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The Korean Repeatable Battery for the Assessment of Neuropsychological Status-Update : Psychiatric and Neurosurgery Patient Sample Validity

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Objective : This study aimed to validate the Korean version of the Repeatable Battery for the Assessment of Neuropsychological Status Update (K-RBANS).

Methods : We performed a retrospective analysis of 283 psychiatric and neurosurgery patients. To investigate the convergent validity of the K-RBANS, correlation analyses were performed for other intelligence and neuropsychological test results. Confirmatory factor analysis was used to test a series of alternative plausible models of the K-RBANS. To analyze the various capabilities of the K-RBANS, we compared the area under the receiver operating characteristic (ROC) curves (AUC).

Results : Significant correlations were observed, confirming the convergent validity of the K-RBANS among the Total Scale Index (TSI) and indices of the K-RBANS and indices of intelligence (r=0.47–0.81; p<0.001) and other neuropsychological tests at moderate and above significance (r=0.41–0.63; p<0.001). Additionally, the results testing the construct validity of the K-RBANS showed that the second-order factor structure model (model 2, similar to an original factor structure of RBANS), which includes a first-order factor comprising five index scores (immediate memory, visuospatial capacity, language, attention, delayed memory) and one higher-order factor (TSI), was statistically acceptable. The comparative fit index (CFI) (CFI, 0.949) values and the goodness of fit index (GFI) (GFI, 0.942) values higher than 0.90 indicated an excellent fit. The root mean squared error of approximation (RMSEA) (RMSEA, 0.082) was considered an acceptable fit. Additionally, the factor structure of model 2 was found to be better and more valid than the other model in χ^2 values ($\Delta\chi^2$=7.69, p<0.05). In the ROC analysis, the AUCs of the TSI and five indices were 0.716–0.837, and the AUC of TSI (AUC, 0.837; 95% confidence interval, 0.760–0.896) was higher than the AUCs of the other indices. The sensitivity and specificity of TSI were 77.66% and 78.12%, respectively.

Conclusion : The overall results of this study suggest that the K-RBANS may be used as a valid tool for the brief screening of neuropsychological patients in Korea.

Key Words : K-RBANS · Convergent validity · Construct validity.

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INTRODUCTION

The purpose of a neuropsychological assessment or examination varies for several reasons including the following : the passage of time (the course of disease), the judgment of a doctor, the patient's needs, and the requirements of research for medical advancement. Considering these purposes, although the contribution of neuropsychological assessment to patient care and treatment and to understanding behavioral phenomena and brain function has increased, its use as a diagnostic tool has decreased. This is possibly attributed in part to the development of highly sensitive and reliable noninvasive neurodiagnostic techniques[22].

Considering the shift of usefulness of neuropsychological assessment in diagnostic process, the requirement for comprehensive batteries developed for neuropsychological assessment has decreased, except for forensic or other required settings[18]. Furthermore, for geriatric patients or patients with severe brain damage, the performance of a comprehensive neuropsychological assessment process is considered a significantly difficult task that requires a considerable amount of time and effort[32]. Patients with primary brain tumor (PBT) are also less likely to withstand the comprehensive neuropsychological assessment, which typically takes 6 to 7 hours. Furthermore, most cancer centers are housed in academic medical centers and other integrated care settings where brief neuropsychological evaluations are mandatory because of space, time, and billing limitations[23]. Conversely, tests such as the Mini-Mental State Examination (MMSE)[8] or the Dementia Rating Scale[25] that screen for dementia or other mild cognitive impairments (MCIs) are not adequately sensitive. Although dementia or cognitive impairment can be easily assessed, tests that cover a wide range of cognitive functions and satisfy the parameters that reevaluate changes in the patient's condition are required[32].

These challenges were already relatively identified in the previous years. To overcome these challenges, various neuropsychological evaluation tools have been developed and distributed in Korea[16,20,21]. These neuropsychological tests that are currently developed and used in Korea are considered sufficient for diagnosing dementia, but confirming whether these tests can be used to adequately screen dementia while including various other cognitive domains is considered difficult. Another limitation of the adapted or standardized comprehensive neuropsychological assessment battery or screening tests for Koreans is the age limitation for the administration or interpretation of these tests. Almost all neuropsychological tests have been standardized to be used by adults or geriatric individuals only, which is different from an intelligence test than can be administered to adults. Moreover, these neuropsychological tests could not be administered to adolescents or young adult patients with neurosurgical and neurological impairments.

Considering these, researchers recognize the need to establish and develop neuropsychological tests to compensate these limitations. Hence, several neuropsychological tests were screened and selected based on the following criteria : the test can be performed in a short but sufficient time so that critically ill or elderly patients with relatively few age restrictions should not be burdened, and similar to the comprehensive test, the test should include each cognitive domain and should measure the overall level of cognitive ability, such as the intelligence quotient. Finally, repeatable measurements were recommended. Hence, the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) was adapted, and the RBANS is possibly considered when assessing cognitive impairment and evaluating the neuropsychological status of liver disease patients with minimal hepatic encephalopathy according to the International Society for Hepatic Encephalopathy and Nitrogen Metabolism[31]. This assessment tool showed supportive evidence for utility as a brief but comprehensive assessment tool that assessed the cognitive functioning of PBT patients[23].

The RBANS was initially designed as a screening tool for the assessment of dementia[32]. However, since its inception, it has gained popularity for use in patients diagnosed with neuropsychological disorders considering its several advantages. These advantages include the following : short administration time, co-normed index scores, inclusion of a summary score, and availability of four alternate forms[26]. These advantages allow the standardization and use of this assessment tool in several countries with various languages[5,6,33,37]. However, Korea has adapted this assessment tool relatively late, and several study results have already reported that the factor structure suggested by the original version does not match the composition of the index scores[35]. In the adaptation of the RBANS original version to the Korean version, verifying the Korean version of the Repeatable Battery for the Assessment of Neuropsychological Status Update (K-RBANS) psychometric values and comparing these values with the theoretical index scores are considered essential for the proper use of this tool. In this study, we corrected the data from various patients and age ranges. That is, we assumed that the limited sampling of patient data showed the characteristic of sampling bias more than the characteristic of the original test and in the adaptation process of the psychological or neuropsychological test. Thus, this study aimed to verify the construct and convergent validity of the K-RBANS.

MATERIALS AND METHODS

The study protocol was approved by the Institutional Review Board (IRB) of Yeungnam University Hospital (IRB No. YUMC 2015-08-106).

Patients

The study participants were individuals who visited the psychiatric or neurosurgery department at a university hospital in the Republic of Korea from October 2015 to May 2018. They were referred for neuropsychological assessment because of cognitive impairment. Patients excluded from recruitment included cases where severe medical needs were directly related to cognitive impairment requiring hospitalization and outpatient care, where problem behavior was persistent and severe requiring frequent visits or hospitalization, or where a medical approach was required because of the rapid deterioration of cognitive impairment. Moreover, patients who had acute delirium that required treatment (when there is evidence of delirium, chaos, or other unconsciousness) and patients with internal medicine disorders/comorbidities that can result in severe cognitive decline, such as using medications that can seriously affect cognitive function, were also excluded from recruitment.

Procedure

The data of the participants were recruited by a neurosurgeon and a psychiatrist based on the inclusion and exclusion criteria, and nine (3.66%) incomplete tests results were excluded. Orders of neuropsychological test administration were counterbalanced according to the order of visit, and all neuropsychological tests were administrated or rated by a psychiatrist and a certified clinical psychologist with standardized instructions and procedures for each test including the K-RBANS. Additionally, an intra-correlation coefficient among the assistant researchers was verified in the K-RBANS standardization study[19].

Materials

The K-RBANS[19,29,30] : the RBANS comprises 12 subtests, five indexes and Total Scale Index (TSI) that can be administered by trained examiners in approximately 20 to 30 minutes. The immediate memory composed of list learning and story memory subtests measures the examinee's ability to remember information immediately after it has been presented. The visuospatial/constructional index composed of the figure copy and line orientation subtests indicates the examinee's ability to perceive spatial relations and to construct a spatially accurate copy of a drawing. The language score composed of the picture naming and semantic fluency subtests indicates the examinee's ability to respond verbally to either naming or retrieving learned material. The attention component composed of the digit span and coding subtests indicates the examinee's capacity to remember and manipulate both visually and orally presented information from short-term memory storage. The delayed memory composed of list recall, list recognition, story recall, and figure recall subtests assesses the examinee's anterograde memory capacity. Scores from the list recall, list recognition, story recall, and figure recall contribute to this index. The TSI is calculated by summing the above five index scores. The Korean adaptation was completed and based on the assessments of 606 normal Korean subjects who participated in the norm development of the K-RBANS[19].

Korean MMSE[8,14] : the MMSE developed by Folstein et al.[8] is the most widely used instrument for measuring global cognitive performance and identifying individuals with cognitive dysfunction. The MMSE was modified and translated into Korean by Kang et al.[14], and the resulting K-MMSE has been widely used in clinical evaluations and research involving patients with dementia in Korea. The K-MMSE incorporates a range of elements that include time orientation (5 points), spatial orientation (5 points), memory registration (3 points), attention and calculation (5 points), memory recall (3 points), language (8 points), and space-time configuration (1 point). This creates a potential total score of 30 points[16].

Clinical Dementia Rating (CDR) scale[12,28] : the CDR is obtained through semi-structured interviews of patients and caregivers. Cognitive functioning is rated in six domains of functioning: memory, orientation, judgment and problem-solving, community affairs, home and hobbies, and personal care. In the CDR, in its current expanded version, a value of 0 indicates no impairment, and 0.5 indicates questionable impairment, while the values of 1, 2, 3, 4, and 5 indicate mild, moderate, severe, profound, and terminal cognitive impairment, respectively. The information obtained in these six areas can be summed, yielding a "Sum of Boxes" score[2] with a potential scoring range of 0–30. Alternatively, with Memory as the primary component, the number of higher or lower scores among the other five cognitive domains is determined, and a prescribed algorithm is followed to identify the global CDR score.

Seoul Neuropsychological Screening Battery-II (SNSB-II)[16] : The SNSB-II evaluates five cognitive factors such as attention, language & related functions, visuospatial functions, and memory and frontal/executive functions with other indices (K-MMSE, Geriatric Depression Scale, Barthel Activities of Daily Living, and CDR). The following subtests were added to the SNSB 1st edition[15] : the vigilance test, clock drawing test, digit symbol coding, Korean-Trail Making Test-Elderly's version, and Korean-Color Word Stroop Test-60. Age, sex, and education-specific norms for each of the above tests were based on the assessment of 1067 normal Korean participants aged 45 to 90 years to determine the norm development.

Korean Wechsler Intelligence Scale-IV (K-WAIS-IV)[13,36] : The K-WAIS-IV is an individually administered intelligence test for individuals aged between 16 and 90 years. It comprises 10 core and five supplemental subtests (block design, similarities, digit span, matrix reasoning, vocabulary, arithmetic, symbol search, visual puzzles, information, coding, letter number sequencing, figure weights, comprehension, cancellation, and picture completion). It provides a subtest and six composite scores that represent intellectual functioning in specific cognitive domains (verbal comprehension index, perceptual reasoning index, working memory index, processing speed index, general ability index, and full-scale intelligence quotient [FSIQ]). The Korean adaptation of the WAIS-IV developed over time, and various validity estimates are presented in the technical and interpretive manual[13].

Statistical analyses

The data for statistical analysis in this study were obtained from different neuropsychological tests and intelligence test and heterogeneous groups, and raw scores of these test results have different statistical distribution values. Because of these statistical characteristics and for the verification of K-RBANS validities in within groups, standard scores based on age, sex, and even educational level were used for all data used in the analysis except for scores of the MMSE and CDR.

The data were analyzed using the International Business Machines Corporation (IBM Corp., Armonk, NY, USA) Statistical Package for the Social Sciences Statistics for Windows version 25.0 (IBM Corp.) and Amos version 25.0 (IBM Corp.)[1]. Prior to performing the analyses, the data were screened for missing or uncompleted test results because of a test failure in a subtest or sub-indices. In all tests, statistical significance was defined as a p value <0.05.

For convergent validity verification, correlational analyses were used among the index scores of the K-RBANS, K-WIAS-IV, SNSB-II, and MMSE total score. A confirmatory factor analysis (CFA) with the maximum-likelihood procedure was used to test a series of alternative plausible models of the K-RBANS. The CFA has been used to test statistically whether a hypothesized linkage pattern between the observed variables and their underlying latent constructs actually exists. It was selected because it not only enables specific hypothesis testing but also determines a priori the structure of the instrument as theoretically designed[3,4].

To verify the respective abilities of the K-RBANS to diagnose dementia, we compared the area under the receiver operating characteristic (ROC) curves (AUCs). ROC analysis was performed to confirm the optimal cutoff points, sensitivity, and specificity of the K-RBANS. This method was used to verify how well it distinguishes between having or not having a particular condition. Sensitivity refers to how extensively a particular state can be found, while specificity refers to how competently a person can be classified who is not in a particular state. To determine the cutoff points of a test, it is reasonable to select the value that has high sensitivity and specificity. To this end, we used the ROC curve that graphically represented the false-positive rate (X-axis) and the actual positive rate (Y-axis) for different possible cutoff points. The accuracy of the test can be determined by the AUC. It is considered to be a complete inspection tool if the AUC is 1, whereas 0.5 in-

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dicates it is a useless tool[34]. The data of 126 participants who completed the K-MMSE and CDR were classified into two groups based on the K-MMSE score of 26 and the CDR score of 0.5. The data of 32 participants were classified to the suspecting-a-cognitive-impairment group (dementia), and the data were analyzed using MedCalc software version 19.1.5 (Ostend, Belgium; http://www.medcalc.org; 2020).

RESULTS

Demographic and clinical characteristics

Of the 283 participants, 56.5% were male, with an average age of 50.52±21.58 years and 10.05±4.43 years of education. In the diagnostic classification of the participants, 63.3% (n=179) participants were patients with neurocognitive disorders, and 36.7% (n=104) were psychiatric patients with suspected cognitive impairment (Table 1).

Convergent validity : association of other clinical measures

Table 2 shows that correlations among the TSI and five indices (immediate memory, visuospatial capacity, language, attention, delayed memory) of the K-RBANS, and the FSIQ and index scores (Verbal Comprehension Index, Perceptual Reasoning Index, Working Memory Index, Processing Speed Index) of the K-WAIS-IV are at moderate and above significance (p<0.001). Specifically, the correlation between the TSI and the FSIQ was the highest (r=0.81) with a significance of p<0.001.

Moreover, Table 3 shows that correlations among the TSI and five indices of the K-RBANS and K-MMSE, and the five indices of the SNSB (attention, language, visuospatial function, memory, and frontal/executive function) showed moderate and above significance (p<0.001).

Factor structure of the K-RBANS

A CFA was performed to verify the factor structure of the K-RBANS. In this study, according to the results of a prior study, the RBANS comprised hierarchical structures. The model's goodness of fit was examined by constructing a hierarchical second-factor model secondary to the K-RBANS with five indices (immediate memory, visuospatial capacity, language, attention, and delayed memory).

Table 1. Demographic and clinical characteristics of 283 participants

Characteristic	Value
Age (years)	
16–39	91 (32.2)
40–49	30 (10.6)
50–59	53 (19.1)
≥60	109 (32.9)
Mean	50.5±21.6
Gender	
Male	160 (56.5)
Female	123 (43.5)
Education	
≤6	73 (25.8)
>6 and ≤12	134 (47.3)
>12	76 (26.9)
Mean	10.1±4.4
Diagnostic classification	
Neurocognitive disorders	179 (63.3)
Major or mild neurocognitive disorder due to Alzheimer's disease	24 (8.5)
Major or mild vascular neurocognitive disorder	28 (9.9)
Major or mild neurocognitive disorder due to traumatic brain injury	119 (42.0)
Major or mild neurocognitive disorder due to another medical condition	6 (2.1)
Major or mild neurocognitive disorder due to multiple etiologies	2 (0.7)
Unspecified neurocognitive disorder	0 (0.0)
Non-neurocognitive disorders	104 (36.7)
Anxiety disorders	12 (4.2)
Bipolar and related disorders	4 (1.4)
Depressive disorders	40 (14.1)
Neurodevelopmental disorders	12 (4.2)
Other mental disorders	36 (12.7)

Values are presented as mean±standard deviation or number (%)

The delayed memory index originally comprised list recall, list recognition, delayed recall, and figure recall subtests. However, several studies have shown that the factor structure is more stable when it comprises a delayed memory index with list recognition and a sum of the recall scores (by summing up all recall subtests as a single variable), (the sum of recall) rather than associating the delayed memory index with the four subtests.

Therefore, in this study, we compared the goodness of fit of model 1, which used 12 subtest scores for assuming the factor structure of the K-RBANS, and model 2 confirmed that the factor structure of the K-RBANS was constructed of 10 subtest scores by converting 3 recall subtests of the delayed memory index into one variable.

The goodness of fit of the two models was tested using Amos (ver. 25.0; IBM Corp.). Whereas the goodness of fit of model 1 was unacceptable (standardized root mean square residual [sRMR], 0.062; goodness of fit index [GFI], 0.876; comparative fit index [CFI], 0.877; root mean squared error of approximation [RMSEA], 0.115), model 2 was valid (sRMR, 0.042; GFI, 0.942; CFI, 0.949; RMSEA, 0.082). In model 2, the CFI values of 0.90 or higher indicated a good fit, and the GFI values greater than 0.90 indicated an excellent fit. The RMSEA values of 0.05 or less are indicative of a good fit. Values up to 0.08 can indicate fair or reasonable errors of approximation, and values between 0.08 and 0.10 indicate a mediocre fit. Regarding the RMSEA, smaller sRMR values reflect good model fit. sRMR values of 0.05 or less are indicative of a close fit, whereas values of 0.08 are considered an acceptable fit[11]. Additionally, the two models show statistically significant differences in χ^2 values ($\Delta\chi^2$= 7.69, p<0.05), and the factor structure of model 2 was found to be better and more valid than model 1. A detailed description is provided in Table 4 and Fig. 1.

Table 2. Correlation coefficients between K-RBANS and K-WAIS-IV among 157 participants

K-RBANS indix	K-WAIS-IV				
	VCI	PRI	WMI	PSI	FSIQ
Immediate memory	0.66	0.53	0.66	0.54	0.67
Visuospatial capacity	0.57	0.59	0.60	0.52	0.65
Language	0.75	0.65	0.66	0.58	0.74
Attention	0.66	0.66	0.77	0.71	0.77
Delayed memory	0.47	0.49	0.53	0.62	0.60
Total scale	0.72	0.67	0.74	0.69	0.81

Presented numbers are Spearman's coefficients. All correlations are significant at p<0.001. K-RBANS : the Korean version of the Repeatable Battery for the Assessment of Neuropsychological Status Update, K-WAIS-IV : Korean Wechsler Intelligence Scale-IV, VCI : verbal comprehension index, PRI : perceptual reasoning index, WMI : working memory index, PSI : processing speed index, FSIQ : full scale intelligence quotient

Receiver operating characteristic analysis for suspected cognitive impairment

In the ROC analysis using the MMSE score of 26 and the CDR score of 0.5 of the TSI and the five indices (immediate memory, visuospatial capacity, language, attention, delayed memory) of the K-RBANS among 126 patients, the AUCs of the TSI and five indices were 0.716–0.837. The AUC of TSI (AUC, 0.837; 95% confidence interval [CI], 0.760–0.896) was higher than the AUCs of the other indices. The sensitivity and specificity of TSI were 77.66% and 78.12%, respectively. A detailed description is provided in Table 5 and Fig. 2.

DISCUSSION

The field of test translation and adaptation methodology has advanced rapidly in the past 25 years. These advancements have been necessary because of the growing interest in cross-cultural psychology, large-scale international comparative studies of educational achievement, credentialing exams being

Table 3. Correlation coefficients between K-RBANS and K-MMSE & SNSB-II among 126 participants

K-RBANS index	K-MMSE	SNSB-II				
		Attention	Language	Visuospatial function	Memory	Frontal/executive function
Immediate memory	0.51	0.54	0.52	0.45	0.55	0.49
Visuospatial capacity	0.51	0.42	0.45	0.46	0.44	0.48
Language	0.55	0.52	0.63	0.52	0.55	0.51
Attention	0.42	0.63	0.46	0.37	0.44	0.46
Delayed memory	0.46	0.41	0.44	0.38	0.56	0.41
Total scale	0.60	0.60	0.60	0.54	0.61	0.57

Presented numbers are Spearman's coefficients. All correlations are significant at p<0.001. K-RBANS : the Korean version of the Repeatable Battery for the Assessment of Neuropsychological Status Update, K-MMSE : Korean Mini-Mental State Examination, SNSB-II : Seoul Neuropsychology Screening Battery-II

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used worldwide, and fairness in testing considerations by permitting candidates to choose the language in which their assessments are administered[9]. The local adaptation of psychological or neuropsychological tests with foreign languages, customs, and other ecological backgrounds can be a more difficult process than the development of new tests that simply go beyond translating and collecting normal or target sample data. Furthermore, translation of western cognitive or neuropsychological testing is only part of the adaptation process. This, on its own, can be a significantly simplistic approach to transporting a test from one language to another with no regard for educational or psychological equivalence[24].

Fortunately, different from intelligence tests such as the K-WAIS-IV[13,36] or the Kaufman Assessment Battery for Children, 2nd edition[17,27], the RBANS had relatively few challenges when examining the quality of translation, the adequacy of pictorial stimuli, and the result of a pilot study to determine whether the test instructions and items were interpreted as intended. This is possibly attributed to the goal development and purpose of the RBANS. The RBANS was developed as a stand-alone core battery for the detection and characterization of dementia in the elderly. It was intended as a neuropsy-

Table 4. Confirmatory factor analysis of K-RBANS among 283 participants

Model	χ^2	df	NC	sRMR	GFI	TLI	CFI	RMSEA (90% CI)
Model 1	232.444	49	4.744	0.062	0.876	0.834	0.877	0.115 (0.101–0.130)
Model 2	86.390	30	2.880	0.042	0.942	0.924	0.949	0.082 (0.062–0.102)

K-RBANS : the Korean version of the Repeatable Battery for the Assessment of Neuropsychological Status Update, NC : normed chi square, sRMR : standardized root mean square residual, GFI : goodness of fit index, TLI : Tucker-Lewis index, CFI : comparative fit index, RMSEA : root mean squared error of approximation, CI : confidence interval

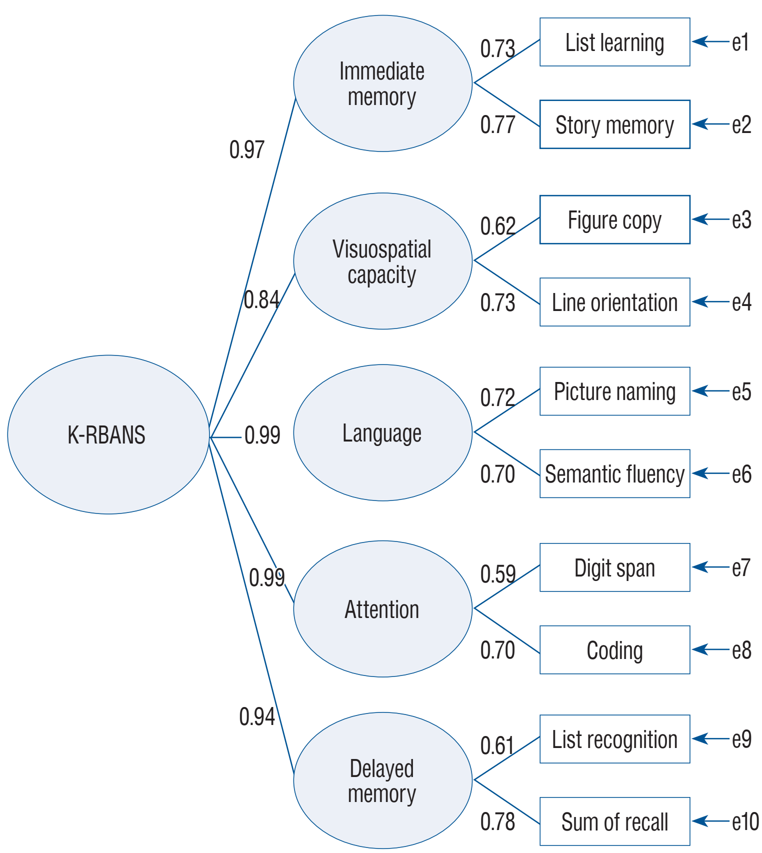

Fig. 1. Second-order factor structure of the K-RBANS among 256 participants. K-RBANS : the Korean version of the Repeatable Battery for the Assessment of Neuropsychological Status Update.

Table 5. Screening ability on the cut-off Z score (T score) of K-RBANS using K-MMSE=26 and CDR=0.5 among 126 participants

	Immediatememory	Visuospatial capacity	Language	Attention	Delayed memory	Total scale
Cutoff point (T score)	≤-1.642 (≤75)	≤-0.842 (≤87)	≤-1.529 (≤77)	≤-1.276 (≤81)	≤-2.551 (≤62)	≤-2.320 (≤65)
AUC	0.802 (0.722–0.868)	0.798 (0.717–0.864)	0.769 (0.686–0.840)	0.754 (0.669–0.826)	0.716 (0.628–0.792)	0.837 (0.760–0.896)
Sensitivity	75.53 (66.5–83.8)	71.28 (61.0–80.1)	72.34 (62.2–81.1)	69.15 (58.8–78.3)	71.28 (61.0–80.1)	77.66 (67.9–85.6)
Specificity	75.00 (56.6–88.5)	71.87 (53.3–86.3)	75.00 (56.6–88.5)	68.75 (50.0–83.9)	71.87 (53.3–86.3)	78.12 (60.0–90.7)
LR+	3.02 (1.6–5.6)	2.53 (1.4–4.5)	2.89 (1.6–5.3)	2.21 (1.3–3.8)	2.53 (1.4–4.5)	3.55 (1.8–6.9)
LR-	0.33 (0.2–0.5)	0.4 (0.0–0.6)	0.37 (0.0–0.5)	0.45 (0.0–0.7)	0.4 (0.3–0.6)	0.29 (0.2–0.4)
PPV	89.9 (82.8–94.2)	88.2 (80.8–92.9)	89.5 (82.2–94.0)	86.7 (79.3–91.7)	88.2 (80.1–92.9)	91.2 (84.3–95.3)
NPV	51.1 (41.0-61.1)	46 (36.7-55.6)	48 (38.6-57.5)	43.1 (34.1-52.6)	46 (36.7-55.6)	54.3 (43.9-64.4)

K-RBANS : the Korean version of the Repeatable Battery for the Assessment of Neuropsychological Status Update, K-MMSE : Korean Mini-Mental State Examination, CDR : clinical dementia Rating, AUC : area under the curve, LR+ : likelihood ratio positive, LR- : likelihood ratio negative, PPV : positive predictive value, NPV : negative predictive value

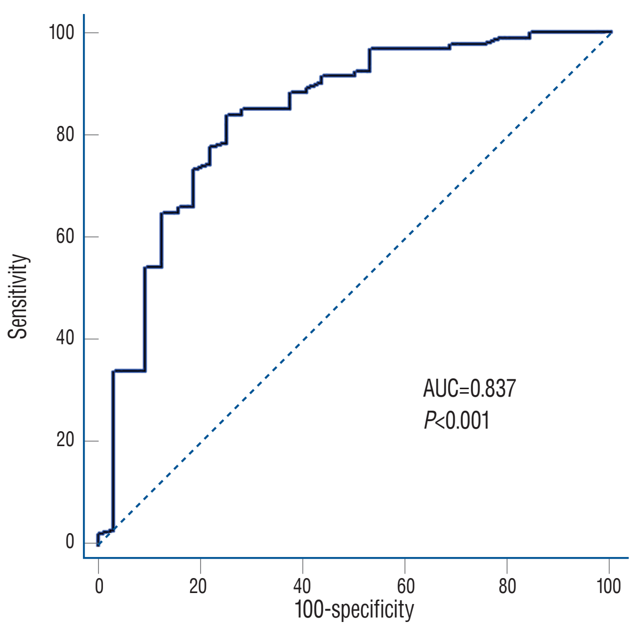

Fig. 2. The receive operating characteristic curve of the Total Scale Index in K-RBANS among 126 participants. K-RBANS : the Korean version of the Repeatable Battery for the Assessment of Neuropsychological Status Update, AUC : area under the curve.

chological screening battery for use when lengthier standardized assessments are either impracticable or inappropriate. It was also developed for repeat evaluations when an alternate form of assessment is desirable to control for content practice effects[30,32]. However, the posteriori procedures to examine differential item functioning and structural equivalence, specifically structural equivalence, were not evident in studies using the RBANS.

The RBANS comprises five sections or domains, and 12 subtests contribute to each domain. However, the original factor structure of the RBANS has received little empirical support, although at least eight alternative factor structures have been identified in the literature[35]. In this study, one study, which used CFA methods, has supported a model that is closely associated with the original factor structure of the RBANS[5]. Because that study only included the five RBANS subfactors, and not a general factor, it did not provide an exact test of the original RBANS' factor structure. Additionally, that study was performed using a Chinese translation of the RBANS, which introduced other confounding factors that might potentially make it more difficult to draw inferences regarding the original English version of the test[35]. The Japanese version of the RBANS reported only the usefulness of detecting and characterizing early dementia and is widely utilized for a neuropsychological screening battery in clinical practice throughout Japan. However, it did not report an association with the original RBANS factor structure[37].

Recently, in studies comprising elderly adults with suspected cognitive impairment[7] and Alzheimer' disease samples[10], the five-factor model demonstrated a good to excellent fit following modifications to the model. Results of chi-squared difference tests demonstrated that the five-factor model was statistically superior to the two- and three-factor models. These study results provide support for the theoretically derived five-factor structure of the RBANS in a clinical sample of elderly adults. Cautious interpretation of the RBANS index scores as five distinct cognitive domains may be required,

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particularly when there is minimal discrepancy across the performance on the tests that comprise each index[7].

Studies supporting the five-factor structure of the RBANS suggest that the proposed five distinct constructs and use of the index scores did not report a usefulness of TSI. In our study, TSI score followed the theoretical distribution compared to the K-MMSE and CDR, and the suspected cognitive impairment or MCI was classified as "Borderline" (theoretical TSI score, 70–79; empirical cutoff score using the CDR score of 0.5 only, 76 with age-corrected CI) or "Extremely Low" (theoretical TSI score, 69 and below; empirical cutoff score using the MMSE score of 26 and the CDR score of 0.5, 65 with age-corrected CI).

In conclusion, the RBANS was developed to achieve three important goals: the detection and characterization of dementia, a shortened screening method compared to that of lengthier standard assessments, and a repeatable evaluation that controlled practice effects. We attempted to achieve these goals. With these in mind, the adaptation of the Korean version of the RBANS was undertaken. When used in patients diagnosed with psychiatric and neurosurgical disorders, the psychometric value of the K-RBANS was confirmed to be satisfactory. However, this study has some limitations. First, we verified the statistical value of the K-RBANS for heterogeneous groups, but it could not be free of sampling bias when verifying the process, and it includes the inherent problems of verifying screening tools. Second, the K-RBANS is considered a repeatable evaluation that controlled practice effects, but in this study, we used an A-type K-RBANS only, and other types were not used. An equivalence study among four types of the K-RBANS for normal adults showed acceptable results and suggested correcting scores for practice effects and differences among test types. However, in this study and other standardization studies, verification studies of validity and reliability for other types of the K-RBANS including types B, C, and D were not conducted. Finally, the K-RBANS was not verified for reliable cognitive changes of patients according to time, recovery process, or rehabilitation process with other objective clinical values. To overcome these limitations of the K-RBANS, other studies were also in progress, but repeated test results using other types were interpreted with caution.

CONCLUSION

In this study, the K-RBANS secured convergence validity by showing a significant correlation with the K-WAIS-IV, K-MMSE, and SNSB. Additionally, the factor structure comprising 10 subtests by converting three recall subtests of delayed memory index into one variable was found to be valid, providing a basis for the RBANS factor structure discussed in the previous study. Finally, the ROC analysis confirmed that K-RBANS has an appropriate level of sensitivity and validity for MCI or dementia screening.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

INFORMED CONSENT

This type of study does not require informed consent.

AUTHOR CONTRIBUTIONS

Conceptualization : JOP, MSC, OLK
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Funding acquisition : JOP, OLK
Methodology : JOP, MSC, OLK
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