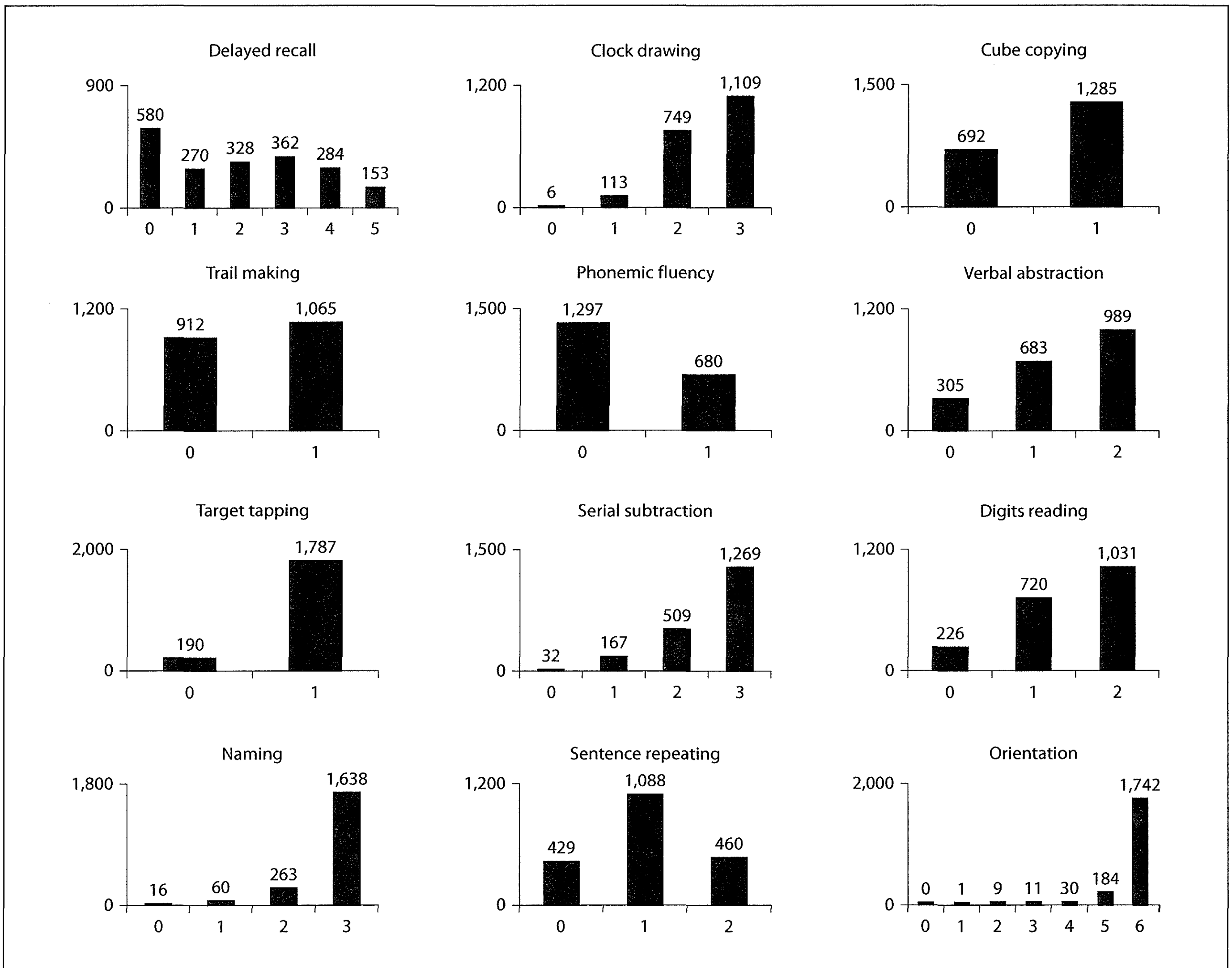

Fig. 1. Histograms of scores for respective cognitive tasks in MoCA. Each panel shows a histogram for one of the 16 cognitive tasks in the MoCA. Horizontal and longitudinal axes of each panel indicate points scored and frequency count for each point, respectively.

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

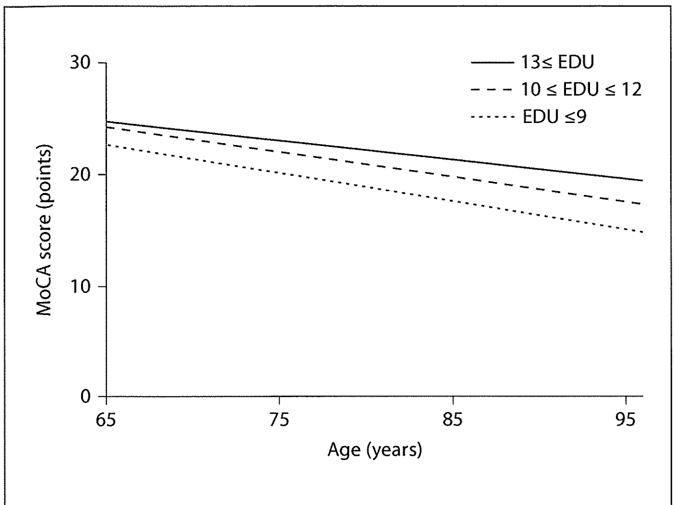

Fig. 2. Regression lines between age and MoCA scores in three education levels. EDU denotes years of formal education. Intercepts (at 65 years) and slopes for respective regression lines are as follows: 24.73 and –0.17 in 13 ≤ EDU; 24.30 and –0.22 in 10 ≤ EDU ≤ 12; 22.66 and –0.25 in EDU ≤9.

Table 1. Normative data for MoCA scores

	Education level			Total by age
	≤9 years	10–12 years	≥13 years	
Age category				
65–75 years	371	659	248	1,278
	21.4 ± 3.7	23.3 ± 3.1	24.0 ± 3.0	22.9 ± 3.4
	22 (9–29)	23 (14–30)	24 (13–30)	23 (9–30)
70–80 years	406	471	157	1,034
	20.2 ± 3.8	22.1 ± 3.4	23.2 ± 3.0	21.6 ± 3.7
	20 (6–29)	22 (12–30)	23 (13–29)	22 (6–30)
75–85 years	327	320	83	730
	19.2 ± 4.0	21.3 ± 3.4	22.6 ± 3.1	20.5 ± 3.9
	19 (5–28)	21 (12–29)	23 (16–29)	21 (5–29)
≥80 years	161	170	35	366
	18.0 ± 4.4	20.5 ± 3.5	22.1 ± 4.0	19.6 ± 4.2
	19 (5–28)	21 (8–29)	23 (12–29)	20 (5–29)
Total by education	692	964	321	1,977
	20.1 ± 4.1	22.5 ± 3.4	23.6 ± 3.2	21.8 ± 3.9
	20 (5–29)	23 (8–30)	24 (12–30)	22 (5–30)

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

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).

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 (n = 90; mean, 27.4 points; SD, 2.2) and was indeed close to that for the patients with MCI (n = 94; mean, 22.1 points; SD, 3.1) in the original normative study performed by the development group of the MoCA [4]. These trends were unchanged even after the preferred 1-point correction of MoCA scores for formal education (mean, 22.7 points; SD, 3.8). Furthermore, more than three quarters of the scores (82.6% without the correction or 75.1% with the correction) fell below the preferred cutoff of 26 points for detecting MCI while the reported prevalence of MCI in older populations ranges from 15 to below 30% [19–23]. This percentage is still high even considering the potential inclusion of patients with undiagnosed dementia. Because multiple population-based studies have also observed MoCA scores comparable to the present one [12, 13, 24], this discrepancy may not be attributed to some administrative issues in the present study but to a low external validity of the cutoff score due to the limited 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 linguistic artifacts occurring in the translation process of the original MoCA into the Japanese version [8, 18]. Although the cross-cultural and cross-linguistic adaptations appear to be taken into account during the development process of the Japanese version [5], the validity of the adaptations was examined with a limited number of clinical-based subjects and, therefore, the possibility of cultural and linguistic artifacts in population-based use cannot be ruled out.

As observed in previous population-based studies with subjects in a wide age range [12, 13], the present results show significant associations of age and education with the MoCA scores in older samples. Specifically, MoCA scores were lower in participants with higher age and/or fewer years of formal education. In contrast, no association was found between sex and the MoCA score. The effects of age and education have been well documented for neuropsychological tests in population-based studies and have been taken into account with age- and education-specific norms when the obtained scores have been evaluated [17, 18]. Because both age and education are now recognized as risk factors of cognitive decline [25, 26] rather than just biasing factors of the tests, it can be misleading and problematic to count the effects by adjusting an obtained score for these variables and evaluate the adjusted score using a single cutoff [17, 27]. In the light of this discussion, the current MoCA procedure, comprising a 1-point adjustment for 12 or fewer years of formal education and a subsequent evaluation with a single cutoff of 25/26, may not be the best for screening MCI in population-based samples.

Taken together, it is considered reasonable to assume that the current MoCA procedure is somewhat premature for MCI screening in community-dwelling older people. However, because we didn't employ a clinical diagnosis 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 can allow clinicians and researchers to detect individuals with abnormal cognitive decline from the 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 carefully made in practical use, depending on the context and circumstances in which the MoCA test is administered.

Our report has some limitations which are worth noting here. First, the sample of the present study was affected to some extent by the nonresponse, withdrawal and exclusion of originally designated subjects. Specifically, the participants of the present study differed from the rest of the subjects in terms of sex distribution. However, we believe the influence of this discrepancy on the present results was not considerable because the regression analysis showed no association between sex and the MoCA score. Second, because 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 normative data, some strata were formed with relatively small numbers of samples and, thus, are probably less reliable in terms of age-education relationships.

Associations of MoCA scores with other socio-demographic factors, such as ethnicity, culture, language, financial security and family configuration, remain to be explored by future investigations in order to generalize the findings of this research. Obtaining these types of research 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.

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