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Original Article

Validation of the Korean Version of the University of California San Diego Performance-Based Skills Assessment for High-Functional Capacity in the Elderly

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SUMMARY

Background: We evaluated the versatility of the Korean version of the University of California San Diego Performance-based Skills Assessment, Validation of Intermediate Measures version (K-UPSA-2-VIM) as a new diagnostic modality to overcome the difficulties associated with an accurate objective assessment of functional capacity for evaluating mental competency.
Methods: One hundred sixteen community-dwelling elderly individuals were enrolled. Questionnaires, including the Mini-Mental State Examination (MMSE), the clinical dementia rating (CDR), the neurocognitive battery of the Korean version of the consortium to Establish a Registry for Alzheimer's Disease Assessment Packet (CERAD-K-NP), the Korean version of Instrumental Activities of Daily Living Index (K-IADL), and the K-UPSA-2-VIM, were administered. A receiver operating characteristic (ROC) curve analysis was performed to explore the discriminative potential.
Results: Seventy-eight cognitively normal (CN) participants and 38 individuals with cognitive impairment no dementia (CIND) were analyzed. The K-UPSA-2-VIM showed fair internal consistency (Cronbach alpha = 0.886). There were significant differences among groups in all subdomains (finance, communication, comprehension/planning, transportation, and household skills) of the K-UPSA-2-VIM, which were significantly correlated with CERAD-K-NP subscales. The K-UPSA-2-VIM showed high sensitivity (73.7%) and specificity (82.1%), with an area under the curve (AUC) of 0.828 (95% confidence interval: 0.747–0.909, $p < 0.001$) to discriminate CIND.
Conclusion: The K-UPSA-2-VIM is a reliable performance-based instrument for evaluating real-world high-functional capacity of older Korean adults in the community.

1. Introduction

The currently increasing trend of the elderly population[1,2] prompts the need to evaluate functional decisional capacity and cognitive function or "competence," in legal terminology, which is characterized by managing one's affairs according to one's values.[3] The fifth edition of the Diagnostic and Statistical Manual of Mental disorders (DSM-5)[4] recommends that clinicians pay careful attention to a patient's baseline daily functioning. Previous research has suggested that a decline in decision-making capacity may be evident even in individuals with subtle cognitive impairment.[5,6] However, the difficulty of obtaining a detailed clinical history of the patient without their cooperation or reliable reports from a proxy complicates the assessment of competence. Occasionally, disputes among caregivers over the subject's property make it difficult to evaluate the actual competence in legal situations.

Most psychometric instruments, including neurocognitive batteries, tend to focus on the impairment of specific cognitive domains and are likely not to fully reflect a patient's level of daily function. Although the Mini-Mental State Examination (MMSE)[7] is regarded as a convenient screening instrument for cognitive decline, it may be limited by a scale-attenuation effect called the ceiling/floor effect, even after correcting for education.[8] The Barthel Activities of Daily Living Index (BADL)[9] and the Instrumental Activities of Daily Living (IADL)[10] are considered the gold standards for evaluating functional abilities; however, they still depend on the information provided by the subject's caregiver. Although the American Bar Association has warned against the heavy reliance of legal professionals on clinical neurocognitive tests, such as MMSE,[11] courts in many countries, including Korea, still apply such neurocognitive batteries.

Objective performance-based individual measurement can provide crucial information for clinicians or judges on the ability of subjects to make appropriate social judgments, independently of a neurocognitive battery. Recently, studies have emphasized that a multi-dimensional approach is needed for the elderly, including their assessment of functional capacity, and efforts have been made to develop related performance-based instruments.[12–14] However, the

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literature review revealed no validated instruments for the Korean elderly.

Developed in 2001, the University of California San Diego Performance-based Skills Assessment (UCSD Performance-based Skills Assessment [UPSA])[15] is a rater-administered measure of functional capacity and competence that requires approximately 30 minutes. The original English version of the UPSA has high interrater reliability and a good test-retest reliability (Cronbach's alpha = 0.91). It features five domains to perform daily activities through the analogs of real-world activities: financial skills (counting money and interpreting bills), communication (dialing an emergency number and scheduling medical appointments), comprehension/planning (reading a newspaper article regarding an opening ceremony and planning a visit), transportation (choosing a bus route), and household management (reading recipes and cooking). The UPSA was originally designed for middle-aged to older patients with severe mental illness, such as schizophrenia. Recently, a study has shown that it is equally a useful standard for cognitive decline cases, such as Alzheimer-associated dementia and mild cognitive impairment (MCI).[16]

We hypothesized that UPSA could help determine the actual functional difficulties of subjects based on real-world performance tasks. Having developed a Korean version of the UCSD Performance-based Skills Assessment, Validation of Intermediate Measures version (K-UPSA-2-VIM), this study aimed to evaluate the functional capacity of community-dwelling elderly using the K-UPSA-2-VIM.

2. Methods

2.1. Participants

We recruited participants attending four discrete senior centers in Seoul from March to December 2019. All subjects were aged over 60 years and literate. Study eligibility was determined after a medical interview. All research procedures were approved by the Institutional Review Board for Human Research, National Center for Mental Health, Seoul, Korea (IRB No. 116271-2018-52). Participants were provided informed consent and freely willing to enroll in the study. Individuals with any major psychiatric diseases other than neurocognitive disease defined by DSM-5 were excluded. Similarly, participants with poorly controlled physical/neurologic disorders, in whom UPSA could not be directly performed, were excluded. None of the participants was being treated for dementia, and we confirmed no cognitive decline in case of major neurocognitive disorder.

"Cognitively normal" (CN) participants were defined as those who did not fulfill the criteria for major or mild neurocognitive disorders defined by DSM-5 and had a clinical dementia rating (CDR) of 0. We classified subjects into the "cognitive impairment no dementia" (CIND) category operatively to discriminate them from those with CN, which included participants exceeding 1.5 standard deviation below normative expectation on a single neurocognitive domain.

2.2. Functional & cognitive assessments

The original material of the UPSA, Validation of Intermediate Measures version (UPSA-2-VIM, version 2.4), was obtained with a written license agreement from NeuroCog Trials (managing the copyright on behalf of an author, Thomas Patterson), translated into Korean, and compared after reverse translation into English by a professional translator. To accommodate cultural differences, electric bill designs were changed to Korean gas bill forms because electricity rates are not stated in the form of a regular bill in Korea. Currency and emergency phone numbers were modified. In addition to the bus route, the subway route used in Seoul was similarly presented. The cooking menu was adapted to Kimbap, a food familiar to Koreans. Pantry items included plastic models that have been photographed and printed on highly legible plastic rather than real ones.

All researchers confirmed the final translated version after review. The K-UPSA-2-VIM was administered according to the original protocol. The raw scores of all subscales were converted to domain scores ranging from 0–20 and transformed to yield comparable scores ranging from 0–100, with higher scores indicating better performance.

The informant-administered BADL[10] and the Korean version of the Instrumental Activities of daily living (ADL) (K-IADL)[17] were administered. BADL is a 10-item informant-administered assessment tool for exploring the ability to perform basic activities independently, with higher scores indicating independence in performing basic activities. The K-IADL has 11 items scored by proxy for evaluating more sophisticated daily functions than those of the BADL, with lower scores suggesting better performance.

We used the neurocognitive battery of the Korean Version of the Consortium to Establish a Registry for Alzheimer's Disease neuropsychological battery (CERAD-K-NP, 2nd version; including the Korean version of the Mini-Mental State Examination [MMSE-KC]),[18,19] self-reported version of the Korean Dementia Screening Questionnaire (K-DSQ),[20] and the CDR[21] as relevant criteria. The neuropsychiatric battery of the CERAD-K-NP, 2nd version has been described in detail previously.[18] The K-DSQ consists of 15 questionnaires with proven sensitivity and specificity[22] and assesses the extent of cognitive performance deterioration compared to the previous year, with higher scores suggesting poorer function. The CDR involves a semi-structural interview with both the participant and informant to assess impairment in individual domains (memory, orientation, problem-solving/judgement, community affairs, home/hobbies, and personal care). Each scored domain is used to determine overall CDR scores. The Korean short version of the Geriatric Depression Scale (SGDS-K)[23] was administered to control for depression as a confounding factor.

2.3. Statistical analysis

Sample sizes were calculated using G*power 3.1.9.7 with targeted effect size, α (type I error), and β (type II error) of 0.8, 0.05, and 0.2, respectively. Since participants with CIND comprise 21.3–27.9% of the Korean elderly population,[24] we set the allocation ratio (CIND/CN) as 0.25. All analyses were conducted using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA) and R version 4.0.0 (The R Foundation for Statistical Computing). All parameters were compared using t-tests (continuous variables) and chi-square tests (categorical variables). We performed Pearson's partial correlation analysis controlling for depression. We set Bonferroni's corrected/adjusted p-value. To avoid family-wise type I error, partial canonical correlation analysis[25] was performed, followed by partial correlation analysis to measure association among the intercorrelated variables.

We separately performed simple linear regression analysis for age, sex, and education to determine the contribution of these variables to the K-UPSA-2-VIM total score. Consequently, age and education were considered significant and included in multiple linear regression analysis. We performed receiver operating characteristic (ROC) analysis to evaluate sensitivity and specificity and selected the optimal cutoff using the area under the curve (AUC) with 95% confidence interval (CI).

3. Results

One hundred sixteen participants were eligible for analysis (Figure 1); of these, 34 were men, and 82 were women. The mean age and educational years of the participants were 75.84 ± 5.82 years (mean ± standard deviation, range 61–93) and 8.04 ± 4.38 years (range 0–21), respectively. The details of the demographic and clinical characteristics of the participants are described in Table 1. Age, educational level, and sex did not differ significantly between the two cognitive groups. Comparing CN and CIND, there was a significant difference in each subscale of CERAD-K-NP, except for the constructional praxis (J5). For depression, significant differences in SGDS-K were observed between the CN and CIND groups. The K-UPSA-2-VIM showed significant differences in all domains between the CN and CIND groups (Table 2).

Except the trail-making test B (J9B), which did not follow a

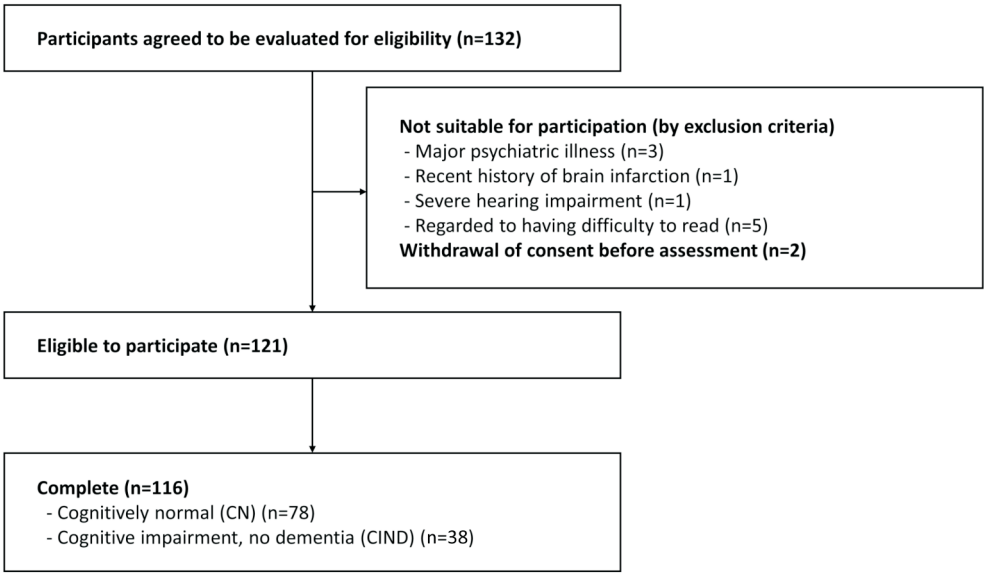

Figure 1. Flowsheets of subjects included.

Table 1
Demographic data.

	CN (N = 78)	CIND (N = 38)	p-value
Age	75.99 (5.75)	75.53 (6.02)	0.691
Educational years	7.59 (4.18)	8.97 (4.69)	0.111
Sex (female %)	65.4%	81.6%	0.073
Sum of box of CDR	0.21 (0.25)	1.18 (0.70)	0.000**
Verbal fluency test (J1)	15.65 (3.90)	11.74 (2.59)	0.000**
Modified Boston naming test (J2)	11.77 (1.96)	10.39 (2.39)	0.001*
Mini-Mental State Examination (J3)	27.62 (1.68)	25.53 (2.75)	0.000**
Wordlist memory (J4)	18.22 (4.35)	13.29 (3.26)	0.000**
Constructional praxis (J5)	9.69 (1.28)	9.39 (1.48)	0.267
Word list recall (J6)	6.14 (2.01)	3.53 (1.84)	0.000**
Wordlist recognition (J7)	8.99 (1.27)	7.53 (2.30)	0.001*
Constructional recall (J8)	6.51 (2.58)	4.24 (2.24)	0.000**
Trail making test A, time by seconds (J9A)	61.69 (24.88)	107.24 (77.44)	0.001*
Trail making test B, time in seconds (J9B)	211.50 (77.23)	267.23 (79.94)	0.000**
Short version of the Geriatric Depression Scale (SGDS-K)	4.87 (3.51)	6.37 (3.17)	0.028*

CIND: cognitive impairment, no dementia; CN: cognitively normal.
Values are presented as mean (standard deviation). Independent t-tests (continuous variables) and chi-square tests (categorical variables). * $p < 0.05$, ** $p < 0.001$.

Table 2
K-UPSA-2-VIM and functional assessment.

	CN (N = 78)	CIND (N = 38)	p-value
K-UPSA-2-VIM			
Finance	14.36 (3.61)	11.48 (4.17)	0.000***
Communication	12.31 (4.04)	8.42 (3.80)	0.000***
Comprehension/planning	10.92 (3.78)	7.67 (3.85)	0.000***
Transportation	13.82 (4.87)	8.54 (5.26)	0.000***
Household skills	15.26 (4.55)	10.13 (6.10)	0.000***
Total	66.66 (13.32)	47.24 (16.77)	0.000***
Barthel ADL (BADL)	19.99 (0.12)	19.68 (0.74)	0.016*
Korean Instrumental ADL (K-IADL)	0.0717 (0.1273)	0.3879 (0.3351)	0.000***
Korean Dementia Screening Questionnaire (K-DSQ), self-report	5.05 (3.76)	8.87 (4.79)	0.000***

* $p < 0.05$, ** $p < 0.001$, *** $p < 0.0011$, corrected Bonferroni p-value.

normal distribution, all five subdomains of K-UPSA-2-VIM and subscales of CERAD-K-NP (J1 to J9A), K-IADL, and K-DSQ were used for further analyses. Using the corrected p-value, all domains of K-UPSA-2-VIM significantly correlated with the CERAD-K-NP subscales (Table 3), after controlling for depression. Subdomains, including finance, communication, and transportation, of K-UPSA-2-VIM were significantly negatively correlated with those of K-IADL. Correlations with self-reported K-DSQ were not statistically significant in any subdomains using the corrected p-value.

The partial canonical correlation model showed statistically significant difference in multivariate test (F(55, 466.46) = -3.708; p = 0.000). Examining five models, only the first function was considered noteworthy (squared canonical correlations (R_2^c) = 0.832), and only the full model (functions 1 to 5) was statistically significant, explaining approximately 81.34% with Wilks' λ of 0.221 of the entire canonical solution for dimension reduction analysis. Squared structure coefficients supported that all subdomains of K-UPSA-2-VIM were important contributors to the CERAD-K-NP. MMSE (J3) and Wordlist memory (J4) contributed mainly to the K-UPSA-2-VIM. All potential contributors showed negative vectors, suggesting that all contributors had a similar direction of relations (Table 4). The multiple regression model revealed statistical significance in age and education (F = 6.918; p = 0.001) and explained 9.3% of K-UPSA-2-VIM. The regression equation was estimated as K-UPSA-2-VIM = 39.592 + 1.144 * age – 1.086 * educational years; it showed weak positive autocorrelations among the residuals, with a Durbin-Watson statistic of 1.248.

ROC curves demonstrated the sensitivity and specificity as 73.7% and 82.1%, respectively, with an AUC of 0.828 (95% CI: 0.747–0.909, p < 0.001), suggesting a high discriminatory power for the K-UPSA-2-VIM. The AUC of K-IADL was not significant (AUC 0.843, 95% CI: 0.763–0.923, p = 0.503). However, when K-UPSA-2-VIM and K-IADL were simultaneously used, the sensitivity increased to 94.7% with an AUC of 0.908 (95% CI: 0.857–0.958, p <

Table 3
Partial correlations (n = 116) after controlling for depression.

	CERAD-K-NP									K-IADL	K-DSQ
	J1	J2	J3	J4	J5	J6	J7	J8	J9A		
K-UPSA-2-VIM											
Finance	0.377*	0.362*	0.434*	0.395*	0.200	0.275	0.204	0.371*	-0.404*	-0.317*	-0.037
Communication	0.342*	0.405*	0.482*	0.425*	0.030	0.297	0.259	0.292	-0.189	-0.472*	-0.281
Comprehension/planning	0.404*	0.377*	0.443*	0.421*	0.058	0.464*	0.295	0.349*	-0.311*	-0.220	-0.103
Transportation	0.341*	0.374*	0.484*	0.474*	0.152	0.415*	0.206	0.306*	-0.375*	-0.481*	-0.179
Household skills	0.274	0.327*	0.485*	0.331*	0.230	0.312*	0.188	0.403*	-0.406*	-0.275	-0.105

CERAD-K-NP subscales: Verbal fluency test (J1); Modified Boston naming test (J2); Mini-Mental State Examination (J3); Wordlist memory (J4); Constructional praxis (J5); Wordlist recall (J6); Wordlist recognition (J7); Constructional recall (J8), Trail making test A, time by seconds (J9A). K-IADL: Korean version of Instrumental Activities of Daily Living Index, K-DSQ: Korean Dementia Screening Questionnaire. All domains of K-UPSA-2-VIM and higher scores in all subscales of CERAD-K-NP except J9A indicate the subject's better performance. Lower K-IADL and K-DSQ scores suggest better performance. * p < 0.001.

Table 4
Results of partial canonical correlation analysis.

Function	Eigenvalue	Canonical correlation	Squared structured coefficient (%)	Wilk's λ	p-value
1	2.245	0.692	83.2	0.187	0.000*
2	0.295	0.228	47.7	0.605	0.076
3	0.148	0.129	35.9	0.784	0.523
4	0.069	0.065	25.4	0.900	0.793
5	0.040	0.038	19.6	0.962	0.760

* p < 0.05.

	Standardized canonical coefficient	Structured correlation coefficient	Squared structured coefficients (%)
K-UPSA-2-VIM, performance-based instrument			
Finance	-0.270	-0.719	51.7
Comprehension	-0.178	-0.711	50.6
Communication/planning	-0.387	-0.703	49.5
Transportation	-0.282	-0.773	59.7
Household management	-0.278	-0.680	46.2
CERAD-K-NP, neurocognitive batteries			
Verbal fluency test (J1)	-0.138	-0.591	34.9
Modified Boston naming test (J2)	-0.199	-0.616	37.9
Mini-Mental State Examination (J3)	-0.428	-0.777	60.3
Wordlist memory (J4)	-0.243	-0.687	47.2
Constructional praxis (J5)	0.114	-0.227	5.1
Wordlist recall (J6)	-0.026	-0.614	37.7
Wordlist recognition (J7)	-0.036	-0.392	15.3
Constructional recall (J8)	-0.150	-0.584	34.1
Trail making test A, time by seconds (J9A)	0.201	0.579	33.6
K-IADL, Instrumental ADL	0.217	0.562	31.5
K-DSQ, Dementia Screening Questionnaire (K-DSQ)	-0.156	0.216	4.7
R_c^2 (%)			83.2

Canonical solution for function 1. Squared structured coefficients greater than 45% are underlined.

0.001: sensitivity 76.9%). The best probabilistic cutoff of the total K-UPSA-2-VIM score was estimated to be 54/55. The AUCs of the total scores of K-UPSA-2-VIM were significantly different from those of the MMSE (Figure 2).

We administered the same K-UPSA-2-VIM to 25 subjects (19 CN, 6 CIND) to measure its reliability after four weeks. The Cronbach's alpha was 0.886, and the interclass correlation of all subdomains ranged from 0.703–0.827, demonstrating good to excellent internal consistency and reliability. The interclass correlation of total K-UPSA-2-VIM score was 0.879 (95% CI: 0.727–0.947, $p < 0.001$).

4. Discussion

Our findings suggest that the K-UPSA-2-VIM can discriminate a subclinical cognitive dysfunctional condition from normal cognitive function in community-dwelling older adults in Korea. Previous research showed that the former version of the UPSA had a significantly higher AUC than the K-IADL.[26] We could not compare K-UPSA-2-VIM with K-IADL due to statistical insignificance in the latter; however, K-UPSA-2-VIM seems superior to MMSE for evaluating functional capacity. Since 25% of the elderly population in Korea were estimated to have CIND,[24] the positive predictive values were determined to be 57.9% (K-UPSA-2-VIM only) and 57.8% (K-UPSA-2-VIM with K-IADL), respectively. As K-IADL is a measure obtained from caregivers, our study findings support the usefulness of K-UPSA-2-VIM for discriminating subjects with reduced functional capacity when information cannot be properly obtained from the proxy.

This finding is consistent with previous studies on the English version of the UPSA comparing normal cognitive function to MCI.[16] Our findings suggest that in addition to MCI patients, subjects with cognitive impairment who do not fully conform to the diagnostic criteria of MCI may exhibit functional impairments. Considering that decline of functioning is considered the most powerful predictor of dementia,[27] our results suggest that the K-UPSA-2-VIM complements existing cognitive function tests regarding functional assessment from a performance-based perspective and can promptly detect vulnerable subjects with impaired functional capacity.

The results of partial correlation analysis and derived canonical solution supported a consistent relationship between functional capacity measured by K-UPSA-2-VIM and cognition measured by CERAD-K-NP. However, except for MMSE and Wordlist memory, other neurocognitive subscales were not predictable in the canonical function. Korean courts recommend neurocognitive testing as an objective indicator of the competency of subjects requiring adult guardianship; however, this may raise concerns that cognitive tests results do not truly reflect actual functional capacity. Hence, future studies are needed to explore the association.

The K-UPSA-2-VIM is considered a pragmatic tool for exploring functional assessment among older adults in Korea, despite featuring implicit cultural differences with the original edition. However, while the UPSA has been adapted to suit the various cultures,[28–32] few studies have suggested optimal cutoff values for elderly patients or those with cognitive dysfunction. Our study identified a cutoff point of 54/55 for discriminating CIND with fair to high sensitivity and specificity. The cutoff value is slightly lower than that in previous research discriminating individuals with Alzheimer's disease, MCI, and normal cognition;[16] the study reported cutoffs of 64 for MCI and 42 for Alzheimer's disease. Although we modified the instrument considering cultural differences, the discrepancy of the cutoff may be attributable to the relatively lower education level of the participants enrolled. Although our multiple linear regression model requires careful interpretation due to autocorrelation, the current results recommend identifying a cutoff value in further larger cohorts after correcting for the participants' age and academic background.

This study should be carefully interpreted considering the absence of dementia among subjects and the small sample size. Because the number of CIND subjects was relatively small, it was not possible to confirm the test-retest reliability by group. Nevertheless, we confirmed that the K-UPSA-2-VIM is appropriate for evaluating

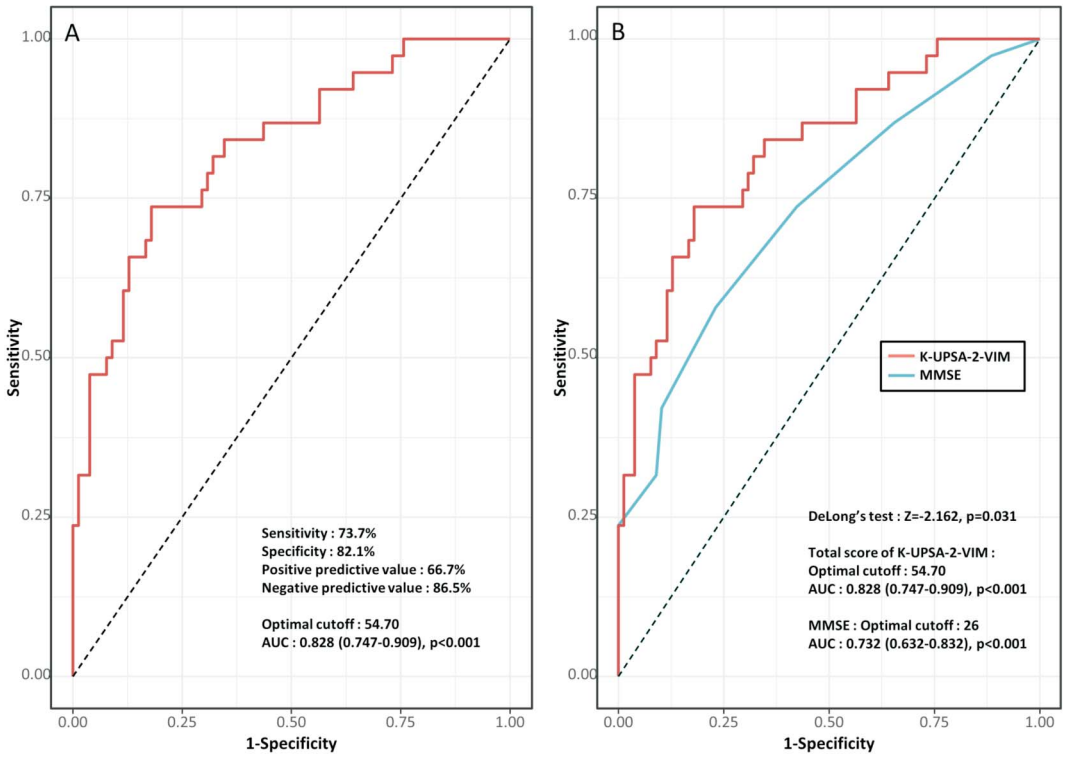

Figure 2. (A) Receiver operating characteristic (ROC) curve of the K-UPSA-2-VIM total score. (B) Comparison of ROC curves between K-UPSA-2-VIM and MMSE.

actual capacity in numerous aspects and find "at-risk" individuals with asymptomatic cognitive disease. Similarly, K-UPSA-2-VIM can be used clinically for patients for whom evaluating instrumental ADL with conventional methods is difficult and may provide objective insight into legal situations, especially those involving legal disputes between the proxy.

In conclusion, the K-UPSA-2-VIM may be useful for evaluating performance-based "real-world" functional assessment and the decision-making capacity when objective information is lacking. Considering the possibility that K-UPSA-2-VIM can detect subjects vulnerable to decreased functional capacity, it may prove useful in clinical and legal practice. To conduct a functional assessment in an actual legal environment, future research, including more patients with major NCD, is required.

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Disclosure statement

The authors declare no potential conflicts of interest.

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