

Targeting Functional Impairments in the Treatment of Children and Adolescents with ADHD

Tyler Sasser¹  · Erin N. Schoenfelder¹ · Mark A. Stein¹

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Abstract The diagnostic criteria for attention-deficit hyperactivity disorder (ADHD) require both symptoms and impairment to be present. Impairment in functioning is commonly the primary reason for referral, and is also a better predictor of long-term outcomes than ADHD symptoms. And yet, only recently has research begun to examine the impact of ADHD treatments on functional impairment using efficient and psychometrically sound outcome measures. In this article, we identify several noteworthy multidimensional measures of functional impairment (ADHD FX, Barkley Functional Impairment Scale [BFIS], Impairment Rating Scale [IRS], Weiss Functional Impairment Rating Scale [WFIRS]) utilized in recent clinical trials for ADHD, and describe their psychometric properties and clinical utility. We also review existing evidence on the impact of pharmacological and behavioral treatments on different domains of functional impairment in ADHD youth as measured by these specific measures. Further research is needed to evaluate longitudinal effects of ADHD treatments on functional impairment, and the use of these measures in adaptive treatment designs.

Key Points

Measuring functional impairments in children and adolescents with ADHD is imperative for both diagnosis and treatment planning.

A recently emerging set of multidimensional measures of functional impairment related to ADHD in youth have strong psychometric properties and are sensitive to the effects of pharmacological and behavioral treatment for ADHD.

Future clinical trials using adaptive treatment designs are needed to further develop and evaluate these measures as tools for personalizing treatment.

1 Introduction

Attention-deficit hyperactivity disorder (ADHD) is among the most common psychiatric disorders, affecting 5–10% of children and adolescents [1]. The diagnosis of ADHD requires both developmentally inappropriate symptoms of inattention and/or hyperactivity and impulsivity and functional impairments in multiple settings [2, 3]. Functional domains adversely affected by ADHD include academic functioning, peer relationships, and family functioning [4]. Importantly, functional impairments, rather than symptoms, tend to be the primary reason for clinical referral [5]. Although numerous randomized controlled trials have demonstrated the robust short-term efficacy of stimulant and non-stimulant medications in reducing ADHD symptomatology [6, 7], improvements in symptoms do not necessarily yield improvements in functioning [8–11]. As a

✉ Tyler Sasser
tyler.sasser@seattlechildrens.org

¹ Department of Psychiatry and Behavioral Sciences, Seattle Children's Hospital and University of Washington School of Medicine, 4800 Sand Point Way NE, OA.5.134, Seattle, WA 98105, USA

result, more recent clinical trials have begun to include measures of functional impairment as outcomes.

Due to the wide range of constructs and measures utilized to conceptualize impairment in youth with ADHD, we have targeted the scope of this article, rather than conducting a comprehensive systematic review or meta-analysis. Our purpose is to (a) provide an overview of functional impairments commonly seen in children and adolescents with ADHD, (b) bring attention to a set of psychometrically sound measures that can efficiently assess functional impairments in ADHD in clinical and research settings, (c) briefly summarize the impact of pharmacological and behavioral treatments as observed using these specific measures, and (d) discuss implications and future directions for research.

2 ADHD and Functional Impairments

Barkley and colleagues have described functional impairments as the “real-world consequences” of the symptoms of a disorder [12]. ADHD tends to have particularly notable consequences for three domains of functioning: academic functioning, peer relationships, and family functioning [4]. In the classroom, children with ADHD complete less work, violate classroom rules more often, tend to underachieve, and may ultimately fail to graduate [13]. Socially, children with ADHD tend to be more bossy, immature, and aggressive than their peers, and have difficulty making and keeping friends [14]. The families of children with ADHD are characterized by increased family conflict, negative parenting practices, and parenting stress [15].

ADHD symptoms and functional impairments, though interrelated, are not isomorphic [16–18]. In a recent meta-analysis, Willcutt et al. [19] estimated that the correlation between ADHD symptoms and impairments ranges from $r = 0.16$ – 0.54 . Additionally, the majority of children who meet the symptom count criterion of ADHD do not demonstrate the impairment necessary for a diagnosis [17, 20]. Moreover, although it is assumed that treating symptoms will reduce impairment, the few treatment studies that explored this association suggest only a modest correspondence between symptom and impairment outcomes following treatment [8–11]. Therefore, it cannot be assumed that measuring symptoms is sufficient to diagnose and evaluate treatment for ADHD.

Evaluation of ADHD symptoms and functioning optimally includes a multi-method (e.g., interview, rating scale), multi-informant (e.g., parents, teachers), and multi-setting (e.g., home, school) approach to compare qualitative and quantitative reports and to minimize bias [21]. Importantly, rating scales are as effective as more intensive

and costly methods at determining whether impairments exceed the threshold required for diagnosis [4]. Even so, a thorough evaluation of functional impairment is critical. The modest correlation between ADHD symptoms and impairments suggests that factors beyond ADHD symptoms contribute to academic, peer, and family difficulties. Identifying the degree to which impairments are due to ADHD, as opposed to another condition (e.g., academic impairment due to a learning disorder) or psychosocial factor (e.g., family dysfunction due to inter-parental conflict), is critical for accurate diagnosis and planning and sequencing treatments.

3 Measures of Functional Impairments

In the ADHD literature, functional impairment has been measured in a variety of ways. One strategy is to measure impairment using objective indicators of real-world functioning, such as grade point average or high school graduation. Unfortunately, objective data can be cumbersome and costly to obtain, and is heavily influenced by contextual factors, which limits comparisons over time and across participants. In another approach, some structured diagnostic interviews (e.g., the Diagnostic Interview Schedule for Children [22]) ask youth or parents whether symptoms of a disorder cause impairment in school or social functioning. Despite their diagnostic utility, interviews are also costly, impractical for repeated assessments, and do not add incremental validity to more efficient approaches [4].

Impairment can also be measured by rating scales, including clinician report on global scales such as the Children’s Global Assessment Scale (C-GAS) [23, 24] or the Columbia Impairment Scale (CIS) [25, 26], and parent report on broadband multidimensional scales such as the Child and Adolescent Functional Assessment Scale (CAFAS) [27]. While global measures are efficient and sensitive to treatment effects [28, 29], measurement of symptoms and impairment may overlap, and such scales do not offer domain-specific information useful for identifying treatment targets or evaluating outcomes. On the other hand, while broadband multidimensional scales such as the CAFAS provide domain-specific information, they are often time-consuming to administer (e.g., the CAFAS has 164 items), and are not always relevant to impairments associated with ADHD.

By contrast, narrowband rating scales thoroughly assess specific domains of impairment. For instance, children’s peer relationships can be assessed using the Social Skills Rating System (SSRS) [30], or academic functioning with the Academic Competency Evaluation Scale [31]. The specificity of narrowband scales may reduce bias and enhance sensitivity to treatment effects in clinical trials.

Limitations of narrowband scales include the time and expense of administering multiple scales in order to capture several domains of impairment pertinent to ADHD. Yet another approach to measure impairment involves the use of behavior rating scales that include subscales measuring ADHD-specific impairments; for example, items on the Learning and Peer Problems subscales of the Conners 3rd Edition [32]. Although it is efficient to assess symptoms and functioning simultaneously, very brief subscales such as these may lack adequate coverage of important domains, and thus may have psychometric issues.

In summary, measures of functional impairment must be psychometrically sound and easy to administer. They must also demonstrate utility, providing rich, domain-specific information that is useful for guiding treatment and evaluating treatment effects in children and adolescents with ADHD. The remainder of this article focuses on a set of multidimensional rating scales with these attributes. To identify rating scales, searches in PubMed and PsychInfo databases were conducted including the following terms: [ADHD, attention deficit/hyperactivity disorder] AND [functional impairment, functioning] AND [measure, rating scale] AND [child, adolescent]. Original studies and review articles were examined, and reference sections were reviewed for related articles. We identified four rating scales thus far used with ADHD samples and in ADHD treatment studies that are psychometrically sound, efficient, and useful: the ADHD FX, the Barkley Functional Impairment Scale (BFIS), the Impairment Rating Scale (IRS), and the Weiss Functional Impairment Rating Scale (WFIRS). Table 1 provides a brief description of each measure, its psychometric properties, and references to ADHD treatment studies that have employed each.

3.1 ADHD-FX

The ADHD-FX is available in Spanish and English and is designed to be a culturally sensitive measure of impairments specific to ADHD [33]. The parent version (32 items) assesses the three domains of functioning most impacted by ADHD: school, peer, and home functioning. The teacher version (19 items) assesses school and peer functioning. Parents and teachers rate—without a designated time frame—the degree to which each item affects the child using a 4-point scale, ranging from 0 (never or not at all) to 3 (very often or very much), with higher scores reflecting greater impairment. The ADHD-FX provides an overall impairment score as well as subscale scores to capture specific treatment targets. The ADHD-FX demonstrates adequate internal consistency, test–retest reliability, and convergent validity with related measures [34, 35].

One concern with the ADHD-FX items is overlap with the ADHD symptoms themselves (e.g., “Doesn’t listen

and/or pay attention during class instruction”, versus “Doesn’t pay attention to, follow, and/or obey teacher instructions”). However, the association between the school subscale and other symptom scales is in the moderate to strong range [35], similar to associations of other measures of impairment with symptoms. To date, the measure has been employed as a treatment outcome measure in a small pilot of a culturally adapted parent training program for Latino youth with ADHD [36]. There is a need to evaluate the ADHD-FX in larger samples, examine convergent validity with a variety of measures of functional impairment, identify clinical cut-offs using clinical and non-clinical samples, and determine its sensitivity to change and utility as a treatment outcome measure. The ADHD-FX is available by request from the author.

3.2 Barkley Functional Impairment Scale: Children and Adolescents (BFIS)

The BFIS [37] (15 items) is a norm-referenced parent rating scale for children ages 6–17 years. An extension of 30 years of accumulated research on the Home Situations Questionnaire [38], the BFIS assesses functioning in social interactions with mother, father, and other adults, school performance, activities in the community, and completing homework. Impairment over the past 6 months is rated using a 10-point scale: 0 (not at all), 1–2 (somewhat), 3–4 (mild), 5–7 (moderate), or 8–9 (severe). Principal components analysis supports two underlying factors as indicated by two summary scores, Home–School functioning, and Community–Leisure functioning, though this limits to a degree its utility for differentiating academic versus family functioning. The BFIS has strong internal consistency, and adequate test–retest reliability [37].

Correlations between the BFIS scales and ADHD symptoms ranged from 0.56 to 0.73. Additionally, children with ADHD within the BFIS normative sample showed the greatest impairments on the measure [39], even relative to children with other developmental disorders [38]. In summary, the BFIS is easily administered and offers key advantages as a brief, norm-referenced measure assessing multiple domains of functioning that can be used in clinical and research settings. As yet, however, it has not been used as an outcome measure in ADHD treatment trials. The BFIS is available for purchase.

3.3 Impairment Rating Scale (IRS)

Developed by Fabiano et al. [40–43], the IRS is a brief parent or teacher rating scale of functional domains specific to ADHD. The parent version (7 items) assesses—without a designated time frame—the degree to which the child’s problems impact relationships with peers, relationships

Table 1 Measures of functional impairment in children and adolescents with ADHD

Impairment measure ^a	Description	Reliability	Validity	ADHD treatment studies
ADHD-FX [33–36]	Parent or teacher rates impairment on 32 items using a 4-point Likert-type scale (0 = not at all, 3 = a lot). Items average to form an overall impairment score, as well as subscale scores in the ADHD-specific domains of academic, peer, and family impairment	Support for internal consistency for overall and subscale scales (Cronbach's $\alpha = 0.89-0.95$) Support for test-retest reliability over 1–2 week period for parent-rated measure ($r = 0.77-0.91$) Support for inter-rated (parent-teacher) reliability for school and peer subdomains ($r = 0.37-0.56$)	Moderate to high correlations with ratings of ADHD and the DBD Rating Scale and other rating scales of impairment: BASC-2, Child Behavior Checklist, Teacher Report Form, Conners-3	Not established
Barkley Functional Impairment Scale (BFIS) [37–39]	Parent rates impairment on 15 items using a 10-point Likert-type scale (0 = not at all, 8–9 = severe). All items form an overall summary score, 9 items form the Home-School score, and 6 items form the Community-Leisure score	Support for internal consistency (Cronbach's $\alpha = 0.95-0.97$) Support for test-retest reliability over 3–5 week period for both items ($r = 0.56-0.89$) and summary scores ($r = 0.86-0.87$)	Moderate to high correlation with a rating scale corresponding to DSM-IV-TR criteria for ADHD Children with ADHD in normative sample showed greatest impairments on BFIS	Not established
Impairment Rating Scale (IRS) [40–43]	Parent or teacher rates impairment in multiple domains (e.g., relationships with peers and adults, academic progress) by placing an 'X' on a continuum ranging from "no problem; definitely does not need treatment or special services" (0) to "extreme problem; definitely needs treatment or special services" (6)	Support for stability over 1-year period for item and summary scores for parents ($r = 0.54-0.76$) and teachers ($r = 0.40-0.67$) Support for inter-rater (parent-teacher) reliability for item and summary scores ($r = 0.47-0.64$)	Moderate to high correlations with ratings of ADHD and DBD symptoms (e.g., DISC, DBD Rating Scale) and other ratings of impairment (e.g., C-GAS, Daily Hassles) Accurate in identifying impairment in children with ADHD	Sensitive to stimulant [44] and behavioral treatment effects for children and adolescents with ADHD [68–71]
Weiss Functional Impairment Rating Scale (WFIRS) [45–47]	Parent rates impairment on 50 items using a 4-point Likert-type scale (0 = never or not at all, 3 = very often or very much). Items are averaged to form a total score as well as six domain scores, including Family, Learning and School, Life Skills, Child's Self-Concept, Social Activities, and Risky Activities scales	Support for internal consistency (Cronbach's $\alpha > 0.80$ for all scales except Life Skills and Risky Activities, which had Cronbach's $\alpha > 0.70$) Support for test-retest reliability over 2- to 3-week period ($r = 0.73-0.89$ for all scales except Risky Activities, which had $r = 0.57$)	Low to moderate correlation with the ADHD symptoms (ADHD-RS-IV) and severity (CGI-S); stronger correlations for the Family, Learning and School, and Life Skills scales Sensitive to treatment effects	Sensitive to stimulant [49–52], non-stimulant [53–59], and behavioral [46, 72] treatment effects for children and adolescents with ADHD
Available in the public domain				

ADHD Attention-Deficit/Hyperactivity Disorder, *ADHD-RS-IV* ADHD Rating Scale-IV, *BASC-2* Behavior Assessment System for Children, Second Edition, *C-GAS* Children's Global Assessment Scale, *CGI-S* Clinician Global Impressions—Severity, *DBD* disruptive behavior disorders, *DISC* Diagnostic Interview Schedule for Children, *DSM-IV-TR* Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision

^a This table does not represent a systematic review of all measures or studies

with siblings, relationships with parents, broader family functioning, academic progress, the child's self-esteem, and overall severity of functioning and need for treatment. The teacher version (5 items) assesses the impact of the child's problems on relationships with peers, relationships with teachers, broader classroom functioning, academic progress, and the child's self-esteem. The rater places an 'X' along a line with anchors ranging from "no problem; definitely does not need treatment or special services" to "extreme problem; definitely needs treatment or special services." The line is then subdivided into seven equal parts and a numerical score from 0 ("no problem") to 6 ("extreme problem") is applied. A score of 3 or greater indicates significant impairment. Raters also provide a brief narrative description of the impairment in each domain.

The IRS has strong test–retest reliability and moderate to high inter-rater reliability between parents and teachers [41, 42]. The measure also shows good convergent validity, and discriminates between children with and without ADHD [41]. Additionally, the IRS is sensitive to both psychopharmacological and behavioral treatment effects for youth with ADHD [44]. Advantages of the IRS include opportunities for raters to indicate whether the child or adolescent "needs treatment or special services" in each domain and to provide a narrative description of the problem, which may aid treatment planning. Disadvantages include single-item measurement of each domain, which may limit specificity and present psychometric problems. The IRS is available in the public domain.

3.4 Weiss Functional Impairment Rating Scale: Parent Report (WFIRS-P)

The WFIRS-P [42] (50 items) asks parents to rate their child's functional impairment over the past month using a 4-point scale ranging from 0 (never or not at all) to 3 (very often or very much). Items are aggregated to produce a total score and six domain scores: Family, Learning and School, Life Skills, Child's Self-Concept, Social Activities, and Risky Activities. The self-report version of the WFIRS (WFIRS-S) is designed for use with older adolescents [45, 46].

The six-domain model was supported by confirmatory factor analysis [45]. The WFIRS-P scales had adequate to strong internal consistency and test–retest reliability and were modestly correlated with clinician-rated ADHD symptoms (ADHD-RS-IV) and severity (Clinical Global Impressions—Severity [CGI-S]). Furthermore, the WFIRS-P scale and summary scores have demonstrated sensitivity to change and treatment effects across numerous recent ADHD treatment studies. Additional advantages to the WFIRS-P are its availability in several languages and validation across multiple countries and samples [47]. The WFIRS-P is also available in the public domain.

4 Treatment Effects on Functional Impairments

Over the past 60 years, numerous studies have demonstrated effects of stimulant and, more recently, non-stimulant medications to reduce ADHD symptoms [6, 7]. Less is known about the short- and long-term impact of these treatments on functional impairments. Here we summarize results of recent treatment studies that have measured functional impairment, with an emphasis on stimulant, non-stimulant, and behavioral treatments for ADHD that have included the previously discussed rating scales. To identify relevant treatment studies, searches were conducted in PubMed and PsychInfo using the following terms: [ADHD-FX, Barkley Functional Impairment Scale, BFIS, Impairment Rating Scale, IRS, Weiss Functional Impairment Rating Scale, WFIRS] AND [ADHD, attention deficit/hyperactivity disorder] AND [stimulant, pharmacotherapy, medication, behavioral, psychosocial, treatment, trial] AND [child, adolescent]. We examined original studies and again consulted reference sections for related papers. We selected key studies that illustrate and add to the knowledge base of ADHD treatment effects on these measures of functional impairment.

4.1 Stimulant Effects

Two landmark trials examined the impact of stimulants on functional impairments using global and narrowband measures. In the Multimodal Treatment of ADHD (MTA) study ($n = 579$ children; ages 7–9 years), children treated with methylphenidate (IR-MPH) or a combination treatment (IR-MPH + behavioral treatment) displayed improvements relative to community care on social skills using the SSRS at the end of the 14-month treatment [48], and on global impairment using the CIS at the 14-month follow-up [28]. Similarly, in an open-label continuation of the Preschoolers with ADHD Treatment Study ($n = 165$ children; ages 3–5 years) [45], 140 of the original participants entered a 10-month maintenance phase with intensive medication management (IR-MPH) [29]. At the end of the open-label trial, children displayed significant improvement in global functioning as measured by the clinician C-GAS, and social functioning using the SSRS.

Recent stimulant trials have adopted the WFIRS-P to measure functional impairment outcomes. Stein and colleagues [49] conducted an 8-week, double-blind, placebo-controlled study with weekly switches ($n = 56$; ages 9–17 years), using a two-period dose-response design comparing extended-release dexamethylphenidate (ER-d-MPH) and extended-release mixed amphetamine salts (ER-MAS). Both stimulants resulted in a significant linear effect of dose on the WFIRS-P total score, and on the Family, Learning and School, Social Activities, and Risk Taking

subscales, but not on Life Skills or Self-Concept. Similarly, in a large, 7-week, randomized, double-blind, placebo-controlled trial comparing (1) once-daily lisdexamfetamine dimesylate (LDX), (2) osmotic-release oral system methylphenidate (OROS-MPH), or (3) placebo [50], both stimulants outperformed placebo to improve the same WFIRS-P scores [51]. Across these two short-term studies, only youth receiving OROS-MPH also demonstrated improvement on the WFIRS-P Life Skills and Self-Concept subscales. Interestingly though, in a 26-week, open-label maintenance trial of LDX with the latter sample [52], participants showed significant improvement across all WFIRS-P subscale scores after an additional 8 weeks, suggesting that stimulant responders who continue with treatment may display broader improvements in functioning.

4.2 Non-Stimulant Effects

Non-stimulant medication trials have also adopted the WFIRS-P as an outcome. For guanfacine extended release (GXR), Stein and colleagues [53] examined the impact of daytime or evening administration of GXR versus placebo ($n = 333$; ages 6–12 years) in an 8-week double-blind, placebo-controlled, dose optimization trial. Both GXR administrations were associated with significant improvements on all WFIRS-P scores, again except for the Life Skills and Self-Concept subscales. Similarly, in a multinational, randomized, placebo-controlled trial comparing (1) GXR, (2) atomoxetine (ATX), and (3) placebo ($n = 338$; ages 6–17 years) [54], GXR yielded significant placebo-adjusted improvement on the WFIRS-P total score and the Learning and School, Family, and Social Activities subscale scores. In a longer-term maintenance study [55], GXR responders ($n = 316$ of 528 in original sample; ages 6–17 years) were randomized to (1) continue optimal GXR dose, or (2) placebo for a 26-week withdrawal phase. Significant GXR versus placebo effects were observed on just the WFIRS-P Learning and School subscale, but no other scores.

In contrast to the aforementioned findings, Wilens et al. [56] conducted a study with adolescents with ADHD (ages 13–17 years; $n = 314$) treated with GXR or placebo in a 13-week, randomized, double-blind trial. No group differences were found on any WFIRS-P scores, suggesting that adolescents may require longer or more intensive interventions, such as combined medication and behavioral treatment, to improve functioning, or that the WFIRS-P may be less sensitive for the adolescent age group.

Regarding ATX, a head-to-head comparison of ATX versus LDX ($n = 267$; ages 6–17 years) [57] found that both treatments yielded significant improvements on the WFIRS-P total score and all subscale scores, although

LDX-treated youth demonstrated significantly greater change from baseline to endpoint on the WFIRS-P total score and Learning and School and Social Activities subscales [58]. In the trial described previously pitting GXR and ATX against placebo [54], placebo-adjusted improvements for ATX were observed on the WFIRS-P total score and Learning and School subscales. Similarly, in a multinational, randomized, controlled, open-label trial [59], youth ($n = 398$; ages 6–16 years) were randomized to receive ATX or community care. At 6 months post-treatment, ATX outperformed standard community care on just the WFIRS-P total score and the Learning and School subscale score.

4.3 Behavioral Treatment Effects

While psychopharmacological studies commonly target ADHD symptoms as primary outcomes, behavioral treatments typically target functional impairments in family, school, and peer domains [57]. In fact, in the MTA study [61], only children who received behavioral treatment in addition to medication (i.e., combination treatment) saw significant improvements in child social skills, quality of parent–child relationships, and positive parenting practices. Several behavioral treatments are considered to be “well established” for ADHD [60, 62]. Behavioral parent training (BPT) teaches caregivers to use reinforcement and change environmental structure to improve compliance and parent–child interaction [63–65]. Behavioral classroom management (BCM) uses similar strategies to BPT to help children meet expectations in the classroom. Finally, a variety of behavioral interventions teach and reinforce youth skills to improve social functioning, self-regulation, and organization. Such programs are implemented in summer day camp settings (e.g., Summer Treatment Program) [66], after-school programs (e.g., Challenging Horizons Program [CHP]) [67], or therapy groups (e.g., Supporting Teens Academic Needs Daily [STAND] program) [68].

The IRS and WFIRS-P have been employed to measure functional impairment outcomes in recent behavioral treatment trials. With regard to BPT, a small study with fathers of children with ADHD compared standard BPT with BPT in the context of sports skills coaching [69]. Both treatments yielded improvements in father-rated IRS total score.

In terms of behavioral interventions promoting organizational and social skills, a large randomized trial of middle-school children with ADHD ($n = 326$; grades 6–8) compared (1) the CHP skills training program delivered in a group after-school format (CHP-AS) with (2) an individualized ‘mentorship’ format (CHP-M), and with (3) community care [70]. All three groups showed improved

peer relationships on the IRS. The CHP-AS group also demonstrated small but significant effects over the other conditions on parent (but not teacher) ratings of academic impairment using the IRS. A follow-up study [71] indicated that female participants and those with a higher adolescent-rated working alliance with CHP-AS counselors were more likely to respond to CHP-AS on the academic impairment scale of the IRS. Another similar training intervention for young adolescents with ADHD ($n = 36$; ages 11–15 years), the STAND program, found effects to improve organizational skills and grade point average, but did not find effects on the IRS [68]. Compared with the longer CHP trial, this small randomized trial followed participants for only 8 weeks, indicating more intervention may be needed to affect impairment or longer follow-up may be needed to detect effects.

Two recent trials examining the impact of self-regulation and social skills interventions in youth with ADHD also used the WFIRS-P. In a randomized controlled trial with adolescents with ADHD ($n = 119$ adolescents; ages 15–21 years), youth randomized to receive an intervention promoting self-regulation and planning skills outperformed the wait-list control group in improving WFIRS-P total scores, but not WFIRS-S total scores [46], highlighting the importance of multiple informants to rate functional impairment, especially for adolescents. Additionally, a small nonrandomized trial of a brief summer treatment program ($n = 33$; ages 6–12 years) yielded significant improvements for treated children on the WFIRS-P Family, Learning and School, Life Skills, Self-Concept, and Social Activities subscales, but not the Risky Activities subscale, which may not be relevant in this young age group [72].

Taken together, these studies indicate that behavioral treatments can improve numerous functional impairments, which appear to be sufficiently captured with both general and specific subscales used on the IRS and WFIRS.

4.4 Summary

The evaluation of functional impairment, in addition to symptoms, is imperative for accurately identifying ADHD, guiding treatment planning, and evaluating outcomes. We have described a recently developed set of multidimensional rating scales, the ADHD-FX, BFIS, IRS, and WFIRS-P, which efficiently measure impairments in functioning related to ADHD. These measures have adequate to good psychometric support, and some have demonstrated clinical utility and sensitivity to treatment effects. Recent trials of pharmacological and behavioral treatments for ADHD that have utilized some of these measures provide evidence about which domains are impacted by treatment as well as optimal methods for tracking functional outcomes.

On the WFIRS-P, effects have been found of stimulants, non-stimulants, and behavioral treatments on total score and Family, Learning and School, Social Activities, and Risky Behaviors subscales, which represent key outcomes for children with ADHD and appear to be sensitive to short-term treatment effects. The Life Skills and Self-Concept subscales were less consistent in demonstrating acute effects, but were sensitive to longer-term treatment effects in maintenance trials, indicating that improving these domains may require longer treatment, or perhaps improvement in other domains (e.g., Learning and School). Treatment effects using the WFIRS were less consistent in adolescent samples. Functional impairments in adolescents may be more difficult to treat, perhaps requiring a multimodal approach.

The IRS has also been adopted in several recent behavioral treatment trials. Studies using IRS average score and the academic functioning and social functioning subscales as outcomes demonstrated sensitivity to change on each. However, like the WFIRS-P, the IRS may be less sensitive to treatment effects in adolescents. Considered together, treatment studies suggest the potential for the WFIRS-P and IRS to be used as ADHD treatment targets. The ADHD-FX and BFIS also hold considerable potential for demonstrating treatment effects.

5 Implications and Future Directions

There are several implications for future research in this area. First, the degree to which these multidimensional rating scales capture functional impairment that is secondary to ADHD, as opposed to impairment that is secondary to comorbid disorders or other factors, is unclear. ADHD is often comorbid with other psychiatric disorders [73, 74]. However, we are unaware of extant multidimensional measures asking respondents to rate ADHD-specific impairments. Rather, such measures ask broadly how the child's 'behavior' or 'problems' impact functioning. Therefore, a child's elevated impairment score could be due to ADHD, or to another externalizing or internalizing problem. Determining the source of the impairment is essential for treatment planning and sequencing. For example, treating only ADHD for a child with a comorbid learning disorder would not be expected to completely mitigate academic impairment. Additional research is needed to examine the synergistic or additive impact of comorbidities on these measures of functional impairment, as well as the role of comorbidities in attenuating the impact of treatments designed for ADHD on functional impairments.

Second, there is great utility in systematically assessing functional impairment at baseline to determine treatment

targets (i.e., academic, peer, or family functioning) and develop a personalized treatment plan to target impairments (i.e., medication only, behavioral only, multi-modal treatment) [4]. Moreover, repeated measurement of functional impairment over time is necessary to monitor treatment progress, evaluate additional treatment targets, and ultimately determine whether continued treatment is needed. Clinical trials employing adaptive treatment designs are needed to develop and evaluate functional impairment rating scales for this purpose. In adaptive treatment designs, participants receive dosages or sequences of treatment over time depending on individual need and in accordance with systematic decision rules. In a compelling study, Pelham and colleagues [75] randomly assigned 146 children to receive (1) an initial low dose of behavioral treatment (8 sessions of BPT plus BCM to establish a daily behavioral report card) or (2) an initial low dose of extended-release methylphenidate (0.15 mg/kg twice daily). After 8 weeks and at each month thereafter, treatment response was evaluated using an adapted version of the IRS to assess ongoing impairment and need for additional treatment. A few interesting takeaways from this study were that classroom rule violations and school disciplinary events favored those randomized to an initial dose of behavioral treatment, and that parents were less likely to engage in behavioral treatments if their child was first randomized to an initial dose of medication. More adaptive studies of this type are needed to evaluate the use of multidimensional measures of functional impairments to personalize the sequencing and combination of ADHD treatments in order to address more than symptoms.

And finally, though several treatment studies discussed here demonstrated the sensitivity of these multidimensional measures by the metric of statistically significant improvement, quantitative improvement does not necessarily equate to a clinically meaningful change in the everyday lives of youth and their families. To assist in the interpretation of study findings, more work is needed to evaluate the convergent and, in particular, predictive validity of these measures and their subscales against objective, real-world indicators of functioning, rather than just other concurrent symptom or impairment rating scales. For instance, the IRS has been shown to account for unique variance in functioning 1 year [41] and 7 years later, whereas ADHD symptoms do not [76].

Another way to establish the meaningfulness of treatment-related change is to determine the minimal important difference (MID) of a measure. The MID of a measure is the smallest difference in score that a rater perceives as beneficial or harmful in the child or adolescent's everyday life. A recent study of the WFIRS-P estimated that the MID for change in the total score ranged from 11.31 to 13.47, a bar that can be employed in clinical and research work to

evaluate the meaningfulness of development- or treatment-related change as measured using the WFIRS-P scale [77]. Identifying indicators of meaningful change will be essential for monitoring treatment progress and personalizing treatment planning.

6 Conclusions

In summary, recent multidimensional measures of functional impairment, including the ADHD-FX, BFIS, IRS, and WFIRS are well suited to evaluate impairments commonly associated with ADHD. They each demonstrate adequate psychometric properties and there is emerging evidence suggesting sensitivity to pharmacological and behavioral treatment effects in children and adolescents with ADHD. However, these measures can have greatest utility inasmuch as they are developed to guide treatment planning and ongoing decision making. Future clinical trials adopting these measures within the context of adaptive designs are essential, and will contribute to our understanding of how to use these tools most effectively.

Compliance with Ethical Standards

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