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ARTICLE

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ABSTRACT

Objective: To analyze the psychometric properties of the Norwegian version of the Weiss Functional Impairment Rating Scale parent and self-reports (WFIRS-P and WFIRS-S) in adolescents with ADHD.

Methods: 102 clinically referred patients, of which 86% were enrolled in an ongoing RCT program (Clinical trials NCT02937142), were diagnosed with ADHD according to the Diagnostic and Statistical Manual of Mental Disorders version IV (DSM-IV). The conceptual framework of the WFIRS-P and the WFIRS-S was evaluated using confirmatory factor analysis (CFA), reliability was estimated using Cronbach's alpha, convergent and divergent validity was assessed using correlations with the Children's Global Assessment Scale (C-GAS) and the ADHD Rating Scale-IV (ADHD-RS-IV).

Results: CFA supported the original factor structure of the questionnaires, both a first-order and a second-order model revealed acceptable model fit. Internal consistency was satisfactory across domains. The parent-adolescent agreement was moderate. The correlations between the C-GAS and the total scores of the WFIRS-P and WFIRS-S were low to moderate ($r = -0.29$ to -0.38). The ADHD-RS-IV correlated moderately ($r = 0.49$) with WFIRS-P, the correlation with WFIRS-S was weak ($r = 0.28$) supporting divergent validity. In multiple regression analyses, the ADHD-RS total score was the strongest predictor of the total score in both the WFIRS questionnaires, with internalizing disorder showing an additional small contribution. Age, gender and full-scale IQ gave no additional contribution in explaining the variance.

Conclusions: The findings support the use of the Norwegian version of the WFIRS-S and the WFIRS-P in the evaluation of functional impairment in adolescents with ADHD.

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is defined as persistent developmentally age-inappropriate inattentiveness and/or hyperactivity-impulsivity [1]. It is a common neurodevelopmental disorder affecting approximately 5% of children and adolescents worldwide [2]. Comorbid conditions such as anxiety and depression disorders, oppositional defiant disorder, sleep disorder and learning disorders are common in this patient group [3,4]. The diagnosis is typically associated with underperformance in school, low self-esteem and reduced quality of life [5,6].

Even though both the DSM-5 [1] and the International Classification of Diseases (ICD-10) [7] emphasize the importance of assessing both clinical symptoms and functional impairment when diagnosing psychiatric disorders, systematic assessment of ADHD-related impairment has not yet become routine in clinical practice. When treating ADHD, the

alleviation of symptoms is typically the main focus, although functional impairment may be the primary reason for referral [8]. Research addressing impairment in ADHD has found that functional impairment may persist after medical treatment [9–11], which may leave the patient vulnerable and with unresolved problems. Knowing that impairments typically vary with age and differ among patients [12–14], we need assessment tools that describe functional impairments related to ADHD, and are sensitive to treatment effects over time.

Several questionnaires that address ADHD-related functional impairment have surfaced during the last decades. The Impairment Rating Scale (IRS) [15], the Barkley Functional Impairment scale (BFIS) [16] and the ADHD-FX [17] are all questionnaires that assess impairment from a parent's or teacher's perspective, but none of them include a collaborative patient report. We regard this as a limitation when

working with adolescents, since discrepancies have been found in the ratings of psychopathology between parents and this specific patient group [5].

The Weiss Functional Impairment Rating Scale (WFIRS) is, to our knowledge, the only questionnaire that comprises both a comprehensive parent report and a self-report for the assessment of functional impairment in adolescents with ADHD, and it is commonly used both in research and practice [18,19]. The questionnaires cover six to seven domains related to family, learning and school, work, life skills, child/adolescents' self-concept, social activities and risky activities. Both parent and self-report have been validated in multiple cultures, and are available in 19 different languages, including Norwegian [18]. The examination of factor structures in WFIRS-P using CFA has supported different model solutions. One study [20] found support for both a first-order correlated factors model with five a priori expected factors (excluding the risky activities domain, considered by the authors to be more representative of disruptive behavior), a second-order hierarchical model (including first-order factors and an overall impairment factor) as well as a bifactor model (a general factor and group factors compete equally in explaining the item variance). Other studies have presented acceptable model-fit for a six factor-model [19], and a seven-factor model with school divided into separate learning and behavior domains [21].

The above-mentioned studies have found acceptable internal reliability for all domains except for the risky activities' domain in one study [21]. Test–retest reliability have shown strong correlations between ratings across varying time assessments [19,21]. Former studies have found statistically significant, low to moderate correlations between the total and domain scores on the WFIRS-P and the ADHD-RS-IV, the C-GAS and the Pediatric Quality of Life Inventory (PedsQL)[19–21]. Tarakçioğlu with colleagues [21] found strong associations ($r > 0.6$) between the total score on the WFIRS-P and the C-GAS on the one hand and the Clinical Global Impression Severity (CGI-S) on the other hand, supporting convergent validity.

Validation studies of the WFIRS-S using CFA have confirmed a seven-factor solution [22,23], as well as strong internal consistency for the total score and acceptable to a good consistency for the different domains [22–25]. One study found low to moderate cross-informant reliability between a student sample and collateral reporters on a revised collateral version [25]. The WFIRS-S has shown a moderate correlation with the Global Assessment Functioning (GAF) and Conners Adult ADHD Rating Scale (CAARS) on most domains [22]. The WFIRS-S domains and total score have shown good discriminant ability differentiating between ADHD and non-ADHD populations. Both the WFIRS-P and the WFIRS-S have demonstrated sensitivity to treatment effects [20,26–28].

The implementation of the WFIRS-S and-WFIRS-P in our clinic and its inclusion in a randomized controlled trial (RCT) of group Cognitive Behavior Therapy (CBT) for adolescents with ADHD [29] demanded examination of the psychometric properties of the Norwegian version of the WFIRS

questionnaires. A current review of published WFIRS studies [18] includes results from child and adult populations, but none of the published validation studies to date have included clinically referred adolescents with ADHD. Our aim was thus to provide evidence for the utility of the WFIRS questionnaires in the examination and treatment of functional impairment related to ADHD in adolescence. We wished to examine the psychometric properties of the Norwegian version of the WFIRS-S and the WFIRS-P assessing construct validity, internal reliability and convergent validity. We expected an acceptable model fit for a first-order correlated factors model, with a six-factor solution in WFIRS-P and a seven-factor solution in WFIRS-S in line with the structure of the original scale and previous findings [19,22,23,30]. We also anticipated an acceptable model fit for a second-order hierarchical model, with an overall impairment factor in addition to the first-order factors, as in a previous study [20]. We further expected the internal reliability to be acceptable across domains. Cross- informant reliability between the questionnaires' corresponding total and domain-scores was expected to be low to moderate as found in previous studies [25,31]. As the WFIRS was originally developed as a measure of functional impairment related to ADHD, we anticipated a stronger association between the total and domain scores of the WFIRS-P with the total and subscale scores of the ADHD-RS-IV, than with internalizing disorder (including DSM-IV anxiety and/or depressive disorders), thus supporting discriminant validity. The association between the total score of the WFIRS-P and the C-GAS, another measure of functional impairment, was expected to be high, possibly supporting convergent validity. Furthermore, we wanted to explore the effect of age, gender and IQ in explaining the variance in the WFIRS-P and WFIRS-S total and domain scores.

Method

Participants

Totally 102 patients (14–18 years) were recruited from Child and Adolescent Psychiatric (CAP) Outpatient Clinics in Mid-Norway from April 2017 to April 2019 for this observational study. 88 patients (86%) were included in an ongoing RCT of group CBT for adolescents who still have impairing symptoms after medication [29]. In addition, we assembled questionnaires from 14 patients with ADHD of the same age, mostly from other catchment areas than the RCT study took place, but otherwise with similar characteristics. 93% of this population was medicated for ADHD, 14.3% had comorbid internalizing disorder and 7.1% had comorbid externalizing disorder. Inclusion criteria for the RCT were: a diagnosis of ADHD according to DSM-IV [32] and a CGI-S score of 3 or above (mildly ill or greater) after medical treatment [33]. The patients should use medication, but could be included in the RCT if they had tried medication with little effect or experienced intolerable side effects. The diagnostic process included information from multiple informants (patients, parents and teachers). After a first assessment of emotional and behavioral problems using the Achenbach Symptom Checklists [34], ADHD symptoms were evaluated using the

ADHD-RS-IV [35] in a parent interview. In addition, the patients were examined for ADHD symptoms and comorbid psychiatric disorders by the first and last authors, using the Kiddie Schedule for Affective Disorders and Schizophrenia for School-Aged Children -Present and Lifetime Version (Kiddie-SADS-PL) [36]. Patients with mild to moderate internalizing and comorbid externalizing disorders (other than ADHD) were included in the study. Exclusion criteria for all participants included mental retardation, severe suicidal behavior, psychotic symptoms and moderate to severe autistic disorders. IQ scores were obtained by using the Wechsler Intelligence Scales for Children (WISC-IV) [37] or Adults (WAIS-IV) [38].

Instruments

Weiss functional impairment scale

The WFIRS-S was available in Norwegian at the start of the present study (www.helsebiblioteket.no/psykisk-helse/skaringsverktoy/wfirs-s-weiss-functional-impairment-rating-scale-self-report). The last author of the present study initiated the translation of the parent version (WFIRS-P). A professional forward-backward procedure was adopted. Margaret Weiss approved the final version in June 2016. The WFIRS-P consists of 50 items divided into six domains: family, school, life skills, self-concept, social and risk. The WFIRS-S includes 69 items divided into seven domains; it includes work as a separate domain in addition to the domains mentioned above. The WFIRS-P and WFIRS-S are not parallel forms, but there are many parallel items. Each item employs a four-point Likert rating scale from zero (never or not at all) to three (very often, very much). In addition, each item can be rated as 'not applicable' by the responder if it is considered irrelevant. Mean scores were calculated, omitting items with a missing or 'not applicable' response, to produce the different domain scores and a total score. A higher score on each domain and on the total mean score indicates greater functional impairment. Clinicians can consider any domain with a mean score > 1.5, two items with a score ≥ 2, or one item with a score = 3 as impaired [30].

ADHD Rating Scale-IV

The ADHD-RS-IV [35] is an instrument intended to measure the severity of ADHD symptoms. The instrument comprises 18 items, nine of which cover inattention and nine of which are related to hyperactivity-impulsivity. Each item is rated on a four-point Likert scale, with a high score indicating a more severe problem. A total score was computed for the sum of the scores on all 18 items, and subscale scores were computed for the sum of the inattention items (Inattention subscale) and the hyperactivity-impulsivity items (Hyperactive subscale). The instrument has shown acceptable psychometric properties including inter-rater reliability, test–retest reliability, internal consistency, factor structure, convergent and divergent validity, discriminant validity, and responsiveness to treatment effects [39,40].

Children's global assessment scale (C-GAS)

The C-GAS is a general measure of functional impairment of adaptive functioning, ranging from 0 to 100 (low to high functioning). A clinician typically scores the C-GAS based on all available clinical information [41]. In a recent review of Scandinavian versions of the C-GAS [42] the authors found satisfactory evidence for convergent, discriminant, and predictive validity, as well as interrater reliability. The C-GAS has shown a good ability to differentiate between different patient groups and shown sensitivity to treatment effects [43,44].

Wechsler intelligence test for children and adults (WISC-IV/WAIS-IV)

The WISC-IV is an intelligence scale for children aged 6–16. The WAIS-IV is an intelligence scale for adolescents and adults 16 years of age and above. Both scales are considered the 'gold standard' of intelligence testing. The scales generate four index scores that individually rate verbal comprehension, perceptual reasoning, working memory and processing speed. In addition, a total IQ score (FIQ) that represents a general intellectual ability is calculated. The WISC-IV test has shown good psychometric properties with high internal consistency for the four indices and the total IQ scale. The associations between the total IQ score and the lower order indices across different age groups, have been high, the test–retest reliability coefficients high to medium. CFA has shown good model-fit for the four factors, as well as a higher-order overall IQ factor [37,45]. The WISC-IV total IQ score has shown good convergent validity with other measures of intelligence (WISC-III, Wechsler Abbreviated Scale of Intelligence [WASI]) [37]. CFA analyses have also confirmed a good model fit for the factor structure of the WAIS-IV, internal reliability has been acceptable to excellent, and the construct validity is supported, with strong associations with another measure of intellectual ability (WAIS-III) [38]. The total IQ score (FIQ) was used in the present study.

Procedure

All participants included in the RCT provided informed consent and completed the WFIRS-S at the CAP clinic. The non-RCT participants received a document explaining the purpose of the WFIRS-study. These participants responded to the WFIRS questionnaire anonymously on a visit with their clinician. The data were sent to the last author without an identifiable id. One of the parents, most frequently the biological mother (72%), completed the WFIRS-P simultaneously. All questionnaires were completed prior to CBT treatment. The C-GAS was scored by experienced clinicians for the non-RCT patients, and by the first and last authors for the RCT group. The study was conducted according to the principles set forth in the Declaration of Helsinki.

Statistical analyses

Spearman correlation coefficients were used to measure the relationships between the WFIRS-P and WFIRS-S domain scores with each other and with the total scores (internal validity), as well as in the analyses of cross-informant reliability and convergent validity. Spearman correlations were used because the variables were non-normally distributed. Normality of the data was evaluated by visual inspection of QQ-plots. We regard correlation coefficients between 0.10 and 0.29 as low, correlations between 0.30 and 0.49 as moderate, and correlations of 0.50 and above as high [46]. Raw scores on the WFIRS were converted to mean scores for each domain and a total mean score for all the included items.

Missing values were handled using available case analyses; that is, each analysis included the cases that included the data required for the analysis. We report 95% confidence interval (CI) where relevant and regard two-sided p-values $\leq$ 0.05 as significant. Statistical analyses were conducted using SPSS 25 and Mplus8.

Construct validity

CFA for ordinal categorical variables were conducted to confirm the conceptual framework of the WFIRS-P and the WFIRS-S. We used the estimator WLSMV (weighted least square estimator with robust standard errors and mean- and variance-adjusted chi-square test statistic), which is the default estimator in Mplus for this setting. We applied a first-order correlated factors model with six and seven domains in the WFIRS-P and WFIRS-S, respectively, as factors. We also carried out a second-order hierarchical factor analysis including the factors of WFIRS-S and WFIRS-P individually, to look at the factor loadings on a global total factor. Goodness of fit was assessed based on the following: The chi- square value (χ^2) was considered relative to its degrees of freedom (df). The value should be as small as possible, values between 2 and 3 was considered 'good' and 'acceptable', respectively [47]; in addition, a root mean square error of approximation (RMSEA) less than 0.08, a comparative fit index (CFI) and Tucker Lewis Index (TLI) $\geq$ 0.95 were used in line with recommendations [48]. Among the 50 items in WFIRS-P, four items (item 4 and 5 in the school behavior domain and item 6 and 10 in the risk domain) caused unstable results in the CFA due to their low variance (>98% of the parents rated these items 0 = not a problem or not applicable). The CFA was thus conducted with the remaining 46 items (see the response distribution of the items in WFIRS-P in Supplementary Table S5).

A CFA was not possible to carry out with 69 items on the WFIRS-S. Hence, 12 items (item 2 in the family domain, items 4 and 5 in the work domain, item 6 in the life skills domain, and items 1–3, 6, 8, and 10–12 in the risk domain) were omitted because of the high rate (>50%) of 'not applicable' responses (not relevant due to the young age of the participant or to other circumstances) and/or low variance (many 0 = 'never or not at all a problem' responses). (See the response distribution of the items in WFIRS-S in Supplemental Table S6). The CFA was subsequently conducted for the remaining 57 items.

Reliability

Cronbach's alpha coefficients were used to assess internal consistency in each domain and for the total scores on the WFIRS-S and WFIRS-P. A coefficient of at least 0.7 was regarded as acceptable to confirm consistency [49]. In the WFIRS-S several items in four domains had low variance (high response rate with zero scores = not a problem) or a high percentage (>50%) of 'not applicable' responses. In the family domain, we therefore analyzed internal consistency first with all items included, and then with the exclusion of item 2: 'Problems with spouse/partner'. In the work domain we used the same procedure, first including all items and then excluding item 4:' Problems keeping a job' and item 5: 'Getting fired from work'. We also first included all items in the life skills domain, and then excluded item 6: 'Problems with sex' for comparison. In the risky activities domain, we omitted item 3: 'Road rage', item 6: 'Being involved with the police', item 8: 'Smoking marihuana' and item 10: 'Taking street drugs' in the initial analyses due to low variance (mainly zero scores). Last, we removed three additional items because of the high response rate (>50%) of not applicable responses: item 1: 'Aggressive driving', item 2: 'Doing other things while driving' and item 11: 'Sex without protection'.

Cross-informant reliability

Spearman's correlations were computed to assess whether the six and seven domains and the total score on WFIRS-P and WFIRS-S were associated with each other.

Convergent validity

Convergent validity refers to the degree to which two measures or constructs that should be related theoretically, are in fact related. Spearman correlations were computed to assess the convergent validity of the WFIRS-P and WFIRS-S total and domain scores and the C-GAS score, individually. Convergent validity is sometimes claimed if the correlation coefficient is above 0.50, although above 0.70 is usually recommended [50].

Divergent validity

We examined the association between the ADHD-RS-IV total and subscale scores with the total and domain scores on the WFIRS-P and WFIRS-S individually using Spearman correlations.

We used multiple linear regression to analyze the association between ADHD-RS-IV total score (independent variable) and the WFIRS-P and WFIRS-S total scores (dependent variable) separately, adjusting for gender, age, IQ score and internalizing psychiatric disorders, to see if these covariates had an additional impact on the association between the dependent and independent variable. All covariates were regarded as potential confounders. Internalizing psychiatric disorders included DSM-IV diagnoses of an anxiety disorder and/or a

depressive disorder. Psychiatric comorbidity was regarded as a categorical variable (0 = none, 1 = internalizing disorder).

Results

Sample characteristics

The participants were aged 14–18 years ($M = 15.4$, SD $= 1.2$). 52% were females. 95 (93%) of the participants were on a psychostimulant or non-stimulant ADHD medication when completing the questionnaires. The mean ADHD-RS-IV total score was 23.9 (SD $= 9.1$), the mean Inattention subscale score was 14.8 (SD $= 5.1$) and the mean Hyperactivity sub-scale score was 9.2 (SD $= 5.6$). 35 patients (34.3%) had a comorbid internalizing disorder, four patients (3.9%) had externalizing disorder (DSM-IV diagnosis of oppositional or conduct disorders), and 15 patients (14.9%) had a comorbid somatic disorder requiring medical attention such as diabetes, epilepsy and migraine. Five patients (4.9%) had been prescribed sleep medicine. The FIQ was 93.5 (±12.9). The mean score on the CGAS was 62.5 (SD $= 7.1$).

Construct validity

See Supplementary Table S1 for results from the CFA analysis. 46 of the items in the WFIRS-P were entered in the CFA item to factor model. The goodness of fit indices for the six factors were: $\chi^2/df = 1277/974 = 1.3$, CFI $= 0.89$, TLI $= 0.88$, RMSEA $= 0.06$ [95% CI: 0.05–0.06]. The fit indices for the second-order model were: $\chi^2/df = 1313/983 = 1.3$, CFI $= 0.88$, TLI $= 0.87$, RMSEA $= 0.06$ [95% CI: 0.05–0.07]. Standardized item to factor loadings were all significant ($p < 0.01$) and ranged from 0.30 to 1.0. The factor loadings with the overall global factor ranged from 0.62 to 0.87.

Regarding WFIRS-S, 57 of the items were entered in the first-order solution with seven factors. The goodness of fit indices were: $\chi^2/df = 2062/1518 = 1.4$, CFI $= 0.90$, TLI $= 0.89$, RMSEA $= 0.06$ [95% CI: 0.05–0.07]. The fit indices for the second-order model were: $\chi^2/df = 2174/1532 = 1.4$, CFI $= 0.88$, TLI $= 0.87$, RMSEA $= 0.06$ [95% CI: 0.06–0.07]. The item to factor loadings ranged from 0.47 to 0.97 and the different

factor loadings with the overall global factor ranged from 0.66 to 0.88. Two out of four fit indices were indicative of good/acceptable model fit in all of the CFA analyses. The CFI and TLI were under recommended cut off. Thus, the results yield acceptable support for both a first- order, and a second-order model for both questionnaires.

Reliability

Cronbach's alpha coefficients on the domains and total scores are provided in Table 1. The domains in the WFIRS-P showed acceptable to good internal consistency ($\alpha > 0.71$) except life skills ($\alpha = 0.66$). All domains in the WFIRS-S showed good internal consistency with all items included ($\alpha > 0.79$). Analyses excluding items with low variance and high not applicable score ($>50\%$) yielded comparable results ($\alpha > 0.71$). The overall internal consistency was thus satisfactory.

In WFIRS-P the correlations between the domains and the total score were all significant and moderate to high ($r = 0.52$–0.77). The inter-domain correlations were also significant and varied from low to high ($r = 0.23$–0.60). We found high correlations between the self-concept and the social domain and the family and risk domain (see results in Supplementary Table S2).

In WFIRS-S the correlations between the domains and the total score were all significant and high ($r = 0.63$–0.81), and the inter-domain correlations were all moderate to high ($r = 0.31$–0.70). We found high correlations between the work and school domain and the school and life-skills domain. We also found strong correlations between the social activities' domain and the self-concept, school and family domains respectively (see Supplementary Table S3).

Mean scores on the WFIRS-P and WFIRS-S

Table 2 shows the mean scores and standard deviations for each domain and the total scores on the WFIRS-P and the WFIRS-S. The mean total score on the WFIRS-P was 0.77. The domains with the highest impairment scores were self-concept and life skills. The risk domain had the lowest mean score. The mean total score on the WFIRS-S was 0.81. The domains with the highest impairment scores were self-

Table 1. Internal consistency for the WFIRS-P and the WFIRS-S.

| Domain | WFIRS-P | | | WFIRS-S | | |
	Number of items	α	n	Number of items	α	n
Family	10	0.89	94	8 (7)	0.85 (0.84)	21 (62)
Work	0	–	–	11 (9)	0.79 (0.85)	19 (52)
School	10	0.75	85	10	0.87	90
Life skills	10	0.66	83	12 (10)	0.89 (0.83)	20 (86)
Self-concept	3	0.86	100	5	0.93	98
Social activities	7	0.81	95	9	0.87	86
Risky activities	10	0.71	95	10 (7)	0.84 (0.71)	18 (46)
Total	50	0.90	67	65 (57)	0.96	16

WFIRS-P: Weiss Functional Impairment Rating Scale-Parent form; WFIRS-S: Weiss Functional Impairment Rating Scale Self-report; n: number; α: Cronbach's alpha. The WFIRS-S Risky activities domain was initially analyzed omitting 4 items due to low variance, numbers in parentheses are analyses where items with more than 50% missing/not applicable answers were omitted from the analyses, available case analyses.

Table 2. Mean domain scores of the WFIRS-P and WFIRS-S.

| Domains | WFIRS-P | | | WFIRS-S | | |
	Number of items	Mean (SD)	n	Number of items	Mean (SD)	n
Family	10	0.78 (0.56)	102	8	0.79 (0.60)	102
Work	–	–	–	11	1.00 (0.69)	81
School	10	0.87 (0.54)	102	10	0.98 (0.64)	102
Life skills	10	1.03 (0.51)	102	12	0.96 (0.57)	102
Self-concept	3	1.07 (0.81)	101	5	1.03 (0.92)	101
Social activities	7	0.60 (0.57)	102	9	0.61 (0.55)	102
Risky activities	10	0.24 (0.35)	102	14	0.33 (0.33)	91
Total	50	0.77 (0.38)	102	69	0.81 (0.47)	102

WFIRS-P: Weiss Functional Impairment Rating Scale-Parent form; WFIRS-S: Weiss Functional Impairment Rating Scale Self-report. WFIRS-P and WFIRS-S mean scores represent the mean of answered questions.

concept, work and school. The lowest score was found for the risk domain.

Cross-informant reliability

The Spearman correlations between the corresponding domains and the total scores of the WFIRS-P and the WFIRS-S were all statistically significant, the effect sizes were moderate and, in most cases, stronger than for the non-corresponding domains. Between the non-corresponding domains, we found moderate correlations between the WFIRS-P risk and the WFIRS-S family domain, the WFIRS-P social activities and the WFIRS-S self-concept domain, the WFIRS-P life skills and WFIRS-S school domain, and the WFIRS-P school and WFIRS-S work domain. The results are presented in Table 3.

Convergent validity

The Spearman correlations between the C-GAS and the WFIRS-P total and domain scores were all weak ranging from $r = -0.07$ to -0.26. Correlations between the C-GAS and WFIRS-S total and domain scores were low to moderate. Both the social activities, the family and the school domains showed moderate correlations with the C-GAS, hence the convergent validity was weak (see results in Table 4).

Divergent validity

Table 4 shows the correlations between the WFIRS-P and the WFIRS-S total and domain scores with the ADHD-RS-IV score, Internalizing disorder and IQ score. The WFIRS-P total score correlated moderately with the ADHD RS total score, as well as the Inattentive and Hyperactive subscales. The correlations between the ADHD-RS-IV total score and the WFIRS-P domain scores were all significant and low to moderate, except the self-concept domain that was non-significant. Overall, the results were below 0.5 supporting divergent validity.

Internalizing disorder showed a moderate correlation with the self-concept domain in WFIRS-S, and a significant, but weak correlation with self-concept and risky activities in WFIRS-P. FIQ showed a low, but significant association with the Life skills domain in both WFIRS-S and WFIRS-P, but none of the other domains.

In multiple regression analyses, the ADHD-RS-IV total score was the best predictor of the variance in both the WFIRS-P and WFIRS-S total scores respectively (standardized $\beta = 0.53$, 0.32, $p < 0.05$), with internalizing disorder providing an additional small contribution ($\beta = 0.22$, 0.26, $p < 0.05$).

Table 3. Spearman correlations between WFIRS-S and WFIRS-P domain scores, (n).

	WFIRS-P						
WFIRS-S	Family	School	Life skills	Self-concept	Social	Risk	Total
Family	0.54** (101)	0.23* (101)	0.23* (101)	0.22* (100)	0.27** (101)	0.39** (101)	0.42** (101)
Work	0.11 (81)	0.310.** (81)	0.27* (81)	0.21** (81)	0.22* (81)	0.29** (81)	0.31** (81)
School	0.25* (102)	49** (102)	0.320.** (102)	0.22* (101)	0.26*(102)	0.25* (102)	0.40** (102)
Life skills	0.19 (102)	0.21* (102)	0.44** (102)	0.30** (101)	0.29** (102)	0.12 (102)	0.40** (102)
Self-concept	0.21* (101)	0.23* (101)	0.29** (101)	0.54** (100)	0.32** (101)	0.18 (101)	0.47** (101)
Social	0.25* (102)	0.19* (102)	0.24* (102)	0.34** (101)	0.57** (102)	0.26** (102)	0.48** (102)
Risk	0.30** (91)	0.14* (91)	0.26* (91)	0.27** (91)	0.28** (91)	0.39** (91)	0.36** (91)
Total	0.31** (102)	34** (102)	0.38** (102)	0.39** (102)	0.40** (102)	0.25* (102)	0.51** (102)

WFIRS-S: Weiss Functional Impairment Rating Scale-Self-report; WFIRS-P: Weiss Functional Impairment Rating Scale Parent-report.
*$p < 0.05$. **$p < 0.01$.

Table 4. Spearman correlations between the WFIRS-S and WFIRS-P domain and total scores, with ADHD RS IV, C-GAS, IQ and internalizing disorders.

	ADHD Total	n	ADHD Inattentive	n	ADHD Hyper	n	C-GAS	n	Intern. disorder	n	FIQ	n
WFIRS-S domains												
Family	0.37**	98	0.22*	99	0.39**	100	−0.38**	101	0.17	101	−0.09	89
Work	0.20	78	0.27*	79	0.09	80	−0.15	81	0.07	81	0.01	71
School	0.19	99	0.30**	100	0.07	101	−0.32**	102	0.08	102	0.07	90
Life skills	0.17	99	0.27**	100	0.06	101	−0.22*	102	0.19	102	0.25*	90
Self-concept	0.19	98	0.26**	99	0.08	100	−0.28**	101	0.33**	101	0.18	89
Social activities	0.26**	99	0.16	100	0.28**	101	−0.41**	102	0.18	102	0.05	90
Risky activities	0.28**	88	0.18	89	0.28**	90	−0.18	91	0.02	91	0.03	80
Total	0.28**	99	0.31**	100	0.18	101	−0.38**	102	0.23*	102	0.11	90
WFIRS-P domains												
Family	0.55**	99	0.36**	100	0.54**	101	−0.18	102	−0.01	102	0.03	90
School	0.35**	99	0.47**	100	0.16	101	−0.26**	102	0.08	102	−0.08	90
Life skills	0.36**	99	0.47**	100	0.20*	101	−0.07	102	−0.01	102	0.24*	90
Self-concept	0.19	98	0.21*	99	0.09	100	−0.17	101	0.29*	101	0.14	89
Social activities	0.24*	99	0.17*	100	0.23*	101	−0.25*	102	0.14	102	−0.14	90
Risky activities	0.48**	99	0.32**	100	0.47**	101	−0.07	102	−0.23*	102	−0.11	90
Total	0.49**	99	0.45**	100	0.37**	101	−0.29**	102	0.15	102	0.04	90

WFIRS-S: Weiss Functional Impairment Rating Scale Self-report; WFIRS-P: Weiss Functional Impairment Rating Scale Parent-report; ADHD: ADHD RS IV total score, inattention score and hyperactive/impulsive score, Internalizing disorders: DSM-IV diagnoses of anxiety or depression; FIQ: Full scale IQ from the Wechsler Intelligence Scale for Children or adults (WISC-IV/WAIS-IV); n: number.
*$p < 0.05$; **$p < 0.01$.

Gender, age and IQ gave no additional contribution to explaining the variance in the WFIRS-P overall score. The IQ score showed a small nonsignificant effect ($\beta = 0.17$, $p = 0.10$) in explaining the variance in WFIRS-S. Gender and age had no additional effect on the total variance (see supplemental Table S4).

Discussion

The evaluation of functional impairment in addition to symptoms is imperative for identifying ADHD, guiding treatment planning and evaluating outcome. The aim of this study was to evaluate the psychometric properties of the Norwegian version of the WFIRS-S and WFIRS-P in an adolescent ADHD population. A second aim was to examine the questionnaires̀ clinical utility in the assessment of functional impairment in this patient group. Overall, the findings support the scale construction, the internal reliability and divergent validity of the Norwegian adaptation of both the WFIRS-S and the WFIRS-P. However, the fit of the model was not optimal. When we examined the score distribution of the items in the WFIRS questionnaires, four items were removed from the WFIRS-P and twelve items were removed from the WFIRS-S due to the high rate of 'not applicable' responses and/or a 'floor effect'. These items were mainly from the family, work and risk domains and were considered 'not applicable' largely because of the young age of our sample (mean age 15.4 years). Many of the behavior and risk-related items are considered more relevant for adolescents with conduct disorders, a group underrepresented in our study population. Knowing that the inclusion of these items would improve the instruments clinical value when relevant, led us to keep them in the Norwegian version.

Both a first-order CFA of the six-factor structure of the WFIRS-P and a seven-factor structure of the WFIRS-S, as well as a second-order model with the respective factors loading on a global impairment factor revealed satisfactory results. Chi-square values and RMSEA provided a good model fit, but the TLI and CFI values were below cut off values (borderline range) on both questionnaires. The item-to-factor loadings were all above 0.30 which is the minimum standard of item-convergent validity [51]. The results support the original factor structure in the questionnaires and are in line with validation studies in other languages [19,21–24]. For clinical practice, we suggest the first-order solution to be the more relevant model, since the inspection of impairment across different domains is useful both for diagnostic purposes, as well as targeting treatment intervention for the individual patient. The use of a more narrowband measure also makes it easier to adjust treatment over time, knowing that impairment may shift in different areas for multiple reasons. The use of a global impairment factor may be more relevant in research, measuring treatment effects on a more global scale.

The WFIRS-P showed acceptable internal consistency ($\alpha = 0.71$–0.89) across domains except in the case of the life skills domain ($\alpha = 0.66$). All domains in the WFIRS-S showed good internal consistency. The inter-domain correlations in the WFIRS-P were low to high, while they were moderate to high in the WFIRS-S. The correlations between the domains and the total scores were moderate to high in both questionnaires. Thus, the overall internal consistency of both questionnaires was satisfactory.

The total mean scores on the WFIRS-S and the WFIRS-P were 0.81 and 0.77, respectively. A mean score above 0.65 is an appropriate threshold for differentiating between an ADHD and a normative population [52]. All the domains in the WFIRS-P and WFIRS-S were above this threshold, except the social activities and risk subdomains, which were in the normal range in both questionnaires. These domains were thus less sensitive in revealing functional impairment in our study population. This may be caused by population bias; more research is needed to explore this further.

On the WFIRS-P, the parents reported the highest impairment scores in the life skills, self-concept and school domains, whereas risk received the lowest mean score. The adolescents (WFIRS-S) reported the highest impairment in the self-concept, work, and school domains and the lowest impairment in the risk domain. This is consistent with clinical research demonstrating that ADHD is highly related to functional impairment in the school arena as well as affecting adolescents' self-esteem [5,6]. This pattern in WFIRS-S is similar to patterns presented in American, French and Japanese validation studies of college students and adults with ADHD [22,24,25]. Unfortunately, there are no comparable studies to date of clinical adolescent ADHD populations; however, a WFIRS-S validation study of Iranian adolescents with no ADHD found results similar to ours, with self-concept being the most impaired domain [23]. The mean score in the Iranian population was lower than the mean score in our ADHD sample (0.45 versus 1.0). Even though the results are not directly comparable, this pattern may imply that ADHD symptoms act as an additional risk factor for low self-esteem.

The impairment scores in our adolescent population are similar to the scores reported for American college students with ADHD [25]. The French and Japanese validation studies presented higher impairments scores in their adult populations [22,24]. Reasons for this may be that our sample was younger in age, and under treatment for ADHD at the time of assessment. The importance of psychosocial interventions, including the support of family, teachers and friends with knowledge about ADHD, the implementation of support measures at school, and not least, medical treatment, may all be important contributors to this finding. The discrepancy related to age may also reflect the advantage of being diagnosed in childhood as this may prevent severe comorbid disorders from developing over time and producing accompanying functional impairments. The results nonetheless support a common cross-cultural pattern in impairment profiles, with self-concept, school/work and family being the most affected domains irrespective of cultural disparities in patients with ADHD.

Considering cross-informant validity, we found a moderate agreement between the corresponding domains and total scores on WFIRS-P and WFIRS-S. In most cases the correlations were stronger for the corresponding than the non-

corresponding domains. In the study of Canu et al. 2016 [25] correlations between the responses of college students and collateral informants were low to moderate. A possible explanation for the moderate association in our study may be that the adolescents were living at home during the assessment, and therefore in closer contact with their parent informants.

We found a moderate correlation between the C-GAS score and the WFIRS-S total score, while the correlation with the WFIRS-P total score was low. In the Turkish validation study [21], the correlations between the C-GAS and the WFIRS-P total and domain scores were moderate to high. In our study, a clinician scored the C-GAS on the basis of a Kiddie-SADS-PL interview with the adolescents, which may explain the higher concordance with the WFIRS-S than the WFIRS-P score. The use of different informants with clinicians scoring C-GAS versus parent and adolescents' scoring WFIRS, may also be a possible explanation for the weak correlation. Our finding, as it stands, thus provides limited convergent validity between the WFIRS measures and the C-GAS. We suggest the instruments measure different concepts, with the CGAS representing a more generic measure of overall clinical severity, rather than specific impairment related to ADHD. More studies are needed to further explore this finding.

The WFIRS-P total score showed moderate correlations with the ADHD-RS-IV total score as well as the Inattention and Hyperactivity subscale scores. The ADHD-RS-IV total score correlated significantly with all the WFIRS-P domains, except the self-concept domain. The Inattentive subscale showed strong correlations with the school and life skills domains. The Hyperactive subscale correlated strongly with the family, risk and social domains. A similar pattern is referred in other studies [21,25], although some also found a strong association between the Hyperactivity subscale and the school and learning domains [19,25]. The relatively low hyperactivity score in our clinical sample (probably due to the effect of medication) may explain this discrepancy. Overall, we find that the constructs measured by the ADHD-RS-IV and the WFIRS have something in common; nonetheless, the instruments seem to measure different aspects of function that do not overlap, supporting divergent validity.

The ADHD-RS-IV total score was the best predictor of the overall score in both WFIRS-P and WFIRS-S controlling for IQ, age, gender and internalizing disorder. Only internalizing disorder (comprising both anxiety and depression disorders) showed an additional small and significant contribution in both measures. A previous validation study reported moderate correlations between depression and WFIRS-S total and domain scores in an adult ADHD population [24]. In our clinical population, anxiety disorder was the most common comorbid internalizing disorder. Depression is a more impairing condition for general functioning than anxiety disorder, which could explain the stronger correlations in the adult study.

Some limitations should be considered when interpreting the results. First, 86% of our population was included in an ongoing RCT of group CBT for adolescents treated for ADHD

[29] and adolescents with comorbid externalizing disorders (other than ADHD) were underrepresented in our total population ($n = 4$). Second, 93% of the total sample was on stable stimulant or non-stimulant medication. The effect of medical treatment could have reduced behavior problems for some adolescents to below the cut-off for externalizing disorders. Medication also have a significant impact on the level of ADHD symptoms, making this population better functioning than non-medicated patients. As the WFIRS impairment scores represent function after the initiation of medical treatment, our findings are not representative of all adolescents with ADHD in clinical practice. Third, a high proportion of the participants (52%) were females. Although this is considered a strength in our RCT, the high female proportion may have had an impact on the prevalence of the externalizing and behavior problems, since girls with ADHD generally present less behavior problems and more internalizing problems than boys [53,54]. Furthermore, our population was restricted to adolescents 14–18 years of age in mid-Norway, the results may not be representative of younger or older age groups, nor may the population be equally representative of the population at large.

Finally, several items in the family, work and risk domains were considered irrelevant or 'not applicable' because of the young age of our sample. This may represent a bias in the calculation of overall scores. We therefore recommend calculating the mean scores of relevant domain items and the overall score, or simply inspecting the score profiles in the different domains when evaluating these patients in clinical practice. The age limit for driving is 18 in Norway and getting work and holding a job before the age of 18 is relatively rare. One can therefore preferably omit the work domain in clinical practice with younger patient groups. Future research should investigate WFIRS scores in adolescents with ADHD prior to treatment. The use of adjusted norms for different age groups would also be preferable.

Conclusion

Despite limitations, the overall results of this study suggest the Norwegian WFIRS-P and the WFIRS-S have acceptable psychometric properties. Our findings support both a first-order, item to factor solution, as well as a second-order model, with a general construct of functional impairment in addition to specific domain constructs. The internal reliability was acceptable and the cross-informant reliability was moderate. The convergent validity with C-GAS was weaker than expected, the correlations with ADHD RS were as expected, supporting divergent validity.

We regard the WFIRS questionnaires as useful in the examination of functional impairment in patients with ADHD and comorbid disorders.

Disclosure statement

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