Diagnosis of Attention-Deficit/Hyperactivity Disorder in Adults

A Systematic Review

# Abstract

**Objectives.** This evidence report synthesizes the results of evaluations of available tools for diagnosing attention deficit/hyperactivity disorder in adults to inform patients, clinicians, and policy makers.

**Review methods.** Following a detailed published protocol and informed by a technical expert panel, we reviewed the evidence for diagnostic tools. In October 2024, we searched nine research databases from inception, research and guideline registries, reference-mined existing reviews and practice guidelines, and consulted with experts to identify evaluations that compared tools used for the diagnosis of ADHD in people of 18 years or older to a clinical diagnosis. The review will be updated during peer review. Registration CRD42025638106.

**Results.** We identified 117 studies evaluating the diagnostic performance of self-report questionnaires, peer review questionnaires, neuropsychological tests, neuroimaging, electroencephalogram (EEG), diverse biomarkers, clinician tools, combinations of modalities, and tools to identify feigning ADHD.

We found few direct performance comparisons between tests; the strength of evidence (SoE) was often insufficient for evidence statements. There was low SoE for lower clinical misdiagnosis rates (false positive rate in clinical samples) for self-report versus both clinician tools and neuropsychological tests, and for combinations of input versus neuropsychological tests alone. For sensitivity, results favored self-report and combinations of input over neuropsychological tests alone and studies found no difference between self-reports and clinician tools. For specificity, results favored combinations of input over neuropsychological tests alone, and self-reports over clinician tools.

Combinations of input indicated a fair rate of clinical false positive rates, good sensitivity, and acceptable specificity. Self-reports showed good sensitivity and specificity, but often not both in the same study; administration time was short, but agreement with other raters was limited. Peer reports showed limited specificity. Neuropsychological tests reported substantial false positive rates in clinical samples, acceptable sensitivity and specificity, and short administration times. The small number of neuroimaging studies and EEG studies reported acceptable sensitivity and specificity, and short administration time. Clinician tools reported fair sensitivity. All results were rated low SoE. Results for all other key outcomes (e.g., diagnostic concordance between primary care clinicians and specialists) were rated insufficient, either due to lack of studies or wide variation in results.

**Conclusions.** A substantial volume of research for diagnostic performance of tests for ADHD in adults exists, in particular for self-report questionnaires and neuropsychological tests. Multiple different diagnostic modalities have been explored and combinations of input appear particularly promising. Despite the volume, evidence was insufficient for several key outcomes. Performance is associated with the comparator and whether diagnostic tools aim to distinguish between adults with ADHD and neurotypical adults, or adults with other clinical conditions.

# Introduction

## Background

Attention-deficit/hyperactivity disorder (ADHD) is characterized by persistent symptoms in the domains of inattention, hyperactivity, and impulsivity that often begin in childhood.1 Clinically significant symptoms, especially inattention, persist into adulthood in most individuals.1-5 The lifetime prevalence of ADHD is approximately 5.3%,6 although epidemiological studies that have not required a childhood onset have suggested that its prevalence in adults may be as high as seven percent.7-10 Many adults with ADHD adopt lifestyles that help compensate for their symptoms, they often need to exert excess energy to overcome impairments. Impaired productivity because of poor time management, procrastination, and distractibility can limit work productivity and lower overall quality of life.11 Affected adults are often distressed by their inability to realize their full potential and by persistent symptoms of restlessness, erratic moods, and poor self-esteem.11, 12

ADHD is most often first diagnosed in elementary or middle school age years or, less commonly, in high school or college when increasing academic demands surpass the attentional capacities of the affected person. ADHD can also be first diagnosed in adulthood, when impairments in attention, organization, and impulsivity produce recurrent problems with occupational, social, or family functioning. Adult diagnosis is often difficult because the outward manifestations most readily evident to others, especially hyperactivity and impulsivity, often improve during adolescence and no longer meet diagnostic criteria.13 The symptoms of inattention (e.g., easy distractibility, poor organization, being “spacey,” avoiding and trouble completing tasks that require sustained attention, losing things, forgetfulness) are more subtle and may not reach the level of obvious functional impairment until adulthood, within an occupational setting or a marriage.

The diagnosis of ADHD in adults, as in childhood, is complicated by the overlap of symptoms with other disorders.14, 15 Attention and concentration, for example, can be impaired in persons who have depression, bipolar disorder, anxiety, psychosis, post-traumatic stress disorder, or substance abuse, or in adults who need to perform well in an overdemanding environment or who are highly stressed16 or sleep-deprived. Hyperactivity can be confused with anxiety-related behaviors and the excessive movements of tic and obsessive-compulsive disorders. Impulsivity is often prominent in bipolar and substance use disorders. The accurate diagnosis of adult ADHD is further complicated by individuals who seek stimulant medications to aid cognitive performance, especially college students and highly driven working professionals.17 Stimulants have long been known to improve sustained attention and reduce distractibility in healthy individuals who do not have ADHD,18-22 which may prompt success-oriented individuals to feign symptoms in diagnostic interviews, self-reports, or neuropsychological test assessments to obtain stimulant medications, and some students feign illness to receive academic accommodations, such as extended time on tests, tutoring services, and alternative courses that can improve their grades.

Claims of exceptional diagnostic performance of these tools, the differing measures of performance, and the differing performance characteristics of different versions of a given tool,23 are controversial and often confusing to clinicians, patients, and other stakeholders. In addition, whether the performance of diagnostic tools varies with the characteristics of the participants with ADHD or comparator sample is unknown.24 These diagnostic challenges can complicate the accurate and reliable diagnosis of adult ADHD even for experienced mental health clinicians.

Thus, despite established criteria in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), diagnosing ADHD in adults remains challenging due to the frequent absence of hyperactivity and impulsivity symptoms, the subtlety of inattention symptoms, the inaccuracy of recall in adults for their retrospective assessments of ADHD symptoms in childhood (required to meet DSM-5 diagnostic criteria), the common symptom overlap with other mental health conditions,13-15 and the large number of individuals,17-22 including healthy college students,25, 26 who feign symptoms to obtain stimulant medications. Moreover, the DSM-5 diagnostic criteria, developed primarily for children, may not be equally suitable for adult diagnosis, and its requirement that symptoms begin before age 12 has been debated.27-31 The absence of a true and undisputed “gold-standard” to verify an ADHD diagnosis, the variability in performance of diagnostic tools among clinicians and settings, and the lack of clear practice guidelines further add to diagnostic complexity.32-35

Furthermore, the diagnosis of ADHD in adults is often made not by mental health specialists, but by primary care physicians and nurse practitioners,36 who may benefit particularly from accurate diagnostic aids. Further, the dispensing of ADHD medications to adults has increased steadily over time.30 The accuracy of diagnosis directly affects the management and treatment of ADHD and may help prevent medication misuse, highlighting the need for effective diagnostic tools and guidelines. The existing standards and guidelines for diagnosing ADHD in adults are limited, however, and the use of diagnostic tools and assessments varies widely in practice.37-39 No clinical practice guidelines for the diagnosis of adults with ADHD have thus far been developed in the United States, though one is in development.40 Moreover, the diagnostic accuracy of tools and assessments used in adult ADHD diagnosis is unclear, and their performance may vary depending on the characteristics of the ADHD participants and comparator samples.23, 24

## Purpose and Scope

This systematic review aims to provide a comprehensive and unbiased assessment of diagnostic tools used to diagnose ADHD in adults to inform patients, clinicians, and policy makers. Commissioned by the Food and Drug Administration (FDA), this Agency for Healthcare Research and Quality (AHRQ) report documents the evidence for the diagnostic performance of existing tools for ADHD. We explore the effects of setting and participant characteristics that may influence the diagnostic performance of available tools. A contextual question is which tools are frequently being used in current clinical practice.

# Methods

The systematic review followed a protocol that outlines the methods in detail.41 The methodology followed the EPC Methods Guide.42 The review is registered as CRD42025638106. The project was supported by a technical expert panel (TEP) to provide different perspectives of a broad group of interest holders to ensure the evidence report is relevant to a large audience. The panel included multi-disciplinary experts in adult ADHD and well as advocates considering the needs of affected patients as well as family members.

## Key Questions

The systematic review was guided by the following key questions:

* Key Question 1. What is the comparative diagnostic accuracy, unintended consequences, and impact of tools that can be used in the primary care practice setting or by specialists to diagnose ADHD among adults?
  + Key Question 1a: How does the comparative diagnostic accuracy of these tools vary by clinical setting, including primary care or specialty clinic, or patient characteristics, including age, sex, cultural background, and risk factors associated with ADHD?

In addition, a contextual question provided additional information:

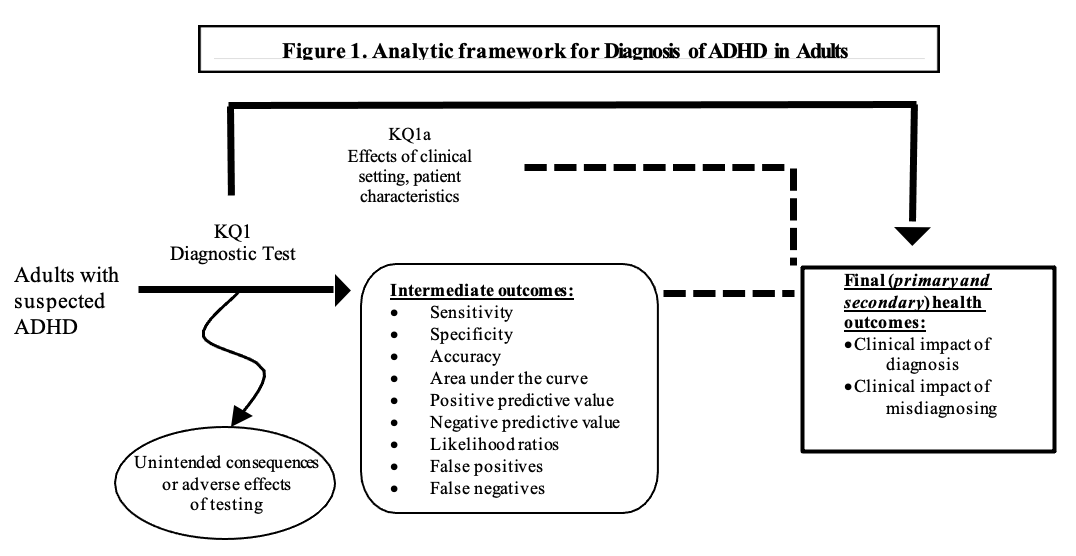
* Contextual Question. How frequently are the various tools to diagnose ADHD in adults currently being used?

We addressed the key question in a systematic review documented in detail in the result chapter. Information pertaining to the context question was incorporated into the discussion.

## Logic Model

Figure 1 illustrates the scope of the review.

Figure 1. Logic Model for Diagnosis of ADHD in Adults



A diagram of a diagram AI-generated content may be incorrect.

Notes: ADHD attention deficit hyperactivity disorder, KQ key question

The model shows the population of interest (adults with suspected ADHD) and depicts the key question (diagnostic test performance) and sub-question (effect modifiers). The model also shows outcomes, ranging from side effects of the testing modality (e.g., relevant for invasive tests), to intermediate outcomes such as the diagnostic accuracy established in the study, to final outcomes such as the impact of a diagnosing or misdiagnosing ADHD.

## Search Strategy

The literature search used a combination of known tests to diagnose ADHD and general search terms for diagnostic accuracy studies to identify novel tools. In October 2024 we searched PubMed (biomedical literature), EMBASE (pharmacology emphasis), and PsycINFO (psychological research) without search date restriction and restricted to English language. The search strategy was peer reviewed within the EPC program. We used existing reviews for reference-mining; these were identified through the same databases plus searching the Cochrane Database of Systematic Reviews, Campbell Collaboration, and PROSPERO. We also searched the ECRI repository, G-I-N, and ClinicalKey for published guidelines and used these for reference-mining cited literature. All searches will be updated during the public comment period.

In addition, we leveraged technical experts to ensure that relevant research studies had been identified. We provided a list of included studies, together with all associated publications, and a list of excluded studies to facilitate this process. A Supplemental Evidence And Data for Systematic Reviews (SEADs) portal was available from January 10 to February 4 2025 for this review. Additional data and publications suggested to us from any source, including peer and public review, will be screened applying the outlined eligibility criteria. The search will be updated during peer review.

## Inclusion/Exclusion Criteria

The eligibility criteria for this review are shown in Table 1.

Table 1. Eligibility Criteria

|  | **Inclusion Criteria** | **Exclusion Criteria** |
| --- | --- | --- |
| Population | Adults 18 years and older with symptoms of ADHD and without the diagnosis of ADHD; studies reporting on broader age samples, had to report separately for adults | Individuals 17 years of age or younger unless findings are reported separately for older participants |
| Intervention | Any ADHD diagnostic tool used for the diagnosis of ADHD in adults | Studies not reporting on diagnostic performance; non-English language questionnaires and interview guides |
| Comparator | Confirmation of diagnosis by a specialist (reference standard), such as a psychologist, psychiatrist or other healthcare provider using a well validated and reliable process of confirming a clinical diagnosis of ADHD | Comparison to diagnosis with another diagnostic instrument |
| Outcome | Diagnostic accuracy (e.g., sensitivity, specificity, accuracy, area under the curve, positive predictive value, negative predictive value, likelihood ratios, false positives, false negatives); unintended consequences and impact associated with diagnosing ADHD | Provider opinion of tests, cost without performance measure |
| Timing | Diagnostic follow-up must be completed before treatment is initiated | Any other timing |
| Setting | Primary or specialty care settings, including telehealth | Settings where diagnosis is for nonclinical or not research purposes |
| Study Design | Diagnostic accuracy studies | Editorials, nonsystematic reviews, letters, case series, case reports, pre-post studies.  Systematic reviews were not eligible for inclusion but were retained for reference mining |

Included ADHD tests were not limited to a set of pre-specified tools; instead, the review documents all tools that have been evaluated in the scientific literature and for which diagnostic accuracy evidence exists. Studies had to compare to a clinical diagnosis made by a clinician in a formal diagnostic interview, typically enhanced by information from patient questionnaires. We searched databases from inception and we did not apply any publication date restrictions. Studies with data exclusively published in non-English language publications were excluded to ensure transparency. We obtained all published reports providing data on a study (a study is defined by the included participants), including trial records and multiple publications, and consolidated the information into one study record.

### Screening Process

We used an online database designed for systematic reviews to screen the literature search output. The team designed detailed citation and full text screening forms to ensure a transparent, consistent, and unambiguous approach. All citations were screened by two independent literature reviewers. Citations found to be potentially relevant by at least one reviewer were obtained as full text. All citations were also screened by a DistillerSR software machine learning algorithm trained by the human reviewers to ensure that no relevant citation was missed. Any citations identified as potentially relevant by the algorithm that were not selected for full text publication review were rescreened for relevance by an independent literature reviewer.

Full text screening applied the detailed eligibility criteria. Training ensured a shared understanding of all inclusion and exclusion criteria. Full text publications were screened by two independent reviewers to reduce errors and bias, and any discrepancy was resolved through discussion in the review team. The screening decisions and reasons for exclusion of publications were tracked in the online database and citation management software. These citations were shared with the technical expert panel and were documented with the review to ensure that the literature flow was transparent and objective.

## Data Extraction and Abstraction

We captured detailed information about eligible studies. One literature reviewer extracted data and categorized information where relevant, and an experienced methodologist checked the data for accuracy and completeness. We designed and pilot tested a detailed form in the software DistillerSR to ensure accuracy and minimize ambiguity.

The data abstraction documented the targeted population and characteristics of all included participants (participants with ADHD and those without). We documented the clinical setting, method of establishing the reference standard (a clinical ADHD diagnosis), and diagnostic tool characteristics (format, name of the tool, employed cut offs, use of a training and validation set). We collected data for a diagnostic meta-analysis where possible (i.e., number of false positives, number of false negatives) along with the summary diagnosis accuracy measures reported by the authors such as sensitivity, specificity, area under the curve, positive predictive value. We differentiated between the diagnostic accuracy to diagnose ADHD and the diagnostic accuracy to detect faking ADHD. For all studies reporting multiple results, we selected the best accuracy performance model (either based on the authors’ opinion, accuracy data, or trying to maximize sensitivity and specificity simultaneously).

## 2.6 Risk of Bias Assessment

The critical appraisal for individual studies applied criteria consistent with QUADAS 2.43 QUADAS-2 evaluates four domains: *patient selection*, *index test* characteristics, *reference standard* quality, as well as *flow and timing:*

* Patient selection: The domain addresses whether the selection of patients could have introduced bias, taking into account whether the study enrolled a consecutive or random sample, whether the data are not based on a retrospective case-control design, and whether the study avoided inappropriate or problematic exclusions from the patient pool.
* Index test: The domain evaluates whether the conduct or interpretation of the test could have introduced bias, taking into account whether the results of the test were interpreted without knowledge of the results of the reference standard and whether any thresholds or cut-offs were pre-specified (e.g., instead of determined during the study to maximize diagnostic performance).
* Reference standard: The domain evaluates whether the reference standard, its conduct, or its interpretation may have introduced bias, taking into account the quality of the reference standard in correctly classifying the condition and whether the reference standard test results were interpreted without knowledge of the results of the index test.
* Flow and timing: The last domain evaluates whether the conduct of the study may have introduced bias. The assessment takes into account whether the interval between the test and the reference standard was appropriate, whether all patients received the reference standard and whether they received the same reference standard, and whether all patients were included in the analysis.

For each domain, we assessed the potential risk of bias in the study to identify high risk of bias and low risk of bias studies. One literature reviewer assessed risk of bias, and a methodologist reviewed individual studies and rating across studies to ensure accuracy and consistency of ratings. As outlined in the applicability section, we also evaluated for each study and appraisal domain whether there were concerns regarding the applicability of the study results to the review question. This encompassed whether the patients included in the studies matched the review question; whether the test, its conduct, or interpretation differed from the review question; or whether the target condition as defined by the reference standard fully matched the review question. The information was incorporated into the strength of evidence assessment.

## Assessing Applicability

Results are based on the international literature and applicability ratings provided assessments regarding the generalizability of samples, settings, and tool results for U.S. clinical practice. For each study, we assessed the population included in the study to identify studies with narrow eligibility criteria (e.g., looking for a specific subgroup of ADHD participants only), studies that excluded participants with comorbidities, or studies that had more complex participants than typically seen in the community (e.g., dually diagnosed participants). We assessed whether studies described tools not used as recommended or commonly used in practice, the presence of highly trained test team or set up (e.g., analysis via complex machine learning models), or assessors that were not qualified for the assessment. We assessed whether the reference standard was ambiguous, different from standard clinical practice, or insufficiently described.

## Data Synthesis and Analysis

We answered the key question with the available evidence. We broadly differentiated diagnostic tools as

* Self-report questionnaires
* Peer report questionnaires
* Neuropsychological tests
* Neuroimaging
* EEG
* Biomarker
* Observational data
* Clinician tools
* Combination predictions using more than one modality
* Tests to detect feigning of ADHD

We documented comparative effect results where studies compared the performance of more than one tool. In addition, we documented the range of results reported in studies within each tool category (e.g., self-reports). We documented the diagnostic accuracy results for all outcomes as reported by the authors in the individual studies. Sensitivity estimates were documented together with specificity estimates given that the estimates are not independent. A detailed evidence table displays key characteristics, the reference standard, psychometric properties and diagnostic accuracy outcomes for all included studies. In addition, we identified the number of true positives, true negatives, false positives, and false negatives where clearly reported for use in a diagnostic meta-analysis. All studies were considered for the narrative synthesis accompanying the summary of findings table.

We documented the results for available diagnostic tools across studies in a comprehensive summary of findings table documenting all assessed outcomes related to the diagnostic accuracy, reliability, and impact of the tool. Key outcomes for the summary of findings table were determined with the help of the TEP:

* Clinical misdiagnosis (risk of missed condition that can appear as ADHD)
* Sensitivity
* Specificity
* Administration and scoring time
* Inter-rater reliability
* Costs
* Diagnostic concordance of primary care provider with specialist

The synthesis took study limitations and the risk of bias of individual studies contributing to estimates into account. We determined whether summary estimates corresponded to data reported in low risk of bias studies or were primarily based on high risk of studies.

To address the sub-question, we reported on subgroup results for different clinical settings (differentiating general and specialty care settings), patient characteristics (differentiating sex, age, cultural background, and comorbidity groups), and ADHD presentation (differentiating predominantly inattentive, hyperactive-impulsive, combined). We assessed whether these variables can explain heterogeneity identified in results across studies.

To address the contextual question, we documented the frequency of identified research for each individual tool. In addition, we summarized data sources that reported on the frequency of tool use in clinical practice with emphasis on the U.S. healthcare setting in the discussion.

## Grading the Strength of the Body of Evidence

We applied the EPC strength of evidence criteria to evaluate the body of evidence. In determining the quality of the body of evidence, the following domains were evaluated:

* Study limitations: The extent to which studies reporting on a particular outcome for a specific test were likely to be protected from bias. The aggregate risk of bias across individual studies reporting an outcome was considered; graded as low, medium, or high level of study limitations.
* Inconsistency: The extent to which studies reported the same direction and/or magnitude of effects for a particular outcome; graded as consistent, inconsistent, or unknown (in the case of a single study or the absence of studies).
* Indirectness: Determines whether the test and the comparator were directly (i.e., within studies) or indirectly (e.g., across studies) compared. The domain was graded as direct or indirect.
* Imprecision: Describes the level of certainty of the estimate of effect for a particular outcome, where a precise estimate is one that allows a clinically useful conclusion. The domain was graded as precise or imprecise.
* Reporting bias: Publication bias, selective outcome reporting, and selective analysis reporting are types of reporting bias. Reporting bias is difficult to assess as systematic identification of unpublished evidence is challenging.

A final strength of evidence grade for each evidence statement was assigned by evaluating and weighing the combined results of the above domains. We formulated comparative evidence statements based on direct comparisons of tests within studies. For all other tests, we evaluated the magnitude of the effects for the outcomes of interest. Given that most outcomes showed some variation and a precise pooled estimate was not available, we broadly characterized the magnitude as follows based on the observed performance and published suggestions:

* Clinical misdiagnosis: low (<5%), fair (<20-5%), substantial (20-60%) rate
* Sensitivity and specificity: limited (<80%); poor (<69%), fair (70-79%), acceptable (80-89%), good (90-95%), excellent (96-100%)
* Administration and scoring time: short (<30 minutes)
* Rater agreement: limited (kappa <0.8, correlations <0.40)
* Costs and concordance: N/A

We differentiated an overall grade of high, moderate, low, or insufficient according to a four-level scale:

* High: We are very confident that the estimate of effect lies close to the true effect for this outcome. The body of evidence has few or no deficiencies. We believe that the findings are stable (i.e., another study would not change the conclusions).
* Moderate: We are moderately confident that the estimate of effect lies close to the true effect for this outcome. The body of evidence has some deficiencies. We believe that the findings are likely to be stable, but some doubt remains.
* Low: We have limited confidence that the estimate of effect lies close to the true effect for this outcome. The body of evidence has major or numerous deficiencies (or both). We believe that additional evidence is needed before concluding either that the findings are stable or that the estimate of effect is close to the true effect.
* Insufficient: We have no evidence, we are unable to estimate an effect, or we have no confidence in the estimate of effect for this outcome. No evidence is available, or the body of evidence has unacceptable deficiencies, precluding reaching a conclusion.

The summary of findings table included the reasons for downgrading or upgrading the strength of evidence. The strength of evidence assessment documented uncertainty and communicated our confidence in the evidence statements that can be drawn from the literature.

# Results

The chapter is organized by the literature search results, the comparative diagnostic accuracy, results for individual tests, reporting on the diagnostic accuracy, unintended consequences, and information on the impact associated testing.

## Results of Literature Search

The flow diagram documents the literature flow of the systematic review.

Figure 2. Literature Flow Diagram

We identified 117 studies meeting inclusion criteria reported in 121 publications.44-164 The earliest identified study was published in 1997.135 Studies evaluated tools in Brazil, Canada, China, Denmark, Germany, Greece, India, Ireland, Israel, Korea, the Netherlands, Norway, Sweden, Switzerland, Turkey, UK, USA, or combined evaluations in multiple countries. Sample sizes varied widely, from a dozen participants to large samples with over a thousand participants.48, 121, 153 Studies included participants diagnosed with ADHD and compared to different non-ADHD samples. These included neurotypical adults not diagnosed with ADHD, adults from a clinical sample evaluated or diagnosed for another clinical condition, and/or adults feigning ADHD. Half of the included studies (51%) incorporated a neurotypical group of adults that did not meet criteria for ADHD, and in some cases, were also selected specifically because they also never had a childhood diagnosis of ADHD. Many studies (40%) compared participants with a diagnosis of ADHD to a clinical sample of participants who were being evaluated for another clinical condition. In addition, two studies each (1%) compared to participants with autism,78, 122 conduct disorder or anger dysregulation,88, 98 or depression,119, 130 respectively. A quarter (23%) of the identified studies included participants identified or specifically trained to pretend to have ADHD. Studies varied in whether they included an additional group (e.g., a neurotypical or clinical sample), but some studies included only participants feigning ADHD, which were compared to participants with a diagnosis of ADHD.44, 127, 133, 134

The risk of bias across studies is shown in figure 3.

Figure 3. Risk of Bias

Nearly half of the identified studies demonstrated high risk of bias in patient selection, indicating prevalent issues with how participants were recruited and selected across the evidence base. Almost two thirds of studies exhibited high risk of bias in the index test domain, indicating widespread concerns about how diagnostic tools were applied and interpreted. The reference standard domain showed the most favorable profile, with about 60 percent of studies at low risk of bias and about 20 percent at high risk, suggesting relatively good quality in how the diagnostic “gold standard” was implemented. The flow and timing domain shows that nearly 60 percent of studies showed high risk of bias in flow and timing, indicating significant concerns about the sequence and intervals of test administration and analysis.

The applicability assessment assessing the generalizability of study results identified in this review is summarized in figure 4.

Figure 4. Applicability to Routine Practice of Reported Results

Few studies had no applicability concerns regarding population, with most studies having narrow eligibility criteria or including more complex patients than typical of community settings. Half the studies had no applicability concerns regarding the test, though many others used tests not common in current practice, or they employed highly selected teams not representative of typical clinical settings. About half of the studies had no applicability concerns for the reference standard, with the remaining studies showing unclear DSM-5 diagnostic criteria or other reference standard issues limiting generalizability. Half the studies indicated no applicability concerns regarding outcomes, with many others using surrogate outcomes that may not directly translate to clinical practice. Most studies had applicability concerns regarding setting, with the vast majority conducted in care levels different from community settings, limiting their generalizability to routine practice.

Identified studies reported on self-report questionnaires, peer review tools, neuropsychological tests, neuroimaging, electroencephalogram (EEG), diverse biomarkers, clinician tools, combinations of modalities, and tools to identify feigning ADHD. Studies reported on the success of identifying ADHD, success in identifying feigning and exaggerating of ADHD symptoms, or both.

3.2 Results of Key Question 1: What is the comparative diagnostic accuracy, unintended consequences, and impact of tools that can be used in the primary care practice setting or by specialists to diagnose ADHD among adults?

We identified numerous studies that included multiple tools used alone or in combination. However, not all studies reported diagnostic performance for all tools and combinations, and only selected studies allowed direct comparisons.

The 11 studies with head-to-head comparisons between modalities compared primarily self-report questionnaires with other modalities, including parent ratings,122 peer reports,65, 98 a combination of self and other ratings,65, 98, 154 neuropsychological tests,98, 145 a combination of self-report and EEG;132 and clinician tools.98, 100 Three studies compared neuropsychological test results to combinations of input;78, 119, 123 one compared a neuropsychological test and one compared EEG data under Go/NoGo task conditions with task performance indicators.54 Table 2 documents the results for key outcomes for the comparative studies.

Table 2. Comparative Studies

| **Study ID**  **Participants** | **Self-report** | **Peer rating** | **Combined prediction** | **Neuropsychological tests** | **EEG** | **Clinician interview** |
| --- | --- | --- | --- | --- | --- | --- |
| Biederman, 201754  N = 60  n ADHD = 36  Specialty care | N/A | N/A | N/A | Go/NoGo task errors, participants were seated in a dimly lit room at a distance of 70 cm from a 17-inch CRT screen; Go stimuli were white letters appearing in equal proportions, the NoGo stimulus was a white x symbol, stimuli were presented on the center of a black background computer screen for 150 ms and were located between 2 vertical white lines, 10 trial practice block, analyzed reaction time, error rates (commission and misses)  **Clinical misdiagnosis**: N/A  **Sensitivity**:N/A  **Specificity**: N/A  AUC 0.67  **Admin time**: 12 minutes across all tests.  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | Event-related potential data to analyze brain activity patterns during Go/NoGo task, Go condition  **Clinical misdiagnosis**: 5%  **Sensitivity:** Go condition 86%; NoGo condition: 76%; cross-validation data: NoGo 68%, Go 62%  **Specificity**: Go condition 95%, NoGo condition: 91%; cross-validation data: NoGo 80%, Go 69%  **PPV**: cross-validation data: NoGo 0.77, Go 0.69  **NPV**: cross-validation data: NoGo 0.72, Go 0.65  **Admin time**: 12 minutes across all tests.  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A |
| Dvorsky, 201665  N = 86 college studients with suspected or previously diagnosed ADHD and interested in special accommodations.  n ADHD = 59  n non-ADHD with internalizing disorder = 27  College | BAARS-IV (Barkley Adult ADHD Rating Scale-IV) for self-reported assessment of ADHD symptoms on a 4-point scale (0 = never or rarely to 3 = very often), cut off > 3 symptoms presence  **Clinical misdiagnosis**: N/A  **Sensitivity**: 89%  **Specificity**: 30%  **Admin time**: N/A  **Rater reliability**: BAARS-IV self-report vs BAARS-IV parent ratings Parent ratings compared against student self-reports Current inattention ICC 0.43, current hyperactivity ICC  **Costs**: N/A  **Concordance**: N/A | BAARS-IV (Barkley Adult ADHD Rating Scale-IV) parent report  **Clinical misdiagnosis**: N/A  **Sensitivity**: 60%  **Specificity**: 77%  **Admin time**: N/A  **Rater reliability**: Parent ratings compared against student self-reports Current inattention ICC 0.43, current hyperactivity ICC 0.31, current impulsivity ICC 0.32, retrospective children inattention ICC 0.42, retrospective childhood hyperactivity/impulsivity ICC 0.37  **Costs**: N/A  **Concordance**: N/A | Combination prediction model with BAARS parent and self rating of current and childhood ADHD diagnosis  **Clinical misdiagnosis**: N/A  **Sensitivity**: 89  **Specificity**: 63  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | N/A | N/A |
| Groom, 201678  N = 57  n ADHD = 33  n ASD = 25  College | CAARS-E (Conners Adult ADHD Rating Scale-subscale E)  **Clinical misdiagnosis**: N/A  **Sensitivity**:  **Specificity**:  AUC: 0.77  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | Integration of CAARS-E (Conners Adult ADHD Rating Scale - ADHD Index) with the AQ10 (Autism Quotient - 10), and the QbTest (computerized Continuous Performance Test with motion tracking)  **Clinical misdiagnosis**: 16% in Autism Spectrum Disorder sample  **Sensitivity**: 94%  **Specificity**: 84%  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | QbTest is a computerized continuous performance test with infra-red motion tracking system, designed to assess attention, impulsivity, and activity levels; participants respond to stimuli on a screen while their movements are tracked, and scores are calculated based on attention accuracy, reaction time, and movement data  **Clinical misdiagnosis**: 20% in Autism Spectrum Disorder sample  **Sensitivity**: 84%  **Specificity**: 80%  UCC: 0.87  **Admin time**: Approximately 20 minutes.  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | N/A |
| Kingston, 201398  N = 120, all in a forensic evaluation, 53.8% in the criminal justice system  n ADHD = 59  no ADHD = 61 | ASRS-v1.1 Part A, a scale based on nosological criteria and pertain to frequency, rather than severity, of ADHD symptoms; Part A comprises 6 screening questions and is considered to be the most predictive of symptoms consistent with ADHD; adminstered together with ASRS-v1.1 Part B, Brown ADD (attention deficit disorder) Scale, CAARS-Self ADHD Index (Connors Adult ADHD Rating Scale, Long Version, Self-Report), and WURS (Wender Utah Rating Scale)  **Clinical misdiagnosis**: 16%  **Sensitivity**: 76% ASRS-v1.1 Part B 66%, Brown ADD Scale 84%, CAARS-Self ADHD Index 63%, WURS 82%  **Specificity**: 84% ASRS-v1.1 Part B 93%, Brown ADD Scale.73%, CAARS-Self ADHD Index.91%, WURS.69%  **Admin time**: N/A  **Rater reliability**: rater agreement between self-report measures (ASRS-v1.1, CAARS-Self, WURS, and Brown ADD Scale) and observer-rated measures (CAARS-Observer) r 0.51  **Costs**: N/A  **Concordance**: N/A | CAARS-O ADHD Index (Observer), observer report  **Clinical misdiagnosis**: 25%  **Sensitivity**: 76%  **Specificity**: 75%  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | Integration of ASRS-v1, CAARS-Self and CAARS-Observer, Brown ADD scale, and WURS in a discriminant function  **Clinical misdiagnosis**: 18%  **Sensitivity**: 91%  **Specificity**: 82%  **Admin time**: N/A  **Rater reliability**:  **Costs**: N/A  **Concordance**: N/A | IVA + Plus FSRCQ (Integrated Visual and Auditory Continuous Performance Test Full Scale Response Control Quotient), a computerized continuous performance test utilizing visual and auditory stimuli to assess response control; constant and sustained attention is required, as participants respond or inhibit their response to 500 counterbalanced trials; FSRCQ measures impulsivity and commission errors, normative quotient scores have a mean of 100 and a standard deviation of 15  **Clinical misdiagnosis**: 26%  **Sensitivity**: 30% IVA + Plus (FSAQ): .39 (.29–.54)  **Specificity**: 74% IVA + Plus (FSAQ): .69 (.53–.82)  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | N/A |
| Kumar, 2011100  N = 110 psychiatric inpatients  n ADHD = 6  n not ADHD = 104 | CAARS-S:SV (Conners' Adult ADHD Rating Scales: Screening Version), 30-item self-report tool that screens for ADHD symptoms in adults, using a 4-point rating scale to assess the frequency of symptoms based on DSM-IV criteria, cut off point wasT score>70  **Clinical misdiagnosis**: 31%  **Sensitivity**: 83%  **Specificity**: 69%  **Admin time**: N/A  **Rater reliability**: Correlation self-report CAARS-S:SV and MINI r 0.58  **Costs**: N/A  **Concordance**: N/A | N/A | N/A | N/A | N/A | MINI (International Neuropsychiatric Interview), a short, structured diagnostic interview designed to assess a range of different mental health disorders  **Clinical misdiagnosis**: 48%  **Sensitivity**: 83%  **Specificity**: 52%  **Admin time**: 10-25 minutes  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A |
| Nikolas, 2019119  N = 246  n ADHD = 109  n Depression and no ADHD = 52  n controls with no ADHD or Depression = 85  Specialty care and community | N/A | N/A | Combination of self/informant symptom ratings (BAARS-IV), family history, and reactiontime variability from TOVA (Test of Variables of Attention)  **Clinical misdiagnosis**: N/A  **Sensitivity**:  **Specificity**:  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | TOVA ommission errors, cutoff <95 as part of a large battery with many exploratory analyses to differentiate ADHD and non-ADHD  **Clinical misdiagnosis**: 15%  **Sensitivity**: 50%  **Specificity**: 85%  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | N/A |
| Palmer, 2023122  N = 71 with Autism Spectrum Disorder  n ADHD and ASD = 40  n ASD but no ADHD = 31  Community | CAARS-S (Conners Adult ADHD Rating Scales Self-Report) ADHD Index assessed ADHD symptoms with a cutoff of ≥56; adminstered together with the SDQ (Strengths and Difficulties Questionnaire), cutoff of ≥9  **Clinical misdiagnosis**: N/A  **Sensitivity**: CAARS 57%; SDQ>9: 28%  **Specificity**: CAARS 81%; SDQ>9: 100%  **AUC**: CAARS 0.70; SDQ>9: 0.65  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | CAARS-P (Conners Adult ADHD Rating Scales Peer Report) parent report, ADHD Index cutoff >56; administered together with ABC (Aberrant Behavior Checklist) Hyperactivity/Non-compliance subscale (a cutoff of ≥3) parent-report  **Clinical misdiagnosis**: N/A  **Sensitivity**: 94% ABC scale: 91%  **Specificity**: 57% ABC scale: 42%  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | N/A | N/A | N/A |
| Pettersson, 2018123  N = 108 outpatients being evaluated for suspected ADHD  n ADHD = 60  n not ADHD = 48  Specialty care | ASRS Screener (Adult ADHD Slef-Report Scale Screener)  **Clinical misdiagnosis**: 8%  **Sensitivity:** 92%  **Specificity:** 27%  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | Model with DIVA report, QbTest cardinal variable Acticity, QbTest cardinal variable Inattention, and CpT II Commission errors, combining neuropsychological tests, DIVA clinician report, and self-report ASRS Screener  **Clinical misdiagnosis**: 17%  **Sensitivity**: 90%  **Specificity**: 83%  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | Model with CPT II Commission errors, QbTest cardinal variable Inattention, and QbTest cardinal variable Activity  **Clinical misdiagnosis**: 33%  **Sensitivity**: 80%; QBTest Act 77%; QBTest Ina 58%; QBTest Omi 73%, QBTest RT Var 43%; PASAT tot 33%; CPT II Com 33%, CPT II Var 27%  **Specificity**: 67%; QBTest Act 44%; QBTest Ina 67%; QBTest Omi 56%, QBTest RT Var 75%; PASAT tot 77%; CPT II Com 92%, CPT II Var 85%  **Admin time**: 20 minutes  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | DIVA (Diagnostic Interview for ADHD in Adults), dichotomized as ADHD if 6 or more symptom criteria in both adulthood and childhood, and in either or both of the domains Attention Deficit and Hyperactivity–Impulsivity, and as non-ADHD if fewer than 6 symptom criteria  **Clinical misdiagnosis**: 27%  **Sensitivity**: 90%  **Specificity**: 73%  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A |
| Robeva, 2004132  N = 12 all female  ADHD n = 6 taking medication  Not ADHD n = 6  College students | WURS (Wender Utah Rating Scale), a 61-item retrospective questionnaire witha cutoff score of 30 on the short form with higher cutoff values  **Clinical misdiagnosis**: N/A  **Sensitivity**: N/A  **Specificity**: N/A  Accuracy: classification <85%  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | Bayesian probability model integrated three diagnostic tools (WURS, ConsistencyIndex (EEG), Alpha Blockade Index (EEG)  **Clinical misdiagnosis**: N/A  **Sensitivity**: 100%  **Specificity**: 100%  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | EEG-based physiological markers  **Clinical misdiagnosis**: N/A  **Sensitivity**: N/A  **Specificity**: N/A  Accuracy: classification <85%  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A |
| Solanto, 2004145  N = 93 evaluated for suspected ADHD  n = 44 combined-type ADHD  n = 26 inattentive ADHD  n=33 mood or anxiety disorder  Specialty care | BADDS (Brown Attention-Deficit Disorder Scale), assesses executive and adaptive functioning across five clusters (Activation, Attention, Effort, Affect, and Memory), cutoff 50  **Clinical misdiagnosis**: 67%  **Sensitivity**: 92%  **Specificity**: 33%  **Accuracy**: 74%  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | N/A | C-CPT (Conners Continuous Performance Test), a 14-minute computerized task where participants respond to non-target stimuli; most CPT scores were in the clinically normal range for all groups; fFor Hit Reaction Time Inter-Stimulus Interval Change in discriminating inattentive ADHD from combined type ADHD  **Clinical misdiagnosis**: 14%  **Sensitivity**: 47%  **Specificity**: 86%  **Accuracy:** 70%  **Admin time**: 15 minutes  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | N/A |
| Van Voorhees, 2011154  N = 269 evaluated for attnetion problems  n ADHD = 184 (n=71 Combined Type; n=89 Predominately Inattentive Type; n = 24 ADHD Not Otherwise Specified)  Specialty care | CAARS:S (Conners’ Adult ADHD Rating Scales, Self Rating, Long Version), 66-items rated on a 4-point scale (0 to 3) to assess ADHD symptoms  **Clinical misdiagnosis**: 39%  **Sensitivity**: 65%  **Specificity**: 61%  **Admin time**: N/A  **Rater reliability**: Self-reports (CAARS-S) and observer reports (CAARS-O including ratings from friends, parents, and spouses) Ranged from r 0.24 (“distractible”) through r 0.46 (“on the go/driven by a motor”)  **Costs**: N/A  **Concordance**: N/A | N/A | CAARS-LV combining self-report CAARS:S and observer-report CAARS-O; T-Scores >65 for Conners’ index  **Clinical misdiagnosis**: 17%  **Sensitivity**: 43%  **Specificity**: 83%  **Admin time**: N/A  **Rater reliability**: N/A  **Costs**: N/A  **Concordance**: N/A | N/A | N/A | N/A |

Notes: N/A not available, not applicable; N number of participants

Several identified studies compared multiple tests, but not all reported results for all outcomes of interest for every test. Two studies compared self-reports versus a clinician interview tool, both reported a lower rate of clinical misdiagnoses for in the direct comparison.100, 123 Two studies found no difference in sensitivity between self-report and a clinician tool.98, 100 Two studies reported higher sensitivity for self-reports versus neuropsychological tests.98, 145 Two studies reported higher specificity for self-reports over a clinician tool.98, 100

Three studies reported on sensitivity for combinations of input versus neuropsychological tests alone, all found higher values for the combination78, 98, 123 One study compared a combination to EEG marker alone and also reported results in favor of the combination.132 Four studies found higher specificity for combinations of input versus neuropsychological tests alone78, 98, 123 or EEG marker alone.132

Evidence for all other comparisons was insufficient and we were not able to make comparative evidence statement for the outcomes administration time, inter-rater reliability, costs, or concordance between primary and specialty care diagnoses. All available comparative results across test modalities (e.g., combinations of variables vs neuropsychological test results alone) are documented in the summary of findings table (Table 3).

### Combination

Eight studies reported on a combination of input from different modalities.57, 65, 78, 98, 119, 123, 132, 154 Several included self and informant symptom ratings, and some also used demographic variables, neuropsychological assessment results, or EEG data. Studies varied in their complexity of the combination; one study, supported by machine learning, used 93 variables.57 The Appendix Table C.1 documents results for all studies that evaluated a combination.

Reported clinical false positive rate ranged from 16 percent in a study combining self-ratings and QBTest data to distinguish ADHD from Asperger’s syndrome78 to 18 percent in a study combining multiple self-reports and an observer report to distinguish from aggression.98 As illustrated in Figure 8, sensitivity was variable but mostly good, but not excellent. Reported sensitivity ranged from 94 percent (corresponding specificity 84%)78 to 43 percent (corresponding specificity 83%)154 in the identified studies. Specificity ranged from 84 percent (corresponding sensitivity 94%)78 to 82 percent (corresponding sensitivity 91%).98 We found no data for the outcomes administration time, inter-rater reliability, costs, or concordance between primary and specialty care diagnoses. The table shows the specific combinations used to diagnose ADHD. Results for key outcomes are synthesized in the Summary of Findings table (Table 3).

3.2.2 Self-Report Questionnaires

Forty-three studies reported at least one self-report measure evaluated for its performance in diagnosing ADHD. The studies reported on numerous self-report measures: ADHD Rating Scale, ADSA (Attention-Deficit Scales for Adults), AHA (Assessment of Hyperactivity and Attention), ALS-SF (Affective Lability Scale-Short Form), APQ (Adult Problem Questionnaire), ASRS (Adult ADHD Self-Report Scale), ASSET-BS (ADHD Symptom and Side Effect Tracking Baseline Scale), BAARS-IV Barkley Adult ADHD Rating Scale), BADDS (Brown Attention-Deficit Disorder Scale), CAARS (Conners Adult ADHD Rating Scale), CBS (Current Behavior Scale), EarlyDetect Questionnaire, IPDE-SQ (International Personality Disorder Examination screening questionnaire), PAI (Personality Assessment Inventory), PDI-4 (Provisional Diagnostic Instrument), SR-WRAADDS (Self-Report Wender-Reimherr Adult ADHD Scale), and WURS (Wender Utah Rating Scale). Nine studies reported on more than one questionnaire.62, 63, 92, 108, 111, 120, 130, 135, 142 The Appendix Table C.2 documents results for all studies that evaluated a written self-report for the diagnosis of ADHD.

Performance for clinical misdiagnosis varied across studies but was generally substantial: reported false positive rates in clinical samples ranged from 12 percent differentiating from depression or generalized anxiety using the WURS130 to 90 percent in students with academic or psychological difficulties using the CAARS-S.101 The ability to detect ADHD varied but was good for many questionnaires as illustrated in Figure 5.

Figure 5. Reported Sensitivity and Specificity of ADHD Self-Report Questionnaires in Adults Across Studies

Notes: ADSA (Attention-Deficit Scales for Adults), AHA (Assessment of Hyperactivity and Attention), ALS-SF (Affective Lability Scale-Short Form), APQ (Adult Problem Questionnaire), ASRS (Adult ADHD Self-Report Scale), ASSET-BS (ADHD Symptom and Side Effect Tracking Baseline Scale), BAARS-IV Barkley Adult ADHD Rating Scale), BADDS (Brown Attention-Deficit Disorder Scale), CAARS (Conners Adult ADHD Rating Scale), CBS (Current Behavior Scale), EarlyDetect Questionnaire, IPDE-SQ (International Personality Disorder Examination screening questionnaire), PAI (Personality Assessment Inventory), PDI-4 (Provisional Diagnostic Instrument), SR-WRAADDS (Self-Report Wender-Reimherr Adult ADHD Scale), and WURS (Wender Utah Rating Scale)

Neurotypical only = true indicates that the study differentiated ADHD from neurotypical adults, neurotypical only = false indicates that the study differentiated ADHD from other clinical conditions or a combination of neurotypical adults and adults with other clinical conditions

Figure 5 represents each study that reported on a self-report with one questionnaire, selecting the scale with the highest sensitivity and specificity where more than one tool was evaluated. In the individual studies sensitivity ranged from 100 percent at the expense of low specificity (CAARS-S corresponding specificity 10%101 or ASRS-v1.1 with specificity not reported)58 to only 14 percent (CAARS-S, corresponding specificity 92%).86 The ability of self reports to correctly rule out ADHD was good in many cases but also rarely excellent: Specificity ranged from 99 percent (CBS corresponding sensitivity 90%)71 to as low as 10 percent (CAARS-S, corresponding sensitivity 100%).101 Only one study explicitly reported on the administration time for the questionnaire, indicating short administration.105 Rater agreement was reported in multiple studies, with most studies indicating limited agreement between different raters.50, 65, 98, 100, 108, 109, 154, 163 We did not identify data on cost or correspondence between primary and specialty care. Results for key outcomes are synthesized in the Summary of Findings table (Table 3).

### 3.2.3 Peer Report Questionnaires

Three studies evaluated peer reports.65, 122, 124 One of the studies asked parents to rate their young adults with autism using the CAARS-P and the ABC (Aberrant Behavior Checklist).122 Another study included parent ratings of undergraduates using the BAARS-IV (Barkley Adult ADHD Rating Scale-IV).65 In both studies, the peer report was a parent rating of young adults. One study in a forensic outpatient clinic reported on CAARS-Observer ratings but did not state who served as the rater.98 The Appendix Table C.3 documents all results for the small number of studies that evaluated a written peer report for the diagnosis of ADHD.

Evidence for clinical misdiagnosis was determined to be insufficient due to lack of information on the observers in the single clinical sample. Sensitivity was determined to be insufficient due to the wide reported range (from poor to good). Specificity was limited and ranged from fair to poor (77% for BAARS-IV, corresponding sensitivity 60%,65 57% for CAARS-P, corresponding sensitivity 60%);122 both illustrated in Figure 8. For rater agreement, only one study reported results and none of the studies reported on costs, administration time, or concordance between primary and specialty care. Results for key outcomes are synthesized in the Summary of Findings table (Table 3).

3.2.4 Neuropsychological Assessment

Twenty-seven studies reported on the performance of neuropsychological assessment to diagnose ADHD. Studies evaluated test batteries such as AQT, BQSS, C-CPT, DII, IVA, MOXO-dCPT, QbTest, SCWT, SNST, or the performance of individual tasks such as the Go-NoGo task or WAIS-IV Processing Speed Index. Five studies reported diagnostic accuracy data for multiple tests and tasks.59, 107, 140, 151, 160 The Appendix Table C.4 documents results for all neuropsychological tests evaluated to diagnose ADHD. The index test description shows the evaluated test selection that showed the best performance, together with all administered tests.

Performance for clinical misdiagnoses showed a substantial false positive rate in most studies. Reported results ranged from 11 percent in a study using Stroop test variables for participants referred for neuropsychological evaluation95 to 60 percent in a model based on QbTest with motion tracking variables,144 Sensitivity was acceptable in most studies as illustrated in Figure 6, but reported sensitivity showed a wide range from 93 percent (corresponding specificity 100%) integrating AQT variables118 to 17 percent for an individual subtest of the C-CPT (corresponding specificity 90%).146

Figure 6. Reported Sensitivity and Specificity of Neuropsychological Tests for ADHD in Adults across Studies

Notes: AQT A Quick Test of Cognitive Speed; BQSS Boston Qualityative Scoring System for the Rey-Osterrieth Complex Figure; C-CPT Conners Continuous Performance Test; IVA Integrated Visual And Auditory Continuous Performance Test Full Scale Response Control Quotient; QbTest quantified behavioral test; SCWT Stroop Color and Word Test; TOVA Test of Variables of Attention

Figure 6 shows the different specific evaluated tests as well as the substantial number of studies that did not evaluate a specific tool but used variables in a test battery to develop a models that maximizes the ability to discriminate between ADHD and comparator characteristics. The figure also shows the wide variation in specificity, with some studies reporting excellent specificity, but most studies were characterized by acceptable or even poor specificity. Reported specificity ranged from 100 percent (corresponding sensitivity 93%) integrating AQT variables118 to 40 percent for a model integrating QbTest Plus variables (corresponding sensitivity 88%).144

There was some variation, but 7 studies estimated the duration of the neuropsychological test administration to be about 20 minutes.45, 55, 66, 69, 78, 123, 144 None of the studies reported on rater agreement, costs, or concordance between diagnostic settings. Results for key outcomes are synthesized in the Summary of Findings table (Table 3).

### Neuroimaging

Five studies evaluated neuroimaging.48, 56, 136, 157, 161 Studies used brain perfusion single-photon emission computed tomography (SPECT),48 3-D SPECT,136 structural magnetic resonance imaging (MRI) and diffusion tensor imaging,56 and resting state functional MRI.157, 161 The Appendix Table C.5 documents results of studies that evaluated neuroimaging for the diagnosis of ADHD. The table provides details on the final selection model where reported.

Reported clinical misdiagnoses rates varied from a low three percent in a brain perfusion SPECT study analyzing a large psychiatric database48 to a substantial 24 percent false positive rate in a sample with various psychiatric and neuropsychiatric disorders using 3D thresholded SPECT.136 Studies reported sensitivity ranges from excellent to poor, but it was acceptable in most studies. Performance ranged from 100 percent in a large retrospective cohort study using brain perfusion SPECT (corresponding specificity 97%)48 to 54 percent in a clinical sample (SPECT, corresponding specificity 76%). Similarly, reported specificity ranged from 97 percent (SPECT, corresponding sensitivity 100%)48 to 65 percent (functional MRI, corresponding sensitivity 91%),161 but most studies reported acceptable specificity as illustrated in Figure 8. Studies varied in how much detail the often machine-learning generated discriminant function that achieved the best diagnostic performance was documented. Only one study reported on administration time; the study reported a procedure duration of 15 to 20 minutes.136 One study evaluated rater agreement, the study reported a kappa coefficient of 0.79 for agreement in visual interpretation of neuroimaging scans.48 None of the studies reported on costs or concordance of diagnostic results between different clinical settings. Results for key outcomes are synthesized in the Summary of Findings table (Table 3).

### EEG

Twelve studies evaluated EEG (electroencephalogram) data used to distinguish ADHD from other clinical conditions or neurotypical developing adults.54, 80, 89, 91, 96, 97, 115, 116, 125, 126, 132, 139 Studies tested the diagnostic performance for very different conditions, ranging from analyzing resting state EEG,96, 125 and event-related potentials during neuropsychological tasks,54, 115 to EEG recording during transcranial magnetic stimulation.80 The Appendix Table C.6 documents results for the studies that evaluated the use of EEG data for the diagnosis of ADHD.

Only one study reported on misdiagnosis in a clinical sample; the study reported a low false positive rate of 3.8 percent using auditory brainstem response profiling test.89 Most studies were conducted in academic samples and did not involve clinical samples. Reported sensitivity results ranged from 100 percent achieved in a machine-learning assisted diagnostic study that utilized phase space reconstruction of brain signals during a continuous performance test (corresponding specificity 87%)91 to only 67 percent (resting state EEG, corresponding specificity 83%)125 with overall acceptable results. Specificity showed an even wider range from excellent to poor performance: Reported specificity ranged from 95 percent (event-related potential, corresponding sensitivity 86%)54 to 37 percent (resting state EEG, corresponding sensitivity 73%)96 but was generally good in identified studies. Reported session duration ranged from six minutes96 to 26 minutes116 with no information about the scoring or interpretation time. Studies did not report on rater agreement, costs, or concordance with diagnoses from other settings. Results for key outcomes are synthesized in the Summary of Findings table (Table 3).

### Biomarkers

Five studies evaluated biomarkers other than EEG or neuroimaging-based indicators.49, 79, 88, 138, 150 Studies evaluated very different markers, including genetic marker,79 eye tracking results,88 blood oxidative status,138 physiological data from a wearable device,49 or used MFNU (Motor Function Neurological Assessment)150 to diagnose ADHD. None of the same modality or type of biomarker was evaluated in more than one study. The Appendix Table C.7 documents all results for the small number of studies that evaluated the use of biomarkers other than neuroimaging or EEG to aid in the diagnosis of ADHD.

The clinical misdiagnosis rate varied widely: one study reported a false positive rate of 17 percent in an eye tracker study in sample of participants with conduct disorder,88 another study reported a false positive rate of 75 percent in a MFNU assessment in a psychiatric outpatient clinic where some patients were considered to have subthreshold ADHD.150 Sensitivity was acceptable in most studies and showed a range of 98 percent for MFNU (corresponding specificity 25%)150 to 80 percent in an eye tracker study (corresponding specificity 83%).88 Specificity varied widely, from 83 percent in the eye tracker study (corresponding sensitivity 80%)88 to only 25 percent in the MFNU assessment (corresponding sensitivity 98%). Only one study reported on the administration time, the study reported that the eye tracking task took about 15 minutes;88 none of the studies reported on test result processing, evaluation, or interpretation time. Studies did not report on rater agreement in interpreting the variables, costs, or concordance between settings. Results for key outcomes are synthesized in the Summary of Findings table (Table 3).

### Clinician Tool

Three studies reported on a clinician interview or questionnaire that was assessed for congruence with an external reference standard.100, 121, 123 Studies evaluated the DIVA (Diagnostic Interview for ADHD in Adults),123 MINI (Mini-International Neuropsychiatric Interview),100 the MINI-Plus121 which were used by clinicians in clinical samples. The reference standards used to evaluate the diagnostic performance of the clinician tools were assessments from trained clinicians,121 the recorded chart diagnosis,100 or clinical case conferences.123 The Appendix Table C.8 documents study and participant details, and presents all reported results for these studies.

The results reported in the identified studies varied widely for the clinical misdiagnosis: false positive rates ranged from nine percent for the MINI-Plus in an addiction treatment center study121 to 48 percent in an inpatient psychiatric hospital unit for the CAARS-O.100 The sensitivity was acceptable, performance ranged from 83 percent (corresponding specificity 52%) to 73 percent (corresponding specificity 90%).123 Specificity showed a wider range, reported results included good as well as poor sensitivity: performance ranged from 91 percent (corresponding sensitivity 75%)121 to 52 percent (corresponding sensitivity 83%).100 The identified studies did not report on administration time, rater agreement, costs, or concordance with specialty care. Results for key outcomes are synthesized in the Summary of Findings table (Table 3).

3.2.9 Key Question 1a: How does the comparative diagnostic accuracy of these tools vary by clinical setting, including primary care or specialty clinic, or patient characteristics, including age, sex, cultural background, and risk factors associated with ADHD?

Because raw data for diagnostic accuracy were often not reported, we were not able to detect effect modifiers in meta-regressions by adding variables to the meta-analytic model. Results are based on subgroups as reported by the authors and analyses conducted within the original studies.

**Clinical setting**: Half of the identified studies were conducted in specialty care (n=55). The next most frequent setting was college (n=37). Very few studies were conducted in primary care (n=2). In addition, none of the identified studies analyzed the effect of the setting on the diagnostic process. Hence the question which tests should be used in primary care is difficult to answer. However, several studies addressed the effect of the reference standard and comparator sample, i.e., study characteristics. In addition, several studies addressed the effect of comorbidities. Although primarily a patient characteristic, participants evaluated for other clinical conditions was more typical of a specialty care clinical setting.

**Reference standard and comparator sample**: Three studies addressed the effect of the method of establishing a clinical ADHD diagnosis, but all addressed different aspects. One study comparing self-reported and neuropsychological tests highlighted that diagnostic accuracy measures were high when comparing ADHD-diagnosed participants to the general population but were less effective when distinguishing ADHD from other psychiatric conditions, with overlapping scores noted for anxiety and depression.145 Similarly, a self report study reported a high false-positive rate in patients with depression.64 Another study evaluating a self-report measure reported that comorbidities such as anxiety and depression were associated with elevated scores on scales which may overlap with ADHD symptoms and potentially contribute to misclassification and highlighted the importance of considering comorbid conditions during assessment.102 One study evaluating neuromuscular assessment reported that they found several patients with subthreshold ADHD in a clinical sample suggesting possible diagnostic overlap and the need for further evaluation.150

Figure 7 differentiates two diagnostic accuracy measures, overall accuracy and the area under the curve (AUC), for all diagnostic modalities. The figure stratifies studies by samples that identified ADHD in a sample of neurotypical adults, in a clinical sample, or in samples that included neurotypical adults, adults with other clinical conditions such as autism spectrum disorder, and/or adults feigning ADHD.

Figure 7. Reported Accuracy and Area Under the Curve (AUC) Across Tools

Figure 7 visualizes a trend toward higher diagnostic accuracy when tools distinguish between people with ADHD and neurotypical adults: diagnostic performance exceeded that of results in clinical samples in five out of six studies reporting on overall accuracy and in three out of four test modalities in studies that reported on AUC.

**ADHD presentation**: Four studies addressed diagnosis in different presentations of ADHD with some conflicting results. One-self-report study reported that diagnostic accuracy did not significantly vary across ADHD presentations/subtypes (inattentive, hyperactive-impulsive, and combined) but noted that combined type ADHD was the most frequently identified subtype, which could influence overall sensitivity and specificity estimates.141 Similarly, another study reported that sensitivity and specificity were consistent across ADHD presentation types (inattentive, hyperactive, and combined), but noted that misdiagnosis rates were slightly higher for the inattentive subtype in self reports compared to clinician diagnoses, and inter-rater reliability between self-reported and clinical ratings was fair, with higher concordance for combined presentation.70 Another self report study highlighted that sensitivity for the inattentive subtype was 100 percent on the Inattentive Symptoms subscale, with specificity at 25 percent.101 One self report study pointed out that inattention symptoms were more predictive of ADHD persistence into adulthood than hyperactivity-impulsivity symptoms; and individuals with the combined-type ADHD in childhood were more likely to retain a diagnosis in adulthood, whereas hyperactive-impulsive presentations were more likely to remit.94

**Participant age**: Several studies reported on the effect of the age of the participants or specifically on the age at diagnosis, but studies focused on different aspects. A self-report study reported that executive functioning impairments were more predictive of ADHD persistence in older adults, while hyperactivity-impulsivity symptoms were more prevalent in younger adults, suggesting age-related shifts in symptom expression and diagnostic criteria applicability; sensitivity and specificity of ADHD diagnoses were higher in younger adults (18–30 years) compared to older adults (31–44 years), likely due to better recall of childhood symptoms and reduced cognitive decline in memory-based reporting.94 A self report and neuropsychological test study reported that age was inversely correlated with scores on scales for attention and effort, suggesting that older participants exhibited fewer ADHD-related symptoms, potentially reflecting developmental improvements in executive functioning.145 One study did not comment on differential effects on the diagnosis, but suggested that a potential biomarker, oxidative stress, may increase with the duration of the disease.138 Another study found that age represented as independent variable in a multiple regression did not significantly influence parameters measured by the QbTest.55 A further study reported that ADHD diagnosis based on CAARS-S or MINI were not correlated with age.100

**Participant sex**: Several studies reported on the effect of the sex of the participants on the diagnostic performance, but studies reported conflicting results. One EEG study reported lower sensitivity in females compared to males.89 A neuroimaging study noted that classification performance was higher in the male-only subgroup compared to the mixed-gender subgroup, suggesting that male ADHD patients may have more significant neuroanatomical deviations from controls.56 A self-report study did not find lower sensitivity but lower specificity in females versus males.155 One study concluded that sex did not influence parameters of the neuropsychological test.55 A self-report study did not detect differences in sensitivity and specificity between sexes.163 A study reporting on a self-report and a clinician interview noted that ADHD diagnosis based on the tests were not correlated with sex.100

**Participant ethnicity**: None of the studies stratified diagnostic performance by race or ethnicity.

**Comorbidities**: Multiple studies reported on the effect of comorbidities in participants with ADHD on diagnostic performance, but results and conclusions differed. One college study reported that comorbidities contributed to challenges in specificity but not sensitivity and that functional impairment was higher in participants with comorbid conditions.101 Similarly, a study in addiction centers reported on variability in specificity values across subgroups while sensitivity remained similar.153 Another study reported reduced specificity in participants with overlapping symptoms of borderline personality disorder and bipolar disorder in neuropsychiatric clinics.66 One study reported lower sensitivity and higher specificity in participants with comorbidity in a mental health center.106 Two studies in outpatient centers reported that diagnostic performance was unaffected by comorbidities.55, 102 Some studies pointed out the high prevalence of comorbid conditions such as depression and anxiety.77, 94, 135, 141 One study suggested that participants with ADHD and depression reported higher levels of anxiety.64

### Key Question 1 Summary of Findings

Despite the large number of studies, many did not report on the exact number of true positives, true negatives etc. The most common metrics were the author reported sensitivity. Given that sensitivity and specificity are not independent of each other, we plotted both for all reported tests in Figure 8. The tool indicates also whether studies differentiate adults with ADHD from neurotypical adults or adults with another clinical diagnosis.

Figure 8. Sensitivity and Specificity of ADHD Tests in Adults across Studies

Figure 8 visualizes the much larger evidence base for self-reports compared to all other modalities. The figure also illustrates the wide variability reported in the individual studies for the same modality. In addition, the visualization shows that tests were sometimes able to maximize sensitivity or specificity, but not both. Finally, with few exceptions, the evaluated tests were limited in their success of detecting a clinical diagnosis of ADHD.

The summary of findings table (Table 3) provides a synthesis of the results for the key outcomes. Direct comparisons between test modalities are shown first, followed by the test performance for individual tests, and the summary of the subquestion. The summary of findings table shows results for the key outcomes for which at least one study with data was identified. The clinical misdiagnosis results were limited to studies reporting on clinical samples and/or studies comparing to another clinical condition such as anxiety. We downgraded by one or by two, depending on the impact of the reasons for downgrading on our confidence in the summary estimate and resulting evidence statements. Results of individual studies for all abstracted outcomes beyond the key outcomes are shown in the evidence tables in Appendix C.

Table 3. Summary of Findings Table Comparative Performance, Performance of Combinations, and Performance of Individual Tools against a Reference Standard

#### Table goes here

Notes: We broadly categorized performance as follows: low (<5%), fair (<20-5%), substantial (20-60%) clinical misdiagnosis rate; limited (<80%), poor (<69%), fair (70-79%), acceptable (80-89%), good (90-95%), excellent (96-100%) sensitivity and specificity; short (<30 minutes) administration and scoring time; limited rater agreement (kappa <0.8, correlations <0.40); \*clinical samples defined as composed of participants undergoing diagnostic workup (as opposed to general, unselected, and/or neurotypical participant samples)

Abbreviations: ADHD Attention-Deficit/Hyperactivity Disorder; AQT Adult ADHD Quick Test; ASRS Adult ADHD Self-Report Scale; BAARS Barkley Adult ADHD Rating Scale; BADDS Brown Attention-Deficit Disorder Scales; C-CPT Conners continuous performance test; CAARS-O Conners Adult ADHD Rating Scale-Observer-Report; CAARS-P Conners Adult ADHD Rating Scale-Peer-Report; CAARS-S Conners Adult ADHD Rating Scale-Self-Report; CBS Current Behavior Scale; CPT continuous performance test; DIVA Diagnostic Interview for ADHD in Adults; EEG electroencephalogram; ICC intra-class correlation; GRADE Grading of Recommendations Assessment, Development and Evaluation; KQ key question, MINI Mini-International Neuropsychiatric Interview; MFNU Motor Function Neurological Assessment; MRI magnetic resonance imaging; N/A not applicable or not available; QbTest quantified behavioral test; SPECT single photon emission computed tomography; vs versus; WURS Wender Utah Rating Scale

The included studies did not report on the impact for participants of being correctly or incorrectly diagnosed. Studies reported only on the performance of the tests but not the effect a diagnosis (or a misdiagnosis) had on participants or similar.

None of the included studies reported on unintended consequences, adverse events, adverse effects, or side effects of the diagnostic tools, including blood-based biomarker, EEG, neuroimaging, and neuropsychological test studies.

Finally, we identified numerous studies reporting on the performance of tests for detecting feigning ADHD. All studies also reporting also on the diagnostic performance of diagnosing ADHD are included in the respective test sections earlier in this chapter and the evidence tables C1 to C8. Studies used subjective tests such as self-report questionnaires as well as objective tests such as neuropsychological test batteries. Results of all studies reporting on feigning ADHD are shown in the evidence table in the appendix (Appendix Table C9).

# Discussion

This evidence report synthesizes the results of evaluations of available tools for diagnosing attention deficit/hyperactivity disorder in adults. The systematic review reveals a complex landscape with varying levels of evidence across assessment approaches. We identified over 100 studies evaluating the diagnostic performance of self-report questionnaires, peer review questionnaires, neuropsychological tests, neuroimaging, electroencephalogram (EEG), diverse biomarkers, clinician tools, combinations of modalities, and tools to identify feigning ADHD. Despite the research volume, direct comparisons between tests were limited, often resulting in insufficient strength of evidence for definitive evidence statements.

As part of the review, we also addressed a context question regarding the relative frequency of use of tools, given that the use of tools in routine care can be quite different from the scientific research literature. The current frequency of use of the various tools for diagnosing ADHD in adults by primary care and specialty mental health clinicians is unknown. Nevertheless, some published reports suggest that their use is common and widespread. For example, the American Academy of Family Practitioners recommend obtaining rating scales for ADHD from both the patient and significant others in the patient’s life (spouse, a close relative, employer, or colleague). Likewise, the American Psychiatric Association advises the use of ADHD rating scales in addition an in-depth clinical interview for the ADHD diagnosis.165

Large surveys suggest that primary care physicians, psychiatrists, and psychologists commonly, but nurse practitioners less often, rely on one or more of these tools when diagnosing ADHD. An online survey of 1,924 U.S. physicians completed a survey about care of adults for ADHD; 83 percent of primary care physicians and 97 percent of psychiatrists screened for adult ADHD in adults who complained of typical ADHD symptoms, with 64 percent of primary care physicians and 57 percent of psychiatrists using an ADHD rating scale to aid their screening.166 However, only 20 percent of primary care physicians and 25 percent of psychiatrists conducted an extended interview to confirm the diagnosis. Once initiating stimulant treatment, however, 69 percent reported using a rating scale to help titrate the dose. Another survey of 400 primary care physicians surveyed indicated that 85 percent would take a more active role in making an ADHD diagnosis if they had a screening tool that was appropriately developed and validated and both easy to use and quickly administered.167 Studies of diagnostic reports submitted by young adults who were seeking academic accommodations at postsecondary schools or on medical licensing exams showed that most relied primarily or exclusively on current self-reported symptoms on rating scales, suggesting their widespread use by psychologists. Those studies also reported, however, that the clinicians failed to obtain collateral reports, confirm childhood onset, establish functional impairment, or rule out other potential causes for the reported symptoms.168-171 A survey mailed to 262 nurse practitioners in Alaska indicated that only 12 percent were likely to diagnose ADHD in practice; 38 percent of the 68 who responded to a question about methods used to diagnose ADHD in adults reported using a diagnostic screening tool.172

Neuropsychological test measures and specialized rating scales are also commonly used for both diagnostic and clinical assessment of ADHD in adults. This is particularly true with the recent promulgation of commercial, computer-based platforms for administering various versions of the Continuous Performance Task (CPT), such as the QB test, that claim diagnostic utility for adults with ADHD. An indirect indication of the frequency of use of these tests, at least by psychologists and neuropsychologists, is a Delphi consensus study published in 2019. The study surveyed 27 clinician researchers from around the world who were experienced in working with adults who have ADHD and asked them to rate, over four rounds of questioning that progressively honed a list of most highly prioritized tests, the importance of neuropsychological functions in assessing adults who have ADHD, with the aim of composing a list of the most relevant neuropsychological functions to assess and the corresponding tools to assess them.173 The top five domains identified and the tools recommended to assess them with strong group consensus were: (1) sustained attention (assessed using Conners Continuous Performance Test III), (2) distractibility (Conners CPT III), (3) inhibitory control (Go/NoGo test), (4) task planning and organization (the BRIEF self-report survey), (5) working memory (digit span test). ADHD symptoms identified to assess included impulsivity and hyperactivity. The assessments were not considered to be diagnostic per se, because poor scores on the measures can have multiple causes. The tools were instead recommended for clinical assessment to characterize neuropsychological functioning in adults already diagnosed with ADHD.

## Comparative diagnostic performance of tools to diagnose ADHD among adults

We identified over 100 studies that assessed putative tools to aid the diagnosis of ADHD in adults. Although this is a substantial number of studies, we deemed the strength of evidence for the reported performance measures across each of categories of diagnostic tools to be generally low because of large performance variability across studies, the use of widely varying non-ADHD comparison populations, reporting practices that precluded meta-analyses across studies, and statistical analyses that were often exploratory across a large number of variables.

### Measures Reported for Diagnostic Performance

As outlined in detail in the introduction, diagnosing Adult ADHD is complex and in addition to issues surrounding the reference standard, this review also highlighted limitations associated with reported measures. Most studies reported sensitivity (true positive rate), specificity (true negative rate), and diagnostic accuracy (how many are correctly diagnosed). Although these are standard performance statistics for diagnostic classification, they have the important limitation of being dependent on an arbitrary threshold that is applied to scores from a diagnostic tool that defines whether individual participants do or do not have ADHD – for example, the percent of symptoms endorsed, the numerical score on a rating of symptom severity or measure of cognitive performance, or the power in an EEG frequency band. Studies that use the same diagnostic tool often apply different thresholds to the scores from that tool, which will necessarily alter the reported sensitivities and specificities. Comparing sensitivities and specificities across studies that use differing thresholds is therefore like comparing apples and oranges.

Moreover, sensitivity and specificity, because of how they are defined and calculated, inherently have an inverse relationship to one another, such that raising the diagnostic threshold for a score on a tool will reduce sensitivity (i.e., it will identify fewer people who truly have ADHD) but increase specificity (i.e., falsely identify fewer people as having ADHD who do not in fact have it), and vice versa for lowering the diagnostic threshold. This inherent trade-off between sensitivity and specificity establishes an operational limit for plots of sensitive versus specific as shown in the figures along the y = -x line, i.e., from the upper left to lower right corner of the plot, which would identify diagnostic tests that perform at no better than chance. Tools in the upper right quadrant of that plot improve in overall performance as they approach the upper right corner, or perfect accuracy (100% true positives and 100% true negatives). Identified research shows that, for categories of tools such as rating scales and neuropsychological test measures that have the most data points, many studies perform little better than chance (they lie close to the y = -x line; studies that lie to the left of it perform worse than chance) and, moreover, because they lie on or near the diagonal, the findings suggest that variability in performance likely derives from differences in the thresholds applied to the scores from the diagnostic tools. Unfortunately, adjusting sensitivity and specificity through use of the same diagnostic threshold is impossible without having the scores from the tool for each study participant. Reports of diagnostic accuracy suffer the same limitation of depending inherently on the diagnostic threshold applied to the tool’s score.

One index of diagnostic performance that addresses these limitations of sensitivity and specificity metrics is AUC (area under the curve), a measure from receiver operating characteristic (ROC) curves that was first developed by engineers during World War II to detect enemy objects in the battlefield. An ROC curve is a plot of sensitivity vs specificity across the entire range of possible diagnostic thresholds. The area under this ROC curve provides a single, overall index of performance that is independent of diagnostic threshold. AUC values range of 0.5 (corresponding to the y=x line) indicate that the tool provides no information above chance for diagnostic classification. Values of 1.0 (corresponding to the vertical x=0 line) indicate that the tests performs perfectly, correctly classifying all participants who have ADHD as having it and all non-ADHD participants as not having it. Intermediate AUC values of 90 to 100 are commonly classified as *excellent* performance; 80 to 90 as *good*; 70 to 80 *fair*; 60 to 70 *poor*; and 50 to 60 as *failed*. Studies of diagnostic tools are increasingly reporting performance in terms of AUC, in addition to the more traditional measures of sensitivity and specificity.

A minority of studies reported other measures of diagnostic performance, including positive predictive value (PPV) and negative predictive value (NPV). They are calculated as PPV = True Positives / (True Positives + False Positives), and NPV = True Negatives / (True Negatives + False Negatives). PPV is the probability that a person with a positive test result has the condition; NPV is the probability that a person with a negative test result does not have the condition. False positives will increase and false negatives will decline with lower base rates in the population – if no one has the condition, all positive results are false, and all negative results are correct then PPV will decrease to 0.00 (no one with a positive test result has the condition) and NPV will increase to 1.00 - everyone with a negative test result does not have the condition (and the reverse is true if everyone has the condition). Thus, these metrics represent the utility of diagnostic tools in a particular setting that has a specific base rate of ADHD in population sampled. They will differ across varying diagnostic settings because the base rates of ADHD differ across those settings (the base rate may be, for example, 60-70% in a clinic where patients assessed for suspected ADHD, it may be 50% in a study designed to have equal numbers of ADHD and healthy control participants, or it may be 5% in an epidemiological sample of the general population). Very few studies that we identified for inclusion reported PPV and NPV values, generally without providing accurate and independent estimates of the base rates of ADHD in the study’s specific diagnostic setting.

### 4.1.2 The Importance of the Comparator Sample

Measures of diagnostic accuracy will vary with the characteristics of the non-ADHD participants from which the diagnostic tool is attempting to discriminate the study’s ADHD participants. For example, if the non-ADHD participants are patients who have more symptoms that overlap those of ADHD, as occurs commonly with patients who have autism, depression, or anxiety, false positives will tend to be higher than in studies where the non-ADHD participants have few or no symptoms that overlap, as happens when the comparator group is a sample of neurotypical controls.

In real-world clinical practice, clinicians rarely if ever need to determine whether a patient has ADHD or is healthy and symptom-free (the clinical equivalent of a neurotypical control in many research studies). The patient has presented to the clinician with some kind of clinical problem, or they would not be seeing the clinician. That problem likely has symptoms that overlap those of ADHD, or ADHD would not be considered as a clinical possibility. For these reasons, the much more clinically relevant studies of performance for tools that aid the diagnosis of ADHD are those that employ a comparator group of participants who have mental health problems and symptoms that may overlap those of ADHD. The *most* clinically relevant comparison are from studies in which all participants were presenting for evaluation of possible ADHD, because real-world clinicians are asked to diagnose ADHD in patients who are presenting for an ADHD assessment.33 These comparator samples will tend to produce more false positives in diagnostic testing, thus lowering specificity metrics.168

### 4.1.3 Rating Scales

Numerous studies reported on performance for at least one self-report measure in diagnosing ADHD (Figure 5). The number of different scales was large (17), but the most commonly reported measures were the CAARS, ASRS, and WURS. Studies that used the same measure often applied different diagnostic cut-offs to the score the measure generates. Self-reports were generally able to correctly rule out ADHD, with good but rarely excellent performance and substantial variation across studies.71, 86, 101

Examination of the plotted sensitivity versus specificity suggests that sensitivity and specificity measures are similarly distributed around the y=x line, indicating that self-rating scales are similarly likely to under-identify individuals who truly have ADHD (reflecting sensitivity) and to over-identify individuals who do not have ADHD (reflecting specificity).168 Closer examination also suggests that the measures of CAARS performance tended to lie along the y = -x line or close to it, suggesting poorer performance independent of the specific diagnostic threshold used. Measures of the ASRS tended to cluster closer to the upper right corner, suggesting overall better performance, independent of the diagnostic threshold used. Only three studies reported performance for peer ratings, but the characteristics of the studies preclude interpretation.

### Neuropsychological Tests

A considerable number of studies have been published that report on the performance of various neuropsychological tests to diagnose ADHD in adults. Most of these studies assessed performance of a wide range of measures in a highly exploratory way, without specific hypotheses for which measures would perform best. All the studies reported on performance of some form of CPT, but the CPT, like most of the individual neuropsychological tests, itself generates many measures, and which of those measures was reported and performed best varied widely across studies. These approaches to the analysis and reporting of results greatly complicate comparison of performance across studies and the interpretation and generalization of findings. The best performing of the neuropsychological tests are reported here, which risks a positive bias for assessing overall performance of neuropsychological tests, but which nevertheless seems to be the most efficient way to report findings.

With all these caveats, results indicated a substantial false negative rate in most studies.95, 144 Sensitivity varied widely, from excellent for the AQT118 to very poor,146 with most sensitivity measures in the fair range or poorer, indicating that neuropsychological tests often missed the diagnosis in those who truly had ADHD. Specificity likewise varied widely, from perfect specificity for the AQT118 to poor specificity for QbTest Plus variables,144 though in general, specificity was fair at best, indicating that tests often incorrectly identified non-ADHD controls as having ADHD.

Comparing sensitivity and specificity measures across categories of diagnostic tools, neuropsychological tests do not seem to perform better than self-report measures (self-report measures have more frequent clusters near the upper right corner of the plots, indicating better combinations of sensitivity and specificity). Recent systematic reviews of the diagnostic utility of continuous performance measures for adults with ADHD have concluded that these tests are vulnerable to practice effects and the feigning of symptoms, and they alone do not sufficiently dis­criminate persons who have ADHD from clinical controls.38, 39

### 4.1.5 Other Diagnostic Tools

With a couple of exceptions, overall diagnostic performance of EEG measures was fair to good for the dozen studies that reported them, although, similar to the limitations of neuropsychological test studies, the EEG measures varied widely across studies and were often highly exploratory in assessing performance across many measures. Measures, for example, ranged from resting state EEG,96, 125 to event-related potentials during neuropsychological tasks,54, 115 to EEG recordings during transcranial magnetic stimulation.80 Several of the studies used machine learning or other techniques to combine various EEG measures into a highly complex test measure that would be difficult or impossible to replicate in future studies. Most employed a non-clinical comparator sample, which likely contributed to the reasonable performance measures. Sensitivities ranged from perfect performance during a CPT and using machine learning-derived EEG measure91 to fair performance using resting state EEG measures.125 Specificity showed an even wider range from excellent for event-related potential54 to poor performance in a study evaluating resting state EEG96 but was generally good in identified studies. Most clinical practices and even research centers do not have EEG capability, let alone under the complex testing conditions employed in these studies. The real-world applicability of these measures is therefore currently extremely limited.

The studies that assessed diagnostic performance for neuroimaging measures used a wide range of imaging technologies, including SPECT,48 3-D SPECT,136 structural MRI, DTI,56 and resting state fMRI.157, 161 Limitations of these studies are similar to those for EEG measures, with diagnostic test measures highly ad hoc and complex, precluding generalizability and opportunities for replication. Comparator samples were often non-clinical, and analyses were often exploratory across multiple test measures. Sensitivities ranged from perfect in a large retrospective cohort SPECT study48 to poor in a SPECT study136 with a clinical comparator sample. Specificities ranged from excellent in the retrospective SPECT study48 to fair in an fMRI study).161 Also similar to EEG, the real-world applicability of using neuroimaging methods to aid diagnosis is limited by the practical challenges in acquiring the imaging measures.

Five studies reported on performance of putative biomarkers in diagnosing ADHD. Each used a different technology, including a genetic marker,79 eye tracking,88 blood oxidative status,138 physiological data from a wearable device,49 and Motor Function Neurological Assessment (MFNU).150

## Direct Comparisons of Diagnostic Performance

Because measures of diagnostic performance, especially measures of sensitivity and specificity, vary with the diagnostic threshold applied to the score that the diagnostic tool generates, as well as sample characteristics, interpreting differences in measures of diagnostic performance across studies is exceedingly difficult. All these differences in study characteristics undoubtedly contributed to the scatter of data points in the plots of sensitivity versus specificity shown in the figures; disentangling all of these effects on measures of diagnostic performance across studies is impossible.

For these reasons, studies that directly compare measures of performance across diagnostic tools in the same sample of participants are most valuable to identify better performing tools. We identified 11 such studies. Of those, two had only six participants each who had ADHD100, 132 and preclude interpretation. One study reported performance metrics only for EEG measures.54 Of the remaining studies, seven were discriminating participants with ADHD from participants with other clinical conditions65, 78, 98, 122, 123, 145, 154 and one was discriminating from participants with a mix of patients and neurotypical controls.119 They all assessed performance of self-rating scales for ADHD symptoms. Those that attempted to make very difficult clinical discriminations reported the poorest performance (e.g., ADHD+ASD vs ASD alone: sensitivity 57%, specificity 81%;122 combined type ADHD vs predominantly Inattentive ADHD: sensitivity 65%, specificity 61%).154 The other studies generally reported sensitivities ranging from the mid-70’s to low 90’s, but those with the highest sensitivities had the lowest specificities, in the high 20’s and low 30’s, as expected given the inherent trade-off between sensitivity and specificity that depends on the diagnostic threshold applied to scores from the rating scale. Peer ratings were also assessed in three of the studies:65, 98, 122 one reported substantially lower sensitivities but higher specificities than for the self-ratings;65 one reported performance comparable to self-ratings; 98 and one reported substantially higher sensitivity and specificity when using both an ADHD scale and an ASD scale in discriminating ASD+ASD from ASD alone.122 Combining the self-ratings and peer ratings in two of these studies yielded comparable sensitivity in one study,65 improved sensitivity in the other,98 and improved specificity in both, compared with self-ratings alone.

Neuropsychological measures were assessed in five of these studies.78, 98, 119, 123, 145 Sensitivities ranged from 30 percent (corresponding specificity 74%) 98to 84 percent (corresponding specificity 80%),78 and specificities ranged from 56 percent (corresponding sensitivity 73.3%)123 to 86 percent (corresponding sensitivity 47%).145 Generally, however, performance of these as stand-alone measures was poorer than for self-ratings, and studies were inconsistent in identifying which of the numerous measures from the continuous performance measurement (e.g., omission errors, commission errors, reaction time variability) provided the best performance. Three of these studies assessed diagnostic performance when combining self-ratings with continuous performance measures.78, 119, 123 One found substantially better sensitivity than for the neuropsychological test alone and better specificity than for the self-rating alone, one found better sensitivity and specificity than for the continuous performance test alone,78 and one did not report sensitivity or specificity for the combination.119

These findings from head-to-head comparisons, taken together, suggest that the combination of self-ratings, peer ratings, and continuous performance test scores may one day prove more useful than either measure alone in accurately diagnosing ADHD. Currently, however, self-ratings combined with peer ratings offer the best evidence for improving diagnostic performance over either rating alone.

## 4.3 Implications

Self-report scales are easy to use tools to aid the diagnosis of ADHD in both primary and specialty care settings. They are prone, however, to both false positive and false negative findings, especially when used in a setting where adults present for evaluation of suspected ADHD. A negative test is reassuring but not conclusive, and it likely prompts in a patient complaining about ADHD symptoms an assessment of current symptoms, as well as retrospective assessment of symptoms earlier in childhood (when symptom expression may have been more complete) from other sources – including spouses, significant others, parents, siblings, and teacher comments in school records. A negative test also prompts questions about other mental health problems whose symptoms overlap those of ADHD, especially depression, anxiety, substance abuse, stress, and trauma.

Self-report scales are also prone to false positives, most often from the presence of one or more of these conditions with overlapping symptoms. Therefore, assessing the validity of positive responses to questions on the scale helps in deciding how likely the test result is to be a true positive. Thus, patients with a positive test results should elaborate on experiences of symptoms in their own words, noting when the symptoms first began to discern if they were present in childhood, reviewing the trajectory of the symptoms over time, the settings or experiences that exacerbate them, and what kind of functional impairment they produce, if any.16 ADHD symptoms in childhood can be assessed by asking patients and parents to complete retrospective symptom reports on standard checklists, such as the ADHD rating scale174 or the Conners 3 rating scale.175 Similar to a negative test, positive tests also raise questions about overlapping symptoms from other conditions. Assessing symptoms of other conditions that can overlap with ADHD symptoms can be done even in a busy clinical practice through the use of existing scales for depression and anxiety (such as the PHQ-9176 and GAD-7177). It is critical to assess whether positive responses truly represent ADHD or instead the symptoms of another clinical condition.16

Neuropsychological tests, including the CPT, are not routine in diagnosing ADHD in adults, and both sensitivity and specificity for these tests are on average lower than for self-report measures. Certainly, the long and expensive batteries of traditional neuropsychological testing will not aid diagnosis of ADHD, though they may serve other clinical purposes. Prior reviews of CPT performance as a diagnostic tool in adults with ADHD have yielded these same conclusions.38, 39 Whether the combination of a CPT with self-report measures can improve diagnostic performance is at present unclear. In addition, symptom validity tests and performance validity tests can detect some invalid presentations in self-reports and inadequate effort in neuropsychological tests and many experts have recommended the use of these tools as part of a comprehensive assessment of ADHD in adults.178-184 Identified studies varied regarding the inclusion of validity tests. In addition, an individual’s effort during testing can fluctuate significantly over the course of an assessment, and individuals differ in what cognitive abilities they choose to exaggerate or feign deficits.110, 185

Finally, the quality of evidence for objective tests that are not vulnerable to impression management such as EEG, neuroimaging, and biomarkers, as tools to diagnose ADHD in adults is low. None of the performance findings have been replicated, and no clinical effectiveness studies have been conducted to assess use of these tools in the real world to diagnose ADHD. From a practical perspective, very few primary care or specialty mental health clinicians have access to these technologies. Thus, these tools are not even remotely close to being ready for clinical application to aid diagnosis, even though the FDA has approved one EEG measure as a purported diagnostic aid.186, 187

## 4.4 Strengths, Limitations, and Applicability

A strength of this review is its scope and inclusiveness - publications did not have date restrictions, and they were not limited to use of any pre-specified tools, which led to inclusion of novel EEG, neuroimaging, and biomarker studies in the diagnosis of ADHD. Nonetheless, this review was limited to diagnostic accuracy studies and did not focus on psychometric considerations such as the validity of symptoms supporting a diagnosis. In addition, we restricted the review to English-language studies, which will have missed some tools used locally outside of the U.S. and other English-speaking countries.

The conclusions of this review are limited by the poor quality of evidence for performance of every category of diagnostic tool and by the paucity of reporting findings that would support meta-analysis across studies, including AUCs, false positive and negative rates, and the thresholds applied to scores from the diagnostic tools. Furthermore, limiting to studies reporting on a reference standard added focus to the review, but given the issues surrounding a clinical diagnosis of ADHD in adults also needs to acknowledge that there is no true and universally accepted gold standard in this research area.

Finally, several included studies reported multiple exclusions for eligible participants, which hinders the generalizability of the findings to patients seen in routine practice, in particular in primary care. Furthermore, some studies used sophisticated and resource-intense assessment methods, as well as advanced analytic procedures to optimize diagnostic performance. Hence, diagnostic performance may not translate from the favorable effects shown in the documented research to real world practice and likely represent a best-case scenario.

## Next Steps

Despite the limitations of studies thus far, it seems clear from their findings that no single rating scale or neuropsychological test, and probably no single neuroimaging algorithm or biomarker, will provide the desired combination of high sensitivity and high specificity in diagnosing adults who have ADHD in real-world settings, where the clinical question is whether a given individual who is suspected of having ADHD actually has it. The relatively few studies that have directly compared the performance of diagnostic tools with one another provide some early indication that the combination of tools may yield may improve both sensitivity and specificity in diagnosing ADHD compared with the use of any single tool alone. Future studies should compare the performance of tools within and across categories, both singly and in combination. The methods for optimally combining measures across different tools should be made explicit and have a clear rationale. Algorithms for combining measures that are based on machine learning, neural networks, or other similar “black box” technologies should be made publicly available to facilitate validation, replication, and dissemination. Much more research is needed to determine how to combine data optimally across informants or tools.16, 33

Future studies should move past the use of neurotypical comparator groups, which have little or no real-world clinical relevance, and instead assess diagnostic performance only in clinical samples. Further, future studies should assess diagnostic performance in clinically important participant subgroups, including subgroups defined by age, sex, race, ethnicity, and the presence of disorders that commonly co-occur with ADHD, if only to be able to say with more confidence that there are no differences. We cannot assume that the absence of research equates to the absence of evidence and we had to note several times that the evidence was simply insufficient for more concrete evidence statements. Because the diagnosis of ADHD requires childhood onset, studies are needed to assess how best to assess and validate the presence of symptoms in childhood.168 It is often difficult to obtain childhood educational and medical records and adults’ recall of childhood symptoms is limited.16, 168, 169, 188-193 More research is also needed on measures to detect invalid responses in completing self-report ADHD rating scales and inadequate effort on neuropsychological tests.33

Future studies of diagnostic tools should report their findings in much more detail to support meta-analyses across studies. This would include reporting false positive and negative rates, the thresholds applied to scores from the diagnostic tools, and any data manipulation used to produce the finding. Studies should also report ROC analyses to support comparisons of test performance across studies that are independent of diagnostic thresholds. Studies should also make available their individual-level data in public repositories to support future efforts at replication, synthesis, and new discovery.

Although currently available “objective” measures of neurocognitive performance are not likely to be useful tools in diagnosing ADHD in adults, continued search for and development of better objective, performance-based measures is warranted. Candidate tools will need to overcome the limitations identified for prior continuous performance tests and other neuropsychological tests. New, better-performing tools will need to correlated better with ADHD symptom ratings, have better test-retest reliability, have fewer ceiling effects that likely contribute to false negative diagnoses, and have greater ecological validity – i.e., better simulate the effects of external and environmental distractions that disrupt attention in everyday life. 33, 38, 39, 173

Finally, studies are needed to assess the consequences of being correctly or incorrectly diagnosed as having ADHD and any unintended consequences and adverse effects of diagnostic tools.

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Abbreviations and Acronyms

ABC Aberrant Behavior Checklist

ADHD Attention-Deficit/Hyperactivity Disorder

AHRQ Agency for Healthcare Research and Quality

AQ10 Autism Quotient - 10

BAARS-IV Barkley Adult ADHD Rating Scale-IV

DSM-5 Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition

EEG Electroencephalogram

EPC Evidence-based Practice Center

FDA Food and Drug Administration

N/A Not available

SEADs Supplemental Evidence And Data for Systematic Reviews

SOE Strength of Evidence

TEP Technical Expert Panel

TOVA Test of Variables of Attention

Appendixes

Appendix A. Search Strategy

Appendix B. List of Included, Background, and Excluded Studies

Appendix C. Evidence Tables

Appendix D. Critical Appraisal and Applicability Tables

Appendix A. Search Strategy

**Date: October 14, 2024**

**PubMed**

| "Attention Deficit Disorder with Hyperactivity"[Mesh] OR "attention deficit hyperactivity disorder"[tiab] OR "ADHD"[tiab] OR "attention deficit disorder"[tiab])  AND  Adult[MESH] OR Aged[MESH] OR Middle Aged[MESH] OR Young Adult[MESH] OR Adult[Title/Abstract] OR Adults[Title/Abstract]  AND  "Attention Deficit and Disruptive Behavior Disorders/diagnosis"[Majr] OR mass screening[mesh] OR questionnaires[mesh] OR Interviews as Topic[Mesh] OR Psychometrics[Mesh] OR Psychiatric Status Rating Scales[Mesh] OR diagnosis[mesh:noexp] OR "Diagnostic Techniques and Procedures"[Mesh] OR "Referral and Consultation"[Mesh] OR questionnaire[tiab] OR questionnaires[tiab] OR screening[tiab] OR screen[tiab] OR scale[tiab] OR instrument[tiab] OR instruments[tiab] OR interview[tiab] OR interviews[tiab] OR diagnosis[tiab] OR diagnostic[tiab] OR diagnosed[tiab] OR Measure [tiab] OR test[tiab] OR tests[tiab] OR testing[tiab] OR "Attention Deficit Disorder with Hyperactivity/diagnostic imaging"[Majr] OR ((("Adaptive Behavior Assessment System"[Title/Abstract] OR "ABAS-3"[Title/Abstract] OR "Advanced Clinical Solutions"[Title/Abstract] OR "Word Choice Test"[Title/Abstract] OR "Test of Premorbid Functioning"[Title/Abstract] OR "Social Cognition"[Title/Abstract] OR "Beck Anxiety Inventory"[Title/Abstract] OR "BAI"[Title/Abstract] OR "Beck Depression Inventory"[Title/Abstract] OR "BDI-2"[Title/Abstract] OR "Behavioral Assessment System for Children"[Title/Abstract] OR "Self-Report of Personality"[Title/Abstract] OR "BASC-3 SRP Adolescent"[Title/Abstract] OR "Behavioral Assessment System for Children"[Title/Abstract] OR "Parent Rating Scales"[Title/Abstract] OR "BASC-3 PRS Adolescent"[Title/Abstract] OR "BASC-3 SRP College"[Title/Abstract] OR "Teacher Rating Scales"[Title/Abstract] OR "BASC-3 TRS Adolescent"[Title/Abstract] OR "Brown Executive Function/Attention Scales"[Title/Abstract] OR "Brown EF/A Self"[Title/Abstract] OR "California Verbal Learning Test"[Title/Abstract] OR "CVLT-3"[Title/Abstract] OR "Standard Form California Verbal" "CVLT-3 Brief"[Title/Abstract] OR "California Verbal Learning Test"[Title/Abstract] OR "CVLT-C"[Title/Abstract] OR "Childhood Autism Rating Scale"[Title/Abstract] OR "CARS-2"[Title/Abstract] OR "Childhood Autism Rating Scale"[Title/Abstract] OR "High-Functioning Version"[Title/Abstract] OR "CARS-2 HF"[Title/Abstract] OR "Clinical Evaluation of Language Fundamentals"[Title/Abstract] OR "CELF-5"[Title/Abstract] OR "Comprehensive Executive Function Inventory"[Title/Abstract] OR "CEFI Adult Observer"[Title/Abstract] OR "Comprehensive Executive Function Inventory"[Title/Abstract] OR "CEFI Adult Self-Report"[Title/Abstract] OR "Conners’ Adult ADHD Diagnostic Interview for DSM-IV"[Title/Abstract] OR "CAADID Part 1"[Title/Abstract] OR "CAADID Part 2"[Title/Abstract] OR "CAARS–O:L"[Title/Abstract] OR "CAARS–S:L"[Title/Abstract] OR "CAARS-2 Observer"[Title/Abstract] OR "Conners’ Adult ADHD Rating Scales"[Title/Abstract] OR "CAARS-2 Self-Report"[Title/Abstract] OR "Delis-Kaplan Executive Function System"[Title/Abstract] OR "D-KEFS"[Title/Abstract] OR "Dot Counting Test"[Title/Abstract] OR "Grooved Pegboard Test Kaufman Test of Educational Achievement"[Title/Abstract] OR "KTEA-3"[Title/Abstract] OR "Neuropsychological Assessment Battery"[Title/Abstract] OR "Attention, Language, Memory, Spatial, and Executive Functions Modules"[Title/Abstract] OR "NIH Executive Abilities–Measures and Instruments for Neurobehavioral Evaluation and Re-search"[Title/Abstract] OR "NIH EXAMINER"[Title/Abstract] OR "Personality Assessment Inventory"[Title/Abstract] OR "PROMIS Sleep Assessments Pediatric Parent Proxy"[Title/Abstract] OR "Repeatable Battery for the Assessment of Neuropsychological Status"[Title/Abstract] OR "RBANS"[Title/Abstract] OR "Rey-Osterrieth Complex"[Title/Abstract] OR "Wechsler Abbreviated Scale of Intelligence"[Title/Abstract] OR "WASI-2"[Title/Abstract] OR "Wechsler Adult Intelligence Scale"[Title/Abstract] OR "WAIS-4"[Title/Abstract] OR "WAIS-IV"[Title/Abstract] OR "Wechsler Individual Achievement Test"[Title/Abstract] OR "WIAT-4"[Title/Abstract] OR "Wechsler Intelligence Scale "[Title/Abstract] OR "Wechsler Memory Scale"[Title/Abstract] OR "WMS-4"[Title/Abstract] OR "Wide Range Achievement Test"[Title/Abstract] OR "WRAT-5"[Title/Abstract] OR "Adult ADHD Rating Scale"[Title/Abstract] OR "ADHD-RS"[Title/Abstract] OR "Brown ADD scales"[Title/Abstract] OR "Continuous Performance Tests"[Title/Abstract] OR "Conners CPT"[Title/Abstract] OR "QB Test"[Title/Abstract] OR "TOVA"[Title/Abstract] OR "Wender Utah Adult ADHD Scale"[Title/Abstract]))  AND  "Sensitivity and Specificity"[Mesh] OR "Diagnostic Errors"[Mesh] OR sensitivity[tiab] OR specificity[tiab] OR (accura\*[tiab] AND (diagnos\*[tiab] OR classif\*[tiab])) OR "ROC curve"[tiab] OR "positive predictive value"[tiab] OR "negative predictive value"[tiab] OR "false positive"[tiab] OR "false negative"[tiab] OR "likelihood ratio"[tiab]  NOT |
| --- |
| Editorial[ptyp] OR Letter[pt] OR Case Reports[pt] OR Comment[pt] address[pt] OR "autobiography"[pt] OR "bibliography"[pt] OR "biography"[pt] OR "case report"[tw] OR "case reports"[tw] OR "case series"[tw] OR "comment on"[All Fields] OR congress[pt] OR "dictionary"[pt] OR "directory"[pt] OR "festschrift"[pt] OR "historical article"[pt] OR lecture[pt] OR "legal case"[pt] OR "legislation"[pt] OR "news"[pt] OR "newspaper article"[pt] OR "patient education handout"[pt] OR "periodical index"[pt]  NOT |
| "animals"[mesh] NOT "humans"[mesh]) |

**EMBASE**

(((('adaptive behavior assessment system':ti OR 'abas-3':ti OR 'advanced clinical solutions':ti OR 'word choice test':ti OR 'test of premorbid functioning':ti OR 'social cognition':ti OR 'beck anxiety inventory':ti OR 'bai':ti OR 'beck depression inventory':ti OR 'bdi-2':ti OR 'self-report of personality':ti OR 'basc-3 srp adolescent':ti OR 'behavioral assessment system for children':ti OR 'parent rating scales':ti OR 'basc-3 prs adolescent':ti OR 'basc-3 srp college':ti OR 'teacher rating scales':ti OR 'basc-3 trs adolescent':ti OR 'brown executive function/attention scales':ti OR 'brown ef/a self':ti OR 'california verbal learning test':ti OR 'cvlt-3':ti OR 'standard form california verbal':ti) AND 'cvlt-3 brief':ti OR 'california verbal learning test':ti OR 'cvlt-c':ti OR 'cars-2':ti OR 'childhood autism rating scale':ti OR 'high-functioning version':ti OR 'cars-2 hf':ti OR 'clinical evaluation of language fundamentals':ti OR 'celf-5':ti OR 'cefi adult observer':ti OR 'comprehensive executive function inventory':ti OR 'cefi adult self-report':ti OR 'conners adult adhd diagnostic interview for dsm-iv':ti OR 'caadid part 1':ti OR 'caadid part 2':ti OR 'caars–o:l':ti OR 'caars–s:l':ti OR 'caars-2 observer':ti OR 'conners adult adhd rating scales':ti OR 'caars-2 self-report':ti OR 'delis-kaplan executive function system':ti OR 'd-kefs':ti OR 'dot counting test':ti OR 'grooved pegboard test kaufman test of educational achievement':ti OR 'ktea-3':ti OR 'nepsy-ii developmental neuropsychological battery':ti OR 'neuropsychological assessment battery':ti OR 'attention, language, memory, spatial,':ti) AND 'ex- ecutive functions modules':ti OR 'nih executive abilities–measures':ti) AND 'instruments for neurobehavioral evaluation':ti AND 're search':ti OR 'nih examiner':ti OR 'personality assessment inventory':ti OR 'promis sleep assessments pediatric parent proxy':ti OR 'repeatable battery for the assessment of neuropsychological status':ti OR 'rbans':ti OR 'rey-osterrieth complex':ti OR 'wechsler abbreviated scale of intelligence':ti OR 'wasi-2':ti OR 'wechsler adult intelligence scale':ti OR 'wais-4':ti OR 'wais-iv':ti OR 'wechsler individual achievement test':ti OR 'wiat-4':ti OR 'wechsler intelligence scale':ti OR OR 'wechsler memory scale':ti OR 'wms-4':ti OR 'wide range achievement test':ti OR 'wrat-5':ti OR 'adult adhd rating scale':ti OR 'adhd-rs':ti OR 'brown add scales':ti OR 'continuous performance tests':ti OR 'conners cpt':ti OR 'qb test':ti OR 'tova':ti OR 'wender utah adult adhd scale':ti OR 'diagnostic interview for adult adhd':ti

AND

"Attention Deficit Disorder with Hyperactivity" OR "attention deficit hyperactivity disorder" OR "ADHD" OR "attention deficit disorder")

OR

(#1 'attention deficit disorder with hyperactivity':ab,ti OR 'attention deficit hyperactivity disorder':ab,ti OR 'adhd':ab,ti OR 'attention deficit disorder':ab,ti 61194

#2 ((adult:ab,ti OR aged:ab,ti OR middle:ab,ti) AND aged:ab,ti OR young:ab,ti) AND adult:ab,ti OR adult:ab,ti OR adults:ab,ti 2231374

#3 ((('attention deficit and disruptive behavior disorders/diagnosis':ab,ti OR mass:ab,ti) AND screening:ab,ti OR questionnaires:ab,ti OR interviews:ab,ti) AND as:ab,ti AND topic:ab,ti OR psychometrics:ab,ti OR psychiatric:ab,ti) AND status:ab,ti AND rating:ab,ti AND scales:ab,ti OR 'diagnostic techniques and procedures':ab,ti OR 'referral and consultation':ab,ti OR questionnaire:ab,ti OR questionnaires:ab,ti OR screening:ab,ti OR screen:ab,ti OR scale:ab,ti OR instrument:ab,ti OR instruments:ab,ti OR interview:ab,ti OR interviews:ab,ti OR diagnosis:ab,ti OR diagnostic:ab,ti OR diagnosed:ab,ti OR measure:ab,ti OR test:ab,ti OR tests:ab,ti OR testing:ab,ti OR 'attention deficit disorder with hyperactivity/diagnostic imaging':ab,ti 11386521

#4 'sensitivity and specificity':ab,ti OR 'diagnostic errors':ab,ti OR sensitivity:ab,ti OR specificity:ab,ti OR (accura\*:ab,ti AND (diagnos\*:ab,ti OR classif\*:ab,ti)) OR 'roc curve':ab,ti OR 'positive predictive value':ab,ti OR 'negative predictive value':ab,ti OR 'false positive':ab,ti OR 'false negative':ab,ti OR 'likelihood ratio':ab,ti 2280552

#5 #1 AND #2 AND #3 AND #4 814

#6 #5 AND [humans]/lim 787

#7 #6 AND ([article]/lim OR [article in press]/lim) 509)

**APA PsycINFO**

(((title: ("Adaptive Behavior Assessment System") OR title: ("ABAS-3") OR title: ("Advanced Clinical Solutions") OR title: ("Word Choice Test") OR title: ("Test of Premorbid Functioning") OR title: ("Social Cognition") OR title: ("Beck Anxiety Inventory") OR title: ("BAI") OR title: ("Beck Depression Inventory") OR title: ("BDI-2") OR title: ("Behavioral Assessment System for Children") OR title: ("Self-Report of Personality") OR title: ("BASC-3 SRP Adolescent") OR title: ("Behavioral Assessment System for Children") OR title: ("Parent Rating Scales") OR title: ("BASC-3 PRS Adolescent") OR title: ("BASC-3 SRP College") OR title: ("Teacher Rating Scales") OR title: ("BASC-3 TRS Adolescent") OR title: ("Brown Executive Function/Attention Scales") OR title: ("Brown EF/A Self") OR title: ("California Verbal Learning Test") OR title: ("CVLT-3") OR title: ("Standard Form California Verbal" "CVLT-3 Brief") OR title: ("California Verbal Learning Test") OR title: ("CVLT-C") OR title: ("Childhood Autism Rating Scale") OR title: ("CARS-2") OR title: ("Childhood Autism Rating Scale") OR title: ("High-Functioning Version") OR title: ("CARS-2 HF") OR title: ("Clinical Evaluation of Language Fundamentals") OR title: ("CELF-5") OR title: ("Comprehensive Executive Function Inventory") OR title: ("CEFI Adult Observer") OR title: ("Comprehensive Executive Function Inventory") OR title: ("CEFI Adult Self-Report") OR title: ("Conners' Adult ADHD Diagnostic Interview for DSM-IV") OR title: ("CAADID Part 1") OR title: ("CAADID Part 2") OR title: ("CAARS–O:L") OR title: ("CAARS–S:L") OR title: ("CAARS-2 Observer") OR title: ("Conners' Adult ADHD Rating Scales") OR title: ("CAARS-2 Self-Report") OR title: ("Delis-Kaplan Executive Function System") OR title: ("D-KEFS") OR title: ("Dot Counting Test") OR title: ("Grooved Pegboard Test Kaufman Test of Educational Achievement") OR title: ("KTEA-3") OR title: ("NEPSY-II Developmental Neuropsychological Battery") OR title: ("Neuropsychological Assessment Battery") OR title: ("Attention, Language, Memory, Spatial, and Ex- ecutive Functions Modules") OR title: ("NIH Executive Abilities–Measures and Instruments for Neurobehavioral Evaluation and Re-search") OR title: ("NIH EXAMINER") OR title: ("Personality Assessment Inventory") OR title: ("PROMIS Sleep Assessments Pediatric Parent Proxy") OR title: ("Repeatable Battery for the Assessment of Neuropsychological Status") OR title: ("RBANS") OR title: ("Rey-Osterrieth Complex") OR title: ("Wechsler Abbreviated Scale of Intelligence") OR title: ("WASI-2") OR title: ("Wechsler Adult Intelligence Scale") OR title: ("WAIS-4") OR title: ("WAIS-IV") OR title: ("Wechsler Individual Achievement Test") OR title: ("WIAT-4") OR title: ("Wechsler Intelligence Scale ") OR title: ("Wechsler Memory Scale") OR title: ("WMS-4") OR title: ("Wide Range Achievement Test") OR title: ("WRAT-5") OR title: ("Adult ADHD Rating Scale") OR title: ("ADHD-RS") OR title: ("Brown ADD scales") OR title: ("Continuous Performance Tests") OR title: ("Conners CPT") OR title: ("QB Test") OR title: ("TOVA") OR title: ("Wender Utah Adult ADHD Scale") OR title: ("diagnostic interview for Adult ADHD")))

AND

((title: ("Attention Deficit Disorder with Hyperactivity") OR title: ("attention deficit hyperactivity disorder") OR title: ("ADHD") OR title: ("attention deficit disorder")) OR (abstract: ("Attention Deficit Disorder with Hyperactivity") OR abstract: ("attention deficit hyperactivity disorder") OR abstract: ("ADHD") OR abstract: ("attention deficit disorder"))))

OR

(((title: ("Attention Deficit Disorder with Hyperactivity") OR title: ("attention deficit hyperactivity disorder") OR title: ("ADHD") OR title: ("attention deficit disorder")) OR (abstract: ("Attention Deficit Disorder with Hyperactivity") OR abstract: ("attention deficit hyperactivity disorder") OR abstract: ("ADHD") OR abstract: ("attention deficit disorder"))) AND ((title: (Adult) OR title: (Aged) OR title: (Middle Aged) OR title: (Young Adult) OR title: (Adult) OR title: (Adults)) OR (abstract: (Adult) OR abstract: (Aged) OR abstract: (Middle Aged) OR abstract: (Young Adult) OR abstract: (Adult) OR abstract: (Adults))) AND ((title: ("Attention Deficit and Disruptive Behavior Disorders/diagnosis") OR title: (mass screening) OR title: (questionnaires) OR title: (Interviews as Topic) OR title: (Psychometrics) OR title: (Psychiatric Status Rating Scales) OR title: (diagnosis) OR title: ("Diagnostic Techniques and Procedures") OR title: ("Referral and Consultation") OR title: (questionnaire) OR title: (questionnaires) OR title: (screening) OR title: (screen) OR title: (scale) OR title: (instrument) OR title: (instruments) OR title: (interview) OR title: (interviews) OR title: (diagnosis) OR title: (diagnostic) OR title: (diagnosed) OR title: (Measure) OR title: (test) OR title: (tests) OR title: (testing) OR title: ("Attention Deficit Disorder with Hyperactivity/diagnostic imaging")) OR (abstract: ("Attention Deficit and Disruptive Behavior Disorders/diagnosis") OR abstract: (mass screening) OR abstract: (questionnaires) OR abstract: (Interviews as Topic) OR abstract: (Psychometrics) OR abstract: (Psychiatric Status Rating Scales) OR abstract: (diagnosis) OR abstract: ("Diagnostic Techniques and Procedures") OR abstract: ("Referral and Consultation") OR abstract: (questionnaire) OR abstract: (questionnaires) OR abstract: (screening) OR abstract: (screen) OR abstract: (scale) OR abstract: (instrument) OR abstract: (instruments) OR abstract: (interview) OR abstract: (interviews) OR abstract: (diagnosis) OR abstract: (diagnostic) OR abstract: (diagnosed) OR abstract: (Measure) OR abstract: (test) OR abstract: (tests) OR abstract: (testing) OR abstract: ("Attention Deficit Disorder with Hyperactivity/diagnostic imaging"))) AND ((title: ("Sensitivity and Specificity") OR title: ("Diagnostic Errors") OR title: (sensitivity) OR title: (specificity) OR (title: (accura\*) AND (title: (diagnos\*) OR title: (classif\*))) OR title: ("ROC curve") OR title: ("positive predictive value") OR title: ("negative predictive value") OR title: ("false positive") OR title: ("false negative") OR title: ("likelihood ratio")) OR (abstract: ("Sensitivity and Specificity") OR abstract: ("Diagnostic Errors") OR abstract: (sensitivity) OR abstract: (specificity) OR (abstract: (accura\*) AND (abstract: (diagnos\*) OR abstract: (classif\*))) OR abstract: ("ROC curve") OR abstract: ("positive predictive value") OR abstract: ("negative predictive value") OR abstract: ("false positive") OR abstract: ("false negative") OR abstract: ("likelihood ratio"))) AND Population Group: Human AND Publication Type: Peer Reviewed Journal)

**Cochrane Database of Systematic Reviews** (CDSR)

(#1 ("Adaptive Behavior Assessment System" OR "ABAS-3" OR "Advanced Clinical Solutions" OR "Word Choice Test" OR "Test of Premorbid Functioning" OR "Social Cognition" OR "Beck Anxiety Inventory" OR "BAI" OR "Beck Depression Inventory" OR "BDI-2" OR "Behavioral Assessment System for Children" OR "Self-Report of Personality" OR "BASC-3 SRP Adolescent" OR "Behavioral Assessment System for Children" OR "Parent Rating Scales" OR "BASC-3 PRS Adolescent" OR "BASC-3 SRP College" OR "Teacher Rating Scales" OR "BASC-3 TRS Adolescent" OR "Brown Executive Function/Attention Scales" OR "Brown EF/A Self" OR "California Verbal Learning Test" OR "CVLT-3" OR "Standard Form California Verbal" "CVLT-3 Brief" OR "California Verbal Learning Test" OR "CVLT-C" OR "Childhood Autism Rating Scale" OR "CARS-2" OR "Childhood Autism Rating Scale" OR "High-Functioning Version" OR "CARS-2 HF" OR "Clinical Evaluation of Language Fundamentals" OR "CELF-5" OR "Comprehensive Executive Function Inventory" OR "CEFI Adult Observer" OR "Comprehensive Executive Function Inventory" OR "CEFI Adult Self-Report" OR "Conners’ Adult ADHD Diagnostic Interview for DSM-IV" OR "CAADID Part 1" OR "CAADID Part 2" OR "CAARS–O:L" OR "CAARS–S:L" OR "CAARS-2 Observer" OR "Conners’ Adult ADHD Rating Scales" OR "CAARS-2 Self-Report" OR "Delis-Kaplan Executive Function System" OR "D-KEFS" OR "Dot Counting Test" OR "Grooved Pegboard Test Kaufman Test of Educational Achievement" OR "KTEA-3" OR "NEPSY-II Developmental Neuropsychological Battery" OR "Neuropsychological Assessment Battery" OR "Attention, Language, Memory, Spatial, and Ex- ecutive Functions Modules" OR "NIH Executive Abilities–Measures and Instruments for Neurobehavioral Evaluation and Re-search" OR "NIH EXAMINER" OR "Personality Assessment Inventory" OR "PROMIS Sleep Assessments Pediatric Parent Proxy" OR "Repeatable Battery for the Assessment of Neuropsychological Status" OR "RBANS" OR "Rey-Osterrieth Complex" OR "Wechsler Abbreviated Scale of Intelligence" OR "WASI-2" OR "Wechsler Adult Intelligence Scale" OR "WAIS-4" OR "WAIS-IV" OR "Wechsler Individual Achievement Test" OR "WIAT-4" OR "Wechsler Intelligence Scale" OR "Wechsler Memory Scale" OR "WMS-4" OR "Wide Range Achievement Test" OR "WRAT-5" OR "Adult ADHD Rating Scale" OR "ADHD-RS" OR "Brown ADD scales" OR "Continuous Performance Tests" OR "Conners CPT" OR "QB Test" OR "TOVA" OR "Wender Utah Adult ADHD Scale" OR "diagnostic interview for Adult ADHD"):ti,ab,kw (Word variations have been searched)

#2 ("Attention Deficit Disorder with Hyperactivity" OR "attention deficit hyperactivity disorder" OR "ADHD" OR "attention deficit disorder"):ti,ab,kw (Word variations have been searched)

#3 #1 AND #2 )

OR

(#1

MeSH descriptor: [Attention Deficit Disorder with Hyperactivity] explode all trees

#2

("attention deficit hyperactivity disorder" OR "ADHD" OR "attention deficit disorder"):ti,ab,kw

(Word variations have been searched)

#3

#1 OR #2

#4

MeSH descriptor: [Adult] explode all trees

#5

MeSH descriptor: [Aged] in all MeSH products

#6

MeSH descriptor: [Middle Aged] explode all trees

#7

(Young Adult OR Adult OR Adults):ti,ab,kw

(Word variations have been searched)

#8

#4 OR #5 OR #6 OR #7

#9

MeSH descriptor: [Mass Screening] explode all trees

#10

MeSH descriptor:[Surveys and Questionnaires] explode all trees

#11

MeSH descriptor: [Interviews as Topic] explode all trees

#12

MeSH descriptor: [Psychometrics] explode all trees

#13

MeSH descriptor: [Psychiatric Status Rating Scales] explode all trees

#14

MeSH descriptor: [Diagnosis] this term only

#15

MeSH descriptor: [Diagnostic Techniques and Procedures] explode all trees

#16

MeSH descriptor: [Referral and Consultation] explode all trees

#17

("Attention Deficit and Disruptive Behavior Disorders" AND diagnosis):ti,ab,kw

(Word variations have been searched)

#18

("Attention Deficit and Disruptive Behavior Disorders" AND "diagnostic imaging"):ti,ab,kw

(Word variations have been searched)

#19

(questionnaire OR questionnaires OR screening OR screen OR scale OR instrument OR instruments OR interview OR interviews OR diagnosis OR diagnostic OR diagnosed OR Measure OR test OR tests OR testing):ti,ab,kw

#20

#9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19

#21

("Sensitivity and Specificity" OR "Diagnostic Errors" OR sensitivity OR specificity OR (accura\* AND (diagnos\* OR classif\*)) OR "ROC curve" OR "positive predictive value" OR "negative predictive value" OR "false positive" OR "false negative" OR "likelihood ratio"):ti,ab,kw

#22

#3 AND #8 AND #20 AND #21)

**Campbell Collaboration**

("Adaptive Behavior Assessment System" OR "ABAS-3" OR "Advanced Clinical Solutions" OR "Word Choice Test" OR "Test of Premorbid Functioning" OR "Social Cognition" OR "Beck Anxiety Inventory" OR "BAI" OR "Beck Depression Inventory" OR "BDI-2" OR "Behavioral Assessment System for Children" OR "Self-Report of Personality" OR "BASC-3 SRP Adolescent" OR "Behavioral Assessment System for Children" OR "Parent Rating Scales" OR "BASC-3 PRS Adolescent" OR "BASC-3 SRP College" OR "Teacher Rating Scales" OR "BASC-3 TRS Adolescent" OR "Brown Executive Function/Attention Scales" OR "Brown EF/A Self" OR "California Verbal Learning Test" OR "CVLT-3" OR "Standard Form California Verbal" "CVLT-3 Brief" OR "California Verbal Learning Test" OR "CVLT-C" OR "Childhood Autism Rating Scale" OR "CARS-2" OR "Childhood Autism Rating Scale" OR

"High-Functioning Version" OR "CARS-2 HF" OR "Clinical Evaluation of Language Fundamentals" OR "CELF-5" OR "Comprehensive Executive Function Inventory" OR "CEFI Adult Observer" OR "Comprehensive Executive Function Inventory" OR "CEFI Adult Self-Report" OR "Conners’ Adult ADHD Diagnostic Interview for DSM-IV" OR "CAADID Part 1" OR "CAADID Part 2" OR "CAARS–O:L" OR "CAARS–S:L" OR "CAARS-2 Observer" OR "Conners’ Adult ADHD Rating Scales" OR "CAARS-2 Self-Report" OR "Delis-Kaplan Executive Function System" OR "D-KEFS" OR "Dot Counting Test" OR "Grooved Pegboard Test Kaufman Test of Educational Achievement" OR "KTEA-3" OR "NEPSY-II Developmental Neuropsychological Battery" OR "Neuropsychological Assessment Battery" OR "Attention, Language, Memory, Spatial, and Executive Functions Modules" OR "NIH Executive Abilities–Measures and Instruments for Neurobehavioral Evaluation and Re-search" OR "NIH EXAMINER" OR "Personality Assessment Inventory" OR "PROMIS Sleep Assessments Pediatric Parent Proxy" OR "Repeatable Battery for the Assessment of Neuropsychological Status" OR "RBANS" OR "Rey-Osterrieth Complex" OR "Wechsler Abbreviated Scale of Intelligence" OR "WASI-2" OR "Wechsler Adult Intelligence Scale" OR "WAIS-4" OR "WAIS-IV" OR "Wechsler Individual Achievement Test" OR "WIAT-4" OR "Wechsler Intelligence Scale" OR "Wechsler Memory Scale" OR "WMS-4" OR "Wide Range Achievement Test" OR "WRAT-5" OR "Adult ADHD Rating Scale" OR "ADHD-RS" OR "Brown ADD scales" OR "Continuous Performance Tests" OR "Conners CPT" OR "QB Test" OR "TOVA" OR "Wender Utah Adult ADHD Scale" OR "diagnostic interview for Adult ADHD")

OR

("Attention Deficit Disorder with Hyperactivity" OR "attention deficit hyperactivity disorder" OR "ADHD" OR "attention deficit disorder")

**PROSPERO** (https://www.crd.york.ac.uk/prospero/)

(#1 ("Adaptive Behavior Assessment System" OR "ABAS-3" OR "Advanced Clinical Solutions" OR "Word Choice Test" OR "Test of Premorbid Functioning" OR "Social Cognition" OR "Beck Anxiety Inventory" OR "BAI" OR "Beck Depression Inventory" OR "BDI-2" OR "Behavioral Assessment System for Children" OR "Self-Report of Personality" OR "BASC-3 SRP Adolescent" OR "Behavioral Assessment System for Children" OR "Parent Rating Scales" OR "BASC-3 PRS Adolescent" OR "BASC-3 SRP College" OR "Teacher Rating Scales" OR "BASC-3 TRS Adolescent" OR "Brown Executive Function/Attention Scales" OR "Brown EF/A Self" OR "California Verbal Learning Test" OR "CVLT-3" OR "Standard Form California Verbal" "CVLT-3 Brief" OR "California Verbal Learning Test" OR "CVLT-C" OR "Childhood Autism Rating Scale" OR "CARS-2" OR "Childhood Autism Rating Scale" OR "High-Functioning Version" OR "CARS-2 HF" OR "Clinical Evaluation of Language Fundamentals" OR "CELF-5" OR "Comprehensive Executive Function Inventory" OR "CEFI Adult Observer"):TI

#2 ("Comprehensive Executive Function Inventory" OR "CEFI Adult Self-Report" OR "Conners Adult ADHD Diagnostic Interview for DSM-IV" OR "CAADID Part 1" OR "CAADID Part 2" OR "CAARS?OL" OR "CAARS?SL" OR "CAARS-2 Observer" OR "Conners Adult ADHD Rating Scales" OR "CAARS-2 Self-Report" OR "Delis-Kaplan Executive Function System" OR "D-KEFS" OR "Dot Counting Test" OR "Grooved Pegboard Test Kaufman Test of Educational Achievement" OR "KTEA-3" OR "NEPSY-II Developmental Neuropsychological Battery" OR "Neuropsychological Assessment Battery" OR "Attention, Language, Memory, Spatial, and Ex- ecutive Functions Modules" OR "NIH Executive Abilities?Measures and Instruments for Neurobehavioral Evaluation and Re-search"):TI

#3 ("NIH EXAMINER" OR "Personality Assessment Inventory" OR "PROMIS Sleep Assessments Pediatric Parent Proxy" OR "Repeatable Battery for the Assessment of Neuropsychological Status" OR "RBANS" OR "Rey-Osterrieth Complex" OR "Wechsler Abbreviated Scale of Intelligence" OR "WASI-2" OR "Wechsler Adult Intelligence Scale" OR "WAIS-4" OR "WAIS-IV" OR "Wechsler Individual Achievement Test" OR "WIAT-4" OR "Wechsler Intelligence Scale" OR "Wechsler Memory Scale" OR "WMS-4" OR "Wide Range Achievement Test" OR "WRAT-5" OR "Adult ADHD Rating Scale" OR "ADHD-RS" OR "Brown ADD scales" OR "Continuous Performance Tests" OR "Conners CPT" OR "QB Test" OR "TOVA" OR "Wender Utah Adult ADHD Scale" OR "diagnostic interview for Adult ADHD"):TI

#4 #3 OR #2 OR #1

#5 (MeSH DESCRIPTOR Attention Deficit Disorder with Hyperactivity EXPLODE ALL TREES):TI

#6 MeSH DESCRIPTOR Attention Deficit Disorder with Hyperactivity EXPLODE ALL TREES

#7 ("Attention Deficit Disorder with Hyperactivity" OR "attention deficit hyperactivity disorder" OR "ADHD" OR "attention deficit disorder"):TI

#8 #7 OR #6

#9 #8 AND #4)

OR

#1 MeSH DESCRIPTOR Attention Deficit Disorder with Hyperactivity EXPLODE ALL TREES

#2 "attention deficit hyperactivity disorder" OR "ADHD" OR "attention deficit disorder"

#3 #2 OR #1

#4 MeSH DESCRIPTOR Aged, 80 and over EXPLODE ALL TREES

#5 MeSH DESCRIPTOR Adult EXPLODE ALL TREES

#6 MeSH DESCRIPTOR Middle Aged EXPLODE ALL TREES

#7 Young Adult OR Adult OR Adults

#8 #4 OR #5 OR #6 OR #7

#9 MeSH DESCRIPTOR Mass Screening EXPLODE ALL TREES

#10 "interviews as topics"

#11 psychometrics

#12 MeSH DESCRIPTOR Psychiatric Status Rating Scales EXPLODE ALL TREES

#13 MeSH DESCRIPTOR Diagnosis EXPLODE ALL TREES

#14 MeSH DESCRIPTOR diagnosis EXPLODE ALL TREES

#15 MeSH DESCRIPTOR diagnosis

#16 MeSH DESCRIPTOR Diagnostic Techniques and Procedures EXPLODE ALL TREES

#17 MeSH DESCRIPTOR Referral and Consultation EXPLODE ALL TREES

#18 attention deficit and disruptive behavior disorders

#19 "attention deficit and disruptive behavior disorders" AND diagnosis

#20 "attention deficit and disruptive behavior disorders" AND "diagnostic imaging"

#21 questionnaire OR questionnaires OR screening OR screen OR scale OR instrument OR instruments OR interview OR interviews OR diagnosis OR diagnostic OR diagnosed OR Measure OR test OR tests OR testing

#22 #9 OR #10 OR #11 OR #12 OR #15 OR #16 OR #17 OR #19 OR #20 OR #21

#23 "Sensitivity and Specificity" OR "Diagnostic Errors" OR sensitivity OR specificity OR (accura\* AND (diagnos\* OR classif\*)) OR "ROC curve" OR "positive predictive value" OR "negative predictive value" OR "false positive" OR "false negative" OR "likelihood ratio"

#24 #3 AND #8 AND #22 AND #23

**ECRI Guidelines Trust** https://guidelines.ecri.org/

('"Adaptive Behavior Assessment System" OR "ABAS-3" OR "Advanced Clinical Solutions" OR "Word Choice Test" OR "Test of Premorbid Functioning" OR "Social Cognition" OR "Beck Anxiety Inventory" OR "BAI" OR "Beck Depression Inventory" OR "BDI-2" OR "Behavioral Assessment System for Children" OR "Self-Report of Personality" OR "BASC-3 SRP Adolescent" OR "Behavioral Assessment System for Children" OR "Parent Rating Scales" OR "BASC-3 PRS Adolescent" OR "BASC-3 SRP College" OR "Teacher Rating Scales" OR "BASC-3 TRS Adolescent" OR "Brown Executive Function/Attention Scales" OR "Brown EF/A Self" OR "California Verbal Learning Test" OR "CVLT-3" OR "Standard Form California Verbal" "CVLT-3 Brief" OR "California Verbal Learning Test" OR "CVLT-C" OR "Childhood Autism Rating Scale" OR "CARS-2" OR "Childhood Autism Rating Scale" OR "High-Functioning Version" OR "CARS-2 HF" OR "Clinical Evaluation of Language Fundamentals" OR "CELF-5" OR "Comprehensive Executive Function Inventory" OR "CEFI Adult Observer" OR "Comprehensive Executive Function Inventory" OR "CEFI Adult Self-Report" OR "Conners’ Adult ADHD Diagnostic Interview for DSM-IV" OR "CAADID Part 1" OR "CAADID Part 2" OR "CAARS–O:L" OR "CAARS–S:L" OR "CAARS-2 Observer" OR "Conners’ Adult ADHD Rating Scales" OR "CAARS-2 Self-Report" OR "Delis-Kaplan Executive Function System" OR "D-KEFS" OR "Dot Counting Test" OR "Grooved Pegboard Test Kaufman Test of Educational Achievement" OR "KTEA-3" OR "NEPSY-II Developmental Neuropsychological Battery" OR "Neuropsychological Assessment Battery" OR "Attention, Language, Memory, Spatial, and Executive Functions Modules" OR "NIH Executive Abilities–Measures and Instruments for Neurobehavioral Evaluation and Re-search" OR "NIH EXAMINER" OR "Personality Assessment Inventory" OR "PROMIS Sleep Assessments Pediatric Parent Proxy" OR "Repeatable Battery for the Assessment of Neuropsychological Status" OR "RBANS" OR "Rey-Osterrieth Complex" OR "Wechsler Abbreviated Scale of Intelligence" OR "WASI-2" OR "Wechsler Adult Intelligence Scale" OR "WAIS-4" OR "WAIS-IV" OR "Wechsler Individual Achievement Test" OR "WIAT-4" OR "Wechsler Intelligence Scale" OR "Wechsler Memory Scale" OR "WMS-4" OR "Wide Range Achievement Test" OR "WRAT-5" OR "Adult ADHD Rating Scale" OR "ADHD-RS" OR "Brown ADD scales" OR "Continuous Performance Tests" OR "Conners CPT" OR "QB Test" OR "TOVA" OR "Wender Utah Adult ADHD Scale" OR "diagnostic interview for Adult ADHD"')

OR

("Attention Deficit Disorder with Hyperactivity" OR "attention deficit hyperactivity disorder" OR "ADHD" OR "attention deficit disorder"

FILTER: Patient Age

Adolescent (13 to 18 years), Adult (19 to 44 years), Middle Age(45 to 64 years), Aged(65 to 79 years), Aged (80 and over)

**Guidelines International Network Library** (G-I-N, https://guidelines.ebmportal.com/)

("Adaptive Behavior Assessment System" OR "ABAS-3" OR "Advanced Clinical Solutions" OR "Word Choice Test" OR "Test of Premorbid Functioning" OR "Social Cognition" OR "Beck Anxiety Inventory" OR "BAI" OR "Beck Depression Inventory" OR "BDI-2" OR "Behavioral Assessment System for Children" OR "Self-Report of Personality" OR "BASC-3 SRP Adolescent" OR "Behavioral Assessment System for Children" OR "Parent Rating Scales" OR "BASC-3 PRS Adolescent" OR "BASC-3 SRP College" OR "Teacher Rating Scales" OR "BASC-3 TRS Adolescent" OR "Brown Executive Function/Attention Scales" OR "Brown EF/A Self" OR "California Verbal Learning Test" OR "CVLT-3" OR "Standard Form California Verbal" "CVLT-3 Brief" OR "California Verbal Learning Test" OR "CVLT-C" OR "Childhood Autism Rating Scale" OR "CARS-2" OR "Childhood Autism Rating Scale" OR "High-Functioning Version" OR "CARS-2 HF" OR "Clinical Evaluation of Language Fundamentals" OR "CELF-5" OR "Comprehensive Executive Function Inventory" OR "CEFI Adult Observer" OR "Comprehensive Executive Function Inventory" OR "CEFI Adult Self-Report" OR "Conners’ Adult ADHD Diagnostic Interview for DSM-IV" OR "CAADID Part 1" OR "CAADID Part 2" OR "CAARS–O:L" OR "CAARS–S:L" OR "CAARS-2 Observer" OR "Conners’ Adult ADHD Rating Scales" OR "CAARS-2 Self-Report" OR "Delis-Kaplan Executive Function System" OR "D-KEFS" OR "Dot Counting Test" OR "Grooved Pegboard Test Kaufman Test of Educational Achievement" OR "KTEA-3" OR "NEPSY-II Developmental Neuropsychological Battery" OR "Neuropsychological Assessment Battery" OR "Attention, Language, Memory, Spatial, and Ex- ecutive Functions Modules" OR "NIH Executive Abilities–Measures and Instruments for Neurobehavioral Evaluation and Re-search" OR "NIH EXAMINER" OR "Personality Assessment Inventory" OR "PROMIS Sleep Assessments Pediatric Parent Proxy" OR "Repeatable Battery for the Assessment of Neuropsychological Status" OR "RBANS" OR "Rey-Osterrieth Complex" OR "Wechsler Abbreviated Scale of Intelligence" OR "WASI-2" OR "Wechsler Adult Intelligence Scale" OR "WAIS-4" OR "WAIS-IV" OR "Wechsler Individual Achievement Test" OR "WIAT-4" OR "Wechsler Intelligence Scale" OR "Wechsler Memory Scale" OR "WMS-4" OR "Wide Range Achievement Test" OR "WRAT-5" OR "Adult ADHD Rating Scale" OR "ADHD-RS" OR "Brown ADD scales" OR "Continuous Performance Tests" OR "Conners CPT" OR "QB Test" OR "TOVA" OR "Wender Utah Adult ADHD Scale" OR "diagnostic interview for Adult ADHD")

OR

("Attention Deficit Disorder with Hyperactivity" OR "attention deficit hyperactivity disorder" OR "ADHD" OR "attention deficit disorder")

**ClinicalKey**

("Adaptive Behavior Assessment System" OR "ABAS-3" OR "Advanced Clinical Solutions" OR "Word Choice Test" OR "Test of Premorbid Functioning" OR "Social Cognition" OR "Beck Anxiety Inventory" OR "BAI" OR "Beck Depression Inventory" OR "BDI-2" OR "Behavioral Assessment System for Children" OR "Self-Report of Personality" OR "BASC-3 SRP Adolescent" OR "Behavioral Assessment System for Children" OR "Parent Rating Scales" OR "BASC-3 PRS Adolescent" OR "BASC-3 SRP College" OR "Teacher Rating Scales" OR "BASC-3 TRS Adolescent" OR "Brown Executive Function/Attention Scales" OR "Brown EF/A Self" OR "California Verbal Learning Test" OR "CVLT-3" OR "Standard Form California Verbal" "CVLT-3 Brief" OR "California Verbal Learning Test" OR "CVLT-C" OR "Childhood Autism Rating Scale" OR "CARS-2" OR "Childhood Autism Rating Scale" OR "High-Functioning Version" OR "CARS-2 HF" OR "Clinical Evaluation of Language Fundamentals" OR "CELF-5" OR "Comprehensive Executive Function Inventory" OR "CEFI Adult Observer" OR "Comprehensive Executive Function Inventory" OR "CEFI Adult Self-Report" OR "Conners’ Adult ADHD Diagnostic Interview for DSM-IV" OR "CAADID Part 1" OR "CAADID Part 2" OR "CAARS–O:L" OR "CAARS–S:L" OR "CAARS-2 Observer" OR "Conners’ Adult ADHD Rating Scales" OR "CAARS-2 Self-Report" OR "Delis-Kaplan Executive Function System" OR "D-KEFS" OR "Dot Counting Test" OR "Grooved Pegboard Test Kaufman Test of Educational Achievement" OR "KTEA-3" OR "NEPSY-II Developmental Neuropsychological Battery" OR "Neuropsychological Assessment Battery" OR "Attention, Language, Memory, Spatial, and Executive Functions Modules" OR "NIH Executive Abilities–Measures and Instruments for Neurobehavioral Evaluation and Re-search" OR "NIH EXAMINER" OR "Personality Assessment Inventory" OR "PROMIS Sleep Assessments Pediatric Parent Proxy" OR "Repeatable Battery for the Assessment of Neuropsychological Status" OR "RBANS" OR "Rey-Osterrieth Complex" OR "Wechsler Abbreviated Scale of Intelligence" OR "WASI-2" OR "Wechsler Adult Intelligence Scale" OR "WAIS-4" OR "WAIS-IV" OR "Wechsler Individual Achievement Test" OR "WIAT-4" OR "Wechsler Intelligence Scale" OR "Wechsler Memory Scale" OR "WMS-4" OR "Wide Range Achievement Test" OR "WRAT-5" OR "Adult ADHD Rating Scale" OR "ADHD-RS" OR "Brown ADD scales" OR "Continuous Performance Tests" OR "Conners CPT" OR "QB Test" OR "TOVA" OR "Wender Utah Adult ADHD Scale" OR "diagnostic interview for Adult ADHD")

OR

("Attention Deficit Disorder with Hyperactivity" OR "attention deficit hyperactivity disorder" OR "ADHD" OR "attention deficit disorder"

FILTERS: Journal Articles, Guidelines)

Appendix B. List of Included, Background, and Excluded Publications

This appendix shows the list of included, background studies, and excluded studies with reasons for exclusion. Background papers provided more information on the topic or were retained for reference-mining. We recorded only one reason for exclusion per publications.

Included Publications

1. Abramson DA, White DJ, Rhoads T, et al. Cross-validating the Dot Counting Test Among an Adult ADHD Clinical Sample and Analyzing the Effect of ADHD Subtype and Comorbid Psychopathology. Assessment. 2023 Mar;30(2):264-73. doi: 10.1177/10731911211050895. PMID: 34643101.

2. Adamou M, Jones SL, Marks L, et al. Efficacy of Continuous Performance Testing in Adult ADHD in a Clinical Sample Using QbTest. J Atten Disord. 2022 Sep;26(11):1483-91. doi: 10.1177/10870547221079798. PMID: 35255743.

3. Aita SL, Sofko CA, Hill BD, et al. Utility of the Personality Assessment Inventory in detecting feigned Attention-Deficit/Hyperactivity Disorder (ADHD): The Feigned Adult ADHD index. Arch Clin Neuropsychol. 2018 Nov 1;33(7):832-44. doi: 10.1093/arclin/acx113. PMID: 29186287.

4. Amen DG, Hanks C, Prunella J. Preliminary evidence differentiating ADHD using brain SPECT imaging in older patients. J Psychoactive Drugs. 2008 Jun;40(2):139-46. doi: 10.1080/02791072.2008.10400623. PMID: 18720662.

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6. Andrikopoulos D, Vassiliou G, Fatouros P, et al. Machine learning-enabled detection of attention-deficit/hyperactivity disorder with multimodal physiological data: a case-control study. BMC Psychiatry. 2024;24(1). doi: 10.1186/s12888-024-05987-7. https://www.embase.com/search/results?subaction=viewrecord&id=L2030847356&from=export

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8. Bastiaens L, Galus J. Comparison of the Adult ADHD Self Report Scale Screener for DSM-IV and DSM-5 in a Dually Diagnosed Correctional Population. Psychiatr Q. 2018 Jun;89(2):505-10. doi: 10.1007/s11126-017-9553-4. PMID: 29270886. https://link.springer.com/article/10.1007/s11126-017-9553-4

9. Becke M, Tucha L, Butzbach M, et al. Feigning Adult ADHD on a Comprehensive Neuropsychological Test Battery: An Analogue Study. Int J Environ Res Public Health. 2023 Feb 24;20(5). doi: 10.3390/ijerph20054070. PMID: 36901080. https://mdpi-res.com/d\_attachment/ijerph/ijerph-20-04070/article\_deploy/ijerph-20-04070.pdf?version=1677231890

10. Berger C, Lev A, Braw Y, et al. Detection of Feigned ADHD Using the MOXO-d-CPT. J Atten Disord. 2021 May;25(7):1032-47. doi: 10.1177/1087054719864656. PMID: 31364437.

11. Biederman J, Hammerness P, Sadeh B, et al. Diagnostic utility of brain activity flow patterns analysis in attention deficit hyperactivity disorder. Psychol Med. 2017 May;47(7):1259-70. doi: 10.1017/s0033291716003329. PMID: 28065167. https://www.cambridge.org/core/journals/psychological-medicine/article/abs/diagnostic-utility-of-brain-activity-flow-patterns-analysis-in-attention-deficit-hyperactivity-disorder/D50FB7D73029E6859363142E894C4B5E

12. Brunkhorst-Kanaan N, Verdenhalven M, Kittel-Schneider S, et al. The Quantified Behavioral Test-A Confirmatory Test in the Diagnostic Process of Adult ADHD? Front Psychiatry. 2020;11:216. doi: 10.3389/fpsyt.2020.00216. PMID: 32265761. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7100366/pdf/fpsyt-11-00216.pdf

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