which the cutoff was developed.

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**Disclosure Statement**

The authors declare that there are no conflicts of interest.

**References**


