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Original Article

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National Age- and Education-Specific Normative Data for K-MoCA Total Score, Domain Index Scores, and K-MoCA-22

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The authors have no financial conflicts of interest.

ABSTRACT

Background and Purpose: The Korean-Montreal Cognitive Assessment (K-MoCA) is widely used for cognitive screening, but its normative data require updating to reflect current demographic characteristics. Norms are also unavailable for the K-MoCA domain index scores and the K-MoCA-22. This study aimed to update norms for the K-MoCA total score and to establish norms for the six domain index scores and the K-MoCA-22.
Methods: A nationwide normative sample of 1,177 cognitively healthy adults aged 19–90 years completed the K-MoCA and the Korean–Mini Mental State Examination, Second Edition: Standard Version (K-MMSE~2:SV). Six domain index scores and K-MoCA-22 scores were derived from the K-MoCA. Demographic effects and score distributions were examined. Ordinary least-squares regression modeled the K-MoCA and K-MoCA-22 scores, while quantile regression modeled the domain index scores.
Results: K-MoCA and K-MoCA-22 performance was primarily influenced by age and education, with sex contributing little independent variance. Compared with the K-MMSE~2:SV, the K-MoCA showed a broader score distribution and a smaller ceiling effect. Among domain index scores, the Memory Index Score showed the broadest distribution and the smallest ceiling effect. The K-MoCA-22 showed improved distributional characteristics relative to the K-MoCA, with reduced negative skewness. Age- and education-specific norms were established for all measures.
Conclusions: This study provides updated age- and education-adjusted norms for the K-MoCA, along with the first Korean norms for its domain index scores and the K-MoCA-22. These norms extend the K-MoCA's clinical utility by enabling age- and education-adjusted interpretation of global and domain-specific cognitive performance in clinical practice and research.

Keywords: K-MoCA; K-MoCA-22; Normative Data; Domain Index Scores; Cognitive Screening

Author Contributions
Conceptualization: Kang Y; Data curation: Kang Y, Song M; Formal analysis: Jahng S, Kang Y; Funding acquisition: Kang Y; Methodology: Kang Y, Jahng S; Project administration: Kang Y; Writing - original draft: Kang Y; Writing - review & editing: Kang Y, Jahng S, Song M.

INTRODUCTION

The Montreal Cognitive Assessment (MoCA) was originally developed as a brief screening instrument for mild cognitive impairment (MCI) and, in its original validation study, showed substantially higher sensitivity for detecting MCI than the Mini-Mental State Examination (MMSE).[1,2] Since then, the MoCA has become one of the most widely used paper-and-pencil cognitive screening tools worldwide.[3,4] According to the official MoCA website, validated paper and digital adaptations of the MoCA are now used globally in more than 100 languages and dialects, with multiple adapted forms available, including MoCA Full, MoCA Basic, MoCA Blind/Telephone, MoCA 5-Minute/Telephone, and MoCA Hearing Impairment versions.[5] Reflecting this broad dissemination, the MoCA is currently used across diverse clinical populations, including patients with Alzheimer's disease, vascular cognitive impairment and stroke, Parkinson's disease and related movement disorders, traumatic brain injury, and other neurological or medical conditions.[6-10] Within the vascular cognitive impairment literature in particular, MoCA-based screening has been emphasized because the instrument samples frontal-executive abilities more extensively than the MMSE.[11,12]

As clinical use of the MoCA expanded, efforts were made to extract more detailed information from item-level performance rather than relying solely on the total score. Julayanont and colleagues proposed a method for deriving six MoCA cognitive domain index scores—orientation, attention, language, visuospatial function, memory, and executive function—enhancing the utility of the MoCA as a brief yet more informative multi-domain assessment.[13] Subsequent studies have supported the construct validity and clinical utility of these domain scores, demonstrating meaningful correlations with conventional neuropsychological measures and showing that different index-score profiles may help characterize different cognitive syndromes.[13-15] In the Korean literature, these domain scores have shown significant associations with the corresponding domains of the Seoul Neuropsychological Screening Battery,[16] although the Memory Index Score (MIS) may be less informative in dementia because of floor effects.[17] More recently, international studies have moved beyond total-score interpretation toward domain-based normative approaches, underscoring the growing importance of normative data for MoCA domain index scores.[18]

Interest in abbreviated and remote MoCA administration has also grown. The MoCA-Blind, often referred to as the MoCA-22, was originally developed for individuals with visual impairment by excluding four visually mediated or motor-dependent subtests—Alternating Trail Making, Cube Copy, Clock Drawing, and Naming—reducing the maximum score from 30 to 22.[19] The Telephone-Montreal Cognitive Assessment (T-MoCA) uses the same 22-point item set but is administered remotely by telephone rather than face-to-face. Since the COVID-19 pandemic, the need for remote cognitive assessment has increased markedly, and the T-MoCA has accordingly received greater attention as a practical alternative when in-person testing is not feasible.[20,21] Its usefulness has been supported in patients with transient ischemic attack or stroke, in patients with atrial fibrillation, and in diverse community-based samples, and longitudinal cohort studies further suggest that it can track cognition over time in population-based research.[22-25]

In Korea, the Korean-Montreal Cognitive Assessment (K-MoCA), which incorporates several culturally adapted items to better reflect Korean language and culture, was standardized in 2009, with reliability, validity, and normative data reported for middle-aged and older adults.[26] The K-MoCA has demonstrated good psychometric properties and become one

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of the most widely used cognitive screening instruments in Korea. However, because its normative data were established more than a decade ago, updated norms reflecting contemporary demographic characteristics, educational attainment, and current clinical practice are needed.

Beyond this need to update the K-MoCA's own norms, Korean research has also lagged behind recent international developments in MoCA-derived scores and administration formats. Nevertheless, several recent studies conducted in Korea have shown that the K-MoCA-22 can effectively distinguish cognitively normal individuals from those with MCI and dementia,[27] and have supported the diagnostic validity and score equivalence of the T-MoCA across cognitively normal older adults and patients with MCI or dementia.[28,29] However, these studies have focused primarily on validity and diagnostic performance, and comprehensive normative data for the MoCA domain index scores and the K-MoCA-22 remain unavailable. Because the K-MoCA-22 and T-MoCA are based on the same 22-point content and have demonstrated score equivalence in previous studies, normative data for the K-MoCA-22 may also serve as a reference framework for interpreting T-MoCA performance.

Given that the reliability and validity of the K-MoCA and its derived formats have already been well established in previous studies,[17,26-29] this study focused specifically on norm development, aiming to update normative data for the K-MoCA total score and to provide, for the first time in Korea, normative data for the MoCA cognitive domain index scores and the K-MoCA-22, for use in Korean clinical, community, and research settings.

METHODS

Participants

A total of 1,177 cognitively healthy adults were included in the normative sample, comprising 499 men and 678 women. Participants ranged in age from 19 to 90 years (mean=64.13±16.19 years) and represented a wide range of educational attainment, from illiterate individuals to college graduates or above (mean=10.29±5.97 years). The distribution of participants by age and education is presented in **Table 1**.

The normative sample was drawn from the nationwide standardization study of the Korean–Mini Mental State Examination, Second Edition,[30] conducted between January 2018 and April 2020. Participants were recruited from metropolitan cities, small and medium-sized cities, and rural communities to obtain a nationally representative sample.

Eligibility was determined according to the health screening criteria proposed by Christensen et al.[31] Individuals were excluded if they had a history of neurological or psychiatric disorders, suspected brain injury, untreated chronic medical conditions known to affect cognitive functioning (e.g., hypertension, diabetes mellitus, or hyperlipidemia), or visual or hearing impairments severe enough to interfere with cognitive testing.

Measures

All participants completed the K-MoCA[26] and the Korean–Mini Mental State Examination, Second Edition: Standard Version (K-MMSE~2:SV; Blue Form).[30] The order of test administration was counterbalanced across participants. Both instruments have a maximum total score of 30 points.

Table 1. Demographic distribution of Korean-Montreal Cognitive Assessment normative sample by age group, sex, and education level

Age (yr)	Sex	Education (yr)						Total
		Illiterate	0–5	6–8	9–11	12–15	≥16	
19–39	Men	0	0	0	0	24	23	47
	Women	0	0	0	0	21	26	47
40–44	Men	0	0	0	2	4	10	16
	Women	0	0	0	1	9	8	18
45–49	Men	0	0	0	1	10	15	26
	Women	0	0	0	3	25	13	41
50–54	Men	0	0	1	0	17	18	36
	Women	0	0	5	9	29	14	57
55–59	Men	0	1	3	8	16	20	48
	Women	1	2	10	11	24	9	57
60–64	Men	0	4	13	9	15	18	59
	Women	3	3	13	13	23	16	71
65–69	Men	1	5	7	8	10	19	50
	Women	7	8	21	11	17	13	77
70–74	Men	0	9	15	10	10	24	68
	Women	13	21	13	9	14	16	86
75–79	Men	8	13	17	9	11	20	78
	Women	22	23	20	6	12	13	96
80–84	Men	4	6	10	6	8	11	45
	Women	14	28	13	8	11	13	87
85–90	Men	5	1	7	5	3	5	26
	Women	13	13	7	2	4	2	41
Total	Men	18	39	73	58	128	183	499
	Women	73	98	102	73	189	143	678

Educational groups were categorized as follows: 0–5 years, literate individuals with no formal education and those with 1–5 years of formal education (less than elementary school completion); 6–8 years, elementary school graduates who had not completed middle school; 9–11 years, middle school graduates who had not completed high school; 12–15 years, high school graduates who had not completed college; and ≥16 years, college graduates or above.

For the K-MoCA, the total score and six cognitive domain index scores were calculated according to the scoring method proposed by Julayanont et al.[13] The domain index scores comprised the Orientation Index Score (OIS), Attention Index Score (AIS), Language Index Score (LIS), Visuospatial Index Score (VIS), MIS, and Executive Index Score (EIS).

In addition, K-MoCA-22 scores were derived post hoc from the responses obtained during administration of the full face-to-face K-MoCA by excluding the four visually mediated subtests. The K-MoCA-22 has a maximum score of 22 points.

Data collection procedure

Normative data were collected nationwide by licensed clinical psychologists, graduate students in psychology, and senior undergraduate psychology students (third- and fourth-year students). Before data collection, all examiners completed a standardized training workshop conducted by the research team on the administration and scoring procedures for the K-MoCA and the K-MMSE~2:SV.

Participants were recruited from their local communities through schools, workplaces, community welfare centers, senior community centers, and public health centers. Each participant completed the K-MoCA and the K-MMSE~2:SV (Blue Form) in an individual face-to-face assessment administered by a trained examiner, with the order of administration counterbalanced across participants.

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Following data collection, all test protocols underwent a two-stage quality-control process. In the first stage, completed protocols were reviewed by one of seven regional coordinators to identify missing data, scoring errors, or administration irregularities before being forwarded to the principal investigator (Yeonwook Kang). In the second stage, all protocols were independently reviewed by two licensed clinical psychologists with more than 10 years of experience administering and scoring the K-MoCA and other neuropsychological tests, together with the principal investigator. Protocols with suspected administration errors or scoring inaccuracies were identified and, as appropriate, either corrected or excluded from the normative dataset.

Statistical analysis

Descriptive statistics were calculated for all study variables, including means, standard deviations (SDs), medians, interquartile ranges (IQRs), skewness, kurtosis, and floor and ceiling effects. Because all participants completed both the K-MoCA and the K-MMSE~2:SV, paired *t*-tests were used to compare total scores between the two instruments. To identify demographic determinants of K-MoCA total scores, the six domain index scores, and the K-MoCA-22, multiple linear regression analyses were performed with age, education, and sex entered as predictors. Changes in explained variance were examined to evaluate the incremental contribution of sex.

Because the K-MoCA total and K-MoCA-22 scores exhibited only moderate departures from normality, whereas several domain index scores demonstrated pronounced ceiling effects and substantially greater non-normality, different norming approaches were used: An ordinary least-squares (OLS) regression model with a variance function was applied to the K-MoCA total and K-MoCA-22 scores,[32] whereas quantile regression model was used for the domain index scores to better accommodate their distributional characteristics.[33]

For both models, linear and quadratic effects of age, differences across education levels, and age-by-education interactions were examined. In the OLS regression model, these effects were modeled for both the predicted mean and the variance. In the quantile regression model, they were estimated at the 50th (median), 16th, and 7th percentiles. The 16th and 7th percentiles were selected because they approximately correspond to 1 and 1.5 SD below the mean, respectively, under a normal distribution.

Age was stratified into 11 categories (19–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, and ≥85 years), and education into six levels (illiterate, literate with 0–5 years of education, 6–8 years, 9–11 years, 12–15 years, and ≥16 years). For regression analyses, the age categories were coded sequentially from 0 to 10 and entered as an ordinal continuous predictor rather than as chronological age in years. This coding was intended to represent the ordinal progression of the predefined age groups used for norm development rather than to model the exact linear effect of chronological age. The broader 19–39-year category was used because relatively little age-related variation in cognitive screening performance is expected across early and middle adulthood, whereas 5-year categories were adopted after age 40 to better capture age-related cognitive changes. Education was treated as a categorical variable coded from 0 to 5. OLS regression with a variance function was performed using the PROC MIXED procedure, whereas quantile regression was performed using the PROC QUANTREG procedure in SAS (version 9.4; SAS Institute Inc., Cary, NC, USA).

Ethics statement

The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Hallym University (IRB No. HIRB-2017-042).

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RESULTS

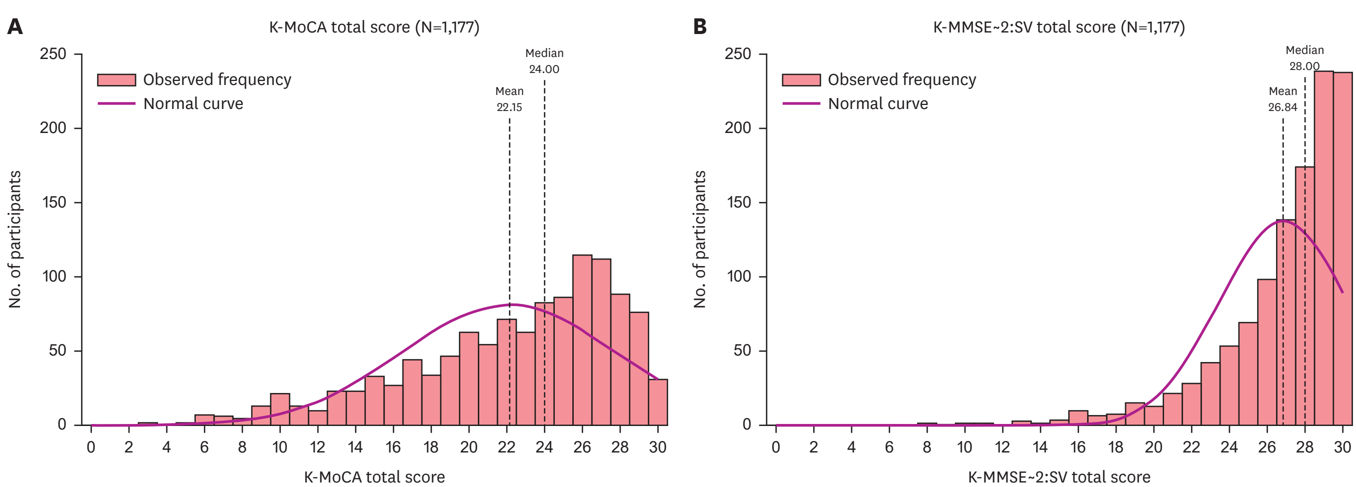
Distributional characteristics of the K-MoCA total scores

Fig. 1 illustrates the distributions of the K-MoCA and K-MMSE~2:SV total scores in the normative sample. The mean total score was 22.15±5.74 for the K-MoCA and 26.84±3.40 for the K-MMSE~2:SV. On average, K-MMSE~2:SV scores were 4.68±3.44 points higher than K-MoCA scores, and this difference was statistically significant, $t(1,176)=46.64$, $p<0.001$.

K-MoCA scores were distributed over a relatively wide range (3–30), with a median of 24 (IQR=19–27). The distribution showed moderate negative skewness (−0.90) and only slight positive kurtosis (0.21), and the ceiling effect was minimal (2.72%). In contrast, K-MMSE~2:SV scores were markedly concentrated at the upper end of the score range (8–30), with a median of 28 (IQR=26–29). The distribution exhibited substantially greater negative skewness (−1.73) and pronounced leptokurtosis (3.53), reflecting a strong clustering of scores near the maximum value. Consequently, the ceiling effect was considerably larger for the K-MMSE~2:SV than for the K-MoCA (20.14% vs. 2.72%).

Normative data of the K-MoCA total scores

A multiple linear regression showed that age and education significantly predicted K-MoCA scores, $R^2=0.658$, adjusted $R^2=0.657$, $F(2, 1{,}174)=1{,}128.83$, $p<0.001$. Both age ($B=-0.121$, $\beta=-0.340$, $t=-17.64$, $p<0.001$) and education ($B=0.574$, $\beta=0.596$, $t=30.95$, $p<0.001$) were significant predictors, with education showing a substantially stronger effect on K-MoCA scores than age, consistent with previous studies.[34] Adding sex to the model resulted in only a negligible increase in explained variance (R^2 increased from 0.658 to 0.659; $\Delta R^2=0.001$); although the regression coefficient reached statistical significance ($\beta=-0.040$,



C

Summary of distribution indices

Measure	N	Mean±SD	Median (IQR)	Min–Max	Skewness (SE)	Kurtosis (SE)	Ceiling effect (score 30), %	Floor effect (score 0), %
K-MoCA	1,177	22.15±5.74	24 (19–27)	3–30	−0.90 (0.07)	0.21 (0.14)	2.72	0.00
K-MMSE~2:SV	1,177	26.84±3.40	28 (26–29)	8–30	−1.73 (0.07)	3.53 (0.14)	20.14	0.00

Fig. 1. Distributions of K-MoCA and K-MMSE~2:SV total scores in the normative sample (N=1,177). (A) K-MoCA total score, (B) K-MMSE~2:SV total score, (C) Summary of distribution indices.
K-MoCA: Korean-Montreal Cognitive Assessment, K-MMSE~2:SV: Korean–Mini Mental State Examination, Second Edition: Standard Version, SD: standard deviation, IQR: interquartile range, Min: minimum score, Max: maximum score, SE: standard error.

Table 2. Age- and education-specific normative data for Korean-Montreal Cognitive Assessment

Age (yr)	Education (yr)					
	Illiterate	0–5	6–8	9–11	12–15	≥16
19–39	19.35±1.47	23.83±1.72	23.83±1.72	25.76±1.72	27.49±1.43	28.58±1.26
40–44	18.13±2.47	22.62±2.89	22.65±2.89	24.59±2.89	26.32±2.41	27.41±2.12
45–49	17.81±2.56	22.33±3.00	22.47±3.00	24.43±3.00	26.16±2.50	27.25±2.20
50–54	17.27±2.66	21.84±3.11	22.16±3.11	24.15±3.11	25.88±2.59	26.97±2.28
55–59	16.51±2.75	21.17±3.23	21.73±3.23	23.76±3.23	25.49±2.69	26.58±2.37
60–64	15.53±2.86	20.30±3.35	21.17±3.35	23.26±3.35	25.00±2.79	26.08±2.45
65–69	14.34±2.96	19.24±3.47	20.50±3.47	22.66±3.47	24.39±2.89	25.48±2.55
70–74	12.94±3.07	17.98±3.60	19.70±3.60	21.94±3.60	23.67±3.00	24.76±2.64
75–79	11.32±3.19	16.53±3.73	18.77±3.73	21.11±3.73	22.84±3.11	23.93±2.74
80–84	9.48±3.30	14.89±3.87	17.73±3.87	20.17±3.87	21.90±3.23	22.99±2.84
85+	7.42±3.43	13.05±4.02	16.56±4.02	19.12±4.02	20.85±3.35	21.94±2.95

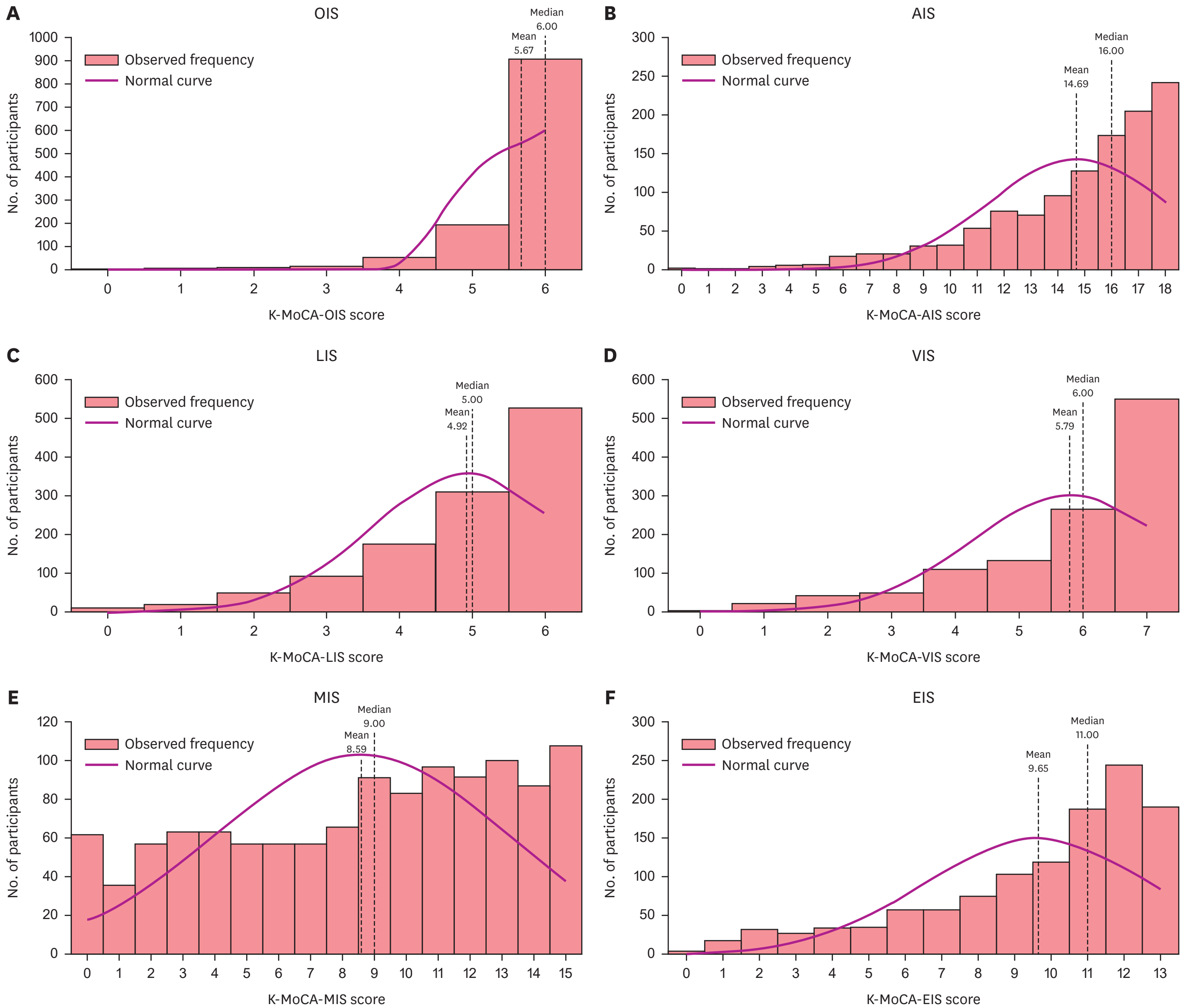
Values are presented as mean ± standard deviation score.
Educational groups were categorized as follows: 0–5 years, literate individuals with no formal education and those with 1–5 years of formal education (less than elementary school completion); 6–8 years, elementary school graduates who had not completed middle school; 9–11 years, middle school graduates who had not completed high school; 12–15 years, high school graduates who had not completed college; and ≥16 years, college graduates or above.
Shaded cells represent regression-based extrapolated estimates for age–education combinations with no observed participants. These values should be interpreted cautiously because they are not supported by direct observations in the normative sample.

p=0.020), this indicates that the independent contribution of sex to K-MoCA performance was minimal. Subsequent subgroup analyses revealed a significant sex difference only among literate participants with 0–5 years of education, in whom men scored significantly higher than women (19.28 vs. 15.61), $t(135)=4.93$, $p<0.001$. No significant sex differences were observed in any other age- or education-defined subgroup. Accordingly, normative data were stratified by age and education, but not sex. **Table 2** presents the age- and education-specific means and SDs for K-MoCA total scores.

Distributional characteristics and normative data of the K-MoCA domain index scores

Fig. 2 illustrates the score distributions for the six K-MoCA domain index scores. The OIS exhibited the most pronounced ceiling effect (76.98%), with scores clustered at the maximum value, resulting in marked negative skewness (−2.78) and high kurtosis (9.46). The LIS and VIS also showed marked negative skewness (−1.33 and −1.35) accompanied by substantial ceiling effects (44.69% and 46.64%). Although the AIS and EIS exhibited comparable negative skewness (−1.23 and −1.07), their ceiling effects were considerably smaller (20.56% and 16.14%). In contrast, the MIS showed the most symmetric distribution (skewness=−0.33), the smallest ceiling effect (9.18%) and a broad spread of scores, indicating greater variability and reduced ceiling compression relative to the other domain indices. Floor effects were negligible across all six domain index scores (0.00%–5.27%).

Multiple regression analyses demonstrated that education and age were the primary determinants of all six K-MoCA domain index scores. Education exerted the strongest influence across domains (β=0.268 to 0.643), with the largest effect observed for the EIS. Age was also a significant predictor of all domain index scores (β=−0.122 to −0.456), exerting its greatest influence on the MIS. Sex did not significantly predict the OIS or AIS; although statistically significant sex effects emerged for the LIS, VIS, MIS, and EIS, the magnitude of these effects was very small (|β|=0.062 to 0.108) relative to those of education and age. Accordingly, normative tables for each K-MoCA domain index score were stratified by age and education. The median (50th percentile), 16th percentile, and 7th percentile raw scores are provided for each subgroup in the **Supplementary Data 1**.



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Summary of distribution indices

K-MoCA index scores	N	Mean±SD	Median (IQR)	Min–Max	Skewness (SE)	Kurtosis (SE)	Ceiling effect (max score), %	Floor effect (min score), %
OIS	1,177	5.67±0.70	6 (6–6)	1–6	−2.78 (0.07)	9.46 (0.14)	76.98	0.00
AIS	1,177	14.69±3.29	16 (13–17)	0–18	−1.23 (0.07)	1.14 (0.14)	20.56	0.08
LIS	1,177	4.92±1.30	5 (4–6)	0–6	−1.33 (0.07)	1.45 (0.14)	44.69	0.76
VIS	1,177	5.79±1.55	6 (5–7)	0–7	−1.35 (0.07)	1.13 (0.14)	46.64	0.17
MIS	1,177	8.59±4.56	9 (5–13)	0–15	−0.33 (0.07)	−1.08 (0.14)	9.18	5.27
EIS	1,177	9.65±3.16	11 (8–12)	0–13	−1.07 (0.07)	0.30 (0.14)	16.14	0.25

Fig. 2. Distributions of K-MoCA index scores for 6 cognitive domains in the normative sample (N=1,177). (A) OIS, (B) AIS, (C) LIS, (D) VIS, (E) MIS, (F) EIS, (G) Summary of distribution indices.
K-MoCA: Korean-Montreal Cognitive Assessment, OIS: Orientation Index Score, AIS: Attention Index Score, LIS: Language Index Score, VIS: Visuospatial Index Score, MIS: Memory Index Score, EIS: Executive Index Score, SD: standard deviation, IQR: interquartile range, Min: minimum score, Max: maximum score, SE: standard error.

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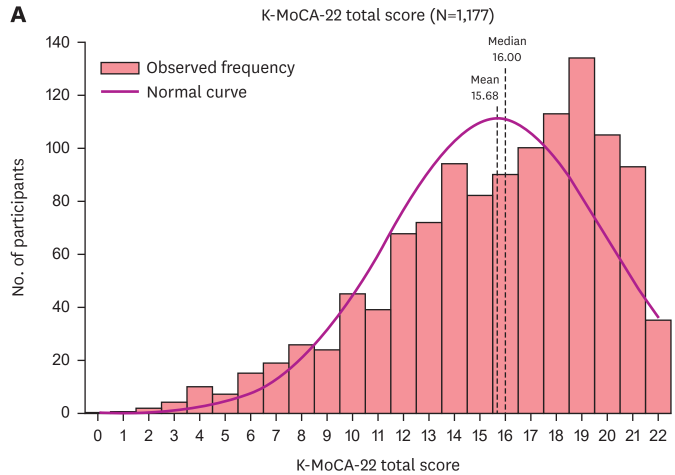
A



B

Summary of distribution indices

Measure	N	Mean±SD	Median (IQR)	Min–Max	Skewness (SE)	Kurtosis (SE)	Ceiling effect (score 22), %	Floor effect (score 0), %
K-MoCA-22	1,177	15.68±4.22	16 (13–19)	2–22	−0.71 (0.07)	−0.04 (0.14)	2.97	0.00

Fig. 3. Distribution of K-MoCA-22 in the normative sample (N=1,177). (A) K-MoCA-22 total score, (B) Summary of distribution indices.
K-MoCA-22: Korean-Montreal Cognitive Assessment-22, SD: standard deviation, IQR: interquartile range, Min: minimum score, Max: maximum score, SE: standard error.

Distributional characteristics and normative data of the K-MoCA-22 scores

Fig. 3 shows the distribution of K-MoCA-22 total scores. The K-MoCA-22 scores exhibited moderate negative skewness (−0.71) and near-zero kurtosis (−0.04), indicating a distribution closer to normal than that of the K-MoCA total score. The median score was 16 (IQR=13–19), with scores ranging from 2 to 22. Ceiling and floor effects were negligible: Only 2.97% of participants achieved the maximum score, and no participants obtained the minimum score.

A multiple linear regression showed that age and education significantly predicted K-MoCA-22 scores, R^2=0.626, adjusted R^2=0.625, F(2, 1,174)=981.08, p<0.001. Both age (B=−0.097, β=−0.372, t=−18.49, p<0.001) and education (B=0.386, β=0.547, t=27.13, p<0.001) were significant predictors, with education showing a substantially stronger effect on K-MoCA-22 scores than age, consistent with the results for the K-MoCA. When sex was added to the model, it did not significantly predict K-MoCA-22 performance (β=−0.013, p=0.468), and the explained variance remained unchanged (R^2=0.626, adjusted R^2=0.625), indicating that sex made no meaningful independent contribution to K-MoCA-22 scores. Accordingly, normative data for the K-MoCA-22 were stratified by age and education, but not by sex. **Table 3** presents the age- and education-specific means and SDs for K-MoCA-22 scores, using the same age and education strata as those applied for the K-MoCA total score.

DISCUSSION

This study extends the clinical utility of the K-MoCA by providing updated normative data for the total score and, for the first time, normative data for the six cognitive domain index scores and the K-MoCA-22 in Korean adults. Across all measures, age and education were the principal determinants of performance, whereas sex contributed little additional variance. Compared with the K-MMSE-2, both the K-MoCA and the K-MoCA-22 demonstrated more

Table 3. Age- and education-specific normative data for Korean-Montreal Cognitive Assessment-22

Age (yr)	Education (yr)					
	Illiterate	0–5	6–8	9–11	12–15	≥16
19–39	14.80±1.26	17.11±1.26	17.11±1.26	18.68±1.26	19.88±1.26	20.74±1.26
40–44	13.58±2.14	15.91±2.14	15.93±2.14	17.50±2.14	18.70±2.14	19.55±2.14
45–49	13.33±2.16	15.72±2.16	15.80±2.16	17.37±2.16	18.56±2.16	19.41±2.16
50–54	12.91±2.20	15.39±2.20	15.57±2.20	17.14±2.20	18.34±2.20	19.19±2.20
55–59	12.32±2.25	14.94±2.25	15.26±2.25	16.68±2.25	18.02±2.25	18.87±2.25
60–64	11.57±2.32	14.36±2.32	14.85±2.32	16.43±2.32	17.62±2.32	18.47±2.32
65–69	10.65±2.41	13.65±2.41	14.36±2.41	15.93±2.41	17.13±2.41	17.98±2.41
70–74	9.56±2.51	12.81±2.51	13.78±2.51	15.35±2.51	16.54±2.51	17.39±2.51
75–79	8.30±2.64	11.84±2.64	13.11±2.64	14.68±2.64	15.87±2.64	16.72±2.64
80–84	6.88±2.80	10.74±2.80	12.34±2.80	13.91±2.80	15.11±2.80	15.96±2.80
85+	5.29±2.98	9.51±2.98	11.49±2.98	13.06±2.98	14.26±2.98	15.11±2.98

Values are presented as mean ± standard deviation score.
Educational groups were categorized as follows: 0–5 years, literate individuals with no formal education and those with 1–5 years of formal education (less than elementary school completion); 6–8 years, elementary school graduates who had not completed middle school; 9–11 years, middle school graduates who had not completed high school; 12–15 years, high school graduates who had not completed college; and ≥16 years, college graduates or above.
Shaded cells represent regression-based extrapolated estimates for age–education combinations with no observed participants. These values should be interpreted cautiously because they are not supported by direct observations in the normative sample.

favorable psychometric characteristics, including broader score distributions and reduced ceiling effects, supporting their greater sensitivity to subtle cognitive differences. Together with the updated normative data for the K-MoCA total score and the first normative data for the six cognitive domain index scores, these findings establish a comprehensive normative framework for interpreting overall and domain-specific cognitive performance, while providing a foundation for the application of the K-MoCA-22 in both face-to-face and telephone-based assessment.

The updated normative data presented in this study provide a contemporary reference for interpreting K-MoCA performance in Korean adults. Since the publication of the original K-MoCA norms in 2009,[26] Korea has undergone substantial demographic changes, including rising educational attainment and population aging. Because normative data should reflect the characteristics of the population to which they are applied, periodic revision is essential for maintaining the clinical accuracy of cognitive screening instruments.[35,36]

Consistent with previous MoCA normative studies across diverse populations,[37,38] age and education were the primary determinants of K-MoCA performance, together accounting for approximately two-thirds of the variance in total scores. Performance declined with advancing age and improved with higher educational attainment, whereas sex contributed little independent variance once these demographic factors were considered. A small sex effect emerged among participants with very low educational attainment, but its influence was negligible overall and did not warrant separate normative tables. Under these circumstances, applying a single cutoff or a single set of norms across all demographic groups is likely to result in substantial diagnostic misclassification. Specifically, cognitively healthy older adults and individuals with lower educational attainment may be over-classified as impaired, whereas younger or more highly educated individuals with genuine cognitive decline may remain undetected. Accordingly, we developed separate norms stratified by age and education level. These age- and education-specific norms should improve the accuracy of clinical interpretation of K-MoCA performance across diverse demographic groups.

An important finding of this study was the favorable distributional characteristics of the K-MoCA relative to the K-MMSE~2:SV. The K-MoCA showed a broader score distribution, less skewness, and a substantially smaller ceiling effect, reflecting greater variability in cognitive performance among cognitively normal adults. These psychometric characteristics enhance discrimination across the normal range of cognitive functioning and likely underlie the superior sensitivity of the MoCA for detecting subtle cognitive impairment reported in previous studies.[2,12,39] In contrast, the marked ceiling effect observed for the K-MMSE~2:SV limits its ability to differentiate individuals with relatively preserved cognition. These findings provide psychometric evidence supporting the continued use of the K-MoCA as a preferred screening instrument for identifying early cognitive decline.

A major contribution of this study is the establishment of the first normative data for the six K-MoCA cognitive domain index scores. Although the MoCA was originally developed as a global cognitive screening instrument, interpretation of domain-specific cognitive profiles has received increasing attention.[14,18,40] This shift reflects the fact that individuals with similar total scores may show markedly different patterns of cognitive strengths and weaknesses. The availability of normative data for the domain index scores therefore extends the clinical utility of the K-MoCA beyond global cognitive screening by enabling interpretation of domain-specific cognitive performance based on age- and education-specific norms.

Consistent with the findings for the K-MoCA total score, age and education were the primary determinants of all six domain index scores, whereas sex contributed little independent variance. Although normative data are provided for all six domain index scores, their potential clinical utility differs because of their distinct distributional characteristics. The OIS exhibited a pronounced ceiling effect, and the LIS and VIS also showed substantial score compression, limiting their ability to discriminate among cognitively healthy individuals. In contrast, the MIS showed the broadest score distribution and the smallest ceiling effect, suggesting that episodic memory captures greater inter-individual variability even within the normal population. The AIS and EIS also demonstrated relatively broad score distributions, indicating greater sensitivity to subtle individual differences. Collectively, these findings suggest that the MIS, together with the AIS and EIS, may be particularly informative for evaluating subtle cognitive variation within cognitively healthy individuals, whereas the OIS, LIS, and VIS appear to provide less discrimination because of their pronounced ceiling effects.

The availability of domain-specific normative data provides clinicians and researchers with a practical framework for evaluating relative cognitive strengths and weaknesses rather than relying solely on the global K-MoCA score. Such an approach may improve cognitive profiling in clinical practice and facilitate future studies of domain-specific cognitive changes associated with normal aging and various neurological disorders.

Another important contribution of this study is the establishment of the first normative data for the K-MoCA-22. Although previous studies have demonstrated the diagnostic validity of the K-MoCA-22 and its score equivalence with the T-MoCA,[27-29] normative reference data have not previously been available. The present findings therefore supply the missing normative framework needed for age- and education-specific interpretation of both the K-MoCA-22 and the T-MoCA.

The K-MoCA-22 also demonstrated favorable psychometric characteristics, including a more nearly normal distribution than the K-MoCA total score. These findings suggest that removing

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the four visually mediated items improves the distributional properties of the test while preserving its ability to differentiate cognitive performance across the normal range, thereby providing a practical instrument for both face-to-face and telephone-based assessment.

The availability of a common normative framework has important implications for longitudinal studies and clinical follow-up. Because the K-MoCA-22 can be derived directly from the standard K-MoCA and has demonstrated score equivalence with the T-MoCA,[28,29] baseline K-MoCA-22 scores obtained during in-person assessment can be compared directly with follow-up T-MoCA scores using the same normative standards. This unified approach allows seamless interpretation of cognitive performance across conventional and remote assessment modes, without requiring separate normative systems, thereby enhancing the consistency of longitudinal cognitive monitoring in both clinical practice and research.

This study has several strengths. It provides updated K-MoCA normative data based on a large community sample spanning the adult lifespan and, to our knowledge, is the first to establish normative data for both the K-MoCA cognitive domain index scores and the K-MoCA-22. In addition, by integrating these normative data with the previously validated T-MoCA equivalence, the present study offers a unified framework for interpreting cognitive performance across face-to-face and telephone-based assessments.

Several limitations should be acknowledged. First, although participants were recruited from multiple regions of Korea, the sample may not fully represent the entire Korean population. Second, age was modeled using ordered age categories rather than chronological age in years. Although this approach was adopted for regression-based norm development, it remains an approximation that may not fully capture the underlying relationship between age and cognitive performance. Third, the present normative data were developed for K-MoCA-22 scores derived from the standard face-to-face K-MoCA administration. Although previous studies have demonstrated score equivalence between derived K-MoCA-22 scores and the T-MoCA,[28,29] the interchangeability of their normative data remains to be established. Future studies should therefore derive normative data from independently administered T-MoCA and evaluate their agreement with the present K-MoCA-22 norms. Finally, because the present study included only cognitively healthy adults, it was not designed to determine whether the updated norms improve diagnostic classification relative to the original 2009 norms. Future studies comparing the diagnostic performance of the previous and updated normative systems in patients with cognitive impairment are needed to establish the clinical value of the revised norms.

In conclusion, this study provides updated normative data for the K-MoCA total score together with the first normative data for the K-MoCA cognitive domain index scores and the K-MoCA-22. These findings extend the clinical utility of the K-MoCA beyond global cognitive screening by supporting domain-specific interpretation and establishing a unified normative framework for both face-to-face and telephone-based assessments. The updated norms should facilitate more accurate cognitive evaluation and longitudinal monitoring in both clinical practice and research.

SUPPLEMENTARY MATERIAL

Supplementary Data 1

Age- and education-specific normative data for the six K-MoCA domain index scores

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