



Cross Validation of Attention-Deficit/Hyperactivity Disorder-After School Checklist

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Objectives: This study aimed to evaluate the efficacy of the attention-deficit/hyperactivity disorder (ADHD)-After School Checklist (ASK) by comparing the results of the Comprehensive Attention Test (CAT) and Clinical Global Impression-Severity (CGI-S) Scale and then by calculating the area under the receiver operating characteristic (ROC) curve.

Methods: We performed correlation analyses on the ASK and CAT results and then the ASK and CGI-S results. We created a ROC curve and evaluated performance on the ASK as a diagnostic tool. We then analyzed the test results of 1348 subjects (male 56.8%), including 1201 subjects in the general population and 147 ADHD subjects, aged 6–15 years, from kindergarten to middle school in Seoul and Gyeonggi province, South Korea.

Results: According to the correlation analyses, ASK scores and the Attention Quotient (AQ) of CAT scores showed a significant correlation of -0.20 – -0.29 ($p < 0.05$). The t-test between ADHD scores and CGI-S also showed a significant correlation ($t = -2.55$, $p < 0.05$). The area under the ROC curve was calculated as 0.81, indicating good efficacy of the ASK, and the cut-off score was calculated as 15.5.

Conclusion: The ASK can be used as a valid tool not only to evaluate functional impairment of ADHD children and adolescents but also to screen ADHD.

Key Words: Attention-deficit/hyperactivity disorder; Self-management; Impulsiveness; After School Checklist; Screening test.

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INTRODUCTION

Attention-deficit/hyperactivity disorder (ADHD) is a disorder marked by symptoms of inattention, hyperactivity, and impulsivity.¹⁾ Historically, the first known account of a constellation of symptoms resembling ADHD is in Shakespeare's Henry IV in 1597. In 1902, George Still reported a description of some children with psychological symptoms arising from a defective moral control. The symptoms of these children showed the greatest resemblance to the current definition of ADHD. After Still's report, the construct of ADHD has been gradually established, and since the 1960s, the explanations of ADHD have been advanced to closely resemble the current definition of ADHD.²⁾ Possible mechanisms and causes of ADHD are currently being studied, including the anatomical and biological aspects of ADHD, and growing evidence indicates that genetic and environmental influen-

es are key factors. Moreover, functional magnetic resonance imaging (fMRI) studies have been conducted to identify regional changes in brain activities in patients with ADHD.³⁾

According to the Diagnostic and Statistical Manual of Mental Disorders-5 (DSM-5) diagnostic criteria for ADHD, the core characteristics of patients with ADHD are inattention and hyperactivity-impulsivity.⁴⁾ Inattention is manifested by difficulty following through with a task, impatience, and deficits in sustained attention. Children who are hyperactive-impulsive may run around like a motor-driven ball, excessively move their body, and talk incessantly in inappropriate situations, which cause serious problems in peer relations.⁵⁾

Children with such ADHD symptoms may experience difficulties in performing in school, maintaining relationships with peers and teachers, and following rules, which may negatively affect their academic performance. Outside school, they may have conflicts with family members, a low self-management ability, and difficulty completing homework and performing extracurricular activities. It has been reported that impairment in functioning and behavioral problems

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take different forms in school and at home.⁵⁾

The number of children diagnosed with ADHD has been increasing in Korea. The rate of ADHD in adults is also increasing to the extent that certain ADHD medications for adults have been covered by insurance since September 2016.⁶⁾

A thorough assessment through objective and accurate behavioral observations is essential for evaluating and providing treatment to children and adolescents with ADHD. Several diagnostic scales that address various aspects of ADHD are currently available to help with diagnosis and assessment. Such scales may be grouped into three categories. The first category includes global rating scales developed to evaluate overall problem behavior in children, such as the Child Behavior Checklist (CBCL), Korean Personality Rating Scale for Children (KPRC), and Children's Global Assessment Scale (CGAS). The CBCL is a 119-item scale used to assess problem behaviors in children and adolescents by rating their social competence and academic performance. The Korean version of the CBCL was developed and standardized by Oh and Lee⁷⁾ and its reliability and validity have been demonstrated. The KPRC is a scale developed to screen and diagnose psychological problems among children and adolescents in Korea. It comprises 255 items and assesses verbal development, physical development, anxiety, depression, somatic concerns, delinquency, hyperactivity, psychoticism, family dysfunction, and social dysfunction.⁸⁾ The KPRC was originally developed as a parent-rated scale, and a teacher report form of the KPRC has also been developed. The CGAS is a clinician-rated assessment of general functioning among children. Although the CGAS does not address as many areas as the CBCL, it is easy to administer as a rating instrument that is widely used by clinicians.⁹⁾ Despite their effectiveness in assessing a child's general behavior problems, the aforementioned scales have limitations in that they are not specifically developed and standardized for patients with ADHD.

The second category includes scales developed to assess ADHD symptoms in children and adolescents. Conners' Rating Scale (CRS) was designed to be completed by parents and teachers to assess ADHD symptoms in children and adolescents aged between 3 years and 17 years. The parent form of the CRS contains 93 items, while the teacher form has 39 items. Short versions of the parent form and teacher form, with 48 items and 28 items, respectively, have also been developed. The reliability and validity of the Korean version of the CRS have been tested by Park et al.¹⁰⁾ The Korean version of the ADHD Rating Scale for Parents and Teachers (ADHD-RS-IV) is a screening measure based on the diagnostic criteria of the DSM-IV, containing nine items for the assessment of inattention and nine items for the assessment of hyperactivity-inattention. This scale is useful for specifying

subtypes, and the validity and reliability tests as well as the standardization of the Korean version have been conducted by So et al.¹¹⁾ Other scales that fall into this category are the Home/School Situations Questionnaire-Revision developed by Barkley, a 14-item questionnaire assessing attention problems that may arise in home or school situations,¹²⁾ and the attention-deficit disorder with hyperactivity Comprehensive Teacher's Rating Scale developed by Carlini and Parks¹³⁾ a measure for assessing attention, hyperactivity, social skills, and hostile behaviors in patients with ADHD to monitor attention prior to and after treatment. These scales evaluate a wide-range of symptoms across different settings, and they are useful for assessing the severity of general symptoms.¹⁴⁾

The third category includes scales for assessing impairment in functioning. Barkley¹²⁾ noted that symptoms of ADHD represent a "behavioral expression associated with the disorder" and described impairments as "the consequences that ensue for the individual as a result of these behavior(s)." Impairments commonly associated with ADHD include low academic performance, failure to advance grades, proclivity to drop out of school, and rejection from peers. The DSM-5 indicates that such impairments negatively affect the prognosis of ADHD and that they are an important part of treatment. A separate assessment is needed for the evaluation of impairment, as the degree of impairment does not always correspond to symptom severity. Scales available for assessing impairment in functioning include the Weiss Functional Impairment Rating Scale,¹⁵⁾ Brief Impairment Scale,¹⁶⁾ and Child and Adolescent Functional Assessment Scale.¹⁷⁾ In Korea, the Child and Adolescents Functioning Impairment Scale¹⁸⁾ was developed for the multidimensional assessment of impairments in children, and it is useful for making diagnoses, establishing treatment plans, and performing follow-up evaluations. These impairment measures, however, have long-scale lengths, making them more complicated and time consuming to complete.¹⁴⁾

ADHD is a disorder marked by difficulties in self-management due to inattention and impulsivity, and the low ability in self-management results in impairment in functioning. Thus, interventions for self-management are an important part of ADHD treatment.¹⁹⁾ Scales to evaluate the self-management ability of children and adolescents with ADHD have still been not developed for use in Korea.

Most children and adolescents in ADHD visiting clinics have parents or other family members. In general, the accompanying family member provides information on the patient's behavior in both school and home settings during the diagnosis and treatment process. Teachers' reports of children's school life are provided to clinicians through parents, who also provide direct observations of the child outside

school. Accordingly, information on a child's behavior at home that is observed and assessed by parents may be more likely to be accurate than information of a child's behavior at school.¹⁰⁾ Although the most accurate way to identify children with ADHD is an assessment from a trained clinician, a reliable assessment scale that can be easily completed by parents for evaluation of the severity of ADHD symptoms and self-management ability of their children may be useful for clinicians.

Thus, Yoo et al.²⁰⁾ developed the attention-deficit/hyperactivity disorder-After-School Checklist (ASK), a quick and easy-to-use scale that can be completed by parents to evaluate the severity of ADHD symptoms and the self-management abilities of their child. The validity and reliability of this scale have also been tested by Yoo et al.²⁰⁾ The ASK scale, however, has not been cross-analyzed with other ADHD scales, and its reference point for evaluation of the severity of ADHD symptoms has not been established. Thus, the present study aimed, first, to evaluate the clinical utility of the ASK by assessing its external validity through correlation analyses with other validated ADHD scales. Then, we attempted to determine whether the ASK may be used as a screening test of ADHD based on the characteristic behaviors displayed by children with ADHD.

METHODS

Study participants

The present study obtained and analyzed data from the development and standardization of study of the ASK.

Questionnaires were completed by 147 caregivers of children aged 6–16 years who visited outpatient psychiatric clinics located in Seoul and 1202 caregivers of children aged 6–16 years attending general kindergarten, elementary school, or middle school located in Seoul or Gyeonggi province. Of the 1358 caregivers who completed the questionnaire, 10 were excluded from the analysis owing to incomplete responses. Of the 1348 questionnaires collected, three controls per ADHD case were selected and frequency matched by age and gender, with the exception of 6-year-old girls, as the number of such girls in the control group was not large enough to meet the 1:3 ratio. Overall, data from 147 participants in the ADHD group and 439 participants in the control group were analyzed.

Children who were diagnosed with ADHD by a pediatric psychiatrist based on the DSM-5 diagnostic criteria were assigned to the ADHD group. Children with the following characteristics were excluded from the study: overall IQ score below 70 on the Wechsler Intelligence Scale; diagnosis of congenital genetic disorder, other than ADHD, or history of

acquired brain injury, such as cerebral palsy; diagnosis of seizure disorder and other neurological disorder; diagnosis of sensory impairments; diagnosis of autism spectrum disorder, schizophrenia, bipolar disorder, major depressive disorder, or psychosis; or history of taking psychiatric medication.

The present study was approved by the Institutional Review Board (IRB) of Inje University Sanggye Paik Hospital (IRB No. 2017-06-015). Participants in the control group were recruited through online and social networking services advertisements. The caregivers of children and adolescents who volunteered to participate in the study were asked to either complete the questionnaires online or fill out a paper version mailed out to them. The participants in the ADHD group were parents of children and adolescents diagnosed with ADHD who visited outpatient pediatric psychiatry clinics and agreed to participate in the study.

Assessment scales

ADHD-After School Checklist²⁰⁾

The ADHD-ASK is a quick, easy to complete assessment scale for parents to measure the inattention and self-management ability of their children. The ASK consists of 7 items, and each item is rated on a 5-point scale, which is anchored to the item. The items assessing self-management ability include the following: 1) delay in initiating a task, 2) motivation and avoidance, 3) voluntary daily life management, and 4) completion and delay in daily life management. The items assessing inattention include 1) intrusion and 2) disruption and interference. The total ASK score is the sum of the individual item score.

The ASK is useful in that it comprises 7 simple items, and detailed rating options are provided for each item, which enables the evaluator to provide consistent answers. Thus, the ASK may be used as a screening tool in large-scale studies on the general population. The 7 items are divided into study behavior and task management, level of daily life management, and impulsivity in interpersonal relationships. Parents can easily complete the questionnaire to assess the severity of ADHD symptoms and self-management ability of their child and monitor changes.

Clinical Global Impression-Severity²¹⁾

The Clinical Global Impression-Severity (CGI-S) scale is a clinician-rated instrument used to rate the severity of a patient's illness from 1, normal, not at all ill, to 7, among the most extremely ill patients, relative to the clinician's past experience with patients with the same illness. It has been reported that clinicians who are familiar with the disease of interest are able to validly evaluate the severity of the disease

using this scale.

Comprehensive Attention Test²²⁾

The Comprehensive Attention Test (CAT) is a test developed to evaluate attention in children and adolescents and is frequently used in clinical practice.

The CAT comprises 6 subtests: the visual selective attention subtest, auditory selective attention subtest, sustained attention to response subtest, flanker subtest, divided attention subtest, and spatial working memory subtest. Each subtest is measured using different methods. The visual and auditory selective attention subtests assess the ability to respond to visual and auditory stimuli, and the responder is instructed to look for a stimulus of interest among the visual and auditory stimuli presented. Sustained attention to the response subtest is designed to evaluate a person's ability to withhold impulsivity while maintaining persistent focus. This subtest assesses whether the person can inhibit a response to a target stimulus by maintaining the same response for all other stimuli presented. The flanker subtest is used to assess a person's ability to suppress responses to irrelevant stimuli of the surrounding and only pay attention to the stimulus of interest. In the flanker subtest, a number of visual stimuli are presented to the responder, and the responder is required to accurately locate certain stimulus and perform a task as instructed. The divided attention subtest is designed to assess a person's ability to simultaneously process two or more stimuli. In this subtest, audiovisual stimuli are continuously presented simultaneously, and the person's attention required to process such stimuli is measured. The spatial working memory subtest evaluates a person's ability to remember a series of stimuli in a given order by asking him or her to remember stimuli in the given or reverse order.

The results of the CAT are presented as attention quotients (AQs), which are based on age- and sex-matched normative data. The mean score of the AQ is assumed to be 100, with standard deviation (SD) of 15. In general, AQ scores below 76 (1.6 SD from the mean) are considered to indicate low attention, those between 76 and 85 (1.0–1.6 SD from the mean) are considered to indicate borderline attention, and those above 85 (within 1.0 SD from the mean) are considered to indicate normal attention.²³⁾

Procedure

Under the investigator's direction, the ASK was provided to the caregivers of school-aged children who visited an outpatient pediatric psychiatry clinic in Seoul and caregivers of children and adolescents attending kindergarten, elementary, or middle school in Seoul and Gyeonggi province.

Data analysis

SPSS for Windows (version 24.0; IBM Corp., Armonk, NY, USA) was used for the data analysis. Descriptive statistics were calculated to analyze demographic characteristics. A correlational analysis of ASK scores and scores of individual categories of the CAT was performed for the ADHD group, whereas only the ASK was completed for the control group to assess its potential as a screening test. A t-test was used to analyze the ASK scores of the ADHD group and control group. The receiver operating characteristic (ROC) curve and area under the ROC curve (AUC) were evaluated to determine the accuracy of the ASK and to establish a cut-off score for screening.

RESULTS

Demographic characteristics

The demographic characteristics of the participants are shown in Table 1 and 2. Of the 147 participants in the ADHD group, 105 were males, and 42 were females. In the 1:3 matched control group, 315 were males, and 124 were females. The mean age of the children in the ADHD group and control group was 9.63 and 9.65, respectively. The mean ASK score of the ADHD group and control group was 18.56 ± 4.64 and 13.67 ± 2.94 , respectively.

Of the 147 children in the ADHD group, 45 (30.61%) were predominantly the inattentive type, 0 were predominantly the hyperactive-impulsive type, 99 (67.35%) were a combined type, and 3 (2.04%) were an un-identified type. Accompanying psychological disorders were, in increasing order of prevalence, oppositional defiant disorder (30.61%), anxiety disorder (20.41%), tic disorder (14.97%), specific learning disorder (14.97%), and depressive disorder (12.93%). The Mann-Whitney U test showed no significant difference in the ASK scores between genders in the ADHD group, with the exception of 8-year-olds.

Correlation between ASK scores and CAT AQ values

The correlation between ASK scores and CAT AQ values is shown in Table 3. The correlation coefficients between the ASK score and the AQ value of the visual selective attention subtest and auditory selective attention subtest ranged between -0.20 and -0.26 ($p < 0.05$). The correlation coefficient between the ASK score and the sustained attention to response subtest score ranged between 0.21 and 0.27 ($p < 0.05$). The correlation coefficient of the AQ of the average response time measure and the SD of the response time measure with the ASK score was -0.28 and -0.32 ($p < 0.01$), respectively. The correlation coefficient of the ASK score with the SD of the response time measure, the omission error measure, and the

commission error measure of the flanker subtest was -0.28 ($p < 0.01$), -0.27 ($p < 0.01$), and -0.24 ($p < 0.01$), respectively. The correlation coefficient between ASK score and the omission error measure and the SD of response time measure of the divided attention subtest was -0.29 ($p < 0.01$) and -0.25 ($p < 0.05$),

respectively. No statistically significant correlation was found between the ASK score and the spatial working memory subtest.

In summary, the ASK questionnaire score was significantly correlated with five of the six subtests of the CAT, as well as

Table 1. Demographic data of study subjects

Demographic characteristics	ADHD group (n=147)	Control group (n=439)	Statistical test
Male (n, %)	105 (25.0)	315 (75.0)	$\chi^2=0.01$, $p=0.94$
Female (n, %)	42 (25.3)	124 (74.7)	
Age (years, mean \pm SD)	9.63 (2.36)	9.65 (2.35)	$t=-0.74$, $p=0.94$
ASK result (mean \pm SD)	18.56 (4.64)	13.67 (2.94)	$t=11.96$, $p=0.00$
Comorbid psychiatric disorders	n	%	
Tic disorder	22	14.97	
ODD	45	30.61	
Conduct disorder	8	5.44	
Intermittent explosive disorder	1	0.68	
Anxiety disorders	30	20.41	
Specific learning disorder	22	14.97	
Other Psychiatric disorder	0	0	

ADHD: attention-deficit/hyperactivity disorder, ASK: After School Checklist, ODD: oppositional defiant disorder, SD: standard deviation

Table 2. Numbers of study subjects by gender and age

Group	Age (years)									
	6	7	8	9	10	11	12	13	14	15
ADHD										
Male	2	19	21	20	11	7	10	6	7	2
Female	2	7	7	6	5	5	3	2	3	2
Total	4	26	28	26	16	12	13	8	10	4
Control										
Male	9	137	148	105	64	60	57	44	26	12
Female	4	87	110	97	51	60	67	26	25	13
Total	13	224	258	202	115	120	124	70	51	25
Total	17	250	286	228	131	132	137	78	61	29

ADHD: attention-deficit/hyperactivity disorder

Table 3. Correlation between ASK and CAT

Pearson correlation	Omission error	AQ	Commission error	AQ	Mean reaction time	AQ	Response time variability	AQ	d	β
Visual selective attention	0.02	-0.04	0.11	-0.12	0.15	-0.21*	0.16	-0.20*	-0.04	-0.09
Auditory selective attention	0.08	-0.08	0.14	-0.17	0.13	-0.14	0.22*	-0.26 [†]	-0.14	-0.07
Sustained attention to response	0.12	-0.14	0.10	-0.12	0.21*	-0.28 [†]	0.27 [†]	-0.32 [†]	-0.12	0.06
Flanker task	0.26 [†]	-0.27 [†]	0.21*	-0.24 [†]	0.10	-0.12	0.22*	-0.28 [†]	-0.20*	0.15
Divided attention	0.22	-0.29 [†]	-0.15	0.12	0.14	-0.21	0.20	-0.26*	-0.00	0.33 [†]
Spatial working memory	0.01	-0.06	-0.03	-0.10	-0.10	-0.16	-0.10	-0.17		

* $p < 0.05$, [†] $p < 0.01$. ASK: After School Checklist, AQ: attention quotient, CAT: comprehensive attention test, d: cohen's d, β : beta coefficients

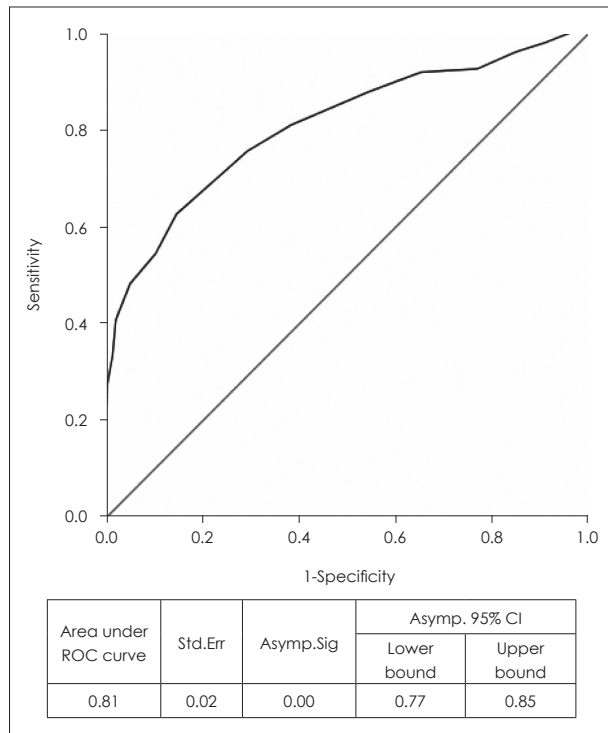


Fig. 1. ROC curve of After School Checklist. Asymp: asymptotic, CI: confidence interval, ROC: receiver operating characteristics, Sig: significance, Std.Err: standard error.

two measures of the CAT, namely, delayed response time and error measures.

Correlation between ASK scores and CGI-S ratings

The correlation between the ASK score and the CGI-S rating of the 118 children diagnosed with ADHD was analyzed. The ASK score and CGI-S rating were found to be correlated, with a Pearson coefficient of $r=0.30$ ($p=0.001$).

ROC curve of the ASK scores for the ADHD group and control group

The difference in ASK scores between the ADHD and control group was analyzed using a t-test. The ASK scores, without considering age, of the two groups showed a significant difference ($t=11.98$, $p<0.001$). A Mann-Whitney U test was performed to examine whether the difference was age specific, and the results showed significant differences between the two groups at all ages, with the exception of 6 year olds. Gender comparisons using a t-test also showed a significant difference in the ASK score between the ADHD group and control group (males: $t=9.29$, $p<0.001$, females: $t=7.79$, $p<0.001$).

To determine the clinical utility of the ASK questionnaire and establish a cut-off value, an ROC curve of all participants was generated, and the results are shown in Fig. 1. The AUC was 0.81 ($p<0.001$).

DISCUSSION

The present study aimed to evaluate the external validity of the ASK by examining its correlation with the CAT, which is widely used by clinicians to assess attention. The correlation analysis between each subtest of the CAT and the ASK score revealed that the AQ values of the selective attention (visual and auditory) subtests, flanker subtest, sustained attention to response subtest, and divided attention subtest were significantly correlated with the ASK score. As the ASK scores increased, the time it took to respond to audiovisual stimulus also increased, with the difference becoming greater with a higher score. The respondents showed more errors when given a stimulus with a flanker. The ASK score was significantly correlated with the sustained attention to response and divided attention subtests of the CAT. No statistically significant correlation was found between the ASK score and the spatial working memory subtest of the CAT, which is not categorized as an attention measure. In summary, the ASK scores were significantly correlated with all of the subtests of the CAT designed to measure attention. Our results are consistent with the findings of a previous study by Doyle et al.²⁴ which showed that performing multiple neuropsychological tests simultaneously may increase the ability to predict ADHD, but the overall diagnostic efficiency is not significantly different. Thus, the ASK questionnaire may be a good replacement of the complicated CAT test that parents can easily complete at home to evaluate the level of inattention and self-management ability of their children.

The ASK scores of the ADHD group were significantly higher than the scores of the control group. The AUC value of the ROC curve was 0.81 ($p<0.001$), which indicates that the ASK is a highly accurate assessment scale.²⁵ Considering that the AUC value of the CAT test, from a previous study, was 0.69²² and that the AUC values of other neuropsychological assessment scales currently used in clinical practice range from 0.59 to 0.61, the clinical utility of the ASK was comparable to that of other neuropsychological scales.²⁴ Thus, the ASK may be used as a screening test for ADHD in children aged between 6 years and 15 years. Using the specificity and sensitivity in the ROC curve, an ASK score of 15.5 was established as the cut-off value at the point where the AUC was 0.81. Thus, children and adolescents with an ASK score of 15.5 or greater may be assigned to an ADHD group.

Tools for assessing a child's self-management ability and inattention in interpersonal relationships are not yet widely used. The Self-control Rating Scale²⁶ is a 33-item scale assessing a child's self-control ability, and it is designed to be completed by parents and teachers. Although the validity of this scale was tested,²⁷ the lack of detailed assessment guidelines

reduces the reliability in scoring across evaluators, and its use in clinical settings is difficult. Other scales for assessing children's self-management ability, such as the Perceived Medical-Condition Self-Management Scale,²⁸⁾ have been developed. Such scales, however, comprise items designed for use with adults to assess self-management in specific medical conditions, and they are not adequate for use with children with ADHD.²⁸⁾ Scales developed to assess inattention in children include Conners' Parent/Teacher Rating Scale,¹⁰⁾ the ADHD Rating Scale,¹¹⁾ and the CBCL,⁷⁾ whereas the Barratt Impulsiveness Scale²⁹⁾ is used for adults to assess inattention and ADHD symptoms. However, the adequacy of these measures in evaluating impulsiveness in interpersonal relationships in children has not been determined.

The ASK comprises 7 simple items that can be quickly and easily completed by the evaluator. It enables parents to evaluate their children at home based on their behaviors and to check them for ADHD. Moreover, the results of the present study show that the ASK score is consistent with those of the CAT and CGI-S, two measures for evaluating the severity of inattention symptoms related to ADHD. In clinical settings, the ASK may be used to examine the effects of a given therapeutic intervention on ADHD symptoms and self-management ability by administering the ASK prior to and after such an intervention. However, self-management ability may be assessed in a wide range of settings, and the ASK, which comprises seven items, cannot give an overall assessment of the entire component of a child's self-management ability. Therefore, additional evaluations, including neuropsychological tests, and a detailed treatment plan by a clinician are needed following the ASK assessment to provide an accurate and thorough assessment of patients and to establish a treatment plan.

The present study 1) assessed the external validity of the ASK through cross-analysis with the widely used CAT and CGI-S and 2) determined whether the ASK may be used as a screening test for ADHD and established a cut-off value for its clinical use. The findings of the present study may be used as a basis for future clinical use of the ASK.

The limitations of the present study are as follows. The number of participants in the ADHD group was small, which limits the statistical power, especially for an analysis of age groups. In particular, when the control and ADHD group were frequency matched by age and gender, the number of 6-year-old girls in the control group was too small to meet the planned ratio. In addition, the participants were recruited from a primary outpatient psychiatric clinic located in Seoul, and the participants of our study may thus not constitute a representative sample of patients diagnosed with ADHD in primary, secondary, and tertiary care.

Moreover, the participants were assigned to the ADHD group based only on a clinical diagnosis, without the use of standardized, structured interview tools, such as the K-SADS-PL.³⁰⁾ In addition, the CAT was administered to the ADHD group alone to determine the concurrent validity of the ASK, while the control group only completed the ASK to assess discriminant validity. Finally, although the ASK scores were cross-analyzed with the CAT and CGI-S scores, the ASK was not compared with the ADHD-RS,¹¹⁾ which is widely used in clinical practice, or other clinical scales assessing the impulsivity dimension of ADHD.

To expand the clinical use of the ASK, the relation between the impulsivity dimension of ADHD and the ASK should be investigated in future research with a greater number of participants.

CONCLUSION

The results of this study indicate that the ASK is a cross-validated, screening tool for ADHD that may be useful in assessing self-management ability and impulsivity in interpersonal relationships in children and adolescents with ADHD.

Conflicts of Interest

The authors have no financial conflicts of interest

REFERENCES

- 1) **Castellanos FX, Tannock R.** Neuroscience of attention-deficit/hyperactivity disorder: the search for endophenotypes. *Nat Rev Neurosci* 2002;3:617-628.
- 2) **Wicks-Nelson R, Israel AC.** Abnormal child and adolescent psychology. 7th ed. Upper Saddle River, NJ: Pearson Education;2009.
- 3) **Bahn GH, Bae J, Moon S, Min J.** ADHD, new developed or newly found: historical review. *J Korean Acad Child Adolesc Psychiatry* 2011;22:57-66.
- 4) **American Psychiatric Association.** Diagnostic and statistical manual of mental disorders, 5th Edition: DSM-5. Washington, DC: American Psychiatric Publishing;2013.
- 5) **Brams M, Moon E, Pucci M, López FA.** Duration of effect of oral long-acting stimulant medications for ADHD throughout the day. *Curr Med Res Opin* 2010;26:1809-1825.
- 6) **Ministry of Health & Welfare of South Korea.** Attention deficit hyperactivity disorder, 58,121 of health insurance patients in 2013 [serial online] 2013 May 11 [cited 2017 Nov 5]. Available from URL: http://www.mohw.go.kr/react/al/sal0301vw.jsp?PAR_MENU_ID=04&MENU_ID=0403&page=1&CONT_SEQ=322261.
- 7) **Oh KJ, Lee HR.** Development of Korean version of child behavior checklist (K-CBCL). Seoul: Korean Research Foundation Report; 1990.
- 8) **Cho SM, Park HY, Kim JH, Hong CH, Hwang ST.** A standardization study of the Korean personality rating scale for children (KPRC). *Korean J Clin Psychol* 2006;25:825-848.
- 9) **Kang YS, Hong CH.** Inter-rater reliability of children's global assessment scale: focusing on children with mental retardation. *Kor J Clin Psychol* 2013;32:875-885.
- 10) **Park EH, So YK, Kim YS, Choi NK, Kim SJ, Noh JS, et al.** The reliability and validity of Korean Conners parent and teacher rating

- scale. *J Korean Acad Child Adolesc Psychiatry* 2003;14:183-196.
- 11) **So YK, Noh JS, Kim YS, Ko SG, Koh YJ.** The reliability and validity of Korean parent and teacher ADHD rating scale. *J Korean Neuropsychiatr Assoc* 2002;41:283-289.
 - 12) **Barkley RA.** Attention-deficit hyperactivity disorder: a handbook for diagnosis and treatment. 3rd ed. New York: The Guilford Press; 2006.
 - 13) **Carlini RJ, Parks TW.** ADD-H comprehensive teacher's rating scale. *J Psychoeduc Assess* 1993;11:95-97.
 - 14) **Efstratopoulou M, Janssen R, Simons J.** Agreement among physical educators, teachers and parents on children's behaviors: a multitrait-multimethod design approach. *Res Dev Disabil* 2012;33:1343-1351.
 - 15) **Gajria K, Kosinski M, Sikirica V, Huss M, Livote E, Reilly K, et al.** Psychometric validation of the Weiss functional impairment rating scale-parent report form in children and adolescents with attention-deficit/hyperactivity disorder. *Health Qual Life Outcomes* 2015;13:184.
 - 16) **Bird HR, Canino GJ, Davies M, Ramírez R, Chávez L, Duarte C, et al.** The brief impairment scale (BIS): a multidimensional scale of functional impairment for children and adolescents. *J Am Acad Child Adolesc Psychiatry* 2005;44:699-707.
 - 17) **Bates MP.** The child and adolescent functional assessment scale (CAFAS): review and current status. *Clin Child Fam Psychol Rev* 2001;4:63-84.
 - 18) **Park JH, Lee SI, Schachar RJ.** Reliability and validity of the child and adolescent functioning impairment scale in children with attention-deficit/hyperactivity disorder. *Psychiatry Investig* 2011;8:113-122.
 - 19) **Gureasko-Moore S, Dupaul GJ, White GP.** The effects of self-management in general education classrooms on the organizational skills of adolescents with ADHD. *Behav Modif* 2006;30:159-183.
 - 20) **Yoo HK, Huh H, Lee S, Jung K, Kim B.** Development of the attention deficit hyperactivity disorder-after school checklist (ASK). *J Korean Acad Child Adolesc Psychiatry* 2018;29:47-53.
 - 21) **Busner J, Targum SD.** The clinical global impressions scale: applying a research tool in clinical practice. *Psychiatry (Edgmont)* 2007;4:28-37.
 - 22) **Yoo HK, Lee J, Kang SH, Park EH, Jung J, Kim BN, et al.** Standardization of the comprehensive attention test for the Korean children and adolescents. *J Korean Acad Child Adolesc Psychiatry* 2009;20:68-75.
 - 23) **Seo JM, Lee JS, Kim SY, Kim HW.** Diagnostic significance of comprehensive attention test in children and adolescents with attention-deficit hyperactivity disorder. *J Korean Acad Child Adolesc Psychiatry* 2011;22:246-252.
 - 24) **Doyle AE, Biederman J, Seidman LJ, Weber W, Faraone SV.** Diagnostic efficiency of neuropsychological test scores for discriminating boys with and without attention deficit-hyperactivity disorder. *J Consult Clin Psychol* 2000;68:477-488.
 - 25) **Hanley JA, McNeil BJ.** The meaning and use of the area under a receiver operating characteristic (ROC) curve. *Radiology* 1982;143:29-36.
 - 26) **Kendall PC, Wilcox LE.** Self-control in children: development of a rating scale. *J Consult Clin Psychol* 1979;47:1020-1029.
 - 27) **Kim KC, Oh AR.** A cross-cultural validation study of SCRS (self-control rating scale). *J Early Child Educ* 2014;34:185-206.
 - 28) **Wallston KA, Rothman RL, Cherrington A.** Psychometric properties of the perceived diabetes self-management scale (PDSMS). *J Behav Med* 2007;30:395-401.
 - 29) **Barratt ES.** Anxiety and impulsiveness related to psychomotor efficiency. *Percept Mot Skills* 1959;9:191-198.
 - 30) **Kim YS, Cheon KA, Kim BN, Chang SA, Yoo HJ, Kim JW, et al.** The reliability and validity of Kiddie-Schedule for affective disorders and Schizophrenia-present and lifetime version-Korean version (K-SADS-PL-K). *Yonsei Med J* 2004;45:81-89.