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Is it possible to determine the level of functional impairment that distinguishes the patients with ADHD from those without ADHD?

Mahmut Cem Tarakçıoğlu[1] · Mehmet Enes Gökler[2] · Muhammed Tayyib Kadak[3] · Nursu Çakın Memik[4] · Umut Mert Aksoy[5]

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Abstract

Introduction Functional impairment in attention deficit hyperactivity disorder (ADHD) can occur in many areas such as in family, social activities, and problems related to school and may also persist during adulthood. The Weiss Functional Impairment Rating Scale-Parent Form (WFIRS-P) is designed to measure the functional impairment related to ADHD symptoms. The aim of this study was to determine the level of functional impairment that distinguishes the patients with ADHD who were diagnosed through semi-structured interviews from those without ADHD.

Method This study consists of ADHD patients who were diagnosed through semi-structured interview aged 5–18 years ($n=250$) and same age gender-matched healthy controls ($n=250$). A receiver operating characteristic (ROC) curve was constructed by calculating the sensitivity and specificity of the scale cut-off values.

Results An area under the curve (AUC) of 0.974 (95% CI 0.956–0.986) was found in this study. For WFIRS-P subdomains, AUC curves, which range from 0.76 to 0.95, were also having strong power for differentiation between groups. The optimal cut-off value for WFIRS-P using Youden's *J* Index is 0.32. There is no significant gender and age group differences in AUC for either the total or subdomain scores.

Conclusion Our findings provide that Turkish version of WFIRS-P could be a reliable way of distinguishing the level of functional impairment in ADHD from controls.

Keywords Functional impairment · Receiver operating characteristics · Attention deficit hyperactivity disorder · Youden's *J* Index

Introduction

Functional impairment is essential for identifying psychiatric disorders from transient psychological distress and planning for the management of the patient's treatment and prognosis [1]. DSM-5 requires the assessment of functional impairment (FI) in ADHD in at least two situations (e.g., at home or at school) [2]. Functional impairment in ADHD can occur in many areas, such as in families, social activities, and school-related problems, and may also persist during adulthood [1, 3–5]. In particular, the primary reason for admitting ADHD patients to psychiatric clinics was functional impairment rather than symptoms [6].

Diagnosis of ADHD can be challenging because of the differences in behavioral symptoms in different environments and changes in symptoms throughout the developmental period [7]. ADHD symptoms mostly overlap or mimic those of other psychiatric disorders [8, 9]. Beyond the symptoms, the severity of functional impairment in ADHD is critical to understand the full impact of ADHD [10, 11]. Studies on the association between ADHD symptoms and functional impairments have revealed modest correlation ranges of $r=0.16$–0.54 [5, 12–17]. Moreover, patients who meet the symptom threshold for ADHD are not always diagnosed with ADHD because of failure to meet the criteria for functional impairment [13, 18].

Although medications have been reported to be effective for symptom reduction in ADHD [10, 19], functional improvements in ADHD treatment have not been specifically evaluated in many studies [20–23]. Studies have shown that symptom reduction alone is not sufficient for remission in

✉ Mahmut Cem Tarakçıoğlu
mtarakcioglu@hotmail.com

Extended author information available on the last page of the article

ADHD [24–27]. Therefore, measuring symptoms is thought to be insufficient for diagnosis and for monitoring the effectiveness of ADHD treatment [5]. Thus, it is important to measure functional impairment as well as symptoms for monitoring treatment outcomes.

The Weiss Functional Impairment Rating Scale-Parent Form (WFIRS-P) is designed to measure functional impairment related to ADHD symptoms [28]. Several studies including non-English-speaking countries have demonstrated adequate reliability and validity scores for this scale [25–27].

There is a lack of information in the literature about the optimal WFIRS-P cut-off and minimal change scores, and only a few studies have evaluated the sensitivity and specificity of functional impairment with the use of the WFIRS-P when the treatment response includes ADHD medications. In one prior study, the change score representing the minimally important difference in functional impairment for the WFIRS-P was found to be 0.25 [29]. In another study, the WFIRS-P total mean score was found to be 0.65 for appropriately distinguishing ADHD patients from non-ADHD patients [11]. The results of this study were based on WFIRS-P scores sent by a postal survey and lacked information about the diagnosis process and clinical features of ADHD (ADHD severity, comorbidity, and treatment status). In psychiatric disorders, it is important that diagnosis is made by the psychiatrist through structured interviews. However, no study has analyzed the WFIRS-P cut-off point by using semi-structured interviews conducted by child psychiatrists. In the assessment of WFIRS-P cut-off scores, it is more reliable to diagnose ADHD through semi-structured interviews and to fulfill WFIRS-P criteria by having parents present in a psychiatric clinical setting rather than by using indirect methods such as postal surveys. Thus, the aim of this study was to determine the level of functional impairment that distinguishes the patients with ADHD who were diagnosed through semi-structured interviews from those without ADHD (healthy controls), and receiver operating characteristic (ROC) analysis was used to examine sex and age differences.

Methods

In this study, we used the data from our previous Turkish validation study of the WFIRS-P by Tarakçıoğlu et al. [26]. The case group included ADHD patients aged 5–18 years and their parents. The control group included healthy young people of the same age and gender as the ADHD sample. Ethics approval was obtained from the Kocaeli University Ethics Committee, and all parents provided written informed consent (Approval Number: 11/06.12.2012).

Selecting the ADHD group

The study group comprised children who were referred to the child psychiatry clinic for ADHD for the first time, and the study excluded children who had a psychiatric disorder other than ADHD and oppositional defiant disorder (ODD). All ADHD patients were newly diagnosed and treatment naive. The Kiddie Schedule for Affective Disorders and Schizophrenia for School-Aged Children-Present and Lifetime Version (KSADS-PL-T) was administered to the patients and one of their parents scores were given for Clinical Global Impressions-Severity Scale (CGI-S). The parents of the patients in the ADHD group completed the Turgay DSM-IV rating scale and the WFIRS-P before the clinical interview.

Selecting the control group

The participants in the control group were recruited from different schools. The Conners' parent rating scale-48 [30, 31] and the WFIRS-P was completed by their parents. The control group included those who had no history of mental or chronic physical disease in themselves or their siblings, who did not report any lesson failure or attention problems, and who received a score lower than the cut-off score on the CPRS-48 form. The control group of 250 children was formed by random sampling such that they would be similar in age and gender to the patient group.

Weiss Functional Impairment Rating Scale

This scale was developed by Dr. Weiss [8, 28] and the reliability and validity study for the Turkish version of the WFIRS-P was performed by Tarakcıoglu et al. [26]. The WFIRS-P contains 50 items spanning six functional domains (family, school and learning, life skills, child's self-concept, social activities, and risky activities). The mean scores were computed for each domain.

Kiddie Schedule for Affective Disorders and Schizophrenia for School-Aged Children-Present and Lifetime Version (KSADS-PL)

The KSADS-PL is a semi-structured interview scale that was developed by Kaufman et al. [32] to rate mental disorders in children and adolescents between 6 and 18 years of age in accordance with the DSM-III-R and DSM-IV diagnostic criteria. The scale's validity and reliability in Turkey have been tested [33].

Turgay's DSM-IV-based ADHD and disruptive behavior disorders screening scale (The T-DSM-IV-S)

The T-DSM-IV-S, developed by Turgay based on the DSM-IV diagnostic criteria, rates disruptive behavior disorders. The scale consists of 41 questions to be answered by either parents or teachers [34]. The scale was tested for validity and reliability in Turkish by Ercan et al. [35].

Conners' parent rating scale-short form (CPRS-48)

The CPRS-48 was developed for parents to rate their children's behaviors. It contains items related to hyperactivity, learning, and behavioral problems as well as psychosomatic problems and frustration. The scale contains 48 items: five on attention deficit, four on hyperactivity, four on ODD, 11 on conduct disorder, and 24 on other problems [30]. The scale has been adapted to Turkish [31].

Analysis

Statistical analyses were performed using SPSS (Version 20). The demographic characteristics of the study group were reported using descriptive statistics such as frequencies, proportions, and means ± standard deviation.

An ROC curve was constructed by calculating the sensitivity and specificity of the scale cut-off values. The area under the curve (AUC) was computed. The AUC is an effective and combined measure of sensitivity and specificity that describes the inherent validity of diagnostic tests. An AUC closer to 1 indicates better performance [36]. The optimal cut-off point was defined as the point at which the sum of sensitivity and specificity was maximal. To test for statistical significance between the AUC for gender and age group differences, DeLong's test was used, and the optimal cut-off for the WFIRS-P was determined using Youden's *J* statistic [37]. This cut-off was determined using the ROC curve for differentiating cases from controls. A significance level of $\alpha = 0.05$ (two-tailed) was applied for all *p* values.

Results

Table 1 summarizes the demographics and WFIRS-P scores. In this study, 500 participants were included, with 250 in the ADHD group and 250 in the control group. Of these, 22.8% of the participants were female in the ADHD and control groups ($p > 0.05$). The mean age of the ADHD group was 9.61 ± 2.19 years, and the mean age of the control group was 9.86 ± 2.13 years ($p > 0.05$). There was no statistically significant difference between the ADHD and control groups in terms of sociodemographic characteristics. The WFIRS-P subdomain and total scores were higher in the ADHD group than in the control group (Table 1).

Table 1 Demographic features and mean scores of WFIRS-P

	ADHD cases (*N*:250)		Controls (*N*:250)		Test statistics (X^2/Z; *p*)
Gender [*N* (%)]					
Male	193	(77.2)	193	(77.2)	0.000; 1.000*
Female	57	(22.8)	57	(22.8)	
Age years [mean, (SD)]	9.61	(2.19)	9.86	(2.13)	1.278; 0.201*
Age group					
5–12 years	227	(90.8)	222	(88.8)	0.546; 0.460*
13–18 years	23	(9.2%)	28	(11.2)	
CGI-S [*N* (%)]					
Mild	35	(14)	–		
Moderate	142	(56)	–		
Severe	73	(30)	–		
WFIRS-P					
Total	0.81	(0.40)	0.15	(0.10)	15.805; < 0.001**
Family	1.00	(0.69)	0.15	(0.16)	17.432; < 0.001**
School	0.93	(0.53)	0.10	(0.14)	16.223; < 0.001**
Life skills	1.08	(0.52)	0.30	(0.23)	10.797; < 0.001**
Child's self-concept	0.81	(0.79)	0.17	(0.29)	13.540; < 0.001**
Social activities	0.80	(0.64)	0.14	(0.19)	13.626; < 0.001**
Risky activities	0.23	(0.22)	0.03	(0.06)	18.349; < 0.001**

*X^2, p, **Mann-Whitney

SD standard deviation, *CGI-S* Clinical Global Impressions-Severity, *WFIRS P* Weiss Functional Impairment Rating Scale-Parent Form

An ROC curve was used to determine the cut-off point for WFIRS-P scores, and an AUC of 0.974 (95% CI 0.956–0.986) was found in this study (Fig. 1). This finding suggests that the WFIRS-P total score has strong power (> 0.95) in discriminating between the ADHD and control group. For the WFIRS-P subdomains, the AUC curves ranged from 0.76 to 0.95 and also had strong power in differentiating between the groups (Table 2).

To estimate the total WFIRS-P cut-off score related to maximum total sensitivity and specificity, Youden's *J* was computed. The maximum value that *J* can attain is 1 when the test is perfect, and the minimum value is usually 0 when the test has no diagnostic value [38]. The highest Youden index of the WFIRS-P was 0.86, with a corresponding cut-off point of 0.32. The sensitivity and specificity were 0.89 and 0.97, respectively (Fig. 2). Finally, according to the results, a score higher than ≥ 0.32 points for the WFIRS-P scale has predictive ability to discriminate those with ADHD from normal individuals. Additionally, there were no significant gender and age group differences in the AUC for either the total or subdomain scores (Fig. 3).

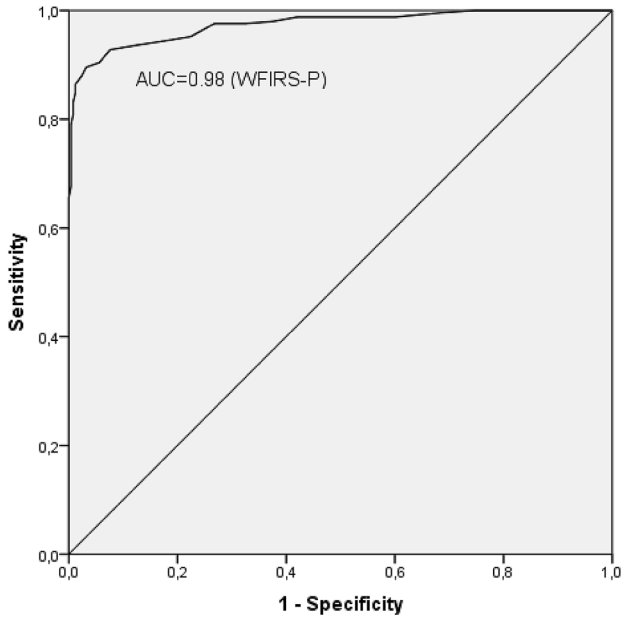

Fig. 1 ROC curve describing differentiation of ADHD/non-ADHD across WFIRS-P total scores. *AUC* area under the curve, *ROC* receiver operating characteristics, *WFIRS P* Weiss Functional Impairment Rating Scale-Parent Form

Discussion

The main purpose of the current study was to identify the cut-off score for the WFIRS-P for the discrimination of functional impairment in the ADHD group from the age- and gender-matched healthy group. Similarly, Thompson et al. [11] also previously investigated the discrimination power of the WFIRS-P. However, in contrast to that study, we examined the ability of the WFIRS-P to discriminate in terms of functional impairment between groups with and without ADHD in a different sample. Our findings revealed that the WFIRS-P total and subdomain scores could be used for the differentiation of functional impairment between ADHD and non-ADHD populations. In addition, the WFIRS-P had a similar profile with respect to gender and age.

Although it was previously reported that the WFIRS-P cut-off value was 0.65 [11], we found 0.32 to be the cut-off point for the Turkish version of the WFIRS-P. Several explanations may account for the different cut-off values between these two studies. In the study of Thompson et al. [11], the sample group consisted of patients who were reported as having ADHD by their parents via a postal survey from different Western countries, but there was no information about ADHD severity, comorbidity, or treatment status. In our study, the ADHD group of individuals who had been diagnosed for the first time consisted of a patient who had used the Kiddie-SADS assessment administered by a child and adolescent psychiatrist. Patients with ADHD who had comorbid conditions other than ODD were excluded from the study. As reported in our previous study [26],

Table 2 AUC and optimal cut-off statistics for WFIRS-P domains

WFIRS-P domain	ROC curves			Optimal threshold scores		
	AUC	95% CI	Scale score	*J*	Sensitivity	Specificity
A. Family	0.90	0.88–0.93	0.30	0.70	0.80	0.89
B. School	0.95	0.92–0.96	0.30	0.79	0.86	0.93
C. Life skills	0.91	0.89–0.94	0.60	0.74	0.80	0.93
D. Child's self-concept	0.76	0.72–0.80	0.01	0.41	0.73	0.68
E. Social activities	0.84	0.80–0.87	0.29	0.56	0.69	0.86
F. Risky activities	0.83	0.79–0.86	0.10	0.54	0.59	0.95
Total score	0.98	0.96–0.99	0.32	0.86	0.89	0.97

AUC area under the curve, *CI* confidence interval, *J* Youden's J value, *ROC* receiver operating characteristics, *WFIRS P* Weiss Functional Impairment Rating Scale-Parent Form

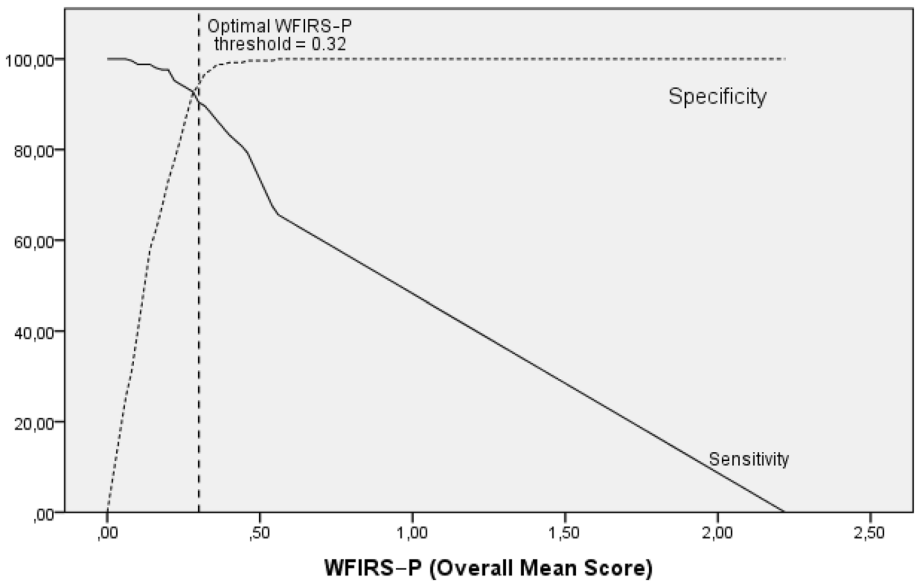

Fig. 2 Sensitivity and specificity across the range of overall WFIRS-P total scores. *WFIRS P* Weiss Functional Impairment Rating Scale-Parent Form

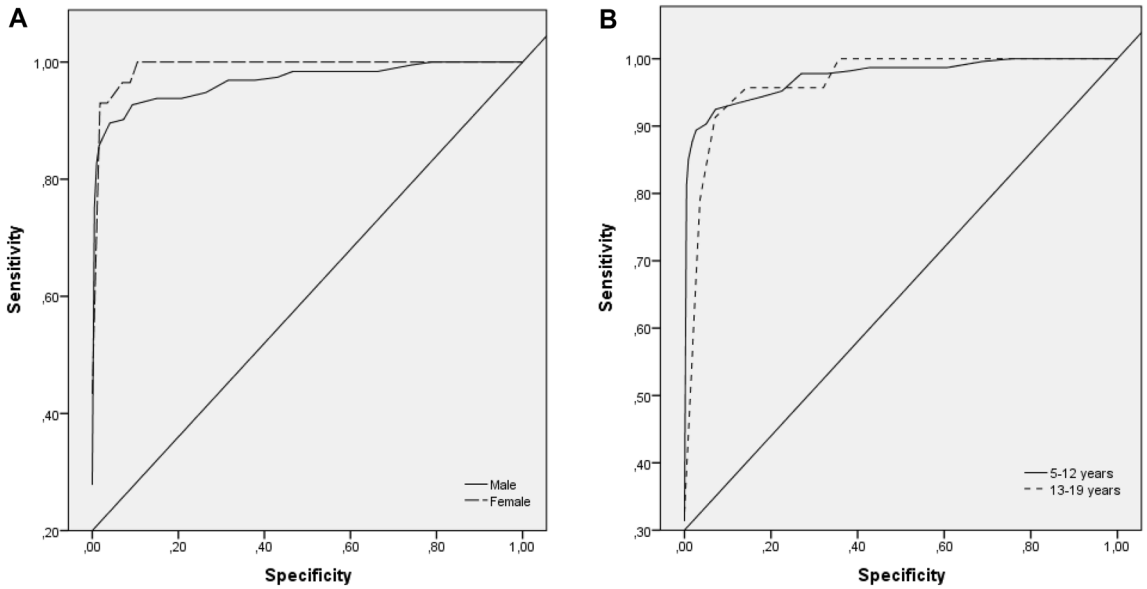

Fig. 3 ROC curves for the overall WFIRS-P total score across gender (**a**) and age group (**b**). *ROC* receiver operating characteristics, *WFIRS P* Weiss Functional Impairment Rating Scale-Parent Form

parents completed the Turgay DSM-IV Rating Scale and the WFIRS-P before the clinical interviews. Most of the ADHD patients (70%) were evaluated as having mild and moderate ADHD according to the CGI-S, and their mean age was 9.61 (Table 1). In our study, the individuals in the ADHD sample had been diagnosed for the first time, were younger, and had mild–moderate severity according to the CGI and no comorbidity. Although Thompson's study did not provide information about general functioning and symptom severity, in our study, we found a lower cut-off point for the WFIRS-P than that found in Thompson's study; this difference might be due to the individuals in our sample group, who might have less severe ADHD than the general ADHD population. As mentioned above, in our study sample, because of the exclusion of subthreshold and comorbid cases, all "gray-area" cases were eliminated by the study design. As a result, we have shown that the WFIRS-P strongly discriminates the level of functional impairment between the ADHD patients and the healthy group. Although using a cut-off score for functional impairment can be a very reliable way of distinguishing the functional impairment level of ADHD individuals from controls, factors such as the procedure for identifying both the ADHD and control samples, the severity of the sample, and the exclusion or inclusion of comorbidity can influence the

severity of functional impairment and cut-off scores. Instead, as Thompson and colleagues suggested [11], our evaluation indicates that the WFIRS-P is an useful tool for measuring functional impairment related to ADHD for clinicians prior to clinical interviews.

This study had some limitations. First, the individuals in the sample were recruited, as a single-center study could not cover the whole Turkish population; therefore, the results should be interpreted with caution. Second, the control group was not assessed with clinical or structured interviews, and ADHD was excluded by using the CPRS-48. Third, because of the high comorbidity rates associated with ADHD, the exclusion of other disorders might restrict the assessment of functional impairment related to comorbid disorders. Despite these limitations, this study suggests that the WFIRS-P can be useful for differentiating functional impairment in patients with ADHD and without ADHD.

This study investigated the threshold level of functional impairment between ADHD and non-ADHD individuals. This study showed that a mean total WFIRS-P score of 0.32 could discriminate functionally impaired patients with ADHD from controls. For clinical practice, our results suggest that total WFIRS-P scores rather than subscale scores could be a reliable way of distinguishing the level of functional impairment in ADHD from controls. Our preliminary findings support the use of the WFIRS-P as a tool for assessing functional impairment independent of age and gender. The clinical implication of our study is that the cut-off score for the WFIRS-P could be identified differently in a sample that includes treatment-naïve individuals who were diagnosed with the gold standard procedure and who did not have comorbidities. Considering that the identification of the cut-off score for the WFIRS-P is an ongoing process, different cut-off scores could be provided for different sample characteristics. Therefore, we believe that our study represents a step in this direction. Instead of focusing on the WFIRS-P cut-off value, future studies could seek to identify age- and gender-adjusted normative values in a representative ADHD group that includes comorbidity and subthreshold cases.

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Affiliations

Mahmut Cem Tarakçıoğlu[1] · Mehmet Enes Gökler[2] · Muhammed Tayyib Kadak[3] · Nursu Çakın Memik[4] · Umut Mert Aksoy[5]

Mehmet Enes Gökler
enesgokler@gmail.com

Muhammed Tayyib Kadak
tayyibkadak@gmail.com

Nursu Çakın Memik
nursucakinmemik@gmail.com

Umut Mert Aksoy
drumutmertaksoy@gmail.com

[1] Department of Child and Adolescent Psychiatry, SBU Kanuni Sultan Suleyman Education and Research Hospital, Istanbul, Turkey

[2] Department of Public Health, Yıldırım Beyazıt University, Ankara, Turkey

[3] Department of Child and Adolescent Psychiatry, Istanbul University-Cerrahpasa, Istanbul, Turkey

[4] Department of Child and Adolescent Psychiatry, Kocaeli University, Kocaeli, Turkey

[5] Department of Psychiatry, SBU Kanuni Sultan Suleyman Education and Research Hospital, Istanbul, Turkey