Screening Tools for Adult ADHD Patients in Primary care

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Highlights

- There are sufficient screening tool for attention-deficit/hyperactivity disorder (ADHD) in adults
- This systematic review and meta-analysis examined sensitivity and specificity of these screening tools, as well as feasibility in general practice and digital practicability
- Results revealed feasibility and efficacy of some screeners in general practice
- Active controls in the examined studies are very heterogenous
- Sufficient cut-offs are needed to avoid misdiagnosis in daily practice

Title: Screening Tools for Adult ADHD Patients in Primary care

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Abstract

Background: General practitioners play a pivotal role in the diagnosis attention-deficit/hyperactivity disorder (ADHD) in adults. This systematic review aims to determine the effectivity and feasibility of screening tools for ADHD in adults in primary care.

Method: A literature search was performed in PubMed, Cochrane Library, Ovid, ERIC, PsycInfo, PSYNDEX and Embase in November 2022. Sensitivity and specificity were considered as primary outcomes. Further psychometric properties, feasibility in general practice as well as digital practicability were evaluated as secondary outcomes. Risk of bias was assessed via QUADAS-2/C. A narrative data synthesis and meta-analysis was performed (PROSPERO: CRD42022374597).

Results: A total of fifty-eight studies were included in data analysis. These studies referred to eighty-four various screening tools. ASRS-6 (DSM-V), WURS-25, CAARS-s:sV and TRAQ10 are suitable instruments for screening of ADHD in adults in primary care. The highest test accuracy was shown by ASRS 6 (DSM-V) (Sensitivity=0.83 [0.67-0.92], Specificity=0.87 [0.93-0.8], AUC=0.92, I2=8.6-12.3%).

Limitations: Included studies used rating scales as reference standard. Some studies compared study groups to control groups with an unknown ADHD status and there is a large degree of heterogeneity between the populations. Some studies referred to the best-balanced results of sensitivity and specificity under a certain cut-off, that has not been determined before.

Conclusion: Feasibility studies are needed to provide more evidence for WURS-25 and CAARS-s:sV. The determination of sufficient cut-offs is important, to improve the identification of ADHD in adults by general physicians.

Keywords: ADHD; primary care; adult; diagnosis; screening

INTRODUCTION

Attention-deficit/hyperactive disorder (ADHD) according to the Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-5) and hyperkinetic disorder (F90) or attention deficit without hyperactivity (F98.8) according to the International Classification of Diseases, editions 10 and 11 (ICD-10/11)) is commonly known as a childhood disorder which is characterized by altered hyperactivity, inattention and impulsivity (1). These symptoms persist until adulthood in about 50% of all diagnosed patients (2, 3). Moreover, patients show

characteristic features, which include executive dysfunction, disorganization and emotional distress, leading to an impairment of their daily lives (4, 5). Common comorbidities are depression, borderline personality disorder, social phobia, anxiety, or substance abuse (6, 7). Although a prevalence of approximately 2-3% of ADHD in adults is estimated, only 0.2-0.4 % are actually diagnosed in Germany (6, 8, 9). A possible reason seems to be a gap in medical care for young adults in a time of transition after leaving the pediatric setting (10, 11). Moreover, ADHD might be masked by other psychiatric symptoms and comorbidities (12). A missing or failed diagnosis prevents access to optimal medical care in the form of an evidence-based treatment of affected adults. General practitioners are considered to act as so-called „gatekeepers“, a role that is characterized by the initial identification of patients (13, 14). Consequently, there is a distinct need for appropriate diagnostic tools in primary care, as has already been identified in relevant guidelines (15, 16). There are many different screening tools, which differ in relevant aspects of the disorder. Some screening tools evaluate childhood symptoms, whereas others focus on current adult symptoms. Some screening tools are based on DSM-5 criteria, others on Utah criteria or no specified criteria. They differ in time or way of application, number of items, and scoring methods. For example, the choice of cutoff scores in ADHD screening tools directly influences clinical decision-making, including the initiation of treatment interventions. A higher cutoff score may exclude individuals who, despite exhibiting significant symptoms, do not meet the stringent criteria, potentially denying them access to necessary interventions. Conversely, a lower cutoff score could lead to the inclusion of individuals with mild symptoms, leading to over-treatment. The variability in cutoff points complicates the determination of treatment eligibility, potentially affecting the efficacy and efficiency of ADHD management strategies. Until, there is no comprehensive overview of validated studies including a quantitative meta-analysis (17). Therefore, the aim of the study was to evaluate screening tools for ADHD in adults, considering sensitivity, specificity and feasibility for primary care.

METHODS

This systematic review and meta-analysis were conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 (PRISMA Statement) (18). A comprehensive study protocol was published in advance (PROSPERO: CRD42022374597).

Eligibility Criteria

We considered peer-reviewed studies, that analyzed the diagnostic accuracy of a screening tools for ADHD in adults. Diagnostic accuracy has to be compared to a reference standard (e.g., clinical diagnosis via self or informant interview (childhood or current diagnosis); clinical diagnosis based on defined criteria (ICD criteria /DSM-5 criteria/ Utah criteria) in medical records/registries; research diagnosis with expert interview; clinical diagnosis methods non specified). Furthermore, psychometric properties like sensitivity and specificity have to be reported as primary outcomes. Both, studies carried out in general population or special population, were considered. We accepted case-control studies as well as longitudinal and cohort studies for inclusion.

Information Source and Search Strategy

Original research studies examining diagnostic tools for ADHD in adults had been selected through a literature search in the following electronic databases: MEDLINE via Ovid and PubMed, PsycINFO, PSYNDEX, Cochrane Library, Embase and ERIC. The literature search has been performed during November 2022 by a single investigator. There was no date restriction. The full electronic search strategy for each of the databases is provided in the Suppl. 1 (supplementary materials).

Study Selection

Titles and abstracts were screened independently by two investigators (JG, RW). Both investigators screened independently all included full text articles for eligibility and evaluated the reference lists for other possibly eligible studies. Any discrepancies were discussed and a consensus was reached.

Data Extraction

Data was extracted by one reviewer (JG) using a standardized data extraction sheet created for this review. A second reviewer (LS) critically checked the first data extraction process. Any disagreement was resolved between both reviewers. Both reviewers were not blinded to any information concerning the paper. For the extraction of

the data items a part of the Standards for Reporting Diagnostic accuracy studies (STARD) 2015 checklist was used (19). Data extraction considered the following data: basic descriptive study information (e.g., date of publication, aim of the study), methods (e.g., recruitment, screening tool, reference standard, statistical analysis), participants (e.g., sample size, age, co-morbidities), results (e.g., primary outcome as sensitivity, specificity; secondary outcome as application, practicability; study limitations; implications for practice), study design (e.g., allocation ratio) and risk of bias (e.g., tool, major concerns).

Risk of Bias in Individual Studies

To rate the quality and risk of bias in each study, the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) tool, consisting of four domains, was used by two independent reviewers (JG, LS) (20). Thereby a series of questions focusing on different aspects of trial design (domain 1: patient selection), conduct and interpretation of the screening tool (domain 2: screening tool), conduct and interpretation of the reference standard (domain 3: reference standard) and patient flow and timing (domain 4: flow and timing) to elicit information about features of the trial that are relevant to risk of bias. All relevant information was extracted using the extraction sheets created for this review. The different studies were rated into three categories: low bias, high bias or unclear bias. Any unclear decision was reported and resolved in discussion. In Suppl. 2 (supplementary materials) all the questions used for the assessment of bias are shown.

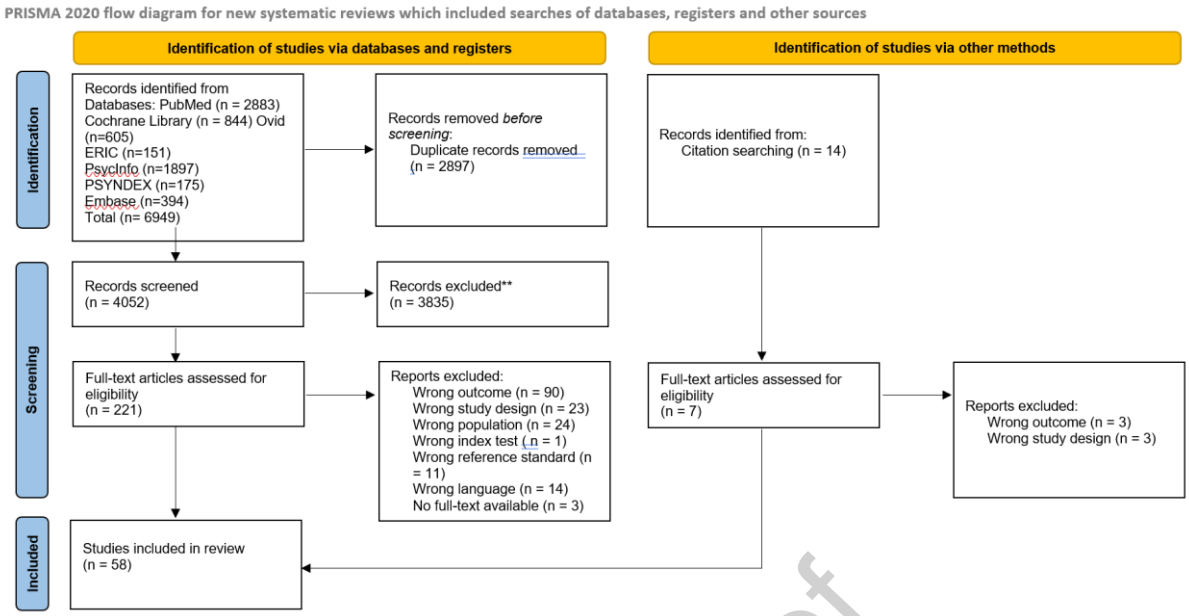
Data Analysis

We provided a narrative synopsis combined with a meta-analysis. We calculate missing parameters from available statistics if necessary. Feasibility was measured via different parameters: time, effort, complexity, application and practicability for patients and medical staff.

If not provided by a study, we calculated true negatives (TN), true positive (TP), false negative (FN), and false positive (FP) based on sensitivity, specificity and sample size and rounded the values of the 2x2 table to its nearest integer. The R-package MADA was used to aggregate data and calculated overall diagnostics (21). The summary sensitivities and specificities were estimated using a bivariate random-effects model (95% Cis) in the function reitsma implemented in R package mada (meta-analysis of diagnostic accuracy). Heterogeneity was assessed by Holling's sample size adjusted measure, where I^2 = 0-25% denotes low heterogeneity and I^2 = 25-50%/50 – 100% moderate / high presence of heterogeneity (22). As the test populations from the screening tools differed substantially, we did a subgroup analysis to study a potential influence on the overall diagnostics. Moreover, as the screening tools apply different cut-offs, we also calculated separate models for low, moderate and high cut-offs.

RESULTS

The PRISMA four phase flow diagram, was used to describe the systematic review process as shown in Figure 1. Overall, 6.949 studies were identified through the search in seven different data bases, fourteen studies were identified via other methods as forward- and backward search. Of those, fifty-eight full-texts were screened eligible for inclusion in the review. A summation of excluded articles and the reasons therefore can be found in Figure 1.



<Fig. 1: PRISMA Flow Diagram>

Characteristics of Included Studies

We included fifty-eight studies, which were published between 1993-2022. An overview of the study characteristics is shown in Table 1. The majority of studies was performed in the USA (twenty studies; 34.5%) followed by Germany (nine studies; 15.5%), Switzerland (four studies; 6.9%), the United Kingdom, Spain and Turkey (three studies each; 5.2%). Regarding sex, the study populations included more male than female participants (58.1%). Eighteen studies (31.0%) analyzed a population at risk sample, twelve studies (20.7%) a general population sample and two studies (3.4%) an ADHD patients' sample. The other studies showed mixed samples. The studies referred to various screening tools, altogether eighty-four. The most frequently described screening tool was the ASRS-6 (DSM-IV) in twenty-one studies (36.2%). This test was followed by the WURS-25 (nine studies; 15.5%), the ASRS-18 (seven studies; 12.1%) and the ASRS-6 (DSM-V) (six studies, 10.3%). Studies included a great variety of reference standard tests. Mostly, diagnosis of adult ADHD was defined by the implementation of a diagnostic semi-structured interview (twenty-eight studies; 48.3%), followed by clinical diagnosis via DSM-IV/V, ICD-10 or Utah criteria (twenty-two studies; 37.9%), combined diagnostic assessment with interviews and screening tools (four studies; 6.9%) or via a validated rating scale (four studies; 6.9%).

<Table 1: Characteristics of included studies>

Characteristics of Included Tests

The characteristics of the included tests are shown in Table 2. Of the twenty-nine different screening tools, ten screening tools (34.5%) related to current symptoms, one exclusively on childhood symptoms, six screening tools (20.7%) on both current and childhood symptoms and twelve screening tools (41.4%) were not further specified. The screening tools consisted of 4-67 items. Most of them were rated on a 4- or 5-point Likert-scale. One was rated digitally with an XGBoost algorithm classifier, which was constructed based on training set data. In most cases, the rating scales were based on DSM-IV/V criteria.

<Table 2: Characteristics of included tests >

Risk of Bias

Twenty-six studies (44.8%) did not show a high risk of bias in any of the four domains. Twenty-three studies (39.7%) had at least in one of the four domains a high risk of bias, whereas twenty-six studies (44.8%) had an unclear risk of bias. To enlarge on concerns regarding applicability, four studies (6.9%) are associated with at least one high and thirteen studies (22.4%) with one unclear concern (see Table 3).

<Table 3: Risk of Bias assessment (QUADAS-2)>

Qualitative Synthesis

Sufficient information for meta-analyzing psychometric properties as sensitivity and specificity were found for eighty-four studies. A majority showed a high test accuracy rates as shown in Table 7. Only few studies presented inacceptable low sensitivity or specificity. Sensitivity ranged from 37.9% to 98.0% and Specificity from 11.1% to 100%.

One of our aims for the study was to evaluate the feasibility of different screening tools in a primary care setting. All of the examined screening-tools are self-rating tools (fifty-eight screening tools; 100%). We assume that self-rating tools might be less time-consuming in daily patient care than screening tools, that have to be filled by the primary care physician or the respective nurse. Two of the studies were conducted in primary care practices (23, 24). Regarding effort, complexity and practicability, the ASRS-6 was estimated as short, and easy to conduct. Furthermore, the screening tool was characterized for its good feasibility, high acceptability and credibility. Thereby the ASRS was valuated as effective screening tool in a primary care setting, which „would not impede office productivity“ (23). Other studies, which were conducted in other settings, assessed qualities of the screening tools, which can be transmitted to feasibility calculations in primary care. The CAARS-s:sV was seen as an appropriate tool for use at home and the ADHD-scale Form A and B as an „easy-to-answer self-evaluation instrument“, which was comprehensive (25, 26). The WURS 4 was shown as tool to „quickly and efficiently screen large numbers of the at-risk population of adults“ with a brief administration time of 1-2 minutes(27). The WURS-8 was described as „economical and short screening tool for primary care“(28). Also, the BAARS-IV brief screening tool was presented as „resource-effective tool“, but primarily in a sample of adult males in the criminal justice system (29). ADHS-SB and WURS-25 in combination was shown as „quick“ instrument as well as the ADHD-RS(30). The TRAQ as the only digital screening tool was described as tool, which „could facilitate the professional’s diagnostic process of ADHD“ given the fact, that it has an automated design „allowing it to be used without the need to manually calculate results or use statistical tables“. This leads to „gain of time“, „less susceptibility to human error“, and „direct implementability“(31). An overview of feasibility characteristics can be found in Table 4.

<Table 4: Primary and secondary outcome >

Meta-analysis

We performed a calculation of pooled sensitivities and specificities for all screening tests via a bivariate diagnostic random-effects meta-analysis, which resulted in a sensitivity of 0.801 (95% CI = 0.773-0.826, p< .001) and a specificity of 0.894 (95% CI = 0.826-0.78, p< .001) of high significance. The Area Under the Curve (AUC) of 0.87 confirmed the high test accuracy. I2 estimates showed low heterogeneity (I2 = 3.3 - 6.6 %).

For five of the 29 screening tests we could perform a separate calculation of pooled sensitivity and specificity, shown in Table 5. The highest test accuracy was shown by the ASRS 6 (DSM-V) (Sensitivity=0.83 [0.67-0.92], Specificity=0.87 [0.93-0.8], AUC=0.92, I2=8.6-12.3%), followed by the WURS-25 (Sensitivity=0.855 [0.801-0.896], Specificity= 0.832 [0.868-0.789], AUC=0.906, I2=3.1-3.6 %) and the CAARS-s:sV (Sensitivity=0.855 [0.78-0.91], Specificity= 0.78 [0.81-0.74], AUC=0.84, I2=2.4-2.7 %). The ASRS-6 (DSM-IV) yielded a sensitivity of 0.78 [0.729-0.827], a specificity of 0.77 [0.79-0.73], an AUC=0.83 and a heterogeneity of 1.3-2.5%. The ASRS-18 showed a pooled sensitivity of 0.705 [0.658-0.748], a specificity of 0.703 [0.759-0.64] and an AUC of 0.757.

<Table 5: Pooled sensitivity, specificity and (Area Under the Curve) AUC>

Due to the significant heterogeneity of the different study groups, we analyzed the effect of samples on test accuracy. Statistically comparing the moderator model (with sample included as a regressor) to the non-moderator model yield no significant difference (p = 0.8). Therefore, sample did not contribute significantly to heterogeneity.

We also analyzed the sensitivity, specificity and AUC results, as shown in Table 6. For the tests using a high cut-off we found a sensitivity of 0.713 [95% CI = 0.640-0.776], a specificity of 0.827 [95% CI = 0.885-0.746], an AUC of 0.827 and I2 estimates of 1.9-2 %. The model for medium cut-offs showed a sensitivity of 0.804 [95% CI = 0.765-0.839], a specificity of 0.819 [95% CI = 0.819-0.785], an AUC of 0.879 and I2 estimates of 6.9 - 8.9 %. Calculations for the low cut-offs showed the following results: Sensitivity = 0.806 [95% CI = 0.755-0.848],

specificity = 0.808 [0.845-0.764], AUC = 0.874, I2 estimates = 2-2.2 %. In that respect, sensitivity was increasing with lower cut-offs, while specificity was decreasing.

<Table 6: Correlation of cut-offs and sensitivity, specificity, AUC>

DISCUSSION

Summary of findings

We conducted a systematic review and meta-analysis of screening tools for adult ADHD, to provide estimates of their validity and feasibility in primary care. The majority of tests or questionnaires resulted in a sensitivity of 0.801 (95% CI = 0.773-0.826, p<0.001) and a specificity of 0.894 (95% CI = 0.826-0.78, p<0.001), showed high test accuracy rates with a pooled AUC of 0.87. Comparing each test (where possible) lead to highest accuracy for the ASRS-6 (DSM V) followed by the WURS-25 and the CAARS-s:sV.

Increasing cut-offs lead to high specificity provoking a decrease of sensitivity and therefore an enlargement of false negative cases. Reducing cut-offs on the other hand, is on the expenses of specificity and results in increasing cases of false positive tests. In primary care, we focus on a general population. According to this, medium cut-offs are recommended. The screening tools we examined were all self-rating tools, since they are best suited to a primary care setting concerning time-effectivity and practicability, as there is no observer or informant needed.

In a sample of ADHD patients, the tests showed highest sensitivity and specificity rates compared to general samples or control samples.

Implications for research and clinical practice

The screening tool, which shows the highest suitability for primary care concerning validity, effectivity, practicability and complexity, is the ASRS-6 (DSM-V). The meta-analysis confirmed an overall accuracy rate of AUC = 0.92. This accuracy might be a suitable option to apply it in a primary care setting, which has been validated in studies by Ballmann et al. and Hines et al., who could show in a primary care setting, that the ASRS-6 is being short, simple and comprehensible as well as having good feasibility, high acceptability and credibility (23, 24). The high-quality standard of the ASRS-6 regarding practicability, complexity and effectivity was verified by other studies having been conducted in other settings (32-36).

Another screening tool with high validity and a good feasibility in primary care is the TRAQ10. The TRAQ10, which was presented by Trognon et al., showed very high test accuracy with a sensitivity of 97,0% and a specificity of 100,0% (31). Besides its high validity, it has been characterized as being an effective and resource saving tool particularly due to his digital implementation (31). Given the fact that we have only data of one study, there is a need of further studies confirming validity and testing it in a primary care setting.

Concerning validity, the WURS-25 and the CAARS-s:sV are very effective screening tools. Regarding to a lack of studies focusing on practicability, complexity and effectivity of those tools, we are not able to assess their suitability for a primary care setting with absolute certainty. As both of them consist of less than 27 items time effort seems to be limited, even though they probably require a higher effort than the ASRS-6 with its six items. Moreover, their characteristics as self-rating instruments increase their eligibility for primary care requirements.

Comparison to literature

Our results for adults ADHD screening tools mirror evidence established for children's tools. In 2022, another systematic review analyzed the accuracies of a broad range of screening tools for ADHD in children and adolescents (37). Most of tools showed an excellent diagnostic accuracy. Yet, regarding insufficient sensitivity and specificity, none of the tools as a single measure completed by a single reporter convinced for clinical use, whether they were performed by teachers, parents or the children themselves. The results were of high heterogeneity (37). Our Review only focused on self-rating tools. Three of them showed exceptionally high accuracy rates and a very promising sensitivity and specificity (>0.8) with high homogeneity.

Strengths and limitations

The majority of the studies was conducted from 2012 onward. Thus, we could show an actual overview of recently testes screening tools. Until now, there is no other systematic review and meta-analysis not only referring to the validity but also to the feasibility of screening tools for ADHD in adults in primary care.

However, there are some limitations of our systematic review to be mentioned. First, we included studies, which used rating scales as reference standard. This could confound the diagnostic precision with which conclusions about an actual diagnosis of ADHD have been drawn. Furthermore, some studies showed control groups not been diagnosed for ADHD and therefore with lack of guarantee concerning their actual ADHD status. Moreover, there was a large degree of heterogeneity between the populations of the different studies. Many studies were conducted in a selected clinical population, in which recruitment was dependent on the presence of an additional diagnosis or disorder. This interferes with the representativeness of the study samples and leads to a population bias. Furthermore, many studies included only the best-balanced results of sensitivity and specificity under a certain cut-off, which was not determined before and therefore a non-a priori-threshold. This reduces the ability to draw conclusions about the test performance in comparison. Since we included only self-rating tools, we face bias which is created by an inside view of the situation by the self-rating patient without the awareness of external manifestations. Another limitation occurs regarding retrospective types of scales like the WURS, which can cause affected reliability by recall bias. Finally, having limited the inclusion criteria to published papers available in German or English language, it leads to a possible language and publication bias.

CONCLUSION

Our findings show that screening tools as the ASRS-6 (DSM-V), the WURS-25, the CAARS-s:sV and the TRAQ10 are suitable instruments for screening of ADHD in adults in primary care due to their high validity and perceived feasibility in this setting. The best evidence exists for the ASRS-6, which was included in our meta-analysis. For more evidence concerning feasibility of the WURS-25 as well as the CAARS-s:sV, which also were part of the meta-analysis, feasibility studies are required. Regarding other tests like the TRAQ10 with equivalent promising results but insufficient options of comparison there is a need of further validation studies to create more evidence in that part. The determination of cut-offs is of great importance since it affects the ability of a screening tool distinguishing between real and false positives respectively negatives. Further research is required to identify the optimal cut-off of the different tests for a general population sample as we find it in primary care. Hence, the identification of ADHD in adults by general physicians would be improved without leading to increased misdiagnoses.

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Ethical approval: An ethical approval for the present research was not required.

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Availability of data and materials: data extracted from included studies and template data collection forms are available from the corresponding author on reasonable request.

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Supplementary material

<Suppl. 1: Electronic literature search strategy in different data bases>

<Suppl. 2: QUADAS-2/C: risk of bias in comparative diagnostic accuracy studies>

Legend:

ASRS = Adult ADHD Self Report Scale Screener for DSM-IV and DSM-5

AASS-5 = self-report A-ADHD scale after DSM-V

WURS = Wender Utah Rating Scale

CAARS-s:sV = Conners' Adult ADHD Rating Scales self-rating, short version

CAARS-s:lV = Conners' Adult ADHD Rating Scales self-rating, long version

SCL-90-R = Symptom Checklist 90

BAARS-IV = Barkley Adult ADHD Rating Scale-IV

K-AARS = Korean Adult ADHD Rating Scale

BADDS = Brown ADD Rating Scale

ADSA = Attention deficit Scales for Adults

ADHD-SB = ADHS-Selbstbeurteilungsskala

ADHD-RS = ASHD Rating Scale

ADHS-E = ADHS-Screening für Erwachsene (Kurzform)

ADHS-LE = ADHS-Screening für Erwachsene (Langform)

TRAQ10 = Trognon & Richard ADHD Questionnaire French 10-items

AAPS = Adult Attention Problems Scale

ADHD-SQ = ADHD screening questionnaire

SR-WRAADS = Self-Report Wender-Reimherr Adult Attention Deficit Disorder Scale

ARS = Adult Rating Scale

AHA = Assessment of Hyperactivity and Attention

<Table 1: Characteristics of included studies>

author (year), country	n_all	age_mean (SD)	male_all in %	screening tool	standard reference test	study population
Abass et al. (2020), Switzerland	all=412 adhd = 259 controls= 153	34.15 (12.04)	59.47	ADHD-SCL-90-R	Clinical diagnosis	ADHD suspected sample
Baggio et. al. (2021), France + Switzer-land	all=484 adhd = 236 controls= 248	37.9 (14.7)	47.6 male_adhd in % = 50.4; male_controls in % = 44.8	ASRS-6 (DSM-V)	ACE+ DIVA 2.0:	ADHD sample; healthy control sample; borderline personality disorder/bipolar disorder sample with ADHD
Bakare et. al. (2020), United Kingdom	all=69 adhd =61 controls= 8	45.0 (6.95)	61.7	WURS-4	psychiatric diagnostic assessment	ADHD sample
Ballmann et al. (2022), Germany	all=261 adhd =113 controls = 148	39 (13.6)	45.0	ASRS-6 (DSM-V)	IDA-R	ADHD sample; healthy control sample
Brevik et al. (2020), Norway	all=1554 adhd =646 controls =908	age_adhd_ mean (SD) = 34.0 (10.3); age_controls_mean (SD) = 29.4 (7.8)	45.8 male_adhd in % = 51.5; male_controls in % = 40.1	a.WURS-25; b.ASRS-6 (DSM-V)	ICD-10 diagnosis	ADHD sample; healthy control sample
Brownlie et al. (2012), Canada	all=205	18.88 (0.39)	65.8	AAPS	Childhood ADHD status (Child Behavior Checklist (CBCL), Conners Teacher Rating Scale)	ADHD sample; healthy control sample
Buchli-Kammermann, J. (2011), Switzerland	all=378	35.06 (10.75)	59.3	a. ASRS-6 (DSM-IV); b. ASRS-18	ADHS-SB, CAARS-R, WIR	ADHD suspected sample

Caterino et. al (2009), USA	all= 115 adhd =56 controls =59 all=112 adhd =55 controls =57	a. 19.6; b. 20.59	52.0 male_adhd in % = 55.0; male_controls in % = 49.0	a. ADHD-scale Form A b. ADHD-scale Form B	expert interview	ADHD sample; healthy control sample
Christiansen et al. (2012), Germany	all=1313 adhd =466 controls =847	35.56	40.5 male_adhd in % = 42.0; male_controls in % = 39.0	CAARS-s:sV	diagnosis via DSM-IV and ICD-10	ADHD sample; healthy control sample; clinical sample
Daigre et. al (2009), Spain	all=80 adhd =16 controls =64	36.15 (10.43)	80.0	ASRS-6 (DSM-IV)	CAADID-II	substance use disorder patients sample
Daigre et. al. (2015), Spain	all=355 adhd = 75 controls =280	36.15 (10.43)	78.3	a. WURS-61; b. ASRS-6 (DSM-IV)	CAADID	alcohol dependent patients' sample
Dakwar et al. (2012), USA	all=102 adhd =25 controls =77	/	83.0	a. ASRS-6 (DSM-IV); b. WURS-25; c. CAARS-s:sV	CAADID	cocaine dependent patients' sample
Das et al. (2016), USA	all=990 adhd =109 controls =881	/	48.0	a. WURS-8; b. WURS-25	ADHD-previous diagnosis CAARS	ADHD suspected sample
Dunlop et al. (2018), USA	all=40 adhd =20 controls =20	49.55	27.5 male_adhd in % = 25.0; male_controls in % = 30.0	ASRS-6 (DSM-V)	MINI	healthy control sample; major depressive disorder patients sample
Dvorsky et al. (2016), USA		20.1	50.0 male_adhd in % = 57.6; male_controls in % = 42.4	a. BAARS-IV (self) - Current symptoms; b. BAARS-IV (self) - childhood symptoms	CAADID	sample of university students

Eich et al. 2012, Switzerland	all=165 adhd =100 controls =65	36.14	62.05 male_adhd in % = 58; male_controls in % = 66.1	ADHD-SCL-90-R	WIR	ADHD sample; control sample of opiate-dependent outpatients without an ADHD diagnosis
Erhardt et al. (1999), Canada + USA	all=78 adhd =39 controls= 39	34.3 (11.6)	59.0 male_adhd in % = 59.0; male_controls in % = 59.0	CAARS-s:sV	Semi-structured interview for adult ADHD	ADHD sample; healthy control sample
Evren et al. (2016), Turkey	all=190 adhd =36 controls= 154		100.0 male_adhd in % = 100.0; male_controls in % = 100.0	a. ASRS-18; b. ASRS-6 (DSM-IV)	adult ADHD scale	alcohol use disorder (AUD) sample
Genc et al. (2021), Turkey	all=136 adhd =68 controls= 68	30.17	46.1 male_adhd in % = 45.6; male_controls in % = 46.6	ASRS-6 (DSM-V)	SCID-5	ADHD sample; clinical control group
Gift et al. (2021), USA	all=487 adhd =137 controls =350	35.37	50.45 male_adhd in % = 67.0; male_controls in % = 33.9	a. WURS-61; b. WURS-25	psychiatric interview: diagnosis after DSM-IV criteria	ADHD sample; major depressive disorder/ generalized anxiety disorder-sample; healthy control sample
Heo et al. (2018), Korea	all=209 adhd =51 controls =158	23.64 (5.91)	52.9 male_adhd in % = 64.7; male_controls in % = 41.1	a. ASRS-18; b. ASRS-6 (DSM-IV)	MINI	ADHD sample; healthy control sample
Hines et al. (2012), USA	all=60 adhd =25 controls= 35	40.1	35.0	ASRS-6 (DSM-IV)	CAARS-S:S	primary care sample
Hong et al. (2019), Korea	all=179 adhd =135 controls= 144	26.7	63.15 male_adhd in % = 68.1; male_controls in % = 58,2	K-AARS	psychiatric interview: diagnosis after DSM-5 criteria	ADHD sample; healthy control sample

Kakubo et al. (2018), Brazil	all=200 adhd =100 controls =100		67 male_adhd in % = 87.0; male_controls in % = 47.0	BADDS	ASRS	drug user sample; healthy control sample
Kessler et al. (2005), USA	all=154			ASRS-6 (DSM-IV)	ADHD rating scale, semi-structured clinical interview for recent DSM-IV adult ADHD, self-report battery	general population
Kessler et al. (2007), USA	all=218 adhd =155 controls =63			ASRS-6 (DSM-IV)	ADHD rating scale, semi-structured clinical interview for recent DSM-IV adult ADHD, self-report battery,	general population
Kiatrungrit et al. (2017), Thailand	all=100 adhd =50 controls =50	37.7 (8.36)	43.6	a. ASRS-6 (DSM-IV); b. ASRS-18	ACDS v1.2	general population
Kivisaari et al. (2012), Finland	all=78 adhd =37 controls= 41	35.2 (10.7)	53.8 male_adhd in % = 56.8; male_controls in % = 48.8	WURS-25	diagnostic interview, DSM-V criteria	ADHD sample; dyslexia sample; healthy control sample
Kouros et al. (2018), Sweden	all=121 adhd =40 controls =81		25.7	WURS-25	CAADID	ADHD sample; borderline personality disorder sample; bipolar disorder sample
Kumar et al (2011), USA	all=110 adhd =6 controls =104	36.6 (11.1)		CAARS-s:sV	K-SAD	psychiatric inpatients sample
Lovett et al. (2021), USA	all=190 adhd = 41 controls =149		13.7	ASRS-6 (DSM-IV)	chart diagnosis: diagnosis through a previous diagnostic interview	undergraduate students sample
Luderer et al. (2019), Germany	all=404	47.6 (10.7)	72.0	a. ASRS-6 (DSM-IV); b. CAARS-s:sV	CAARS	alcohol dependent patients' sample

Luderer et al. (2019), Germany	all=402		72.0	a. ADHS-SB; b. WURS-25	DIVA	alcohol dependent patients' sample
Luty et al. (2009), United Kingdom	all=96 adhd =37 controls =59	37.8 (11.4)	63.0	a. ASRS-6 (DSM-IV); b. CAARS-s:IV; c. WURS-61	expert interview: DSM-IV-multirater-evaluation-form	drug and alcohol dependent patients sample
Manor et al. (2012), Israel	all=103 adhd =79 controls =24	27.6	29.5 male_adhd in % = 26.0; male_controls in % = 33.0	ADHD-SQ	expert diagnosis: clinical history, clinical examination, SCID, WURS	college students: learning disability sample; healthy control sample
Marchant et al. (2015), USA	all=240 adhd =122 controls =120	34.2	60.5 male_adhd in % = 71.0; male_controls in % = 50.0	SR-WRAADS	WRAADS	ADHD sample; normative sample
McCann et al. (2004), USA	all=82 adhd =38 controls =44	37.5 (10.1)	59.45 male_adhd in % = 55.3; male_controls in % = 63.6	a. Symptom Inventory; b. ARS; c. ADSA	semi-structured clinical interview	ADHD sample
Mehringer et al. (2002), USA	all=100 adhd =61 controls =39	33.7 (9.7)	74.0	AHA	DSM-based semi-structured interview	nicotine-dependency sample; cocaine-dependency sample
Oncü et al. (2005), Turkey	all=204 adhd =59 controls =145	28.0 (9.9)	male_adhd in % = 67.8	WURS-25	DSM-IV criteria diagnosis	ADHD sample; depression sample; bipolar affective disorder sample
Paucke et al. (2018), Germany	all=274 adhd =190 controls =84	33.0	62.285 male_adhd in % = 57.9; male_controls in % = 66.67	ADHS-SB and WURS-25 in combination	detailed medical and psychological examination according to the DSM	ADHD suspected sample
Petters-son et al (2018), Sweden	all=108 adhd =60 controls =48	30.2	52.7 male_adhd in % = 53.3; male_controls in % = 52.1	ASRS-6 (DSM-IV)	DIVA 2.0, SCID-I and SCID-II	ADHD suspected sample

Philipp-Wiegmann et al. (2017), Germany	all=324 adhd =45 controls =279	70.06 (7.00)	57.09	ADHD-SB	clinical examination	sensum samples: sample 1: ADHD suspected sample; general sensum sample
Retz-Junginger et al. (2003), Germany	all=1329 adhd =63 controls = 1266	34.12	male_adhd in % = 95.24	WURS-25	specific psychiatric examination	healthy control sample; prison inmates sample; forensic expert reports sample; general psychiatric patients sample; persons in detention sample
Reyes et al. (2019), USA	all=379 adhd =29 controls =350	41.9 (11.7)	65.4	ASRS-6 (DSM-IV)	PRISM	alcohol addicted sample
Richarte et al. (2017), Spain	all=398 adhd =304 controls =94	33.29 (10.50)	66.0	ADHD-RS	SCID-I, CAADID-II	ADHD sample; healthy control sample
Rösler et al. (2004), Germany	all=250 adhd =48 controls =202	30.0 (12.0)	79.6	ADHD-RS	diagnosis after ICD-10, WURS-K	psychiatric expert cases from different jurisdictions sample; psychiatric patients' sample; healthy control sample
Schmidt et al. (2011), Germany	all=366 adhd =183 controls = 183	a. age_adhd_mean (SD) = 32.07 (10.86); age_control_mean (SD) = 43.11 (13.53); b. age_adhd_mean (SD) = 32.75 (9.95); age_control_mean (SD) = 28.21 (9.63)		a. ADHS-E; b. ADHS-LE	diagnosis unspecified	ADHD sample; healthy control sample

Semeijn et al. (2013), Netherlands	all=231 adhd =10 controls = 221	71.6	40.7 male_adhd in % = 4.6	ADHD Screening list	DIVA 2.0	general sensum sample
Solanto et al. (2004), USA	all=103 adhd =70 controls =33	age_control_mean (SD) = 44.39 (10.35)	54.24 male_adhd in % = 60.0; male_controls in % = 48.48	BADDS	Diagnostic interviews after DSM-IV criteria, CAARS	general population
Takeda et al. (2017), Japan	all=1084 adhd =48 controls =1036	age_adhd_mean (SD) = 31.3 (9.5)	51.72 male_adhd in % = 52.08; male_controls in % = 51.35	a. ASRS-18; b. ASRS-6 (DSM-IV)	ASIA	ADHD sample; non-ADHD clinical sample; non-clinical adult sample; non-clinical student sample
Trognon et. al (2022), France	all=220 adhd =110 controls = 110	age_adhd_mean (SD) = 34.09 (9.35); age_control_mean (SD) = 21.6 (2.42)	17.27 male_adhd in % = 17.27; male_controls in % = 17.27	TRAQ10	Previous diagnosis, not specified	general population sample
Ustun et al. (2017), USA	all=337 adhd = 95 controls = 242	33.1 (11.4)		a. ASRS-6 (DSM-V); b. ASRS-6 (DSM-IV)	ACDS	general population sample
van de Glind et al. (2013), Netherlands	all=1286 adhd =148 controls =149	/	74.0	a. ASRS-6 (DSM-IV) (t1); b. ASRS-6 (DSM-IV) (t2)	CAADID	substance use disorder sample
Van Wijk et al (2020)	all=1917 adhd =63 controls =1854	/	58.6	AASS-5	Expert interview	sample of full-time employed adults
Ward et al (1993)	all=228 adhd =81 controls =147	age_adhd_mean (SD) = 30.7 (5.7)	52.61 male_adhd in % = 55.56; male_controls in % = 49,66	WURS-61	Utah criteria diagnosis	ADHD sample; healthy control sample
West et al. (2007)	all=200 adhd = 35 controls =165	37.52	69.0	ADSA	standardized psychiatric structured interview	substance abuse patients' sample

Young et al.(2016), a	all=392 adhd = 268 controls = 124	30.3	100.0	a. BAARS-IV; b. BAARS-IV brief screener	DIVA 2.0	male offenders' sample
Zohar et al. (2010),a	a. + b. all=120 adhd =20 controls =100 c. + d. all=72 adhd =23 controls =49	a. 24.9; b. 24.9; c. 24.8; d. 24.8		a. ASRS-18_PaperPencil; b. ASRS-6_(DSM-IV)_PaperPencil; c. ASRS-18_Computer; d. ASRS-6_(DSM-IV)_Computer	Clinical diagnosis	students' sample

<Table 2: Characteristics of included tests >

Index test	Type of scale	Items	Completion method	Cut-off scores	Score range	Scale development
ASRS-6 (DSM-IV/V)	Self-report of current symptoms	6 after DSM-IV	Symptom frequency is rated on a 5 point Likert scale (0–4)	4/6 or 14/24	0–6 (symptom count) 0–24 (summed)	Based on DSM-IV/DSM-V criteria
ASRS-18	Self-report of current symptoms	18 (2 subscales; 9 inattention + 9 hyperactivity)	Symptom frequency is rated on a 5 point Likert scale (0–4)	9/18 across both subscales Or 21/36 on either subscale	0–18 (symptom count) 72 (summed)	Based on DSM-IV criteria
AASS-5	Self-report of current symptoms	21 items according to DSM-5 Criteria A to D. Items 1–18 (DSM-5 Criterion A), Items 19–21 (Criteria B to D) While updated to DSM-5 criteria	4-point Likert-type scale (anchored with never and often) for 1-18, yes or no for 19-21	Sum totals of 26–33 suggests that ADHD is possible, >33 suggests that ADHD is likely.	/	modified version of the ASRS, updated to be aligned to DSM-5 Criterion A. 3 items added to reflect DSM-5 Criteria B to D to the modified scale, Set A not substantially changed
WURS-4	Self-report of childhood symptoms	4	5-point Likert scale, Not at all or minimal (=0), To a certain extent (=1), Pretty much (=2), Very much (=3), All the time (=4).	>5	0-16	The 4 items included in this study have been adapted from the highest loading items on each factor of the WURS
WURS-8	Self-report of current and childhood symptoms	8	Symptom frequency is rated on a 5 point Likert scale (0–4)	/	0-32	Based on the WURS-61
WURS-25	Self-report of current and childhood symptoms	25	Symptom frequency is rated on a 5 point Likert scale (0–4)	>36 if depression is present >46 if depression is absent	0–100	Based on the WURS-61

WURS-61	Self-report of current and childhood symptoms	61	Symptom frequency is rated on a 5 point Likert scale (0–4)	No cut off scores have been reported owing to the weaker psychometric properties compared with the 25-item scale	0–244	signs and symptoms collected from Wender's 1971 monograph Minimal Brain Dysfunction in Children
CAARS-s:sV	Self-report of current symptoms	26 (20 items in 4 subscales + 12 item ADHD index) Some items tap into both subscales	Symptom frequency is rated on a 4 point Likert scale (0–3)	T > 65	0–78 (T = 0–100)	20 items selected from the 42 subscale items in the long CAARS, that discriminated ADHD the best
CAARS-s:lV	Self-report of current symptoms	66 (42 items in 4 subscales +18 DSM-IV items +12 item ADHD index) Some items tap into more than 1 subscale	Symptom frequency is rated on a 4 point Likert scale (0–3)	T > 65	0–198 (T = 0–100)	Developed 93 items from children's rating scale and Utah criteria in 9 domains. After factor analysis of these 93 items, 42 were chosen.
ADHD-SCL-90-R Screening Scale	Self-report	16 items (2, 9, 10, 11, 24, 26, 28,41, 54, 55, 57, 67, 74, 78, 79, and 81) with a 4-factor structure, including Inattention/Memory Problems, Hyperactivity/Restlessness, Impulsivity/Emotional Lability, and Problems with Self-Concept	5-point Likert scale with a score of 0 (not at all) to 4 (extremely)	19	0-64	Comparison of the SCL-90-R with the CAARS-S:L items; if content matched, items were included.
SCL-ADHD scale	Self-report	9 items (2, 9, 11, 24, 28, 55, 57, 74, and 78)	A total score was formed by summing up the individual item scores.	12	0-36	Selected SCL-90-R items based on the Wender Utah Rating Scale as well as on clinical experience
BAARS-IV	Self-report based on DSM IV diagnostic criteria	27, 18 current and childhood symptoms of ADHD and 9 symptoms of sluggish cognitive tempo	ordinal scale items (0–4)	/	0-108	18 DSM-IV symptoms of ADHD and 9 symptoms of sluggish cognitive

						tempo (e.g., easily confused, slow moving)
BAARS-IV brief screener	Self-report based on DSM IV diagnostic criteria	6 items, three from childhood and three from adulthood	Each item was scored on a simple yes/no basis provides an additive scale ranging from 0 to 6.	cut-off of > 3	0-36	best subset of the BAARS-IV items in a prison sample
K-AARS	Self-report	73 items, which comprised three parts: six clinical subscales with 55 questions, IMP with 6 questions, and a subscale for DR with 12 questions. The six clinical subscales are inattention (IA), hyperactivity (HYP), impulsivity (IM), antisocial personality/conduct behavior/oppositional defiant behavior (ACO), emotional dysregulation (ED), and disorganization (DO)	five-point Likert-type scale with the following responses: never, rarely, sometimes, often, and always. The never response is scored 1 (lowest score) for all questions, and the always response is scored 5 (highest score) for all questions	>132	73-365	Developed through the Korean Academy of Child and Adolescent Psychiatry (KACAP) based on the ASRS
BADDS	Self-report of current symptoms	40 items in 5 subscales: 1.organizing and prioritizing work and activation for work; 2.focusing on tasks, sustaining this focus and shifting attention to tasks; 3.regulating alertness and sustaining effort, and the ensuing processing speed; 4.managing frustration and modulating emotions; and 5.using working memory and accessing recall	Each question has a possible score from 1 to 4. The higher the cluster score and overall score are, the higher the risk is that the individual has ADHD. All individuals who complete the BADDS questionnaire are classified into three groups: i) possible, but unlikely to have ADHD, if the score is less than 40; ii) possible, but unconfirmed ADHD, if the score is between 40 and 54; and iii) highly likely but unconfirmed ADHD, if the score is above 55.	_>50	0-160	Assessment of functional impairment

ADSA	Self-report of current symptoms	54, 9 factors with individual subscales focusing on: Attention, focus, and concentration; Interpersonal; Behavior-disorganized activity; Coordination; Academic-theme; Emotive; Consistency=long-term; Child-hood; and Negative-social	Scored on a 5-point Likert scale	Conservative: 181 Liberal: 161	0-216	established by Santo J. Triolo & Kevin R. Murphy 1996
ADHD-SB	Self-report	22, the ADHD-SB records the psychopathological characteristics of the 3 symptom areas of attention (items 1-9), overactivity (items 10-14) and impulsivity (items 15-18), 4 further items record the age at onset of the disorder, the symptom-specific suffering pressure and the impairments associated with the ADHD symptoms in various areas of life.	4-point Likert scale	>15	0-66	based on the 18 psychopathological characteristics of the DSM-IV for recording the symptoms of adult ADHD and their degree of severity
ADHD-RS	Self-report of current and childhood symptoms	21, 18 adult items (2 subscales; 9 inattention + 9 hyperactivity) + 3 childhood items	The sentences do not start with ''often'', and interviewees are asked about how often the said symptoms have occurred to them during the past 6 months. Each item is scored from 0 to 3 points	For combined ADHD = 24 points, predominantly attention-deficit ADHD = 21	0-54	Based on DSM-5 criteria for ADHD
ADHS-E	Self-report of current symptoms	25 questions after ADHS-SB DSM-IV and others	/	T-Wert > 60	/	Based on the ADHS-LE
ADHS-LE	Self-report of current and childhood symptoms	67 questions after ADHS-SB, correlation with WURS-k DSM-IV and others	/	T-Wert > 60	/	Consideration of the guidelines of the DGPPN, the diagnostic classification systems ICD-10-GM, DSM-IV-TR, the Wender-Utah

						criteria as well as symptoms from everyday clinical practice
ADHD Screening list	Self-report	9, 7 executive functioning items and 2 DSM-IV-TR criteria	Symptom list	2	0-9	Based on the Executive Functioning model. List of the most common complaints considering verbal impulsiveness, working memory, sense and use of time, emotional self-regulation, and planning and forethought
TRAQ10	Self-report	10, two-factors structure for the TRAQ10 questionnaire, with items TRAQ1;2;4;8;10 grouped in the "Attention" factor, and TRAQ3;5;6;7;9 grouped in the "Inhibition/Impulsivity" factor	XGBoost algorithm classifier was constructed based on training set data	/	/	43 preliminary items based on the DSM-5 criteria were administered to 110 ADHD subjects and 110 controls. Then were statistically selected the most discriminating items in regard to the presence or absence of the subject's clinical condition in order to generate the final Trognon & Richard ADHD Questionnaire French 10-items (TRAQ10).
AAPS	Self-report	18 items correspond to the 18 domains of DSM-IV ADHD symptoms	Likert-type scale ranging from 1 (never) to 4 (often). Responses were summed, with a maximum total score of 72.	18-72	48	DSM-IV-based

ADHD-scale Form A + B (Caterino)	Self-report	18 (in 4 scales, self-report of child and adult symptoms)	Rated on a 3 point scale (0–2) in 4 situations – As a child, at work, at home, in social settings	Non presented	0–144	The scale closely followed the ADHD diagnostic criteria that appear in the DSM–IV
ADHD-SQ	Self-report	18, Part-1 includes the items related to the inattentive aspect with 9 items and Part-2 the items related to the Hyperactive-Impulsive aspect with 9 items	/	Non presented	/	Hebrew self-report screening questionnaire (Attention deficit hyperactivity disorder Screening questionnaire based on the DSM-IV criteria, that is similar to the ASRS
SR-WRAADS	Self-report	7	Summation of the 7 symptom domains	Not presented	/	Assessment of the same 7 ADHD domains as in the interviewer administered WRAADS
Symptom Inventory	Self-report	18 items	Each symptom was rated on a 4-point Likert-type scale, ranging from 0 (“not at all”) to 3 (“almost always”).	6 or more of the inattentive symptoms and/or 6 or more of the hyperactivity/impulsivity symptoms would qualify for a diagnosis of ADHD	/	An inventory based on the 18 DSM-IV symptoms of ADHD was developed for clinic use.
ARS	Self-report	25 items	Each item is rated in terms of “how much of a problem each one is for you” on a 4-point scale ranging from 0 (“Not at all”) to 3 (“Very much”)	Not presented	0-75	Based on DSM-III-R criteria for ADHD

AHA	Self-report of current and childhood symptoms	18 (2 subscales of 9 inattention + 9 hyperactivity/ impulsivity items) items from DSM-IV	Symptoms are rated 'Yes' or 'No' as to whether or not they were present in childhood and adulthood	4/9 adult symptoms + 6/ 9 childhood symptoms (on one or both subscales)	0–18	Based on DSM-IV criteria that includes evaluation of both adult and childhood symptoms

<Table 3: Risk of Bias assessment (QUADAS-2)>

Study	ScreeningTool	Risk of bias (QUADAS-2)				Applicability concerns (QUADAS-2)			Risk of bias (QUADAS-C)			
		P	ST	R	FT	P	ST	R	P	ST	R	FT
Abbass, 2020	ADHD-SCL-90-R	✗	✗	✓	✓	✓	✓	✓	-	-	-	-
Baggio, 2021	ASRS-6 (DSM-V)	✓	✗	✓	✓	✓	✓	✓	-	-	-	-
Bakare, 2020	WURS-4	✓	✓	✓	✓	✓	✓	✓	-	-	-	-
Ball-mann, 2022	ASRS-6 (DSM-V)	?	✓	✓	✓	✓	✓	✓	-	-	-	-
Brevik, 2020	a. WURS-25	✓	✗	✓	✓	✓	✓	✓	✓	?	✓	✓
	b. ASRS-6 (DSM-V)	✓	✗	✓	✓	✓	✓	✓	✓	?	✓	✓
Brownlie, 2012	AAPS	✓	✗	✓	?	✓	✓	✗	-	-	-	-
Buchli-Kammermann, 2011	ASRS-6 (DSM-IV) + ASRS-18	✓	✓	✓	✓	✓	✓	✓	-	-	-	-
Caterino, 2009	ADHD-scale Form A + ADHD-scale Form B	✓	✗	✓	✓	✓	✓	✓	-	-	-	-
Christian-sen, 2012	CAARS-s:sV	✗	✓	✓	✓	✓	✓	✓	-	-	-	-
Daigre, 2009	ASRS-6 (DSM-IV)	✗	✗	✓	✓	?	✓	✓	-	-	-	-
Daigre, 2015	a. WURS-61;	✓	✗	✓	✓	?	✓	✓	✓	?	✓	✓
	b. ASRS-6 (DSM-IV)	✓	✗	✓	✓	?	✓	✓	✓	?	✓	✓
Dakwar, 2012	a. ASRS-6 (DSM-IV)	✓	✓	✓	✓	✓	✓	✓	?	✓	✓	✓
	b. WURS-25	✓	✓	✓	✓	✓	✓	✓	?	✓	✓	✓
	c. CAARS-s:sV	✓	✓	✓	✓	✓	✓	✓	?	✓	✓	✓
Das, 2016	a. WURS-8;	✓	✗	?	?	✓	✓	✓	✓	?	?	✓
	b. WURS-25	✓	✗	?	?	✓	✓	✓	✓	?	?	✓
Dunlop, 2018	ASRS-6 (DSM-V)	✗	✓	✓	✓	?	✓	✓	-	-	-	-

Dvorsky, 2016	a. BAARS-IV (self) - Current symptoms + BAARS-IV (self) - childhood symptoms	✓	?	✓	✓	✓	✓	✓	-	-	-	-
Eich, 2012	ADHD-SCL-90-R	?	✗	✓	✓	✓	✓	✓	-	-	-	-
Erhardt, 1999	CAARS-s:sV	?	?	✓	✓	✓	✓	✓	-	-	-	-
Evren, 2016	a. ASRS-18	✓	✗	?	✓	✗	✓	✓	✓	✓	?	✓
	b. ASRS-6 (DSM-IV)	✓	✗	?	✓	✗	✓	✓	✓	✓	?	✓
Genc, 2021	ASRS-6 (DSM-V)	✓	✓	✓	✓	✓	✓	✓	-	-	-	-
Gift, 2021	a. WURS-61	✗	?	✓	✗	✓	✓	✓	?	✗	✓	✓
	b. WURS-25	✗	?	✓	✗	✓	✓	✓	?	✗	✓	✓
Heo, 2018	a. ASRS-18 + b. ASRS-6 (DSM-IV)	✓	?	✓	✓	✓	✓	✓	-	-	-	-
Hines, 2012	ASRS-6 (DSM-IV)	✓	✓	✗	✗	✓	✓	✓	-	-	-	-
Hong, 2019	K-AARS	✗	✗	✓	✓	✓	✓	✓	-	-	-	-
Kakubo, 2018	BADDS	✓	✗	?	✓	✓	✓	✓	-	-	-	-
Kessler, 2005	ASRS-6 (DSM-IV)	✓	?	✓	✓	✓	✓	✓	-	-	-	-
Kessler, 2007	ASRS-6 (DSM-IV)	✓	✗	✓	✓	✓	✓	✓	-	-	-	-
Kiatrun-grit, 2017	a. ASRS-6 (DSM-IV) + b. ASRS-18	✓	✗	✓	✓	✓	✓	✓	-	-	-	-
Kivisaari, 2012	WURS-25	✗	?	✓	?	✓	✓	✓	-	-	-	-
Kouros, 2018	WURS-25	✗	✗	?	✗	✓	✓	?	-	-	-	-
Kumar, 2011	CAARS-s:sV	✓	✓	✓	✗	✓	✓	✗	-	-	-	-
Lovett, 2021	ASRS-6 (DSM-IV)	✓	?	?	✓	✓	✓	✓	-	-	-	-
Luderer, 2019, a	a. ASRS-6 (DSM-IV)	✓	✓	✓	?	?	✓	✓	✓	✓	✓	✓

	b. CAARS-s:sV	✓	✓	✓	?	?	✓	✓	✓	✓	✓	✓
Luderer, 2019, b	a. ADHS-SB;	✓	✗	✓	?	?	✓	✓	✓	✓	✓	✓
	b. WURS-25	✓	✗	✓	?	?	✓	✓	✓	✓	✓	✓
Luty, 2009	a. ASRS-6 (DSM-IV);	✓	✓	✓	✓	?	✓	✓	✓	?	✓	✓
	b. CAARS-s:IV;	✓	?	✓	✓	?	✓	✓	✓	?	✓	✓
	c. WURS-61	✓	✓	✓	✓	?	✓	✓	✓	?	✓	✓
Manor, 2012	ADHD-SQ	✗	✓	✓	?	✓	✓	✓	-	-	-	-
Marchant2015	SR-WRAADS	✗	✓	✓	✓	✓	✓	✓	-	-	-	-
McCann, 2004	a. Symptom Inventory;	✓	?	✓	✓	✓	✓	✓	✓	✓	✓	✓
	b. ARS;	✓	?	✓	✓	✓	✓	✓	✓	✓	✓	✓
	c. ADSA	✓	?	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mehringer, 2002	AHA	✓	✗	✓	✓	?	✓	✓	-	-	-	-
Oncü, 2005	WURS-25	✓	✗	✓	✓	✓	✓	✓	-	-	-	-
Paucke, 2018	ADHS-SB and WURS-25 in combination	✓	?	✓	✓	✓	✓	✓	-	-	-	-
Pettersson, 2018	ASRS-6 (DSM-IV)	✓	✓	✓	✓	✓	✓	✓	-	-	-	-
Philipp-Wiegmann, 2017	ADHD-SB	✓	✗	✓	✓	✓	✓	✓	-	-	-	-
Retz-Junginger, 2003	WURS-25	✗	?	?	?	✓	✓	?	-	-	-	-
Reyes, 2019	ASRS-6 (DSM-IV)	✓	✓	✓	✓	?	✓	✓	-	-	-	-
Richarte, 2017	ADHD-RS	?	✗	✓	✓	✓	✓	✓	-	-	-	-
Rösler, 2004	ADHD-RS	✗	✗	?	✓	✓	✓	✓	-	-	-	-
Schmidt,	a. ADHS-E;	✗	✗	?	?	✓	✓	?	?	✗	✗	?

2011	b. ADHS-LE	✗	✗	?	?	✓	✓	?	?	✗	✗	?
Semeijn, 2013	ADHD Screening list	✓	✗	✓	✓	✓	✓	✓	-	-	-	-
Solanto, 2004	BADDS	✓	?	✓	?	✓	✓	✓	-	-	-	-
Takeda, 2017	a. ASRS-18 + b. ASRS-6 (DSM-IV)	✓	✗	✓	?	✓	✓	✓	-	-	-	-
Trognon, 2022	TRAQ10	✗	?	?	✗	✓	✓	✗	-	-	-	-
Ustun, 2017	a. ASRS-6 (DSM-V)	✓	✗	✓	✓	✓	✓	✓	✓	?	✓	✓
	b. ASRS-6 (DSM-IV)	✓	✗	✓	✓	✓	✓	✓	✓	?	✓	✓
van de Glind, 2013	a. ASRS-6 (DSM-IV) (t1) + b. ASRS-6 (DSM-IV) (t2)	✓	✓	✓	✓	✓	✓	✓	-	-	-	-
Van Wijk, 2020	AASS-5	✓	✗	✓	✓	✓	✓	✓	-	-	-	-
Ward, 1993	WURS-61	?	✗	✓	✗	✓	✓	✓	-	-	-	-
West, 2007	ADSA	✓	✓	✓	✓	?	✓	✓	-	-	-	-
Young, 2016	a. BAARS-IV;	✓	✓	✓	✓	?	✓	✓	✗	?	✓	✓
	b. BAARS-IV brief screener	✓	✗	✓	✓	?	✓	✓	✗	?	✓	✓
Zohar, 2010	a. ASRS-18_PaperPencil + b. ASRS-6_(DSM-IV)_PaperPencil	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✗
	c. ASRS-18_Computer + d. ASRS-6_(DSM-IV)_Computer	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✗

P = patient selection; ST = screening tool; R = reference standard; FT = flow and timing.

✓ indicates low risk; ✗ indicates high risk; ? indicates unclear risk.

<Table 4: Primary and secondary outcome >

Index test	Author, year,	Sensitivity in %	Specificity in %	Application/ Practicability	Effort/ Complexity
ASRS-6 (DSM-IV)	Buchli-Kammermann, J. (2011)	66.6	64.9	SR, simplicity of application	effort: a couple of minutes, simplicity of interpretation
	Daigre et. al (2009)	87.5	68.8	SR, easy to administer	low burden for the patient, simple
	Daigre et. al. (2015)	86.7	66.1	SR	/
	Dakwar et al. (2012)	60.87	85.51	SR	/
	Evren et al. (2016)	75.0	79.0	SR	/
	Heo et al. (2018)	62.7	80.4	SR	/
	Hines et al. (2012)	92.0	69.0	SR, effective screener in a primary care setting, would not impede office productivity	average time it took to complete the ASRS was 54.3 seconds (range, 22–252 seconds) = brief time to administer, easy to complete
	Kessler et al. (2005)	68.7	99.5	SR	easily and quickly (less than 2 minutes)
	Kessler et al. (2007)	64.9	94.0	SR	easily and quickly (less than two minutes)
	Kiatrungrit et al. (2017)	90.91	62.50	SR	/
	Lovett et al. (2021)	66.0	84.0	SR	/
	Luderer et al. (2019)	57.1	97.2	SR	/
	Luty et al. (2009)	89.0	83.0	SR	/
	Pettersson et al (2018)	91.7	27.1	SR	/
	Reyes et al. (2019)	79.3	70.3	SR	/
	Takeda et al. (2017)	67.0	84.0	SR	/

	van de Glind et al. (2013), t1	84.0	66.0	SR	low costs of applying the ASRS (approximately 5 min for the patient to fill out, and less than a minute for a professional to count the result)
	van de Glind et al. (2013), t2	88.0	67.0	SR	low costs of applying the ASRS (approximately 5 min for the patient to fill out, and less than a minute for a professional to count the result)
	Zohar et al. (2010), Paper Pencil	65.0	68.0	SR - paper/pencil vs. Computer based	/
	Zohar et al. (2010) Computer	73.9	62.7	SR - paper/pencil vs. Computer based	/
	Ustun et al. (2017)	84.2	89.5	SR	short, easily scored
ASRS-6 (DSM-V)	Baggio et. al. (2021)	84.3	91.9	SR	/
	Ballmann et al. (2022)	95.6	72.3	SR good feasibility, high acceptability, credibility	short and comprehensible
	Brevik et al. (2020)	98	22	SR	/
	Dunlop et al. (2018)	60	68.6	SR	/
	Genc et al. (2021)	85.1	89.5	SR; practical and effective	/
	Ustun et al. (2017)	91.4	96.0	SR	short, easily scored
ASRS-18	Buchli-Kammermann, J. (2011)	72.3	68.1	SR	/
	Evren et al. (2016)	81.0	75.0	SR	/
	Heo et al. (2018)	70.6	80.4	SR	/
	Kiatrungrit et al. (2017)	90.91	45.0	SR	/
	Takeda et al. (2017)	71.0	74.0	SR	/
	Zohar et al. (2010) Paper Pencil	40.0	78.4	SR - paper/pencil	/

	Zohar et al. (2010) Computer	52.0	73.5	SR - Computer based	/
AASS-5	Van Wijk et al (2020)	95.1	93.8	SR	/
WURS-4	Bakare et. al. (2020)	88.9	11.1	SR	used to quickly and efficiently screen large numbers of the at-risk population of adults (brief administration time of 1-2 minutes, ability to correctly predict a diagnosis of ADHD in adults)
WURS-8	Das et al. (2016)	85.0	78.0	SR	WURS-8 as effective, economical and short screening tool for primary care
WURS-25	Das et al. (2016)	81.0	81.0	SR	/
	Brevik et al. (2020)	75	95	SR	/
	Dakwar et al. (2012)	87.5	75.32	SR	/
	Gift et al. (2021)	91.0	92.0	SR	/
	Kivisaari et al. (2012)	89.0	85.0	SR	/
	Kouros et al. (2018)	88.0	70.0	SR	/
	Oncü et al. (2005)	82.5	90.8	SR	/
	Retz-Junginger et al. (2003)	85.0	76.0	SR	/
	Luderer et al. (2019)	63.1	89.9	SR	/
WURS-61	Gift et al. (2021)	84.0	94.0	SR	/
	Luty et al. (2009)	88.0	70.0	SR	/
	Daigre et. al. (2015)	79.6	60.3	SR	/
	Ward et al (1993)	96.0	96.0	SR	/
CAARS-s:sV	Christiansen et al. (2012)	69.05	85.4	SR, question-naires for use at home	/

	Dakwar et al. (2012)	80.00	90.54	SR	/
	Erhardt et al. (1999)	82.0	87.0	SR	/
	Kumar et al (2011)	83.0	69.0	SR	/
	Luderer et al. (2019)	70.6	94.0	SR	/
CAARS-s:IV	Luty et al. (2009)	97.0	83.0	SR	/
BAARS-IV	Dvorsky et al. (2016) Current symptoms	89.0	30.0	SR	/
	Dvorsky et al. (2016) Childhood symptoms	78.0	39.0	SR	/
	Young et al.(2016)	37.9	96.3	SR	
BAARS-IV brief screener	Young et al.(2016)	82.2	84.0	SR	resource-effective tool for adult males in the criminal justice system
K-AARS	Hong et al.(2019)	80.0	79.9	SR	/
BADDS	Kakubo et al. (2018)	72.4	88.7	SR	/
	Solanto et al. (2004)	92.0	33.0	SR	/
ADSA	West et al. (2007)	71.0	82.0	SR	/
	McCann et al. (2004)	81.0	46.0	SR	/
ADHD-SB	Philipp-Wiegmann et al. (2017)	42.0	94.0	SR	/
	Luderer et al. (2019)	75.3	94.0	SR	/
ADHS-SB and WURS-25 in combination	Paucke et al. (2018)	94.0	56.0	SR	can quickly provide initial indications of the additional presence of ADHD and thus significantly improve diagnostic certainty with relatively little time expenditure
ADHD-RS	Richarte et al. (2017)	81.90	74.7	SR	/

	Rösler et al. (2004)	88.0	67.0	SR	5-7 min
ADHD-SCL-90-R Screening Scale	Abass et al. (2020)	77.6	56.2	SR	/
SCL-ADHD scale	Eich et al. (2012)	75.0	54.0	SR	/
ADHS-E	Schmidt et al. (2011)	91.0	87.0	SR	/
ADHS-LE	Schmidt et al. (2011)	95.0	83.0	SR	/
ADHD Screening list	Semeijn et al. (2013)	80.0	77.0	SR	/
TRAQ10	Trognon et. al (2022)	97	100	SR	could facilitate the professional's diagnostic process of ADHD, given its automated design, allowing it to be used during a consultation without the need to manually calculate results or use statistical tables -> gain of time, less susceptible to human error, and directly implementable
AAPS	Brownlie et al. (2012)	62	89	SR	/
ADHD-scale Form A,	Caterino et. al (2009)	95.0	86.0	SR	easy-to-answer self-evaluation instrument, comprehensive
ADHD-scale, Form B	Caterino et. al (2009)	93.0	88.0	SR	easy-to-answer self-evaluation instrument, comprehensive
ADHD-SQ	Manor et al. (2012)	45.8	94.9	SR	/
SR-WRAADS	Marchant et al. (2015)	97.0	89.0	SR	/
Symptom Inventory	McCann et al. (2004)	78.4	53.5	SR	/
ARS	McCann et al. (2004)	91.9	32.6	SR	/
AHA	Mehringer et al. (2002)	80.0	60.0	SR	/

<Table 5: Pooled sensitivity, specificity and (Area Under the Curve) AUC>

Test	Sensitivity [95% CI]	Specificity [95% CI]	AUC	Heterogeneity I2
all	0.801 [0.773-0.826]	0,894 [0.826-0.78]	0.87	3.3 - 6.6 %
WURS-25	0.855 [0.801-0.896]	0.832 [0.868-0.789]	0.906	3.1 - 3.6 %
CAARS-s:sV	0.855 [0.78-0.91]	0.78 [0.81-0.74]	0.84	2.4-2.7 %
ASRS-6 DSM V	0.83 [0.67-0.92]	0.87 [0.93-0.8],	0.92	8.6-12.3 %
ASRS-18	0.705 [0.658-0.748]	0.703 [0.759-0.64]	0.757	1.3 - 1.4 %

<Table 6: Correlation of cut-offs and sensitivity, specificity, AUC>

Cut-off	Sensitivity [95% CI]	Specificity [95% CI]	AUC	Heterogeneity I2
high	0.713 [0.640-0.776]	0.827 [0.885-0.746],	0.827	1.9-2 %
medium	0.804 [0.765-0.839]	0.819 [0.819-0.785]	0.879	6.9 - 8.9 %
low	0.806 [0.755-0.848]	0.808 [0.845-0.764]	0.874	2-2.2 %

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