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Original Article
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Validation of the Korean-Everyday Cognition (K-ECog)

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ABSTRACT

Background: In the early diagnosis of dementia, an important factor is the evaluation of activities of daily living. The Everyday Cognition (ECog) scale was developed to measure functional changes that are the everyday correlates of specific neuropsychological impairments. This study aimed to examine the validity of the Korean version of Everyday Cognition (K-ECog).

Methods: The participants were 268 cognitively normal older adults (NA), 151 amnestic mild cognitive impairment (aMCI), and 77 dementia of the Alzheimer's type (DAT). The Korean-Mini Mental State Examination (K-MMSE), Korean-Montreal Cognitive Assessment (K-MoCA), and Short form of the Geriatric Depression Scale (SGDS) were administered to all the participants. The K-ECog and Korean-Instrumental Activities of Daily Living (K-IADL) were rated by their informants.

Results: Internal consistency (Cronbach's α) of K-ECog global function was 0.93, and its test-retest reliability (Pearson's *r*) was 0.73. K-ECog was significantly correlated with K-IADL (0.66), K-MMSE (−0.38), and K-MoCA (−0.26). Confirmatory factor analysis of K-ECog yielded seven factor model that the original ECog proposed. K-ECog global score and six domain scores were significantly different across the NA, aMCI, and DAT groups. Receiver operating characteristic curve analyses showed that K-ECog effectively differentiated aMCI and DAT patients from NA, suggesting that K-ECog is as sensitive for detecting functional impairments as K-IADL. The proposed optimal cut-off score to differentiate aMCI from NA was 1.41.

Conclusion: K-ECog is proven reliable and valid for clinical use. K-ECog can be used to distinguish very early stages of impaired ADL and cognitive impairment in the community.

Keywords: Everyday Cognition; Activities of Daily Living; Mild Cognitive Impairment; Dementia

INTRODUCTION

One of the important factors in the early diagnosis of dementia is the evaluation of activity of daily living (ADL). In addition to cognitive impairment, the impairment of ADL is an important criterion for distinguishing mild cognitive impairment (MCI) from dementia.[1]

Disclosure
The authors have no potential conflicts of interest to disclose.

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

That is, if two patients have a similar level of cognitive impairment, the one with unimpaired ADL is diagnosed with MCI, whereas the other with impaired ADL is diagnosed with dementia. However, recent studies have reported that mild levels of daily living dysfunction are often observed even at the MCI stage.[2] The diagnostic criteria for "MCI due to AD" of the National Institute on Aging–Alzheimer's Association (NIA-AA) workgroups allow a mild level of daily living dysfunction.[3] Thus, ADL as well as cognitive function can be impaired early from the MCI level.

The importance of accurate assessment of ADL is more emphasized given the increasing trend in measuring ADL rather than cognitive function in longitudinal studies that examine the effects of pharmacological/non-pharmacological interventions. ADL is a critical outcome in tracking disease progression in clinical contexts and treatment trials.[4] Problems in ADL help predict who will more rapidly decline and convert to dementia.[5]

There are two ways to evaluate ADL: self-rated and informant-rated. As the severity of dementia progresses, the patients' insight decreases, and the difference between the impairment perceived by the patients and by the caregivers becomes larger. Therefore, it is difficult to trust the patients' self-report.[6] In most clinical settings and studies, patients' ADL is rated by caregivers who know the patients well.[7-9]

Several scales for ADL are available. However, most of the scales focus on the loss of independence in basic and instrumental ADL.[10-13] The activities included in these scales are not variable enough to assess various mild functional impairments observed in daily life.[14] The Everyday Cognition (ECog) scale was developed to create a psychometrically rigorous instrument for assessing the functional abilities of older adults across a wide range of ability, spanning normal aging through mild to moderate dementia. It emphasizes assessing functional changes that may occur "very early" in the course of an incipient degenerative disease, such as during the syndrome of MCI.[15] ECog consists of 39 items that can measure subtle and mild functional changes before reaching a level where one cannot independently perform key activities, such as use of transportation. A particular strength of the scale is that it categorizes the items according to specific cognitive domains. Therefore, if a problem occurs in one item, it can be interpreted as a change in a related cognitive domain. ECog gives a global score and six domain scores, including memory, language, visuospatial function, and executive functions (planning, organization, and divided attention). Farias et al.[15] reported that the global factor score and the patterns of the six domain-specific factor scores are useful in differentiating MCI as well as dementia from normal older adults (NA). Moreover, subtypes of MCI have showed different patterns of domain scores in ECog.

ECog is a scale constructed through a psychometrically rigorous process and has been widely used in clinical and research areas. Especially, it has been selected for ADL measurement in the Alzheimer's Disease Neuroimaging Initiative (ADNI), which is a multisite longitudinal study for the prevention and treatment of Alzheimer's disease (AD) conducted in more than 13 countries.[16] In Korea, few scales have been developed to assess cognitively mediated functional abilities in older adults for early detection and monitoring progression of MCI and dementia. Thus, this study aimed to validate and standardize the Korean version of ECog (K-ECog).

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METHODS

Participants

The participants were 268 cognitively NA, 151 amnestic mild cognitive impairment (aMCI) patients, and 77 dementia of the Alzheimer's type (DAT) patients. As ECog is an informant-rated questionnaire, the caregivers of all of the participants also participated in the study. NA participants were recruited through community outreach. They were those who fulfilled Christensen's health screening criteria[17] and showed normal performance in the Korean-Mini Mental State Examination (K-MMSE).[18] DAT and aMCI participants were selected from the patients who visited the Department of Neurology of two university hospitals. All of the patients underwent clinical diagnostic dementia work-up, which included a comprehensive neuropsychological battery and brain imaging. Cognitive impairment was defined as at least 1.5 standard deviation (SD) below the normal norms.[19] Their ADL status was assessed based on the Korean-Instrumental Activities of Daily Living (K-IADL).[13,20] The Petersen criteria for MCI were used.[1] In aMCI patients, those with either single or multiple cognitive domain impairments were selected for the study. The aMCI included only patients with a Clinical Dementia Rating (CDR) global score of 0.5. The clinical diagnosis of DAT was based on the NINCDS-ADRDA criteria.[21] The patients with either a CDR global score of 0.5 (range for CDR sum of boxes, 2.5–4.0; n = 23; 30%)[22] or CDR global score of 1.0 (n = 54; 70%)were included in the DAT group.

Materials

K-ECog

The original ECog[15] is an informant-rated measure for cognitively-relevant everyday abilities. It is composed of 39 items, providing one global factor and six cognitively relevant domain-specific factors: 8 items for memory, 9 items for language, 7 items for visuospatial function, and 15 items for executive function domains, including 5 items for planning, 6 items for organization, and 4 items for divided attention. For each item, informants are asked to compare the participants' current level of everyday functioning with how he or she functioned 10 years earlier. Response options include the followings: 1 = better or no change, 2 = occasionally worse, 3 = consistently a little worse, 4 = consistently much worse, and "I don't know." The ECog global score, which is the sum of all items divided by the number of items completed excluding the number of "I don't know" items, ranges between 1 and 4.

Two clinical neuropsychologists translated the original 39 items into Korean (**Appendix 1**). The back-translation was performed by a bilingual translator to confirm that the meanings of the original items were well translated. One item that was not appropriate to the Korean elderly, "balancing the checkbook without error," was modified into "I know how much I have in my bank account."

Neuropsychological measures

K-MMSE and the Korean-Montreal Cognitive Assessment (K-MoCA)[23] were also administered to all of the participants. Their caregivers completed K-IADL as well as K-ECog. For the aMCI and DAT groups, CDR[24] and the Global Deterioration Scale (GDS)[25] were additionally administered to measure the severity of dementia. The Short form of the Geriatric Depression Scale (SGDS)[26] was given to control the depression level for all groups.

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Procedures

Clinical psychology graduate students who were familiar with psychometric scales and trained by the authors collected the data of the NA group. They visited the older adults' houses or welfare centers for older adults in the community and then administered the tests and scales to the NA and their caregivers.

Clinical neuropsychologists at the Department of Neurology, Hallym University Chuncheon Sacred Heart Hospital and Dongtan Sacred Heart Hospital administered K-MMSE, K-MoCA, and SGDS to the patients. On the same day, the patients' caregivers completed K-ECog and K-IADL. For assessing the test-retest reliability, 51 participants selected from the NA group were re-administered the K-ECog after a 4-week interval.

Statistical analysis

Group differences were examined using one-way analysis of variance (ANOVA). The significant results of the ANOVA were followed up by post-hoc comparisons using Bonferroni correction. Pearson's χ^2 tests were performed for categorical variables. Internal consistency was assessed using Cronbach's alpha coefficient. The test-retest reliability was assessed with the Pearson's correlation coefficient (r). Convergent validity was evaluated by calculating the partial correlation coefficients among K-ECog, K-IADL, K-MMSE, and K-MoCA. Construct validity of K-ECog was evaluated based on confirmatory factor analysis (CFA). Analysis of covariance (ANCOVA) and multivariate analysis of covariance (MANCOVA) were conducted to evaluate the differences of the K-ECog global score and six cognitive domain scores of the three groups (NA, aMCI, and DAT), with age, education, and SGDS score controlled as covariates. Repeated measures ANOVA was also conducted to compare the six cognitive domain scores in each group. Receiver operating characteristic (ROC) curve analyses were performed to examine the ability of K-ECog to discriminate NA from aMCI and DAT, while controlling the effects of age, education, and depression level as covariates. Sensitivity, specificity, positive and negative predictive values, and optimal cut-off scores of K-ECog were obtained by ROC curve analyses. ANOVA, ANCOVA, MANCOVA, and correlation analysis were conducted using IBM SPSS statistics 21.0 program (Armonk, NY, USA). Mplus Version 7.4 program was used for CFA. Statistical analysis software (SAS; SAS Inst., Cary, NC, USA) program was used for ROC curve analysis.

Ethics statement

The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Hallym University (IRB No. HIRB-2014-51). Informed consent forms were submitted by all of the participants upon their enrollment to the study.

RESULTS

Characteristics of demographic and other variables

The demographic characteristics of the diagnostic groups are shown in **Table 1**. There were no significant group differences in gender ratio and years of education. However, significant group differences were observed in age, depression level, instrumental ADL, general cognitive function (K-MMSE and K-MoCA), and severity of dementia (CDR and GDS).

Among the informants, 42% were spouses, 47% were adult children (or spouses of adult children), 5% were other family members, and 6% were friends of the participants. The average age of the informants was 54.65 (SD = 15.15) years, and informants had a mean of 12.64

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Table 1. Demographic characteristics of the participants

Variables	NA (n = 268)	aMCI (n = 151)	DAT (n = 77)	For χ^2 or t	*P* value	Post-hoc (Bonferroni)
Age, yr	65.27 ± 9.43	70.95 ± 8.53	76.57 ± 6.43	F = 56.64	< 0.001	a < b < c
Gender (men), No. (%)	108 (40.30)	56 (37.09)	25 (32.47)	χ^2 = 1.65	0.438	NS
Education, yr	9.72 ± 4.02	8.75 ± 4.59	8.78 ± 4.93	F = 3.04	0.049	NS
SGDS	2.28 ± 2.82	5.76 ± 4.34	5.82 ± 4.51	F = 55.95	< 0.001	a < b < c
K-IADL	0.06 ± 0.13	0.24 ± 0.34	0.87 ± 0.57	F = 203.16	< 0.001	a < b < c
K-MMSE	27.92 ± 1.94	25.46 ± 2.74	20.83 ± 3.53	F = 246.78	< 0.001	a > b > c
K-MoCA	23.57 ± 3.92	19.50 ± 3.89	14.26 ± 4.67	F = 171.99	< 0.001	a > b > c
CDR-GS	-	0.49 ± 0.08	0.85 ± 0.23	F = 2,587.15	< 0.001	a < b < c
CDR-SB	-	1.50 ± 0.90	5.06 ± 1.85	t = −15.93	< 0.001	b < c
GDS	-	3.03 ± 0.38	4.25 ± 0.71	t = −14.08	< 0.001	b < c

Values are presented as mean ± standard deviation.
Post-hoc (Bonferroni): a = NA, b = aMCI, c = DAT.
NA = normal older adults, aMCI = amnestic mild cognitive impairment, DAT = dementia of the Alzheimer's type, NS = not significant, SGDS = Short form of the Geriatric Depression Scale, K-IADL = Korean-Instrumental Activities of Daily Living, K-MMSE = Korean-Mini Mental State Examination, K-MoCA = Korean-Montreal Cognitive Assessment, CDR-GS = Clinical Dementia Rating-global score, CDR-SB = Clinical Dementia Rating-sum of boxes, GDS = Global Deterioration Scale.

(SD = 3.71) years of education. On average, the informants had known the participants for 38.76 (SD = 12.34) years and spent an average of 56.94 (SD = 60.90) hours per week with them.

Reliability

Cronbach's alpha coefficient for the K-ECog global score was 0.93, and those of the six domain scores were in the range of 0.76 to 0.89. The Pearson's correlation coefficient for test-retest reliability (average interval, 31 days; range, 13–42 days) varied from 0.49 to 0.82 ($P < 0.001$) (**Table 2**).

Validity

The global score and all six domain scores of K-ECog were significantly correlated with K-IADL, K-MMSE, and K-MoCA (**Table 3**). However, the K-ECog scores were more strongly correlated with the K-IADL rather than the K-MMSE or K-MoCA scores.

Table 2. Internal consistency and test-retest reliability of the K-ECog

K-ECog	Chronbach's α	1st	2nd	Pearson's *r*	*P* value
Memory	0.88	1.56 ± 0.60	1.49 ± 0.62	0.82	< 0.001
Language	0.89	1.32 ± 0.49	1.28 ± 0.42	0.67	< 0.001
Visuospatial function	0.76	1.29 ± 0.47	1.27 ± 0.40	0.74	< 0.001
EF: planning	0.76	1.34 ± 0.48	1.30 ± 0.46	0.79	< 0.001
EF: organization	0.77	1.33 ± 0.49	1.29 ± 0.44	0.49	< 0.001
EF: divided attention	0.78	1.56 ± 0.62	1.50 ± 0.57	0.72	< 0.001
Global function	0.93	1.39 ± 0.43	1.35 ± 0.40	0.73	< 0.001

Values are presented as mean ± standard deviation.
K-ECog = Korean-Everyday Cognition, EF = executive function.

Table 3. Partial correlation of the K-ECog and the K-IADL, K-MMSE, and K-MoCA

K-ECog	K-IADL		K-MMSE		K-MoCA	
	Correlation	*P* value	Correlation	*P* value	Correlation	*P* value
Memory	0.57	< 0.001	−0.37	< 0.001	−0.29	< 0.001
Language	0.52	< 0.001	−0.22	< 0.001	−0.15	0.001
Visuospatial function	0.59	< 0.001	−0.32	< 0.001	−0.23	< 0.001
EF: planning	0.60	< 0.001	−0.33	< 0.001	−0.23	< 0.001
EF: organization	0.62	< 0.001	−0.35	< 0.001	−0.20	< 0.001
EF: divided attention	0.54	< 0.001	−0.29	< 0.001	−0.21	< 0.001
Global function	0.66	< 0.001	−0.38	< 0.001	−0.26	< 0.001

Values are presented as partial correlation coefficients controlled age, education, and depression level. K-ECog = Korean-Everyday Cognition, K-IADL = Korean-Instrumental Activities of Daily Living, K-MMSE = Korean-Mini Mental State Examination, K-MoCA = Korean-Montreal Cognitive Assessment, EF = executive function.

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The CFA for K-ECog revealed that the seven-factor model (one global factor and six domain-specific factors) fitted the data well (root mean square error of approximation [RMSEA], 0.04; 95% confidence interval [CI], 0.03–0.04; comparative fit index [CFI], 0.99; Tucker-Lewis index [TLI] = 0.99). The six domain-specific factors are memory, language, visuospatial function, executive function (EF): planning, EF: organization, and EF: divided attention.

The ANCOVA revealed a significant difference among groups on K-ECog global score ($F[2,461] = 96.14$; $P < 0.001$). The MANCOVA revealed a significant difference among groups on the K-ECog six domain scores ($\lambda = 0.61$; $F[12, 912] = 21.69$; $P < 0.001$; partial $\eta^2 = 0.22$): memory ($F[2,461] = 120.62$; $P < 0.001$), language ($F[2,461] = 33.89$; $P < 0.001$), visuospatial function ($F[2,461] = 59.35$; $P < 0.001$), EF: planning ($F[2,461] = 72.85$; $P < 0.001$), EF: organization ($F[2,461] = 65.67$; $P < 0.001$), and EF: divided attention ($F[2,461] = 51.50$; $P < 0.001$). Follow-up post-hoc analysis with Bonferroni correction showed that each group was significantly different from the other two groups (**Table 4**). The repeated measures ANOVA revealed a significant difference among the K-ECog six domain scores for each group: NA ($F[1,265] = 3,094.69$; $P < 0.001$), aMCI ($F[1,142] = 1,241.12$; $P < 0.001$), and DAT ($F[1,73] = 875.62$; $P < 0.001$). Follow-up post-hoc analysis with Bonferroni correction showed that the memory and EF: divided attention scores were higher compared with other domain scores in all three groups (**Table 5**).

ROC curve analysis revealed that the K-ECog global score were comparable to the K-IADL, K-MMSE, and K-MoCA scores in differentiating NA from older adults with cognitive impairments. Areas under the curve (AUC) values between the normal group and the two clinical groups for the K-ECog global score, K-IADL, K-MMSE, and K-MoCA scores are presented in **Table 6** and ROC curve graphs are presented in **Figs. 1-3**. The differences between the AUC of K-ECog and those of K-IADL ($\chi^2 = 0.06$; $P = 0.81$), K-MMSE ($\chi^2 = 0.12$; $P = 0.73$), and K-MoCA ($\chi^2 = 0.57$; $P = 0.45$) were not significant in differentiating the NA

Table 4. Group differences of the K-ECog

K-Ecog	NA (n = 268)	aMCI (n = 151)	DAT (n = 77)	F	*P* value	Effect size (partial η^2)	Post-hoc (Bonferroni)
Memory	1.56 ± 0.51	2.33 ± 0.76	3.28 ± 0.65	120.62	< 0.001	0.34	a < b < c
Language	1.31 ± 0.44	1.73 ± 0.70	2.32 ± 0.91	33.89	< 0.001	0.13	a < b < c
Visuospatial function	1.26 ± 0.42	1.68 ± 0.76	2.54 ± 1.00	59.35	< 0.001	0.21	a < b < c
EF: planning	1.26 ± 0.47	1.72 ± 0.77	2.68 ± 1.01	72.85	< 0.001	0.24	a < b < c
EF: organization	1.26 ± 0.43	1.71 ± 0.77	2.57 ± 0.97	65.67	< 0.001	0.22	a < b < c
EF: divided attention	1.52 ± 0.59	2.11 ± 0.86	2.95 ± 0.90	51.50	< 0.001	0.18	a < b < c
Global function	1.36 ± 0.39	1.89 ± 0.63	2.70 ± 0.74	96.14	< 0.001	0.29	a < b < c

Values are presented as mean ± standard deviation and controlled age, education, depression level.
Post-hoc (Bonferroni): a = NA, b = aMCI, c = DAT.
K-ECog = Korean-Everyday Cognition, NA = normal older adults, aMCI = amnestic mild cognitive impairment, DAT = dementia of the Alzheimer's type, EF = executive function.

Table 5. Difference among K-ECog 6 domain-specific factor scores on each group

K-ECog	Memory	Language	Visuospatial function	EF: planning	EF: organization	EF: divided attention	F	*P* value	Effect size (partial η^2)	Post-hoc (Bonferroni)
NA (n = 268)	1.56 ± 0.51	1.31 ± 0.44	1.26 ± 0.42	1.26 ± 0.47	1.26 ± 0.43	1.52 ± 0.59	3,094.69	< 0.001	0.92	a = f > b = c = d = e
aMCI (n = 151)	2.33 ± 0.76	1.73 ± 0.70	1.68 ± 0.76	1.72 ± 0.77	1.71 ± 0.77	2.11 ± 0.86	1,241.12	< 0.001	0.90	a > f > b = d = e = c
DAT (n = 77)	3.28 ± 0.65	2.32 ± 0.91	2.54 ± 1.00	2.68 ± 1.01	2.57 ± 0.97	2.95 ± 0.90	875.62	< 0.001	0.92	a > f > e = c = b, f = d > b, d = e = c

Values are presented as mean ± standard deviation and controlled age, education, depression level.
Post-hoc (Bonferroni): a = Memory, b = Language, c = Visuospatial function, d = EF: planning, e = EF: organization, f = EF: divided attention.
K-ECog = Korean-Everyday Cognition, NA = normal older adults, aMCI = amnestic mild cognitive impairment, DAT = dementia of the Alzheimer's type, EF = executive function.

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Table 6. AUCs of the K-ECog and the K-IADL, K-MMSE, and K-MoCA in group comparison

Groups	K-ECog			K-IADL			K-MMSE			K-MoCA		
	AUC	95% CI		AUC	95% CI		AUC	95% CI		AUC	95% CI	
		LL	UL		LL	UL		LL	UL		LL	UL
NA vs. aMCI	0.84	0.80	0.88	0.84	0.80	0.88	0.85	0.81	0.89	0.86	0.82	0.89
NA vs. DAT	0.96	0.94	0.96	0.98	0.95	0.99	0.98	0.96	0.99	0.97	0.96	0.99
NA vs. aMCI+DAT	0.88	0.85	0.91	0.89	0.86	0.92	0.89	0.86	0.92	0.89	0.86	0.92

AUC = area under the curve, K-ECog = Korean-Everyday Cognition, K-IADL = Korean-Instrumental Activities of Daily Living, K-MMSE = Korean-Mini Mental State Examination, K-MoCA = Korean-Montreal Cognitive Assessment, CI = confidence interval, LL = lower limit, UL = upper limit, NA = normal older adults, aMCI = amnestic mild cognitive impairment, DAT = dementia of the Alzheimer's type.

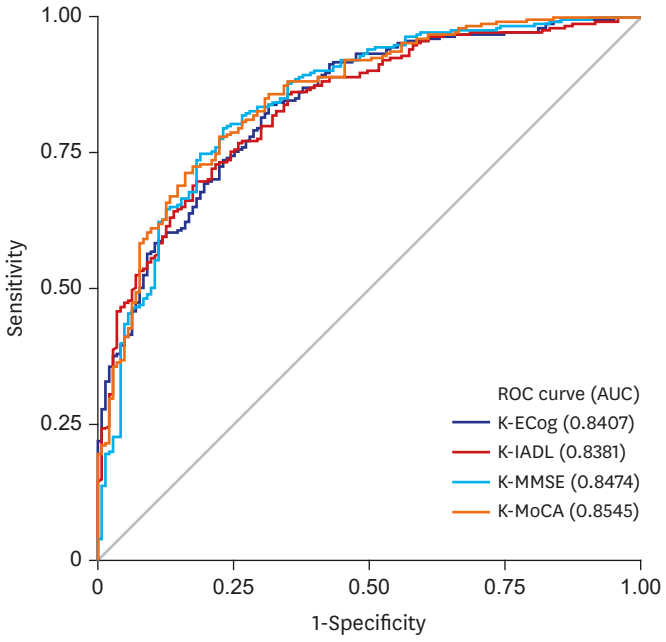

Fig. 1. ROC curves for the K-ECog and the K-IADL, K-MMSE, and K-MoCA in the comparison between NA and aMCI.
ROC = receiver operating characteristic, AUC = areas under the curve, K-ECog = Korean version Everyday Cognition, K-IADL = Korean-Instrumental Activities of Daily Living, K-MMSE = Korean-Mini Mental State Examination, K-MoCA = Korean-Montreal Cognitive Assessment, NA = normal older adults, aMCI = amnestic mild cognitive impairment.

from aMCI (**Fig. 1**). In differentiating the NA from DAT, the AUC of K-ECog was slightly smaller than that of K-IADL ($\chi^2 = 4.37$; $P = 0.04$), whereas no significant differences were seen between the AUCs of K-ECog and K-MMSE ($\chi^2 = 3.19$; $P = 0.07$) and K-MoCA ($\chi^2 = 1.41$; $P = 0.36$) (**Fig. 2**). Further, in differentiating the NA from those with cognitive impairments, including both the aMCI and DAT, the AUC of K-ECog was not significantly different from those of K-IADL ($\chi^2 = 0.61$; $P = 0.44$), K-MMSE ($\chi^2 = 0.41$; $P = 0.52$), and K-MoCA ($\chi^2 = 0.82$; $P = 0.36$) (**Fig. 3**). The cut-off score, sensitivity, specificity, and positive and negative predictive values for each comparison were calculated (**Table 7**). K-ECog had a sensitivity of 70.5% and specificity of 77.5%, when an optimal cut-off score of 1.41 was used for discriminating aMCI from NA. When an optimal cut-off score of 1.61 was used for discriminating DAT from NA, a sensitivity of 81.7% and specificity of 93.5% were obtained. For discriminating aMCI and DAT from NA, K-ECog had a sensitivity of 74.1% and specificity of 81.7% with an optimal cut-off score of 1.59.

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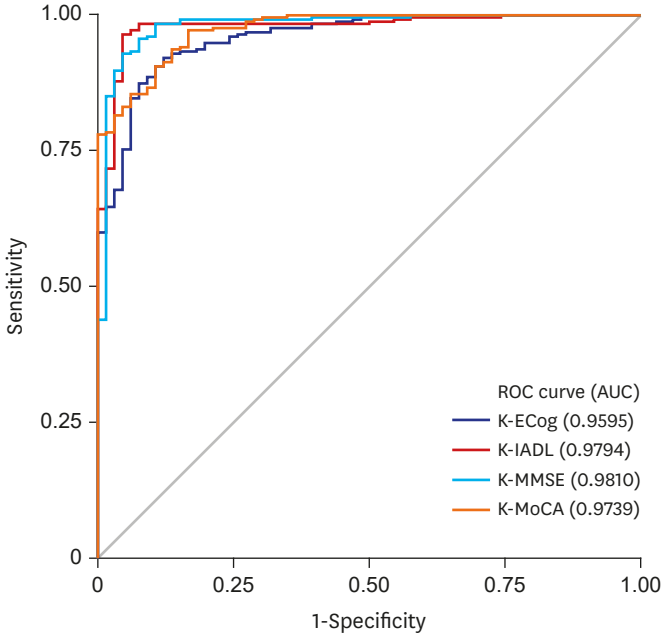

Fig. 2. ROC curves for the K-ECog and the K-IADL, K-MMSE, and K-MoCA in comparison between NA and DAT.
ROC = receiver operating characteristic, AUC = areas under the curve, K-ECog = Korean version Everyday Cognition, K-IADL = Korean-Instrumental Activities of Daily Living, K-MMSE = Korean-Mini Mental State Examination, K-MoCA = Korean-Montreal Cognitive Assessment, NA = normal older adults, DAT = dementia of the Alzheimer's type.

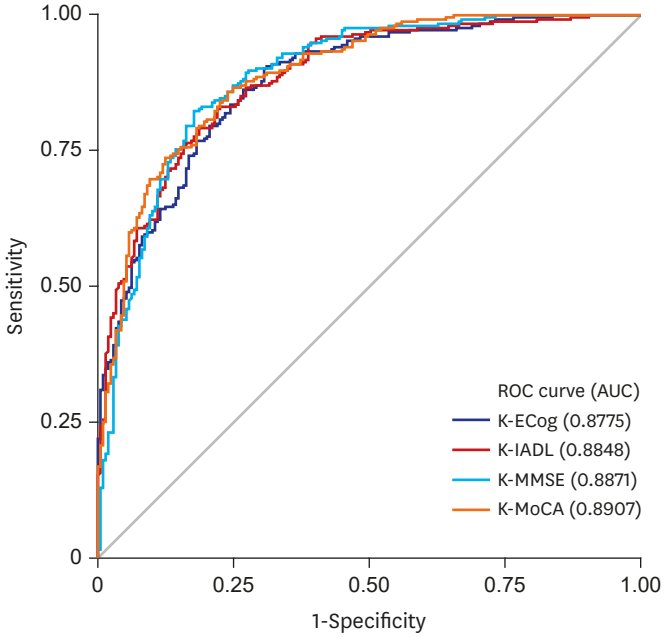

Fig. 3. ROC curves for the K-ECog and the K-IADL, K-MMSE, and K-MoCA in comparison between individuals with cognitively NA and cognitive impairment (aMCI + DAT).
ROC = receiver operating characteristic, AUC = areas under the curve, K-ECog = Korean version Everyday Cognition, K-IADL = Korean-Instrumental Activities of Daily Living, K-MMSE = Korean-Mini Mental State Examination, K-MoCA = Korean-Montreal Cognitive Assessment, NA = normal older adults, aMCI = amnestic mild cognitive impairment, DAT = dementia of the Alzheimer's type.

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Table 7. Optimal cut-off scores, sensitivity, specificity, and positive and negative predictive values for the K-ECog

Groups	Cut-off score	Sensitivity, %	Specificity, %	PPV, %	NPV, %
NA vs. aMCI	1.41	70.5	77.5	84.8	59.7
NA vs. DATs	1.61	81.7	93.5	97.8	59.5
NA vs. aMCI+DAT	1.59	74.1	81.7	77.5	78.8

K-ECog = Korean-Everyday Cognition, NA = normal older adults, aMCI = amnestic mild cognitive impairment, DAT = dementia of the Alzheimer's type, PPV = positive predictive value, NPV = negative predictive value.

DISCUSSION

The results revealed good internal consistency and test-retest reliability of K-ECog, indicating that the items of K-ECog measure the same general construct and that their scores are stable over time. The relationships of K-ECog with existing measures for assessing everyday function or cognitive functions were evaluated. As expected, K-ECog demonstrated reasonable relationships with K-IADL. Such relationship was also found with cognitive screening tests, particularly K-MMSE and K-MoCA. K-ECog, therefore, was shown to have good convergent validity with previously established measures, including IADL and cognitive screening tests.

Everyday function is believed to have a multidimensional construct, as different daily tasks vary in the degree to which they require specific cognitive ability. In the original ECog study, Farias et al.[15] chose the model represented by one general factor and six domain-specific factors, namely, memory, language, visuospatial function, EF: planning, EF: organization, and EF: divided attention. The CFA results of K-ECog also showed that a factor structure with equal weight on all factors of K-ECog is appropriate for indexing overall ADL functioning. The goodness of fit of this model was similar to that of the original ECog (K-ECog: RMSEA = 0.04, CFI = 0.99, TLI = 0.99 vs. ECog: RMSEA = 0.06, CFI = 0.98, TLI = 0.99). This multidimensional structure of K-ECog permits a more detailed investigation of the determinants and course of functional impairments that can be helpful in diagnostic differentiation in the clinical field.

We examined whether K-ECog could measure the degree of ADL impairments. The results showed large group differences on the total score and each cognitive domain scores of K-ECog among the NA, aMCI, and DAT groups. NA participants showed the least degree of change relative to their baseline (comparison to 10 years ago); the aMCI group showed an intermediate level of functional impairment; and the mild AD group showed the greatest degree of functional impairment. This trend indicated that K-ECog is sensitive to relatively subtle ADL changes. We likewise found differences between the domain scores of K-ECog in each group. In the NA, the memory and EF: divided attention scores were significantly higher compared with other domain scores. In the aMCI, the memory score was significantly higher than the EF: divided attention score, although these two scores were significantly higher compared with the other domain scores. In the DAT, the memory score was significantly higher than the EF: divided attention score, although these two scores were significantly higher compared with language, visuospatial function, and EF: organization scores. The EF: planning score did not show significant differences with EF: divided attention, but was significantly higher than language score, although there were no differences among EF: planning, EF: organization, and visuospatial function scores. The memory score was significantly higher compared with any other domain scores. Thus, memory problems were more frequently reported than other cognitive functions in all three groups. Subsequently, EF: divided attention was also reported to be more problematic than the other cognitive

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functions. This finding is consistent with previous studies that reported impaired divided attention in aMCI or AD.[27,28] These characteristics of domain scores in each group showed the progression process of cognitive dysfunction from normal older adult through MCI to DAT. Thus, K-ECog is a useful tool for distinguishing early cognitive dysfunction in daily life by evaluating various cognitive domains.

Further, ROC curve analyses revealed K-ECog is a valid instrument for differentiating between cognitively normal and cognitively impaired older adults. The discriminative accuracy of K-ECog was identical to that of K-IADL, K-MMSE, and K-MoCA. As such, K-ECog is a valid cognitive screening measure as well as ADL scale for differentiating impaired individuals from NAs.

Trained clinicians should meet patients in person to administer MMSE and MoCA. Meanwhile, K-ECog answered by caregivers does not need trained experts for administration. With only a reliable caregiver's report, K-ECog can provide information on patients' general cognitive function as well as ADL. From the ROC curve analyses, the optimal cut-off scores to differentiate the older adults with cognitive impairment from the NA were calculated. The cut-off scores of K-ECog to differentiate aMCI from NA and to differentiate DAT from NA were ≥ 1.41 and ≥ 1.61, respectively.

Most items in the existing ADL scales are related to more than one cognitive domain. For example, “shopping” included in most ADL scales requires multiple cognitive abilities, such as visuospatial function, memory, calculation, and planning. K-ECog consists of six sections, each section includes items strongly associated with a particular cognitive function. Therefore, it allows clinicians to know the specific cognitive domain that causes the impairment of a specific item. That is, K-ECog could also provide information on specific cognitive-domain dysfunctions as well as general cognitive function, as mentioned above, without requiring the clinician to see the patients personally. Therefore, K-ECog would be highly useful in situations where it is difficult for the clinician to assess the patients directly. Further, unlike performance-based cognitive screening tools, such as MMSE, K-ECog is affected minimally by patients' educational background.[9,29,30]

Assessments of both cognitive and everyday functioning levels are essential for the diagnosis and intervention of dementia. Cognitive assessment using neuropsychological tests requires relatively long hours of testing and trained professionals who can examine and interpret the cognitive tests. However, many community-based clinics do not have experts or the settings for it. It is recommended to use K-ECog in such settings. K-ECog is time efficient and useful, as it can be completed by an informant within a few minutes when formal cognitive testing is not feasible. Its role of cognitive screening may identify the need for additional neuropsychological evaluation.[31]

At present, longitudinal studies are increasingly conducted, matching the increased interest in the prevention, early detection, and intervention of dementia. Many researchers have focused on cognitive changes according to dementia severity, but few studies are available on detailed changes in everyday functioning from MCI to dementia. Unlike other existing ADL scales, K-ECog is more optimal for longitudinal studies, as its items are designed to evaluate subtle changes in everyday function. K-ECog also permits researchers to study direct relationships between functional deficits and the related neuropsychological dysfunction. It may help researchers design more valid studies on pharmacological and cognitive intervention targeting specific everyday functions.

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The current study has several limitations. First, follow-up cross-validation in an independent sample is needed to verify the utility of the cut-off values. Second, the clinical groups in our study were confined to aMCI and DAT patients. Further studies with other clinical groups, including patients with subjective cognitive decline, vascular cognitive impairment, and movement disorder, would extend its value. Third, studies to examine differences in the cognitive domain scores of K-ECog in various clinical groups would widen its clinical utility. Investigations revealing different relationships among various clinical groups could help clinicians grasp the cognitive domains that cause the ADL problems of a specific clinical group and thereby formulate a tailored rehabilitation program.

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Appendix 1.

Korean-Everyday Cognition (보호자용)

환자 이름: _____ 병록번호(ID): _____ 검사일: _____년 _____월 _____일

- 환자의 보호자, 가족, 또는 친구가 작성해야 합니다.
- 환자의 현재 일상생활기능이 10년 전과 비교하여 어떠한지 평가해 주시기 바랍니다. 즉, 각 문항에 대해서 환자가 10년 전에 어떠하셨는지 기억해 보시고, 보호자께서 보시기에 지난 10년 동안 환자에게 어떤 변화가 있었는지 평가해 주시면 됩니다.
- 환자의 변화 정도를 다음의 5가지 중 하나로 평가해 주십시오: 1) 변화가 없거나 10년 전보다 실제로 더 좋아졌다. 2) 가끔 10년 전보다 못할 때도 있지만, 항상 그런 것은 아니다. 3) 거의 모든 경우에 10년 전보다 약간 나빠졌다. 4) 거의 모든 경우에 10년 전보다 많이 나빠졌다. 9) 모르겠다(또는 해당 없음).
- 해당하는 번호에 동그라미로 표시해 주십시오.

10년 전과 비교해서, 아래의 문항들에 어떤 변화가 있었습니까?	변화가 없거나 더 좋아졌다	가끔 나쁠 때도 있다	약간 나빠졌다	많이 나빠졌다	모르겠다 *(해당 없음)*
기억력					
1. 쇼핑 목록을 적어가지 않고도 몇 가지의 살 물건들을 기억한다.	1	2	3	4	9
2. 최근에 있었던 일들(최근에 간 여행, 뉴스에서 보도된 사건)을 기억한다.	1	2	3	4	9
3. 몇 일 전에 했던 대화내용을 기억한다.	1	2	3	4	9
4. 물건을 어디에 두었는지 기억한다.	1	2	3	4	9
5. 전에 했던 이야기나 질문을 반복한다.	1	2	3	4	9
6. 오늘이 몇 일인지 또는 무슨 요일인지 기억한다.	1	2	3	4	9
7. 자신이 누구에게 무슨 말을 하였는지 기억한다.	1	2	3	4	9
8. 약속이나 모임 등을 기억한다.	1	2	3	4	9
언어 능력					
1. 물건의 이름을 잊어버린다.	1	2	3	4	9
2. 상대방에게 말로 설명을 한다.	1	2	3	4	9
3. 대화를 할 때, 적절한 단어를 사용한다.	1	2	3	4	9
4. 대화로 자신의 생각을 전달한다.	1	2	3	4	9
5. 책이나 TV 내용을 이해한다.	1	2	3	4	9
6. 상대방이 말하려고 하는 내용의 요점을 이해한다.	1	2	3	4	9
7. 흔히 사용되는 단어들의 의미를 기억한다.	1	2	3	4	9
8. TV로 본 프로그램의 내용을 설명한다.	1	2	3	4	9
9. 말로 주어진 지시나 설명을 이해한다.	1	2	3	4	9
시공간 능력과 지각 능력					
1. 지도(약도)를 보고 낯선 장소를 찾아간다.	1	2	3	4	9
2. 다른 사람이 운전을 하고 있을 때, 지도(약도)를 보고 길을 찾도록 돕는다.	1	2	3	4	9
3. 주차장에서 자신의 자동차를 찾는다.	1	2	3	4	9
4. 백화점(또는 시장)에서 따로 쇼핑을 하다가 만나기로 한 장소로 되돌아온다.	1	2	3	4	9
5. 익숙한 동네에서 길을 찾는다.	1	2	3	4	9
6. 자주 가는 가게 주변에서 길을 찾는다.	1	2	3	4	9
7. 많이 방문했던 집(자녀의 집) 주변에서 길을 찾는다.	1	2	3	4	9

(continued to the next page)

Appendix 1. (Continued)

집행 기능: 계획					
1. 쇼핑을 할 때, 무엇을 먼저 살 것인지 순서를 정한다.	1	2	3	4	9
2. 날씨 변화를 예상하고, 그에 맞추어 계획을 한다(예: 코트나 우산을 챙긴다.).	1	2	3	4	9
3. 예정된 행사가 있으면 미리 해야 할 일들에 대해서 일정을 짠다.	1	2	3	4	9
4. 행동을 하기 전에 과정과 결과를 생각한다.	1	2	3	4	9
5. 앞으로의 일에 대해서 미리 생각한다.	1	2	3	4	9
집행 기능: 조직화					
1. 생활 공간과 작업 공간을 잘 정돈한다.	1	2	3	4	9
2. 통장에 잔고가 얼마 남아있는지 안다.	1	2	3	4	9
3. 본인의 재산내역(은행잔고, 채무관계, 부동산 등)을 잘 알고 있다.	1	2	3	4	9
4. 일의 중요도에 따라서, 일의 우선순위를 정한다.	1	2	3	4	9
5. 우편물과 서류를 잘 관리한다.	1	2	3	4	9
6. 여러 가지 약을 함께 복용하면서 약 먹는 것을 잊지 않도록 조직화된 방법(알람, 요일 별 약통 등)을 사용한다.	1	2	3	4	9
집행 기능: 분할주의					
1. 한 번에 두 가지 일을 동시에 처리하는 능력	1	2	3	4	9
2. 어떤 일을 하다가 다른 일로 방해를 받아 중단된 후, 다시 그 일로 되돌아 온다.	1	2	3	4	9
3. 주변 환경에 의해서 주의가 산만해지지 않고 한가지 일에 집중하는 능력	1	2	3	4	9
4. 말하면서 동시에 음식을 만들거나 일을 한다.	1	2	3	4	9

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