Technical Review

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Diagnosis of Attention-Deficit/Hyperactivity Disorder

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Structured Abstract

Diagnosis of Attention-Deficit/Hyperactivity Disorder

Objectives. This report summarizes current scientific evidence from the literature in four areas: the prevalence of attention-deficit/hyperactivity disorder (ADHD) among children 6 to 12 years old in the general population and the comorbidities that might occur with ADHD; the prevalence of ADHD among children presenting in primary care settings and the comorbidities that might occur with ADHD; the accuracy of various screening methods in diagnosing ADHD; and the prevalence of abnormal findings on selected medical screening tests commonly recommended in evaluating children suspected of having ADHD.

Search Strategy. The evidence on ADHD prevalence and comorbidities was gathered from published literature identified through searches of MEDLINE and PsycINFO databases, reference lists in review articles, and from 10 behavioral rating scale manuals. Articles on medical screening tests were identified through searches of MEDLINE. Additional articles that met eligibility criteria but were not yet listed in MEDLINE were identified by experts.

Selection Criteria. The diagnosis of ADHD was based on criteria in one of the diagnostic reference standards. Study populations were limited to boys and girls 6 to 12 years of age. Only studies using general, unselected populations in communities or schools or pediatric/family practice clinics were used to address the prevalence questions. Data on the performance of screening tests could come from studies conducted in any setting. Two types of scales were examined for this report: "ADHD-specific," designed to target ADHD symptoms only, and "broad-band," designed to screen for various symptoms, including the symptoms found in ADHD patients. Data sought from medical tests included the prevalence of abnormal findings among children diagnosed with ADHD. Evidence was admissible if the study from which it came had representative study populations, comparable control groups and adequate description of demographic information. Only articles published in English between 1980 and 1997 were used in the analysis.

Data Collection and Analysis. Two trained specialists independently read each of the retrieved articles and completed a form which characterized the type of information in the article. The articles accepted for analysis were each abstracted by trained personnel and the subject specialist independently abstracted each article. The resulting sets of abstractions (2 abstractions per article) were compared, with differences discussed and resolved. A multiple logistic regression model with random effects was used to analyze simultaneously for the effect of age, gender, diagnostic tool, and setting. The analysis was done using the EGRET software. Appropriate quality checks were performed.

Main Results. Prevalence of ADHD ranged from 4 to 12 percent in the general, unscreened, school-age U.S. population. Gender, diagnostic tool, and setting are significant factors in the

prevalence of ADHD, but age is not significant. Boys have higher rates of ADHD than in girls for all types of ADHD, with the inattentive type most common. Up to one-third of children diagnosed with ADHD also qualify for one of the five conditions most commonly comorbid with ADHD: oppositional defiant disorder, conduct disorder, anxiety disorder, depressive disorder or learning disorders.

The prevalence of ADHD in a pediatric clinic setting varies between two percent of children and five percent depending on the study. Coexistence of ADHD with other disorders in children seen by a pediatrician was found in the one study to be 59 percent and in a second to range from 8 to 20 percent, depending on the comorbid condition and whether the informant was the parent or the child.

Studies of behavioral rating scales showed that the Conners Rating Scale of 1997, contains two highly effective indices for discriminating between children with ADHD and normal controls 94 percent of the time. The Barkley School Situations Questionnaire was 86 percent effective. Medical screening tests to detect a relationship between ADHD and lead levels, abnormal thyroid function, imaging of brain structures, or EEG abnormalities have not shown any relationship with ADHD.

Conclusions. The prevalence of ADHD in the general unscreened school-age population was estimated from 4 percent to 12 percent. In the general, unscreened, school-age population, prevalence of ADHD co-occurring with other disorders was estimated to be high, based on results of four studies. Of children diagnosed with ADHD, approximately 35 percent also qualified for a diagnosis of oppositional defiant disorder, 28 percent qualified for a diagnosis of conduct disorder, 26 percent qualified for a diagnosis of anxiety disorder, and 18 percent also had a depressive disorder, and 12 percent had learning disabilities. Prevalence of ADHD in a pediatric clinic setting varied widely, with few studies available for analysis. The prevalence of comorbid ADHD in a pediatric clinic setting also varied too widely to draw useful conclusions.

Studies of ADHD-specific rating scales showed that the Conners Rating Scale of 1997 is highly effective for discriminating between children with ADHD and normal controls. The studies reviewed could not be used to derive conclusions regarding the effectiveness of broad-band rating scales in distinguishing children with significant problems from children without significant problems. Evidence does not support the use of tests of such as lead levels, thyroid function brain imaging, EEG, and neurological screening to screen children suspected of having ADHD.

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Summary

Overview

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common childhood-onset psychiatric disorders. It is distinguished by symptoms of inattention, hyperactivity, and impulsivity. ADHD may be accompanied by learning disabilities, depression, anxiety, conduct disorder, and oppositional defiant disorder. The etiology of ADHD is unknown, and the disorder may have several different causes. Investigators have studied, for example, the relation of ADHD to elevated lead levels, abnormal thyroid function, morphologic brain differences, and EEG patterns. With current public awareness of ADHD, pediatricians and health care providers are reporting increases in referral rates of children with suspected ADHD. Numerous rating scales and medical tests for evaluation and diagnosis of ADHD are available, with mixed expert opinion on their usefulness.

The Agency for Health Care Policy and Research sponsored development of this technical review to summarize current scientific evidence from the literature on the prevalence of ADHD and on the value of various evaluation methods. The following questions provided a framework for the analysis:

1. What percentage of the U.S. general population aged 6 to 12 years has ADHD? Of those with ADHD, what percentage has one or more of the following comorbidities: learning disabilities, depression, anxiety, conduct disorder, and oppositional defiant disorder?

2. What percentage of children aged 6 to 12 years presenting at pediatricians' or family physicians' offices in the United States meets diagnostic criteria for ADHD? Of those with ADHD, what percentage has one or more of the following comorbidities: learning disabilities, depression, anxiety, conduct disorder, and oppositional defiant disorder?

3. What is the accuracy (i.e., sensitivity, specificity, positive predictive value) and reliability (i.e., inter/intra-rater agreement) of behavioral rating screening tests for ADHD compared with a reference standard?

4. What is the prevalence of abnormal findings on selected medical screening tests commonly recommended as standard components of an evaluation of a child with suspected ADHD?

Diagnostic screening tests, as analyzed under questions 3 and 4, were of two types: behavioral rating scales and medical screening tests. The behavior rating scales selected for consideration consisted of both ADHD-specific scales and "broad-band" scales designed to screen for various symptoms including ADHD symptoms. The medical screening tests considered included commonly recommended tests that are standard components of an evaluation of a child with suspected ADHD: electroencephalography, lead concentration level testing, thyroid hormone level testing, hearing and vision screening, imaging tests, neurological screening, and continuous performance tests (CPTs).

Reporting the Evidence

The evidence on ADHD prevalence and diagnosis reported here was gathered from 87 published articles and 10 behavioral scale manuals. Studies must have been peer-reviewed and published in the English language between 1980 and 1997. These 97 sources were identified during searches of the databases MEDLINE and PsycINFO and from reference lists in review articles, research study articles, and a draft guideline on ADHD obtained from the American Academy of Child and Adolescent Psychiatry currently in development; recent journal publications; citations suggested by American Academy of Pediatricians members; and a database of bibliographies on studies that used or evaluated the Child Behavior Checklists (CBCL). Abstracts of more than 4000 identified citations were reviewed, from which 507 articles and 10 manuals were retrieved and subjected to further consideration. The published studies had to be soundly designed and conform to specified inclusion and exclusion criteria to qualify for consideration.

Methodology

Data from the 97 accepted articles/manuals were abstracted, tabulated systematically, and subjected to statistical analysis. A multiple logistic regression model with random effects was used to analyze simultaneously for the effect of age, gender, diagnostic tool, and setting. This model accommodates the fact that each study estimated ADHD rates under slightly different conditions. The analysis was done using the EGRET software.

Summary Findings

The significant findings derived from the analysis are summarized below.

Prevalence of ADHD in General Population

- Gender, diagnostic tool (DSM-III or DSM-III-R), and setting (community or school setting) are significant contributors to the ADHD rate, but age (5 to 9 years versus 10 to 12 years) is not a significant factor.

- ADHD prevalence is much higher when academic and behavioral functioning impairment criteria are not considered (16.1% without impairment criteria versus 6.8% with). Boys have higher rates of ADHD than do girls.

Prevalence of Comorbid ADHD in General Population

- One-third of children diagnosed with ADHD also qualify for a diagnosis of oppositional defiant disorder (ODD).

- One-fourth of children diagnosed with ADHD also qualify for a diagnosis of conduct disorder (CD).

- Less than one-fifth of children with ADHD also have a depressive disorder.

- More than one-fourth of children with ADHD qualify for a diagnosis of anxiety disorder.

- Almost one-third of children with ADHD also have more than one comorbid condition.

- Overall, the prevalence rates of comorbid ADHD are high. Estimates of the prevalence rates of various comorbid conditions in children with ADHD range from 12.36 percent (learning disorders) to 35.15 percent (conduct disorder).

Prevalence of ADHD in Pediatric Clinic Setting

- Results on prevalence of ADHD in a pediatric clinic setting are varied. A 1997 study finds prevalence conforms to that of the general population; a 1988 study shows much smaller prevalence.

Prevalence of Comorbid ADHD in Pediatric Clinic Setting

- Results on prevalence of comorbid ADHD in a pediatric clinic setting are varied. A 1997 study finds a high prevalence, similar to that in the general population; a 1988 study gives much smaller rates.

Behavior Rating Scales, ADHD-Specific

- The Conners Rating Scales, 1997 Revision, contain two highly effective indices for discriminating between ADHD children and normal controls. The Barkley School Situations Questionnaire is less effective. These results are based on studies conducted under ideal conditions; actual performance of the scales in physicians' offices is expected to be poorer.

- Hyperactivity subscales that effectively discriminate between ADHD children and normal controls include DSM-III-R SNAP and Conners Abbreviated Teacher Questionnaire (CATQ, HI). The ACTeRS scale performed poorly. These results are based on studies conducted under ideal conditions; actual performance of the scales in physicians' offices is expected to be poorer.

- An inattention subscale that effectively discriminates between ADHD children and normal controls is the DSM-III-R SNAP checklist. The ACTeRS scale performed poorly. These results are based on studies conducted under ideal conditions; actual performance of the scales in physicians' offices is expected to be poorer.

- An impulsivity subscale that effectively discriminates between ADHD children and normal controls is the DSM-III-R SNAP checklist.

Broad-Band Behavioral Rating Scales

- None of the broad-band scales analyzed—the CPCL/4-18-R Total Problem Scale, DSMD Total Problem Scale, CPRS-R:L Global Problem Index, and CTRS-R:L Global Problem Index—effectively discriminate between referred and nonreferred children. Thus they are not useful as tools to detect clinical-level problems in children presenting at a pediatrician's office.

- Externalizing, internalizing, and adaptive functioning scales did not effectively detect referred versus nonreferred children.

Medical Screening Tests

- Analysis of six studies on the relation between elevated lead levels and ADHD showed that lead levels are not useful as a general diagnostic tool for ADHD. This is strengthened by the fact that ADHD prevalence appears to be increasing even as lead levels in the population appear to be decreasing.

- Analysis of four studies showed no relation between abnormal thyroid function and ADHD. Thus, the evidence does not support the use of tests of thyroid function to screen for ADHD.

- Analysis of seven imaging studies of the brain (CT, CAT, and MRI) that were performed to detect morphologic differences in brain structures of children with ADHD yielded sparse and diverse evidence. Thus none of the imaging procedures analyzed is considered useful as a screening or diagnostic tool for ADHD.

- Eight studies of electroencephalogram (EEG) patterns and ADHD found no serious EEG abnormalities in ADHD children, although many studies found significant differences in brain wave activity between ADHD children and normal controls. The heterogeneity of results across studies indicates the EEG should not be routinely used as a screening tool for ADHD.

- Evidence from studies of neurological screening tests did not yield any clues to the etiology of ADHD. Thus these tests are not deemed effective for screening ADHD.

- Continuous performance tests measure impulsivity, inattention, and vigilance. Statistical analysis of studies using these tests indicated that CPTs would not serve as useful screening tools for ADHD.

Future Research Needs

- Continued work to gather data on prevalence of ADHD using the following factors lacking in much of the work already done: DSM-IV, use of both genders as subjects, rates of ADHD--Primarily Inattentive Type, and wider-scale studies across regions of the country or across countries using the same criteria.

- Comparison studies to assess the ability of broad-band behavior checklists to discriminate between clinical and non-clinical samples (those studies available at this time have only presented results of the ability of these tests to discriminate between referred and nonreferred samples). Clinically severe problems are present in both of those groups, as are subclinical problems.

- Continued work in the area of magnetic resonance imaging and PET, when possible, to continue to explore structural and functional differences in the brains of children diagnosed with ADHD and each of the types of ADHD.

Diagnosis of Attention-Deficit/Hyperactivity Disorder

Introduction

Attention-deficit/hyperactivity disorder (ADHD), one of the most common behavioral disorders, is distinguished by symptoms of inattention, hyperactivity, and impulsivity. With recent increased public awareness of the disorder, pediatricians and health care providers in general are reporting increases in referral rates of children with suspected ADHD. A plethora of rating scales and medical tests are available, with mixed expert opinion on their individual usefulness. Evidence is needed on the usefulness, or yield, of the various methods available for evaluation and diagnosis of ADHD, to enable the pediatrician and other health care providers to make confident choices. Careful investigation and thorough discussion of the biological, epidemiological, diagnostic, and treatment issues surrounding ADHD led to the rationale for developing an evidence-based report on this disorder and for the specific topics the report would address—prevalence and diagnostic screening of ADHD.

Methodology

This evidence report used a systematic methodology for gathering and analyzing evidence comprising design of the topic and questions, database searches, literature retrieval and review, data abstraction, data entry, and statistical analysis. The selected topics—prevalence and diagnostic screening of ADHD—were defined as clearly as possible. Specific questions about prevalence and diagnostic screening were chosen through a joint effort involving the Agency for Health Care Policy and Research (AHCPR), the American Academy of Pediatrics (AAP), and Technical Resources International, Inc. (TRI). Certain parameters further refined the questions, providing clear and manageable limits to the information that would be gathered and synthesized as evidence. These parameters, called inclusion and exclusion criteria, were then used to select studies that best provided the information needed to answer the report's questions. Those questions, as well as the inclusion and exclusion criteria, are presented below.

Questions

1. What percentage of the U.S. general population aged 6 to 12 years has ADHD? Of those with ADHD, what percentage has one or more of the following comorbidities: learning disabilities, depression, anxiety, conduct disorder, and oppositional defiant disorder?

2. What percentage of children aged 6 to 12 years presenting at pediatricians' or family physicians' offices in the United States meets diagnostic criteria for ADHD? Of those with ADHD, what percentage has one or more of the following comorbidities: learning disabilities, depression, anxiety, conduct disorder, and oppositional defiant disorder?

3. What are the accuracy (i.e., sensitivity, specificity, positive predictive value) and reliability (i.e., inter/intra-rater agreement) of behavioral rating screening tests for ADHD compared with a reference standard (DSM or ICD-9)?

4. What is the prevalence of abnormal findings on selected medical screening tests commonly recommended as standard components of an evaluation of a child with suspected ADHD?

Inclusion and Exclusion Criteria

The scope of evidence included in this report was defined according to the following categories of inclusion and exclusion criteria: definition of ADHD and comorbid conditions; demographics of the population studied; type of setting; specific behavioral screening tests considered, with outcomes of interest; specific medical screening tests considered, with outcomes of interest; and criteria for admissible evidence. These categories are specified below and illustrated in Table 1.

Definition of ADHD and Comorbid Conditions

Studies were included if the diagnosis of ADHD was based on criteria listed in one of the following diagnostic reference standards: the *Diagnostic and Statistical Manual of Mental Disorders*, 3rd Edition (DSM-III), 3rd Edition-Revised (DSM-III-R), or 4th Edition (DSM-IV) (American Psychiatric Association, 1980, 1987, 1994), or the *International Classification of Diseases* (ICD), all editions (U.S. Department of Health and Human Services, 1994). Data were abstracted on five of the most common conditions known to occur with ADHD: learning disabilities, depression, anxiety, conduct disorder, and oppositional defiant disorder. Combinations of ADHD with these disorders were included for the prevalence data, but not for behavior rating scale or medical screening test data.

Demographics of Population Studied

Patient populations were limited to boys and girls 6 to 12 years of age. Prevalence data were restricted to studies conducted in North America. Data on the performance of behavioral and medical screening tests were not subject to geographic limitation.

Setting

Only studies using general, unselected populations in communities or schools or pediatric/family practice clinics were used to address the prevalence questions appropriately. Studies were excluded if the prevalence data were obtained in a mental health facility or referral clinic or a school for developmentally disabled students. Data on the performance of screening tests could come from studies conducted in any setting.

Table 1. Inclusion and Exclusion Criteria for the Evidence Report

Inclusion Criteria	Exclusion Criteria
Definition of ADHD/Comorbidities	
ADHD with symptoms as listed in DSM-III, DSM-III-R, DSM-IV, and ICD (all editions) Comorbid conditions: learning disabilities, depression, anxiety, conduct disorder, and oppositional defiant disorder Combinations of the 5 listed comorbid conditions allowed in Questions 1 and 2 (prevalence questions)	Criteria other than DSM and ICD Comorbid conditions other than the 5 listed Combinations of the 5 comorbid conditions listed in Questions 3 and 4 (assessment questions)
Patient Population	
Boys and girls Ages 6-12 years Representative population North American studies for Questions 1 and 2 (prevalence questions) Any countries for Questions 3 and 4 (assessment questions)	Adults Preschoolers (ages 2-5) Adolescents (ages 13-18) Referral populations (for prevalence estimates) Children with moderate to severe mental retardation (IQ<55) Children with pervasive developmental disorders and/or severe psychiatric disorders Any studies outside North America for Questions 1 and 2 (prevalence questions)
Setting/Provider Population	
All settings allowed for Questions 3 and 4 (assessment questions) Limited settings for Questions 1 and 2 (prevalence questions): General population (Question 1) Community School surveys Primary care setting (Question 2) Pediatrician's office Physicians in family or general practice	Prevalence studies from: Mental health facilities or referral clinics Schools for developmentally disabled students
Behavioral Screening Tests for ADHD	
Selected Behavior Checklists/Rating Scales (parent, teacher report forms only) ADHD-Specific Checklists ADD-H: Comprehensive Teacher Rating Scale (ACTeRS) Attention Deficit Disorders Evaluation Scale (ADDES) Barkley Questionnaires (HSQ, SSQ, ADHDR) Children's Attention and Adjustment Survey (CAAS) ADHD-Specific Conners Rating Scales (CATQ, CAPQ, CPRS:R-ADHD, DSM) SNAP Checklist (SNAP) Vanderbilt AD/HD Diagnostic Teacher Rating Scale (VADTRS) Broad-Band Checklists Behavior Assessment System for Children (BASC) Burk's Behavior Rating Scales, Grades 1-9 (BBRS) Child Behavior Checklists (CBCL) Broad-Band Conners Rating Scales (CPRS, CTRS) Devereaux Scales of Mental Disorders (DSMD) Ontario Child Health Study Scales (OCHS) Pediatric Symptom Checklist (PSC) Yale Children's Inventory (YCI)	Behavioral screening tests other than those listed under Inclusion Criteria to the left (others to be identified; if sufficient number of studies of additional tests are available, decision will be made whether to extract and analyze data from those tests) Versions of the behavior checklists/rating scales designed for "youth self-report" Tests for comorbid conditions (e.g., tests for learning disabilities or speech disorders)

Table 1. Inclusion and Exclusion Criteria for the Evidence Report (continued)

Inclusion Criteria	Exclusion Criteria
Outcomes of Interest for Behavioral Screening Tests (Question 3) Accuracy for ADHD (for ADHD-targeted checklists only) Sensitivity Specificity Positive predictive value Accuracy for referral population (for broad-band checklists only) Effect size for discriminating referred from nonreferred samples	Treatment outcomes Accuracy and reliability of tests for comorbid conditions
Medical Screening Tests for ADHD (Question 4) Selected Medical and Neurological Screening Tests: Electroencephalography (EEG) Lead concentration level Thyroid hormone level Imaging tests Continuous performance tests Hearing and vision screening Neurological screening tests	Medical or neurological screening tests other than those listed under Inclusion Criteria to the left Medical or neurological screening tests not commonly recommended as standard components of an evaluation of a child with suspected ADHD
Outcomes of Interest for Medical Screening Tests (Question 4) Prevalence of abnormal findings	Accuracy and reliability of tests
Criteria for Admissible Evidence/Bibliographic Database Boundaries Data from published studies Literature published 1980-1997 English language	Non-peer-reviewed Non-English language literature Data from unpublished studies Nondiagnostic outcomes (e.g., treatment)

Behavior Rating Scales

The behavior rating scales evaluated in this study were selected after careful investigation of currently available instruments. Several sources provided this information: catalogs ordered from the major publishers of psychological and psychiatric measurement products, Internet searches, reviews of published expert opinion on diagnosis of ADHD in the primary care setting, all editions published since 1970 of the *Mental Measurements Yearbook* (MMY, a set of professional reviews of psychological assessment products) (Buros, 1998), and the *Psychware Sourcebook* (a reference guide to computerized psychological assessment products) (Krug, 1993). Published sources of expert opinion were as follows: Altepeter and Breen (1992); August and Garfinkel (1989); August, Ostrander, and Bloomquist (1992); Biederman, Faraone, Doyle, et al. (1993); Breen (1989); Breen and Altepeter (1990); Brunshaw and Szatmari (1988); Chen, Faraone, Biederman, et al. (1994); Cohen, Kelly, and Atkinson (1989); Dykman and Ackerman (1991); Edelbrock and Costello (1988); Epstein, Shaywitz, Shaywitz, et al. (1991); Faraone, Biederman, Mennin, et al. (1996); Halperin, Newcorn, Matier, et al. (1993); Horn, Wagner, and Ialongo (1989); Jensen, Burke, and Garfinkel (1988); Jensen, Shervette, Xenakis, et al. (1993); King and Young (1982); Kuehne, Kehle, and McMahon (1987); Luk and Leung

(1989); Newcorn, Halperin, Healey, et al. (1989); Nussbaum, Grant, Roman, et al. (1990); Reeves, Werry, Elkind, et al. (1987); Satin, Winsberg, Monetti, et al. (1985); Shaywitz, Shaywitz, Schnell, et al. (1988); Shekim, Cantwell, Kashani, et al. (1986); Silverthorn, Frick, Kuper, et al. (1996); Steingard, Biederman, Doyle, et al. (1992); Tarnowski, Prinz, and Nay (1986); Zelko (1991). Selected scales can be easily administered and scored. They have at least a parent version, norms, and subscales designed to measure symptoms of ADHD. Scales that did not have standardized norms or had major flaws identified by reviewers in the MMY were excluded. The resulting list was presented to AHCPR and to AAP for review. AAP members requested inclusion of two additional scales: the Pediatric Symptom Checklist and the Yale Children's Inventory.

Two types of scales were examined for this report: "ADHD-specific," designed to target ADHD symptoms only, and "broad-band," designed to screen for various symptoms, including the symptoms found in ADHD patients. These scales are listed below.

ADHD-Specific Scales

- ADD-H: Comprehensive Teacher Rating Scale (ACTeRS)
- Attention Deficit Disorders Evaluation Scale (ADDES)
- Barkley Questionnaires:
  - Home Situations Questionnaire (HSQ)
  - School Situations Questionnaire (SSQ)
  - ADHD Rating Scale (ADHDR)
- Children's Attention and Adjustment Survey (CAAS)
- SNAP Checklist (SNAP)
- Vanderbilt AD/HD Diagnostic Teacher Rating Scale (VADTRS)

Broad-Band Checklists

- Behavior Assessment System for Children (BASC)
- Burks' Behavior Rating Scales (BBRS)
- Child Behavior Checklists (CBCL)
- Conners Rating Scales (CRS)
- Devereaux Scales of Mental Disorders (DSMD)
- Pediatric Symptom Checklist (PSC)
- Ontario Child Health Study Scales (OCHS)
- Yale Children's Inventory (YCI)

Several versions exist for many of these scales, including original and revised versions and parent and teacher report forms. All versions of each scale were included for data abstraction, except the youth self-report forms, because these are designed primarily for adolescents or for children with at least 5th-grade reading levels.

Data of Interest for Behavior Rating Scales. The type of data sought to answer Question 3, "What are the accuracy and reliability of behavioral rating screening tests for ADHD?," differed according to the type of rating scale being evaluated. For the ADHD-specific checklists, data of interest were each scale's sensitivity, specificity, validity, and reliability for diagnostic screening of ADHD with and without comorbid conditions. For the broad-band checklists, data of interest were the sensitivity, specificity, validity, and reliability for screening clinical from nonclinical populations. Treatment outcomes were excluded.

Medical Screening Tests

Medical screening tests evaluated in this report were selected by members of an AAP subcommittee and are commonly used in evaluating a child with suspected ADHD. The evaluated tests were electroencephalography, blood lead level testing, thyroid hormone testing, hearing and vision screening, imaging tests, neurological screening, and continuous performance tests (CPTs).

Data of Interest for Medical Screening Tests. The type of data sought through evaluating the medical tests was the yield of each test for ADHD, or prevalence of abnormal findings among children diagnosed with ADHD at least through DSM criteria, with one exception. Data sought for evaluation of continuous performance tests included the same sort of data gathered for ADHD-specific checklists: each test's sensitivity and specificity for diagnostic screening of ADHD.

Evidence was deemed admissible if the study from which it came was designed soundly. Sound design was defined according to the following elements: representative study population, comparable control group (not necessarily matched), and adequate description of demographic information. Given the design of these studies, one cannot rule out their possible role in detecting conditions that might mimic ADHD.

Literature Search and Scope

Several literature search strategies were used: traditional database searches on MEDLINE and PsycINFO; review of reference lists in review articles, research study articles, and a guideline on ADHD obtained from the American Academy of Child and Adolescent Psychiatry; hand-searching of recent journal publications; request to AAP members for suggested citations; and purchase of a database of bibliographies on studies that used or evaluated the Child Behavior Checklist behavior rating scale.

The AAP identified 556 citations published between 1992 and 1996 in a preliminary database search. This search was used as a guide and quality check on subsequent searches. The subsequent searches, outlined in detail in Table 2, were conducted on MEDLINE and PsycINFO databases within the following parameters: studies must have been peer-reviewed and published in English between 1980 and 1997.

Abstracts of more than 4,000 identified citations were reviewed independently by a subject specialist and a physician. Each chose citations of articles to retrieve; differences in choices were discussed and resolved. Subsequently, 356 articles were ordered for retrieval from libraries.

Review of retrieved articles' bibliographies, Internet searches, and review of a bibliographic database obtained on the Child Behavior Checklist resulted in retrieval of an additional 151 articles. In addition, published manuals were obtained for each of 10 behavior rating scales. Published manuals were not available for the Pediatric Symptom Checklist and the Yale Children's Inventory.

The subject specialist and physician independently read each of the retrieved articles and manuals and completed the appropriate forms (a listing of retrieved articles and manuals is provided in the reference list). If an article or manual was accepted based on the inclusion and exclusion criteria, the Article Overview Form was completed (Attachment A). The Article Overview Form characterized the type of information in the article or manual, including types of children studied, presence of a control group, setting, diagnostic reference standard used, and type of test, if applicable. If it was not accepted, the Article Overview Form's cover sheet, the Accept/Reject page only, was completed (Attachment A). This cover sheet identified the country in which the study was conducted, the topic addressed (prevalence, behavior checklists, or medical tests), and the reason for rejection of the article or manual.

A resulting 87 articles and 10 manuals were selected for data abstraction, yielding a total of 97 accepted sources. The search strategy was restricted to MEDLINE. However, several additional studies that met eligibility criteria but were not yet listed in MEDLINE were identified by experts and included in the analysis. For studies of medical screening tests only, the inclusion criteria were revised after initial review of the literature, to better represent how these tests are used in clinical practice. Because medical tests are often done to rule out underlying medical problems *before* a diagnosis of ADHD is made, the requirement that studies employ one of the diagnostic reference standards to diagnose ADHD cases was dropped. This resulted in the inclusion of 4 studies examining the association between lead levels and behavior (Barlow, 1983; Silva, Hughes, Williams, et al., 1988; Thomson, Raab, Hepburn, et al. 1989; Gittleman and Eskenazi, 1983), studies that had originally been excluded because they employed only behavioral screening tests to identify children with abnormal behavior.

Data Abstraction Methodology

The accepted articles/manuals were each abstracted twice, using the Data Abstraction Form (Attachment A). Trained personnel abstracted each article, while the subject specialist independently abstracted each article. The resulting sets of abstractions (2 abstractions per article) were compared, with differences discussed and resolved.

The abstracted data were entered into a FoxPro database. During and after data entry, quality checks were performed on every entry to ensure accuracy of the abstraction and entry processes. Data were then tabulated systematically, per topic, for further quality checks and facilitation of statistical analyses.

Table 2. Literature Searches

Search #	Database Searched	Years of Publication	Search Terms	Yield
1	MEDLINE	1980-1996	Attention deficit disorder with hyperactivity, and Child	2489
	MEDLINE	1980-1996	Attention deficit disorder with hyperactivity, and Child, and Diagnosis	966
2	PsycINFO	1967-1996	Attention deficit disorder, or Hyperkinesis, and Diagnosis	286
3	MEDLINE	1980-1997	Attention deficit disorder with hyperactivity, and Child, and Psychometrics, or Diagnosis, or Specificity, and/or Sensitivity	1229
	PsycINFO	1967-1997	School age children, and Attention deficit disorder, or Hyperkinesis, and Testing, or Diagnosis	109
4	MEDLINE	1980-1997	Attention deficit disorder with hyperactivity, and Prevalence, or Epidemiology, and Child	224
	PsycINFO	1967-1997	Attention deficit disorder, or Hyperkinesis, and Epidemiology	46
5	MEDLINE PsycINFO	1980-1997 1967-1997	(Each behavior rating scale by name)	177
6	MEDLINE	1980-1997	Attention deficit disorder with hyperactivity, or Behavioral symptoms, and Lead, or Lead poisoning, or Hyperthyroidism, or Hypothyroidism, or Thyroid function tests, or Electroencephalography, or Diagnostic imaging	268

Summary of Findings

Question 1: Prevalence of ADHD in the General School-Age Population

The following prevalence studies of ADHD in the general population satisfied the inclusion criteria for this report: August and Garfinkel (1989); August, Realmuto, MacDonald, et al. (1996); Bird, Canino, Rubio-Stipec, et al. (1988); Cohen, Cohen, Kasen, et al. (1993); Costello, Costello, Edelbrock, et al. (1988); Costello, Edelbrock, Costello, et al. (1988); King and Young (1982); Kuperman, Johnson, Arndt, et al. (1996); Newcorn, Halperin, Schwartz, et al. (1994); Pelham, Gnagy, Greenslade, et al. (1992); Shaffer, Fisher, Dulcan, et al. (1996); Shekim, Kashani, Beck, et al. (1985); Tuthill (1996); Wolraich, Hannah, Pinnock, et al. (1996). Ten studies administered diagnostic instruments to representative samples of children identified in schools or in the general community (Table 3); three studies conducted an initial screening for certain symptoms among a random sample of children and administered diagnostic instruments only to those children who screened positive for symptoms (Table 7). Because of the difference in methodology, these studies are discussed separately.

Table 3. Selected ADHD Prevalence Data for Unscreened School-Age Population

Study	DSM Version	Setting	Gender	Population size (N)	Percent ADHD
August and Garfinkel (1989)	3	S	MF	1,038	4.2
Cohen, Cohen, Kasen, et al. (1993)	3R	C	MF	975	5.2
King and Young (1982)	3	S	M	219	12.0
Kuperman, Johnson, Arndt, et al. (1996)	3R	S	MF	4,022	6.1
Newcorn, Halperin, Schwartz, et al. (1994)	3R	S	MF	72	26.0
Pelham, Gnagy, Greenslade, et al. (1992)	3R	S	M	931	4.0
Shaffer, Fisher, Dulcan, et al. (1996)	3R	C	MF	1,285	4.5
Shekim, Kashani, Beck, et al. (1985)	3	C	MF	114	12.0
Tuthill (1996)	3R	S	MF	277	5.8
Wolraich, Hannah, Pinnock, et al. (1996)	4	S	MF	8,258	11.4

C=Community; S=School

These two groups of studies were analyzed separately. Two data files and analysis files were created. Only one study gave results using the DSM-IV criteria, and this study also gave results for DSM-III-R (Wolraich, Hannah, Pinnock, et al., 1996). Another study that provided prevalence rates using DSM-IV criteria is summarized narratively at the end of this section (Wolraich, Hannah, Baumgaertel, et al., 1998). Thus, the results were based on classification using the DSM-III or DSM-III-R classification scheme. Only one study gave results separately by single-year age categories. Most studies split the results at about age 10 (if they split by age at all), and therefore 10 was used as the cut-point for age. Some studies split results by gender. When studies did not split the results by age or gender, they were assigned an age or gender fraction based on any information given about the study. No studies gave information separately by race, and this factor was not included in the analysis. The analysis table (Table 4) also includes the factors of setting (community or school) and diagnostic tool (DSM-III or DSM-III-R).

To examine whether age, gender, diagnostic tool, and setting influenced the estimated prevalence of ADHD, a multiple logistic regression model with random effects was used. This model explicitly recognizes that each study estimated ADHD rates under slightly different conditions (measurement method, population surveyed, informant, etc.). The analysis methodology is described by Hasselblad (1998). The analysis was done using the EGRET software from Cytel in Cambridge, MA. The results from the analysis of data from unscreened general population samples are presented in Table 4.

Table 4. Combined Estimates of Various Factors' Effects on Unscreened School-Age Population Prevalence of ADHD

Factor	Coefficient	STD Error	P-Value	Odds Ratio
Intercept	-3.847	-0.269	<.001	—
DSM edition (3 vs. 3R)	0.421	-0.179	0.019	1.523
Setting (community vs. school)	0.409	-0.154	0.008	1.505
Age (5-9 vs. 10-12 years)	0.201	-0.216	0.353	1.222
Gender	0.982	-0.123	<.001	2.671
Random effects	465	-0.106	—	—

These results suggest that gender, diagnostic tool (DSM-III or DSM-III-R), and setting (community or school setting) are significant contributors to the prevalence of ADHD, but that age (5 to 9 years versus 10 to 12 years) is not a significant factor in this analysis.

These results give the answers in terms of odds rather than probabilities. The estimates were converted to probabilities and were adjusted so that the estimates represent the expected rates after 1986 (current practice). Using the results in Table 4, the rates of ADHD were estimated for the two gender groups as well as for study setting and criteria used. These estimates are presented in Table 5.

Table 5. Estimated Prevalence Rates of ADHD in School-Age Population by Gender, Setting, and DSM Version from Meta-Analysis

Gender	Prevalence (%)	95% Confidence Interval
Male	9.2	(5.8, 13.6)
Female	3.0	(1.9, 4.5)
School sample	6.9	(5.5, 8.5)
Community sample	10.3	(8.2, 12.7)
DSM-III	6.8	(5.0, 9.0)
DSM-III-R	10.3	(7.7, 13.4)

Only one study of the general population prevalence of DSM-IV ADHD was obtained for this report (Wolraich, Hannah, Baumgaertel, et al., 1998). Results from that study follow. A total of 214 elementary school (K-5) teachers in a Tennessee county consisting of 10 schools completed questionnaires rating each of 4,323 children on DSM-IV symptoms of disruptive behavior disorders, including attention-deficit/hyperactivity disorder, conduct disorder, and oppositional defiant disorder. In addition, ratings were obtained for each child's level of impairment based on 10 items addressing academic and behavioral functioning. The questionnaires also included seven-item screenings for anxiety and depressive symptoms.

Results of the teachers' ratings are presented in Table 6, which indicates the potential for much higher rates when impairment is not considered when making a diagnosis of ADHD. Table 6 suggests higher rates of ADHD across subtypes for boys versus girls, with the inattentive type being most common. The total rate when impairment is considered, 6.8 percent, does fall within the confidence interval of the analyzed studies that used earlier versions of the DSM.

Table 6. Prevalence of DSM-IV ADHD in School-Age Population According to Behavioral Impairment Criteria[a]

	Without DSM Impairment Criteria (%)			With DSM Impairment Criteria (%)
DSM-IV Diagnosis	**Male**	**Female**	**Total**	
ADHD, predominantly inattentive type	11.5	5.8	8.8	3.2
ADHD, predominantly hyperactive-impulsive type	3.9	1.3	2.6	0.6
ADHD, combined type	7.4	2.1	4.7	2.9
ADHD, any type (total of above)	22.8	9.2	16.1	6.8

Source: Wolraich, Hannah, Baumgaertel, et al. (1998).
[a]Impairment is defined in this study as performance at or below the 5th percentile in academic or classroom functioning as measured by teacher ratings on a scale developed by the authors.

Prevalence of ADHD in Screened General Population

Three studies utilized abbreviated screening procedures prior to diagnostic interviews for ADHD. Two of these studies (Bird, Canino, Rubio-Stipec, et al, 1988; Costello, Angold, Burns, et al., 1996) administered the diagnostic instrument to a subsample of "screen-negative" children as well as screen positive children to estimate how many ADHD cases may have been missed in the initial screen. In addition, these studies adjusted for loss of subjects between the initial screen and followup interviews. In contrast, the third study (August, Ostrander, Bloomquist, 1992) did not attempt to adjust for missed cases of ADHD among the screen-negative children (90% of total sample) or among screen-positive children who did not consent for diagnostic testing; it is thus likely to have underestimated the true prevalence of ADHD in its population. Data from these studies (Table 7) were analyzed separately from the single-stage population studies described earlier (Table 3). None of these studies presented gender-specific data.

Table 7. Estimated Prevalence for ADHD in Screened School-Age Population (across gender)

Study	Age	Gender	Prevalence (%)	95% Confidence Interval
Costello, Angold, Burns, et al. (1996)	9-13	MF	1.9	(1.2, 3.0)
August, Ostrander, Bloomquist (1992)	7-10	MF	4.3	(3.3, 5.5)
Bird, Canino, Rubio-Stipec, et al. (1988)	4-16	MF	5.3	(3.4, 7.8)
Combined estimate			3.6	(2.1, 5.6)

Prevalence of Comorbid ADHD in General Population

Only four unscreened studies (August and Garfinkel, 1989; Pelham, Gnagy, Greenslade, et al., 1992; Shekim, Kashani, Beck, et al., 1985; Wolraich, Hannah, Pinnock, et al., 1996) and one screened study (Bird, Canino, Rubio-Stipec, et al., 1988) provided prevalence rates of various comorbid conditions in children with ADHD. August and Garfinkel (1989) gave results separately by age. Shekim, Kashani, Beck, et al. (1985) gave results separately by gender. Therefore, only the combined results (collapsed across age and gender) were analyzed. Rates (and 95 percent confidence limits) were computed for the comorbidities of oppositional defiant disorder, conduct disorder, anxiety disorder, depressive disorder, and learning disability. Rates for each of these were computed ignoring the presence of any other disorder. Multiple disorder rates were also summarized. Only the comorbidities of oppositional defiant disorder and conduct disorder were diagnosed in more multiple studies; anxiety and depression were diagnosed in two studies, and learning disorders in only one. These rates were combined using the empirical Bayes random effects model as described by Hedges and Olkin (1985, p. 199-200). The results are shown in Tables 8 through 13.

Table 8. Estimated Prevalence of Oppositional Defiant Disorder in Children With ADHD

Study	Estimated Prevalence (%)	Confidence Limits for Estimated Prevalence (%)
Pelham, Gnagy, Greenslade, et al. (1992)	44.3	31.5, 57.6
Shekim, Kashani, Beck, et al. (1985)	42.9	16.5, 71.7
Wolraich, Hannah, Pinnock, et al. (1996)	30.2	27.3, 33.3
Combined estimate	35.2	27.2, 43.8

Results in Table 8 indicate that more than one-third of children diagnosed with ADHD also qualify for a diagnosis of oppositional defiant disorder.

Table 9. Estimated Prevalence of Conduct Disorder in Children With ADHD

Study	Estimated Prevalence (%)	Confidence Limits for Estimated Prevalence (%)
Pelham, Gnagy, Greenslade, et al. (1992)	18.0	8.9, 29.5
Shekim, Kashani, Beck, et al. (1985)	28.6	7.0, 57.7
Wolraich, Hannah, Pinnock, et al. (1996)	15.6	13.3, 18.1
August and Garfinkel (1989)	48.3	37.5, 59.2
Combined estimate	25.7	12.8, 41.3

Results in Table 9 indicate that more than one-quarter of children diagnosed with ADHD also qualify for a diagnosis of conduct disorder. Prevalence in the individual studies ranges widely, from 16 to 48 percent.

Table 10. Estimated Prevalence of Depressive Disorder in Children With ADHD

Study	Estimated Prevalence (%)	Confidence Limits for Estimated Prevalence (%)
Bird, Canino, Rubio-Stipec, et al. (1988) (screened sample)	18.8	11.2, 27.7
Shekim, Kashani, Beck, et al. (1985)	14.3	.84, 40.9
Combined estimate	18.2	11.1, 26.6

According to the results presented in Table 10, less than one-fifth of children with ADHD also have a depressive disorder.

Table 11. Estimated Prevalence of Anxiety Disorder in Children With ADHD

Study	Estimated Prevalence (%)	Confidence Limits for Estimated Prevalence (%)
Bird, Canino, Rubio-Stipec, et al. (1988) (screened sample)	24.0	15.8, 33.8
Shekim, Kashani, Beck, et al. (1985)	35.7	11.4, 65.0
Combined estimate	25.8	17.6, 35.3

Results in Table 11 suggest that more than one-quarter of children with ADHD qualify for a diagnosis of anxiety disorder.

Table 12. Estimated Prevalence of Multiple Comorbidities in Children With ADHD

Study	Estimated Prevalence (%)	Confidence Limits for Estimated Prevalence (%)
Pelham, Gnagy, Greenslade, et al. (1992)	16.4	7.7, 27.6
Shekim, Kashani, Beck, et al. (1985)	50.0	22.1, 77.9
Combined estimate	28.5	7.6, 56.3

Analyses of the results of the two studies in Table 12 suggest that almost one-third of children with ADHD also have more than one comorbid condition. Prevalence in the two studies ranges widely, from 16 to 50 percent.

Table 13 summarizes the prevalence of several comorbid conditions in children with ADHD, as discussed above.

Table 13. Summary of Prevalence of Selected Comorbidities in Children With ADHD

Comorbid Disorder	Estimated Prevalence (%)	Confidence Limits for Estimated Prevalence (%)
Oppositional defiant disorder	35.2	27.2, 43.8
Conduct disorder	25.7	12.8, 41.3
Anxiety disorder	25.8	17.6, 35.3
Depressive disorder	18.2	11.1, 26.6

Learning disabilities. Only one study used DSM criteria in examining the coexistence of learning disabilities in children with ADHD (August and Garfinkel 1989); this study estimated prevalence at 12 percent. Several other studies examining this issue were excluded because they used a dimensional measure rather than DSM-based structured diagnostic interviews. The reader may want to reference the following articles for a more comprehensive understanding of the relationship between ADHD and learning disorders: Brown, Madan-Swain, and Baldwin (1991); Robins (1992); Shaywitz, Shaywitz, Schnell, et al. (1988); and Stanford and Hynd (1994).

Overall, the prevalence of comorbid ADHD is high. Estimates of the prevalence of various comorbid conditions in children with ADHD range from 12 percent (learning disorders) to 35 percent (conduct disorder).

Only one study (Wolraich, Hannah, Baumgaertel, et al., 1998) provided rates of comorbid ADHD in the general population (see Table 14). The study also broke down the rates by subtype of ADHD. Rates appear to be consistent with previous versions of the DSM, according to results described earlier in this section, with high rates of comorbidity, particularly for oppositional defiant disorder and the anxiety or depressive disorders. Learning disability rates are correspondingly, and surprisingly, low. The low rate of learning disabilities in this study may reflect the lack of specific DSM criteria for learning disabilities. The main difference between the set of rates below and the rates discussed earlier in this section is a significantly lower rate of conduct disorder in the Wolraich, Hannah, Baumgaertel, et al., sample.

Table 14. Prevalence of Selected Comorbidities in Children With ADHD (DSM-IV)

DSM-IV Diagnosis	Prevalence (%)				
	ODD	CD	ANX/DEP	LD	LI
ADHD, predominantly inattentive type	11.1	3.7	21.3	13.9	6.1
ADHD, predominantly hyperactive-impulsive type	36.3	8.0	11.5	2.7	0.9
ADHD, combined type	49.8	21.5	24.9	10.9	3.0
ADHD, any type (total of above)	26.5	9.6	20.8	11.3	4.4

Source: Wolraich, Hannah, Baumgaertel, et al. (1998).
Abbreviations: ODD=oppositional defiant disorder, CD=conduct disorder, ANX/DEP=anxiety or depression, LD=learning disabilities, LI=language impairment.

Summary of Question 1 Results

In the general, unscreened, school-age U.S. population, prevalence of ADHD ranged from 4 to 12 percent in studies using the DSM-III or DSM-III-R classification scheme. A multiple logistic regression analysis with random effects yielded results suggesting that gender, diagnostic tool, and setting are significant factors in the prevalence of ADHD, but that age is not significant. A single study using the DSM-IV classification scheme demonstrated that the prevalence of ADHD is substantially lower when impairment is required for the diagnosis than when impairment is not considered (7 percent vs. 16 percent). Higher rates of ADHD were found in boys than in girls for all types of ADHD, with the inattentive type most common.

In the general, unscreened, school-age population, prevalence of ADHD co-occurring with other disorders—oppositional defiant disorder, conduct disorder, anxiety disorder, depressive disorder, and learning disability—was estimated to be high, based on results of four studies. Of children diagnosed with ADHD, approximately 35 percent also qualified for a diagnosis of oppositional defiant disorder, 28 percent qualified for a diagnosis of conduct disorder, 26 percent qualified for a diagnosis of anxiety disorder, and 18 percent also had a depressive disorder. Learning disabilities in children with ADHD are estimated at a 12 percent prevalence.

Prevalence of ADHD in the screened school-age population was estimated at about 4 percent.

Question 2: Prevalence of ADHD in a Pediatric Clinic Setting

Two studies on the prevalence of ADHD in a pediatric clinic setting met inclusion criteria for this report. Because the results differed greatly, they were not formally analyzed. Instead, the findings from each study are summarized here.

In the first study (Lindgren, Wolraich, Stromquist, et al., 1989), primary care physicians identified 22 of 457 (4.8 percent) consecutive patients aged 6 to 12 years screened during the study period as positive for a "behavior disorder involving inattention and hyperactivity." Of those 457 screened patients and an additional 10 who could not be seen during the screening period, 100 received a comprehensive evaluation. That set of 100 children included all 22 physician-identified children, 8 identified by their physicians as having another type of behavior disorder, 10 previously identified with ADHD by their physicians who could not be seen during the screening period, and a random sample of 60 of the screen-negative children. Comprehensive evaluations included DSM-III-R structured diagnostic interviews with parents, DSM-III-R-based checklists completed by teachers, and direct evaluation of the child with a continuous performance test, electronic activity monitoring, and examiner ratings of inattention, impulsivity, and hyperactivity. Results of the above modes of identifying children with ADHD are presented in Table 15.

Table 15. Effect of Diagnostic Criteria on Prevalence of ADHD in a Pediatric Clinic Setting

Source	ADHD Prevalence (%)[a]
Diagnosis by primary care physician	4.8
Diagnostic Interview Schedule for Children—Parent Version (DISC-P)	
Possible diagnosis (positive on 8 or more of 14 ADHD symptoms)	11.2
Probable diagnosis (positive on 10 or more of 14 ADHD symptoms)	3.7
DSM-III-R Disruptive Behavior Disorder Rating Scale (DBD) (completed by teacher)	6.9
Direct evaluation of child[b]	5.3

Source: Lindgren, Wolraich, Stromquist et al. (1989).
[a]Weighted prevalence rate based on total screening sample of 457 children
[b]Evaluation included a continuous performance test, monitored activity level, and examiner ratings of impulsive, inattentive, and hyperactive behavior.

Two articles present the results of the second study, each discussing different aspects of the study (Costello, Edelbrock, Costello, 1988; Costello, Costello, Edelbrock, et al., 1988). Children were sampled from a pool of 789 children who visited two HMO clinics in Pittsburgh between November 1984 and October 1985. The children were 7 to 11 years of age, primarily white (78 percent), middle (40 percent) to upper (39 percent) class, living in urban (42 percent) and suburban (58 percent) areas. Using the Child Behavior Checklist (CBCL), the authors screened for high-risk children, who were then evaluated for formal diagnoses. High risk was defined by a CBCL Total Problem Score above the 90th percentile of nonreferred children (T-score=70). Three hundred children were interviewed, including 126 children with high-risk CBCL scores and 174 with CBCL scores in the normal range. Each of these 300 children was interviewed separately.

First, a pediatrician interviewed the children and parents, employing criteria lists from the ICD-9A. Second, each child and parent was interviewed by a psychiatric social worker using the Diagnostic Interview Schedule for Children, Parent and Child Versions (DISC-P, DISC-C). Results indicated that three times as many children received ICD-9A diagnoses of "hyperactivity" from the pediatricians (n=12; weighted prevalence=1.5 percent) as DSM-III diagnoses of ADDH using the DISC (n=4; weighted prevalence=0.5 percent). Results are presented in Table 16.

The study also provided separate prevalence rates for DSM-III attention deficit disorder with hyperactivity (ADDH) and without hyperactivity (ADD). The rates differed depending on whether the informant was the parent (DISC-P) or child (DISC-C). Of the 300 children interviewed, 11 were diagnosed with ADDH using the DISC-P (weighted prevalence of 1.4 percent), and 5 were diagnosed with ADDH using the DISC-C (weighted prevalence of 0.6 percent). Two were diagnosed with ADD using the DISC-P (weighted prevalence 0.2 percent). No rate was provided for children diagnosed with ADD using the DISC-C. These results also are presented in Table 16.

Rates in the Costello et al. study are much smaller than in the Lindgren et al. study. Some of the difference may be attributable to the different versions of the DSM used; rates in studies have tended to increase with each new version of the DSM. However, the 1988 study's rates are even smaller than expected for the earlier DSM. With only two studies, it is difficult to determine which is most accurate, but the Lindgren et al. study results are more consistent with rates found in general population studies.

Table 16. Prevalence of ADHD in a Pediatric Clinic Setting (in percentages) (Costello et al., 1988 study)[a]

Diagnosis	Parent[b]	Child	Parent and Child	Parent or Child	Pediatrician[c]
DSM-III Attention deficit disorder with hyperactivity	1.4	0.6	0.5	2.0	—
DSM-III Attention deficit disorder without hyperactivity	0.2	—	—	0.2	—
ICD-9A Hyperactivity	—	—	—	—	1.5

Source: Costello, Costello, Edelbrock, et al. (1988).
[a]Prevalence rates are weighted estimates based on original pool of 789 children.
[b]Version of diagnostic interview used for diagnosis.
[c]Diagnosed by a pediatrician using the ICD-9A criteria without the use of a diagnostic interview.

Prevalence of Comorbid ADHD in Pediatric Clinic Setting

The same two studies were the only ones providing prevalence rates in a pediatric setting of ADHD with each of several comorbid conditions (Lindgren, Wolraich, Stromquist, et al., 1989; Costello, Costello, Edelbrock, et al., 1988).

In the Lindgren et al. study, comorbid conditions were diagnosed according to parent reports on the DISC-P, a structured diagnostic interview. Weighted estimates based on the total population of children seen during the study's 3-month period (N=457) appear in Table 17. Of note, 59 percent of the children identified by physicians as having ADHD in this study had been placed in special-education classrooms because of learning disorders or developmental disorders, suggesting a relatively high rate of learning problems among these children.

In Costello, Costello, Edelbrock, et al. (1988), prevalence rates were calculated based on the structured diagnostic interviews with parents and children. Rates among DSM-III ADD or ADDH children ranged from 7.7 percent to 20 percent, depending on the comorbid condition and whether the informant was the parent (DISC-P) or child (DISC-C). Results are presented in Table 17. Again, rates in this study are much lower than those both in the Lindgren et al. study described above and in the general population. Changes in the DSM since 1988 cannot entirely explain the lower rates.

Table 17. Prevalence of Selected Comorbid Conditions Among Pediatric Patients Diagnosed With ADHD

DISC (DSM-III) Diagnoses	Prevalence (%)		
	Lindgren et al. Study [a]	Costello et al. Study [b]	
		Parent Informant	Child Informant
Oppositional defiant disorder	38	15[c]	—
Conduct disorder	9	—	20
Anxiety disorder	38	15	20
Depression	9	—	—
Conduct disorder + depressive disorder	—	8	—
Any co-existing emotional or behavioral diagnosis	75	—	—

[a] Source: Lindgren, Wolraich, Stromquist, et al. (1989)
[b] Source: Costello, Costello, Edelbrock, et al. (1988).
[c] Prevalence rates based on total number of ADDH and ADD children in the study.

Summary of Question 2 Results

Two studies yielded information on prevalence of ADHD and comorbid ADHD diagnosed in a pediatric clinic setting. One study found that approximately 5 percent of children seen in a pediatric setting were diagnosed with ADHD and the other found fewer than 2 percent diagnosed with ADHD. Coexistence of ADHD with other disorders in children seen by a pediatrician was found in the first study to be 59 percent and in the other to range from 8 to 20 percent, depending on the comorbid condition and whether the informant was the parent or the child. These different results could not be explained, but the higher rates are consistent with rates found in general population studies.

Question 3: Reliability and Validity of Rating Scales for Diagnosis of ADHD

As discussed earlier, the scales were divided into two categories: ADHD-specific checklists and broad-band checklists. Behavior rating scales employ a series of questions (from 8 to more than 100) that parents or teachers answer regarding the behavior of the child. The responses are then converted into a numeric score. To determine how well a scale distinguishes children with ADHD from normal children, scores between the two populations can be compared.

Qualitative information on each of the scales is presented in Tables 18 and 19. The tables include information on the subscales included in each test, comorbid conditions addressed by each checklist, time required to administer, number of items, ages for which norms are available, computer scoring availability, and ordering information, including cost. Reliability and validity values are presented for each scale in Tables 20 and 21.

A common way to categorize the ability of psychological screening tests to discriminate abnormal from normal behavior is to calculate the "effect size," based on the scores in case and control populations. The effect size is the difference in mean scores between two populations divided by an estimate of the individual standard deviation. The specific definition for the effect size of an experiment, *d*, used in this report is that given by Hedges and Olkin (1985). The effect size measure is easily interpreted. For example, an effect size of 4.0 means that the two populations are four standard deviation units apart and thus are almost completely separated. On the other hand, an effect size of 1.0 indicates much overlap of the two populations. Under some standard assumptions (see Hasselblad and Hedges, 1995), an effect size can be converted to a measure of sensitivity and specificity.

The columns in Table 22 are based on the concept that different cut-points can be used to vary the sensitivity and specificity. In clinical practice, definitions of an "abnormal" score on each rating scale are defined relative to the distribution of scores in a population of normal children; for most scales, an abnormal is one that is above the 90th or 95th percentile of scores in the normal control group (e.g. setting specificity of the scale at 90 or 95 percent). Table 22 illustrates the impact of effect size on the three sets of assumptions: (1) when the sensitivity and specificity are equal, (2) the effect on sensitivity when specificity is set at 90 percent, and (3) the effect on sensitivity when specificity is set at 95 percent. For readers who are familiar with ROC analyses, it is also possible to calculate the area under the curve directly from an effect size (assumptions given by Hasselblad and Hedges, 1995).

Table 18. Selected Behavior Rating Scales, Including Subscales, and Comorbid Conditions Addressed

Behavior Rating Scale	Subscales	Comorbidity				
		A	C	D	L	O
ADHD-Specific Checklists						
ADD-H: Comprehensive Teacher Rating Scale (ACTeRS)	Attention, Hyperactivity, Social Skills, Oppositional Behavior, Early Childhood					X
Attention Deficit Disorders Evaluation Scale (ADDES)	Inattention, Hyperactive-Impulsive, Total					
Barkley's Home and School Situations Questionnaires (HSQ, SSQ)	Number of Problem Settings, Mean Severity, Compliance Situations, Leisure Situations					
Children's Attention and Adjustment Survey (CAAS)	Inattention, impulsivity, hyperactivity, conduct problems, ADD, ADHD, DSM-III-R ADHD		X			
DSM-IV SNAP Checklist (SNAP-IV)	ADHD, ODD, and CD		X			X
DSM-IV Vanderbilt AD/HD Diagnostic Teacher Rating Scale (VADTRS)	Inattention, hyperactive/impulsive, ODD/CD, anxiety/depression, classroom behavior performance, academic performance	X	X	X	X	X
Broad-Band Checklists						
Behavior Assessment System for Children (BASC)	Aggression, hyperactivity, conduct problems, anxiety, depression, somatization, attention problems, learning problems, atypicality, withdrawal, adaptability, social skills, study skills, behavioral symptoms index	X	X	X	X	
Burks' Behavior Rating Scales (BBRS)	Self-blame, anxiety, withdrawal, dependency, ego strength, physical strength, coordination, intellectuality, academics, attention, impulse control, reality contact, sense of identity, suffering, anger control, sense of persecution, aggression, resistance, social conformity	X	X	X	X	X
Child Behavior Checklist-Parent Version (CBCL/4-18)	Adaptive scales (activities, social, school, total), withdrawn, somatic complaints, anxious/depressed, social problems, thought problems, attention problems, delinquent behavior, aggressive behavior, sex problems, internalizing composite, externalizing composite, total problems scale	X	X	X	X	X
Child Behavior Checklist-Teacher Version (CBCL/TRF)	Adaptive scales (academic, working hard, behaving, learning, happy, total), withdrawn, somatic complaints, anxious/depressed, social problems, thought problems, attention problems, delinquent behavior, aggressive behavior, internalizing composite, externalizing composite, total problems scale	X	X	X	X	X
Conners Rating Scales, 1997 Revised Version: Long Form (CPRS-R:L)	Oppositional, cognitive problems, hyperactivity, anxious-shy, perfectionism, social problems, psychosomatic, Conners' global index (restless-impulsive, emotional lability), ADHD index, DSM-IV symptoms (inattentive, hyperactive-impulsive)	X		X	X	X
Short Form (CPRS-R:S)	Oppositional, cognitive problems, hyperactivity, ADHD index				X	X
Devereaux Scales of Mental Disorders (DSMD)	Conduct, attention, anxiety, depression, autism, acute problems, composite scales (externalizing, internalizing, critical pathology, total scale)	X	X	X		X
Ontario Child Health Study Scales (OCHS)	Conduct disorder, hyperactivity, emotional disorder, somatization	X	X	X		
Pediatric Symptom Checklist (PSC)	Total score only					
Yale Children's Inventory (YCI)	Attention, hyperactivity, impulsivity, tractability, habituation, conduct disorder-socialized, conduct disorder-aggressive, negative affect, academics, language, fine motor	X	X	X	X	

Abbreviations: A=anxiety, C=conduct disorder, D=depressive disorder, L=learning disability, O=oppositional defiant disorder.

Table 19. Qualitative Information on the Behavior Rating Scales

Behavior Rating Scale	Minutes Required	# Items	Computer Scoring Available?	Ages	Ordering Information
ADHD-Specific Checklists					
ADD-H: Comprehensive Teacher Rating Scale (ACTeRS)					
Parent Form	5-10	25	Yes	5-12	Kit including 25 forms with manual ($64 per Parent or Teacher Form); software kit @$100 for 50 administrations; Slosson; 1-888-SLOSSON or FAX 1-800-655-3840.
Teacher Form	5-10	24	Yes	5-12	
Attention Deficit Disorder Evaluation Scale (ADDES)					
Parent Version	15-20	60	Yes	4.5-18	Kit including 50 home and 50 school forms with manuals $159; software kit $149; Hawthorne Educational Services, Inc.; 1-800-542-1673.
Teacher Version	10-12	46	Yes	4.5-18	
Barkley's Scales					
Home Situations Questionnaire (HSQ)	5	16	No	4-11	Notebook (ADHD: A Clinical Workbook) with reproducible forms for each of these scales available at bookstores for $40; Guilford Press, NY.
Home Situations Questionnaire Revised (HSQ-R)	5	14	No	6-12	
School Situations Questionnaire (SSQ)	5	12	No	6-11	
School Situations Questionnaire Revised (SSQ-R)	5	8	No	6-12	
Child Attention Profile (CAP)	5	12	No	6-13	
Children's Attention and Adjustment Survey (CAAS)					
Home and School Forms	5-10	31	No	5-13	Kit includes packages of 25 Home and 25 School Forms and Manual; $130; Stoelting Publishing Company; (630) 860-9700.
Conners Teacher Questionnaires					
Conners Abbreviated Teacher Questionnaire, or "Hyperactivity Index" (CATQ-HI)	10	10	Yes	3-17	Kit of 25 original parent and teacher forms with manual quoted at $110; Psychological Assessment Resources, Inc. 1-800-331-TEST. Revised (1997) forms available (kits $113-130) from the Psychological Corporation; 1-800-211-8378.
Conners Parent Questionnaires					
Conners Abbreviated Parent Questionnaire, or "Hyperactivity Index" (CAPQ-HI)	10	10	Yes	3-17	(See information in previous row.)
DSM-IV SNAP Checklist (SNAP-IV)	5-10	40	No	6-12	More information can be obtained from W. E. Pelham, Univ. Pittsburgh or Swanson, Irvine, CA.
DSM-IV Vanderbilt AD/HD Diagnostic Teacher Rating Scale (VADTRS)	5-10	48	No	6-12	More information can be obtained from Vanderbilt Child Development Center, 2100 Pierce Ave., Nashville, TN 37232-3573.

Table 19. Qualitative Information on the Behavior Rating Scales (continued)

Behavior Rating Scale	Minutes Required	# Items	Computer Scoring Available?	Ages	Ordering Information
Broad-Band Checklists					
Behavior Assessment System for Children (BASC)--Parent or Teacher Versions	10-20	130	Yes	4-18	Starter set of sample forms and manual $70; software kit $325; American Guidance Service (AGS); 1-800-328-2560.
Burks' Behavior Rating Scales (BBRS)--Parent or Teacher Version (one form for both uses)	20-30	110	No	3-13	Kit of 25 forms and a manual with diagnostic handbooks $110; Western Psychological Services; 1-800-648-8857.
Conners Teacher Questionnaires	10-25	10-59	Yes	3-17	Kit of 25 original parent and teacher forms with manual quoted at $110; Psychological Assessment Resources, Inc. 1-800-331-TEST. Revised (1997) forms available (kits $113-130) from the Psychological Corporation; 1-800-211-8378.
Conners Teacher Rating Scale, 39-Item Version (CTRS-39)	20	39	Yes	4-12	
Conners Teacher Rating Scale, 28-Item Version (CTRS-28)	15	28	Yes	3-17	
Conners Teacher Rating Scale--Revised, Long Form (CTRS-R:L)	25	59	Yes	3-17	
Conners Teacher Rating Scale--Revised, Short Form (CTRS-R:S)	15	28	Yes	3-17	
Conners Parent Questionnaires	10-30	10-93	Yes	3-17	(See information in previous row.)
Conners Parent Rating Scale, 93-Item Version (CPRS-93)	30	93	Yes	6-14	
Conners Parent Rating Scale, 48-Item Version (CPRS-48)	20	48	Yes	3-17	
Conners Parent Rating Scale--Revised, Long Form (CPRS-R:L)	30	80	Yes	3-17	
Conners Parent Rating Scale--Revised, Short Form (CPRS-R:S)	15	27	Yes	3-17	
Child Behavior Checklist (CBCL)					
Parent Version (CBCL/2-3)	30-60	113+	Yes	2-3	Kit of 25 forms and manual $35 per version; software $195 per version; (802)656-8313; http://www.uvm.edu/~cbcl/
Parent Version (CBCL/4-18)	30-60	113+	Yes	4-18	
Teacher Version (CBCL/TRF)	30-60	113+	Yes	5-18	
Devereaux Scale of Mental Disorders (DSMD)	30	111	Yes	5-18	Kit of 25 forms and manual $150; the Psychological Corporation; 1-800-211-8378.
Ontario Child Health Study Scales (OCHS)—Parent or Teacher Versions	15	34	No	6-16	Contact author, Dr. David Offord, Child Epidemiology Unit, Chedoke Division, Chedoke-McMaster Hospitals, Box 2000, Station A, Hamilton, Ontario, Canada L8N-3Z5.
Pediatric Symptom Checklist (PSC)—Parent Version only	5-10	35	No	6-12	Free of charge; authors provide permission for duplication of checklist published in Jellinek, Murphy, Robinson, et al., 1988).
Yale Children's Inventory (YCI)	60	113+	No		Yale University School of Medicine; (203)764-9150.

Table 20. Reliability and Validity of Various ADHD-Specific Behavior Rating Scales

Behavior Rating Scale[a]	Reliability and Validity: Short-Term Test-Retest	Long-Term Test-Retest	Interrater Reliability	Internal Consistency	Convergent Validity	Notes
ADD-H: Comprehensive Teacher Rating Scale (ACTeRS)	—	—	—	—	—	Interrater compared 2 teachers' ratings. Little available reliability and validity data for parent form.
Parent Form	—	—	—	.88	—	
Teacher Form	.81	—	.61	.95	—	
Attention Deficit Disorders Evaluation Scale (ADDES)	—	—	—	—	—	Interrater: 2 parents' or 2 teachers' ratings. Extensive, relatively strong reliability and validity documented.
Home Version	.91	—	.82	.98	.80 (CPRS)	
School Version	.92	—	.85	.99	.61 (CTRS)	
Barkley's Home Situations Questionnaire (HSQ)[b]	.83-.89	—	—	.84	.60 (CBCL)	
Factor I: Total Problem Situations Score	.68	—	—	—		
Factor II: Mean Severity Score	.62	—	—	—		
Barkley's School Situations Questionnaire (SSQ)[b]	.77	—	—	.88	.63 (CTRS)	
Factor I: Total Problem Situations Score	.78	—	—	—	—	
Factor II: Mean Severity Score	.63	—	—	—	—	
Children's Attention and Adjustment Survey (CAAS)	—	—	—	—	—	Both the home and school versions have little available reliability and validity information.
Home Form	—	.85	—	—	—	
School Form	—	.81	—	.88	—	
Conners Parent Rating Scales[c]	—	.85	—	.61-.95	—	
1997 Revised Version; ADHD Subscale	.72	—	—	.93	—	
1997 Revised Version; DSM Subscale	.76	—	—	.94	—	
Abbreviated Parent Questionnaire (CAPQ-HI)	.90	—	.55-.71	—	.48	
Hyperactivity Index of 48-Item Scale (CPRS-48-HI)	.96	.70	—	—	—	
Conners Teacher Rating Scales (CTRS)[d]	.96	.88	.94	.61-.95	—	SBS=School Behavior Survey
1997 Revised Version; ADHD Subscale	.80	—	—	.94	—	
1997 Revised Version; DSM Subscale	.63	—	—	.95	—	
Abbreviated Teacher Questionnaire (CATQ-HI)	.91	—	—	—	—	
Hyperactivity Index of 28-Item Scale (CTRS-28G-HI)	.86	.70	.92	—	—	
Hyperactivity Index of 39-Item Scale (CTRS-39-HI)	.89	.86	.94	.92	.89 (SBS)	
DSM-Based Checklists	—	—	—	—	—	DBD convergent validity value (.92) relates to correlation between ADHD subscale and the CATQ.
DSM-III SNAP Checklist (SNAP)	—	—	—	—	—	
DSM-III-R Disruptive Behavior Disorder Checklist (DBD)[e]	—	—	—	.96	.92 (CATQ)	
DSM-IV SNAP Checklist (SNAP-IV)	—	—	—	—	—	
DSM-IV Vanderbilt AD/HD Diagnostic Teacher Rating Scale (VADTRS)	—	—	—	.90	—	

[a]Data were obtained from the publishers' manuals for each test when possible; additional data were obtained from studies as noted.
[b]Altepeter and Breen (1989); Barkley, DuPaul, and McMurray (1990); Breen and Altepeter (1991).
[c]Goyette, Conners, and Ulrich (1978).
[d]Barkley (1990); Goyette, Conners, and Ulrich (1978); Ullmann, Sleator, and Sprague (1985).
[e]Lindgren, Wolraich, Stromquist, et al. (1989).

Table 21. Reliability and Validity of Various Broad-Band Behavior Rating Scales

	Reliability and Validity					
Behavior Rating Scale[a]	Short-Term Test-Retest	Long-Term Test-Retest	Inter-rater Reliability	Internal Consistency	Convergent Validity	Notes
Behavior Assessment System for Children (BASC)	.91	—	.80	.89	.92 (CBCL)	
Burks' Behavior Rating Scales (BBRS)	—	—	—	.70	—	Referred sample
Child Behavior Checklist-Parent Version (CBCL/4-18)[c]	.95	—	—	.96	—	
Externalizing Scale (CBCL/4-18-EX)	.93	.87	.78	.93	.75 (CPRS)	
Internalizing Scale (CBCL/4-18-IN)	.89	.75	.64	.90	.59 (CPRS)	
Total Problem Scale (CBCL/4-18-TOP)	.93	.84	.76	.96	.82 (CPRS)	
Child Behavior Checklist-Teacher Version (CBCL/TRF)[b]	.89	.74	.57	.94	.85 (CTRS)	
Externalizing Scale (CBCL/TRF-EX)	.92	.77	.50	.96	.76 (CTRS)	
Internalizing Scale (CBCL/TRF-IN)	.91	.89	.74	.90	.38 (CTRS)	
Total Problem Scale (CBCL/TRF-TOP)	.95	.78	.67	.97	.83 (CTRS)	
Conners Parent Rating Scales (CPRS)						
1997 Revised Version ; Long Form (CPRS-R:L)	.69	—	—	.87	—	
1997 Revised Version; Short Form (CPRS-R:S)	.73	—	—	.90	—	
93-Item Version (1969; CPRS-93)	—	.40-.70	.85	—	—	
48-Item Version (1978; CPRS-48)[c]	—	—	.51	.13-.65	—	
Conners Teacher Rating Scales (CTRS)						
1997 Revised Version ; Long Form (CTRS-R:L)	.71	—	—	.89	—	
1997 Revised Version; Short Form (CTRS-R:S)	.82	—	—	.91	—	
28-Item Version (1978; CTRS-28)[d]	.96	.88	.94	.61-.95	—	
39-Item Version (1969; CTRS-39)	.72-.91	.45	.50	.94	—	
Devereaux Scales of Mental Disorders (DSMD)	.96	—	.52	.92-.96	—	
Ontario Child Health Study Scales (OCHS)[e]	>.70	>.70	—	>.75	.87 (CBCL)	
Pediatric Symptom Checklist (PSC)						
Yale Children's Inventory (YCI)[f]	—	.84	—	—	—	
Attention, Hyperactivity, Impulsivity, Irritability Scales	.84	.84	—	.79-.90	—	

[a]Data were obtained from the publishers' manuals for each test when possible; additional data obtained from studies noted below.
[b]Achenbach (1978); Achenbach and Edelbrock (1981); McConaughy and Achenbach (1994).
[c]Goyette, Conners, and Ulrich (1978).
[d]Barkley, DuPaul, and McMurray (1990); Goyette, Conners, and Ulrich (1978); Ullmann, Sleator, and Sprague (1985)).
[e]Boyle, Offord, Racine, et al. (1993a-b).
[f]Epstein, Shaywitz, Shaywitz, et al. (1991); Shaywitz, Schnell, Shaywitz, et al. (1986).

Table 22. Estimates of Sensitivity and Specificity for Various Values of the Effect Size

Effect Size	If Values are Set to Match		If Specificity is Set at 90%		If Specificity is Set at 95%		Area Under the Curve
	Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	Specificity	
1.0	.71	.71	.40	.90	.24	.95	.66
1.5	.80	.80	.63	.90	.44	.95	.73
2.0	.86	.86	.81	.90	.66	.95	.79
2.5	.91	.91	.91	.90	.83	.95	.85
3.0	.94	.94	.96	.90	.92	.95	.89
3.5	.96	.96	.98	.90	.97	.95	.92
4.0	.97	.97	.99	.90	.99	.95	.94

ADHD-Specific Checklists

Summaries of the results of effect size analyses for various ADHD-specific checklists used to screen for ADHD are shown in Tables 23-26. The analyses reflected in these tables are based on studies done under ideal conditions. In these studies, children with ADHD were differentiated fairly well from normal controls (children presenting without significant problems). Such differentiation is not typical in actual practice, however, where children with ADHD often need to be distinguished from children presenting with a significant emotional or behavioral problem manifested in symptoms similar to those of ADHD. The actual performance of these tests in physicians' offices with patients who have other conditions or comorbidities will be significantly poorer. The effectiveness of these measures in differentiating children with ADHD from children with other disorders could not be addressed in this report because the data were insufficient. More research is needed with these tools in discriminating children with ADHD from psychiatric controls.

Results in Table 23 indicate that the 1997 Revision of the Conners Rating Scale contains two highly effective indices for discriminating between children with ADHD and normal controls. The new ADHD Index and DSM-IV Symptoms Scale each achieved effect sizes greater than 3.0, which translate into matched sensitivity and specificity values of greater than 94 percent. Thus, use of these scales when comparing children with ADHD with normal controls will result in less than a 6 percent miss rate. Meanwhile, the effect sizes for the Barkley School Situations Questionnaire are weak, at less than 2.0, translating into matched sensitivity and specificity values of less than 86 percent. With each of these scales, however, only one study provided data; thus, interpretations of effectiveness must be made with caution.

As shown in Table 24, the hyperactivity subscales of several ADHD-specific checklists are strong in their ability to discriminate between children with ADHD and normal controls. The only hyperactivity subscale to perform poorly was from the ACTeRS Checklist. Its performance may have been lower in part due to a somewhat older sample; hyperactivity as a symptom tends to decrease with age. However, this factor alone would not account for the extremely low effect size. Again, several subscales are represented by only one study, requiring caution in interpretation of effectiveness.

Table 23. Total ADHD-Specific Checklists: Ability to Detect ADHD vs. Normal Controls

Study	Behavior Rating Scale	Age	Gender	Effect Size	95% Confidence Limits
Conners (1997)	CPRS-R:L-ADHD Index (Conners Parent Rating Scale—1997 Revised Version: Long Form, ADHD Index Scale)	6-17	MF	3.1	2.5, 3.7
Conners (1997)	CTRS-R:L-ADHD Index (Conners Teacher Rating Scale—1997 Revised Version: Long Form, ADHD Index Scale)	6-17	MF	3.3	2.8, 3.8
Conners (1997)	CPRS-R:L-DSM-IV Symptoms (Conners Parent Rating Scale—1997 Revised Version: Long Form, DSM-IV Symptoms Scale)	6-17	MF	3.4	2.8, 4.0
Conners (1997)	CTRS-R:L-DSM-IV Symptoms (Conners Teacher Rating Scale—1997 Revised Version: Long Form, DSM-IV Symptoms Scale)	6-17	MF	3.7	3.2, 4.2
Breen (1989)	SSQ-O-I Barkley's School Situations Questionnaire-Original Version, Number of Problem Settings Scale	6-11	F	1.3	0.5, 2.2
Breen (1989)	SSQ-O-II Barkley's School Situations Questionnaire-Original Version, Mean Severity Scale	6-11	F	2.0	1.0, 2.9
Combined				2.9	2.2, 3.5

Table 24. Hyperactivity Subscales of ADHD-Specific Checklists: Ability to Detect ADHD vs. Normal Controls

Study	Behavior Rating Scale	Age	Gender	Effect Size	95% Confidence Limits
Ullmann, Sleator, Sprague, et al. (1997)	ACTeRS-Parent Version-Hyperactivity Subscale	6-14	MF	1.5	1.3, 1.7
Atkins, Pelham, Licht (1985)	DSM-III SNAP Hyperactivity Subscale	7-12	MF	5.1	3.9, 6.3
Horn, Wagner, Ialongo (1989)	DSM-III-R SNAP Hyperactivity Subscale	7-11	M	3.1	2.3, 3.9
Horn, Wagner, Ialongo (1989)	DSM-III-R SNAP Hyperactivity Subscale	7-11	F	3.7	2.5, 5.0
Tarnowski, Prinz, Nay (1986)	CATQ-HI (Conners Abbreviated Teacher Questionnaire Hyperactivity Index)	7	M	4.1	2.7, 5.5
Combined				3.4	2.3, 4.5

Results presented in Tables 25 and 26 indicate that the SNAP Checklist's inattention and impulsivity subscales discriminate well between children with ADHD and normal controls, with effect sizes greater than 4.0. Such performance can be translated into matched sensitivity and specificity values of greater than 97 percent. Meanwhile, the ACTeRS again performed poorly.

Table 25. Inattention Subscales of ADHD-Specific Checklists: Ability to Detect ADHD vs. Normal Controls

Study	Behavior Rating Scale	Age	Gender	Effect Size	Confidence Limits
Ullmann, Sleator, Sprague, et al. (1997)	ACTeRS-Parent Version, Attention Subscale	6-14	MF	2.0	1.8, 2.2
Atkins, Pelham, Licht (1985)	DSM-III SNAP Checklist Inattention Subscale	7-12	MF	4.2	3.2, 5.2
Horn, Wagner, Ialongo (1989)	DSM-III-R SNAP Checklist Inattention Subscale	7-11	M	3.5	2.6, 4.3
Horn, Wagner, Ialongo (1989)	DSM-III-R SNAP Checklist Inattention Subscale	7-11	F	4.0	2.8, 5.3

Table 26. Impulsivity Subscales in ADHD-Specific Checklists: Ability to Detect ADHD vs. Normal Controls

Study	Behavior Rating Scale	Age	Gender	Effect Size	Confidence Limits
Atkins, Pelham, Licht (1985)	DSM-III SNAP Checklist Impulsivity Subscale	7-12	MF	5.5	4.3, 6.7
Horn, Wagner, Ialongo (1989)	DSM-III-R SNAP Checklist Impulsivity Subscale	7-11	M	4.7	3.7, 5.7
Horn, Wagner, Ialongo (1989)	DSM-III-R SNAP Checklist Impulsivity Subscale	7-11	F	4.0	2.7, 5.2

No data were found, even in the scales' manuals, that compared mean performance of ADHD vs. normal controls with the following ADHD-specific checklists: Attention Deficit Disorders Evaluation Scale (ADDES), Barkley's Home Situations Questionnaire (HSQ), Children's Attention and Adjustment Survey (CAAS), Disruptive Behavior Disorders (DBD) Checklist, and DSM-IV Vanderbilt AD/HD Diagnostic Teacher Rating Scale (VADTRS).

Broad-Band Checklists

The purpose of this set of analyses is to determine which of the broad-band scales—those that screen for a variety of conditions including symptoms of ADHD—could serve as useful instruments in detecting clinical-level problems in children presenting at a pediatrician's office. Any scale performing well could serve as a tool to screen for the many comorbid conditions typically found in children with ADHD. Unfortunately, the only data found compared the performance of referred versus nonreferred populations, rather than clinical versus normal populations. Because no diagnosis or screening was involved other than if a child had been referred for services, it is highly likely that many normals were among the referred and that many clinically significant problems were present in nonreferred children. Therefore, the results in this section should not be used to derive conclusions regarding the effectiveness of the scales in discriminating between children with significant problems versus children without significant problems.

Results of effect-size analyses for the broad-band checklists are described in this section. Data for these analyses compared mean performance of referred versus nonreferred populations. The bulk of the data used in this section were found in the scales' published manuals (Achenbach 1991a,b,c; Burks, 1996; Conners, 1990; Lambert, Hartsough, and Sandoval, 1990; McCarney, 1995a,b; Naglieri, LeBuffe, and Pfeiffer, 1994; Reynolds and Kamphaus, 1992; Ullmann, Sleator, Sprague, et al., 1997).

The effectiveness of these scales' global or total problem indices for discriminating referred from nonreferred populations is presented in Table 27. The analyses of the externalizing subscales, internalizing subscales, and then competence scales, are presented in Tables 28 through 30.

The global or total scales are relatively consistent across the various studies, but the combined effect size of 1.5 represents a sensitivity and specificity of only about 80 percent. None of the tests had good estimated effect sizes for discriminating between referred and nonreferred populations.

The externalizing scales are less consistent across the various studies than are the total scales, but the combined effect size is similarly low (1.5). In general, this corresponds to a sensitivity and specificity of about 80 percent, which is not strong. None of the tests had a strong estimated effect size although the revised version of the Conners Parent Rating Scale appears to perform the best (see Table 28).

The internalizing scales are moderately consistent across the various studies, but the combined effect size of only 1.0 corresponds to a sensitivity and specificity of about 70 percent, which is poor. None of these tests had a good effect size for discriminating referred from nonreferred populations.

The adaptive functioning scales are very consistent across the various studies, probably because they come from the same parent scale (CBCL), in this analysis. Their combined effect size is low, at 1.2, corresponding to a sensitivity and specificity of about 72 percent, which is poor. Again, none of the tests had a good effect size.

Table 27. Total Scales of Broad-Band Checklists: Ability to Detect Referred vs. Nonreferred

Study	Behavior Rating Scale	Age	Gender	Effect Size	95% Confidence Limits
Achenbach (1991b)	CBCL/4-18-R, Total Problem Scale (Child Behavior Checklist for Ages 4-18, Parent Form)	4-11	M	1.4	1.3, 1.5
Achenbach (1991b)	Same as above	4-11	F	1.3	1.2, 1.4
Achenbach (1991c)	CBCL/TRF-R, Total Problem Scale (Child Behavior Checklist, Teacher Form)	5-11	M	1.2	1.0, 1.4
Achenbach (1991c)	Same as above	5-11	F	1.1	1.0, 1.3
Naglieri, LeBuffe, Pfeiffer (1994)	DSMD-Total Scale (Devereaux Scales of Mental Disorders)	5-12	MF	1.0	0.8, 1.3
Conners (1997)	CPRS-R:L-Global Problem Index (1997 Revision of Conners Parent Rating Scale, Long Version)	—	MF	2.3	1.9, 2.6
Conners (1997)	CTRS-R:L-Global Problem Index (1997 Revision of Conners Teacher Rating Scale, Long Version)	—	MF	2.0	1.7, 2.3
Combined				1.5	1.2, 1.8

Table 28. Externalizing Scales of Broad-Band Checklists: Ability to Detect Referred vs. Nonreferred

Study	Behavior Rating Scale	Age	Gender	Effect Size	95% Confidence Limits
Achenbach (1991b)	CBCL/4-18-R, Externalizing Scale (Child Behavior Checklist for Ages 4-18, Parent Form)	4-11	M	1.2	1.0, 1.3
Achenbach (1991b)	Same as above	4-11	F	1.0	0.9, 1.1
Achenbach (1991c)	CBCL/TRF-R, Externalizing Scale (Child Behavior Checklist, Teacher Form)	5-11	M	1.0	0.8, 1.1
Achenbach (1991c)	Same as above	5-11	F	0.9	0.7, 1.0
Naglieri, LeBuffe, Pfeiffer (1994)	DSMD-Externalizing Scale (Devereaux Scales of Mental Disorders)	5-12	MF	1.4	1.1, 1.7
Conners (1997)	CPRS-R:L-DSM-IV Symptoms (1997 revision of Conners Parent Rating Scale, Long Version)	—	MF	2.9	2.5, 3.3
Conners (1997)	CTRS-R:L-DSM-IV Symptoms (1997 revision of Conners Teacher Rating Scale, Long Version)	—	MF	2.0	1.8, 2.3
Combined				1.5	1.0, 2.0

Table 29. Internalizing Scales of Broad-Band Checklists: Ability to Detect Referred vs. Nonreferred

Study	Behavior Rating Scale	Age	Gender	Effect Size	95% Confidence Limits
Achenbach (1991b)	CBCL/4-18-R, Internalizing Scale (Child Behavior Checklist for Ages 4-18, Parent Form)	4-11	M	1.1	0.9, 1.2
Achenbach (1991b)	Same as above	4-11	F	1.1	1.0, 1.2
Achenbach (1991c)	CBCL/TRF-R, Internalizing Scale (Child Behavior Checklist, Teacher Form)	5-11	M	0.7	0.6, 0.9
Achenbach (1991c)	Same as above	5-11	F	0.7	0.6, 0.9
Naglieri (1994)	DSMD-Internalizing Scale (Devereaux Scales of Mental Disorders)	5-12	MF	1.6	1.3, 1.9
Combined				1.0	0.8, 1.3

Table 30. Adaptive Functioning Scales of Broad-Band Checklists: Ability to Detect Referred vs. Nonreferred

Study	Behavior Rating Scale	Age	Gender	Effect Size	95% Confidence Limits
Achenbach (1991b)	CBCL/4-18-R, Total Competence Scale (Child Behavior Checklist for Ages 4-18, Parent Form)	4-11	M	1.2	1.1, 1.3
Achenbach (1991b)	Same as above	4-11	F	1.1	1.0, 1.2
Achenbach (1991c)	CBCL/TRF-R, Total Competence Scale (Child Behavior Checklist, Teacher Form)	5-11	M	1.2	1.0, 1.3
Achenbach (1991c)	Same as above	4-11	F	1.2	1.1, 1.4
Combined				1.2	1.1, 1.2

Summary of Question 3 Results

Among ADHD-specific checklists, the 1997 revision of the Conners Rating Scale contains two highly effective indices for discriminating between children with ADHD and normal controls. The new ADHD Index and DSM-IV Symptoms Scale each are able to distinguish children with ADHD from normal controls 94 percent of the time. On the other hand, the Barkley School Situations Questionnaire is weak, with less than 86 percent effectiveness. Only one study provided data for these two tests and thus interpretations of effectiveness must be made with caution.

Hyperactivity subscales of the SNAP Checklist and the Conners Rating Scale are strong in their ability to discriminate between children with ADHD and normal controls. The only hyperactivity subscale to perform poorly was from the ACTeRS Checklist. The inattention and impulsivity subscales of the SNAP Checklist discriminated well between children with ADHD and normal controls, with effectiveness of greater than 97 percent. The ACTeRS Checklist performed poorly.

Broad-band checklists screen for a variety of conditions including symptoms of ADHD and serve as useful instruments in detecting the many comorbid conditions typically found in children with ADHD. Unfortunately, the studies reviewed could not be used to derive conclusions regarding the effectiveness of the scales in distinguishing children with significant problems from children without significant problems.

Question 4: Medical Screening Tests

A variety of different medical tests were proposed as part of the workup of children suspected of having ADHD. The purpose of the tests was to detect underlying causes or to help confirm a diagnosis by finding underlying abnormalities consistent with ADHD. This section examines studies trying to determine the likelihood of these tests diagnosing children with probable ADHD. Two categories of evidence were examined: (1) whether results of medical screening tests were significantly different in children with ADHD versus normal controls (e.g., mean TSH levels) and (2) how frequently screening tests detected conditions that required specific intervention (e.g., clinical hypo- or hyperthyroidism).

Lead Levels

Elevated levels of blood lead have been linked to a variety of adverse neurologic effects, ranging from symptomatic neurotoxicity at levels above 50 ug/dL to more subtle adverse effects on IQ and attention at milder elevations (10-50 ug/dL) in blood lead (U.S. Preventive Services Task Force 1996). The importance of elevated lead levels as a contributor to more severe behavioral problems, and the clinical value of blood lead measurements in the diagnosis of children with suspected ADHD remains controversial. A number of studies have suggested that children with increased lead levels in body tissues show decreases in cognitive ability, lower academic skills, and hyperactivity. Increased levels of lead have been reported in children with ADHD in some studies but not in others. Six studies were reviewed for this report (Barlow, 1983; Gittelman and Eskenazi, 1983; Kahn, Kelly, Walker, et al., 1995; Silva, Hughes, Williams, et al., 1988; Thomson, Raab, Hepburn, et al., 1989; Tuthill, 1996).

Table 31 presents the results of the analysis. Two studies showed no significant relationship between elevated lead levels and ADHD (Barlow, 1983; Gittelman and Eskenazi, 1983). One study did show such a relationship (Tuthill, 1996), and one study showed a weak association that did not reach statistical significance (Kahn, Kelly, Walker, et al., 1995). Two others demonstrated relationships between elevated lead levels and behavior problems (Silva, Hughes, Williams, et al., 1988; Thomson, Raab, Hepburn, et al., 1989). The study design, methods of linking lead levels to manifestations of ADHD, and sources and methods of lead level measurement differed across studies.

Although it appears possible that increased levels of lead play some role in ADHD, one can conclude that, overall, lead is not a major cause of ADHD. The dramatic decline in population lead levels in the U.S. over the past decade is likely to further reduce the role of lead as a contributor to attentional behavior problems, but we found only one study examining lead levels among a sample of ADHD patients in this country within the last 5 years. The available evidence suggests that routine lead screening contributes little to subsequent diagnostic or treatment strategies in children with suspected ADHD.

Thyroid

Abnormal thyroid function can have a range of behavioral effects, ranging from severe neuropsychological deficits in children with congenital hypothyroidism, hyperactivity associated with hyperthyroidism, and impaired concentration arising from hypothyroidism. For this report, four studies were reviewed for the relationship between abnormal thyroid function and ADHD (Elia, Gulotta, Rose, et al., 1994; Spencer, Biederman, Wilens, et al., 1995; Stein, Weiss, Refetoff, 1995; Weiss, Stein, Trommer, et al., 1993) (see Table 32). Data on TSH, or thyrotropin levels, were profiled, because this is the most routinely ordered thyroid level test. Not one study discovered a relationship between abnormal thyroid levels and ADHD. Overall, the prevalence of any thyroid disorder in children with ADHD appears to be the same as, or only slightly above, the prevalence of thyroid disorder in normal children. The evidence does not support the use of tests of thyroid function to screen for ADHD.

Interestingly, several of the studies from which data were pulled on TSH focused on the relationship between ADHD and a thyroid disorder called "Generalized Resistance to Thyroid Hormone" (GRTH). A high percentage of children with GRTH are diagnosed with ADHD as well. Researchers are intrigued by the relationship. Despite the fact that the relationship is unidirectional (children with ADHD rarely have GRTH), researchers are hoping it may shed light on the etiology of ordinary ADHD.

In the study by Elia, Gulotta, Rose, et al. (1994), 53 children with ADHD were screened for the presence of GRTH by several tests of thyroid function. No patient with ADHD was found to have GRTH. In a similar study by Spencer, Biederman, Wilens, et al. (1995), 132 children were examined for the presence of GRTH. Again, no patient with ADHD was found to have GRTH. In both of these studies, all thyroid hormone levels of the children with ADHD were in the normal range.

Weiss, Stein, Trommer, et al. (1993) studied 277 children with ADHD of whom none were found to have GRTH. However, 14 of 277 children with ADHD (5.4 percent) had some type of thyroid hormone abnormality, whereas only 1 of 106 normal children (1 percent) had such abnormalities. It should be noted that the abnormal levels in most of the children with ADHD in this study fell into the borderline range.

Table 31. Medical Screening Tests: Lead (Pb) Levels

Study	Type of Measure	Abnormal Cutoff	Study Group			Control Group			p Value	Setting	Comments
			#ADHD	Level	Yield	n	Level	Yield			
Kahn, Kelly, Walker (1995) [a,b]	Blood	>25 g/dL[c]	31	2.174 g/dL (mean)	Not given	85	2.265±1.6 g/dL (mean±SD)	Not given	0.082	Military base; Pacific Northwest, USA	No difference between patients and controls
Tuthill[b] (1996)	Hair	75th percentile of all children in the study	16	<1 11.99 ppm (g/g) (range)	8/16	261	<1 11.99 ppm (g/g) (range)	48/261	0.006	Pop. 50k, Amherst, Massachusetts, USA	Logistic regression model; The higher the Pb level the higher the behavior problems score
Gittelman, Eskenazi (1983)	Urine	>0.08 mg/L	103	0.10±0.08 mg/L (mean±SD) 0.02-0.52 (range)	11/20[d]	33	0.08±0.05mg/L (mean±SD) 0.02-0.22 (range)	7/20[d]	Not significant	Suburbs of New York City, USA	Weak association between increased Pb level and abnormal scores
Silva, Hughes, Williams, et al. (1988)	Blood	None given	579	11.1 g/dL (mean)	Not given	0	None; (regression analysis comparing blood levels of Pb and behavior ratings)	Not given	Not applicable	Urban; Dunedin, New Zealand	Raised blood Pb levels associated with small increase in behavioral problems
Thomson, Raab, Hepburn, et al. (1989)	Blood	None	501	10.4 g/dL (mean)	Not given		None; (regression analysis)	Not given	Not applicable	Urban; Edinburgh, Scotland	The higher the Pb level, the more abnormal the Rutter score
Barlow (1983)	Hair	None	68	8.4±9.8 g/g (mean±SD)	Not given	66	6.9±7.6 g/g (mean±SD)	Not given	Not significant	ADHD: urban/ lower class; Controls: suburban/upper-middle class; UK	No significant difference in Pb levels between hyperactive child and controls

[a] This study also included patients with developmental delay.
[b] Children were diagnosed with ADHD in these 2 studies; children were screened only for disruptive behavior in the latter 4 studies.
[c] This figure is given for neurotoxic effect level.
[d] For yield information, data from 20 ADHD and normal sibling pairs were used.

Table 32. Medical Screening Tests: Thyroid Levels

Study	Test Type	Abnormal Cutoff	ADHD Patients		Controls		p Value	Comments
			#	Test Data	#	Test Data		
Elia, Gulotta, Rose, et al. (1994)	TSH	6 U/mL	53	2.34±1.08 U/mL (mean±SD) 0 of 53 had values above 5 U/mL (yield)	39	2.31± 0.85 mV/mL (mean±SD)	Not significant	None of these values suggested the presence of global or pituitary thyroid hormone resistance in the children with ADHD.
Spencer, Biederman, Wilens, et al. (1995)	TSH	5 U/mL	126	1 of 126 had a value slightly above 5 U/mL (yield)	147 normal adults	1 of 147 had value slightly above 5 U/mL (yield)	Not significant	None of the children with ADHD had evidence of clinical significant thyroid dysfunction.
Weiss, Stein, Trommer, et al. (1993)	TSH	6 U/mL	277	6 of 277 had values above 6 U/mL (yield)	106	0 of 106 had values above 6 U/mL (yield)	Not given	Abnormal TSH was noted in 6 of 277 (2.2%) of children with ADHD; less than 1% of normal children have such abnormalities. No Children with ADHD had "Generalized Resistance to Thyroid Hormone" (GRTH).
Stein, Weiss, Refetoff (1995)	TSH	3.6 U/mL	12	2.7±1.0 U/mL (mean±SD) 0 of 12 had values above the study's 3.6 U/mL limit (yield)	12 with GRTH	2.9±1.7 U/mL (mean±SD) 5 of 12 had values above the study's 3.6 U/mL limit, but 0 of 12 were above the more conventional 5 U/mL limit (yield)	Not significant	All children with ADHD alone had normal thyroid function.

The last study, by Stein, Weiss, and Refetoff (1995) had a different focus. The authors studied 12 children with GRTH and 12 children with ADHD. The latter had completely normal thyroid function. The purpose was to compare the behavioral and cognitive characteristics of these two groups. The authors found that children with GRTH were similar behaviorally to children with ADHD, but differed in several other respects from children with the usual form of ADHD. Specifically, children with GRTH demonstrated lower nonverbal intelligence, or weaker perceptual-organizational skills, and lower academic achievement, suggesting more severe overall impairment in GRTH than in children with ADHD.

Imaging

A number of imaging studies of the brain have been performed to investigate whether any morphologic differences in various brain structures are present in children with ADHD. Morphologic differences might provide clues to biological correlates or causes of this disorder. A body of research exists on several biochemical and neurological pathways and processes known to mediate psychological and cognitive functioning within the brain. Gaining an understanding of structural or functional differences through imaging studies could lead to a more global understanding of the etiology of ADHD.

Nine imaging studies with children with ADHD were reviewed for this report (Table 33) (Castellanos, Giedd, Marsh, et al., 1996; Filipek, Semrud-Clikeman, Steingard, et al., 1997; Harcherik, Cohen, Ort, et al., 1985; Hynd, Semrud-Clikeman, Lorys, et al., 1990, 1991; Hynd, Hern, Novey, et al., 1993; Lyoo, Noam, Lee, et al., 1996; Semrud-Clikeman, Filipek, Biederman, et al., 1994; Shaywitz, Shaywitz, Byrne, et al., 1983). In two studies, no significant differences on brain CT or CAT scans were observed between children with ADHD and normal controls. In the other studies, several different abnormalities were noted in children with ADHD. Findings comprised either differences in size, in asymmetries, or in the shape or volume of the ventricles. In all cases, the structures in the children with ADHD were smaller than those of the normal control subjects.

In the future, a better understanding of ADHD is likely to evolve from the work currently being done with imaging. At the present time, however, the evidence is sparse and diverse. Therefore, none of these imaging procedures are supported by research as useful screening or diagnostic tools for ADHD.

Electroencephalography

One of the most researched medical tests used for evaluating children with ADHD is the electroencephalogram (EEG). This report abstracted data from eight studies seeking relationships between EEG patterns and ADHD (Holcomb, Ackerman, Dykman, 1985; Kuperman, Johnson, Arndt, et al., 1996; Lahat, Avital, Barr, et al., 1995; Matsuura, Okubo, Toru, et al., 1993; Newton, Oglesby, Ackerman, et al., 1994; Robaey, Breton, Dugas, et al., 1992; Satterfield, Schell, Nicholas, et al., 1990; Valdizan and Andreu, 1993) (see Table 34). None of the studies discovered any serious EEG abnormalities (e.g., signs of seizure activity) in children with ADHD. However, many found significant differences in brain wave activity between children with ADHD and normal controls.

Table 33. Medical Screening Tests: CT, CAT, and MRI

Study	Parameters/Method	#/Type of Subject	#/Type of Control	Structures Showing a Difference in ADHD Patients	p Value	Comments
Shaywitz, Shaywitz, Byrne, et al. (1983)	Measurement of the anterior horn of the lateral ventricles by computer tomography (CT)	35 ADD DSM-III	20 Variety of unspecified clinical conditions	None	NS	Measurements performed blinded.
Harcherik, Cohen, Ort, et al. (1985)	Ventricular volume and brain density by computed axial tomographic (CAT) scans	22 ADD DSM-III	64 Medical controls Patients with other neurological disorders or medical problems	None	NS	Measurements performed blinded.
Hynd, Semrud-Clikeman, Lorys, et al. (1990)	Various portions of the cerebral cortex	10 ADHD children by DSM-III or III-R criteria	10 Normal controls	Children with ADHD had bilaterally smaller anterior cortexes with decreased right anterior width measurement.	$p<0.05$	This study also included patients with dyslexia.
Hynd, Semrud-Clikeman, Lorys, et al. (1991)	Regional measurements of the corpus callosum (CC)	7 ADHD	10	Region 4 of the CC was smaller in patients with ADHD	$p<0.05$	
Hynd, Hern, Novey, et al. (1993)	Measurement of asymmetry of the head of the caudate nucleus by magnetic resonance imaging (MRI)	11 ADHD DSM-III-R	11 Normal controls	72.7% of normal controls had left larger than right asymmetry of head of caudate nucleus; reverse pattern found in 63.6% of children with ADHD.	$p<0.03$	Measurements performed blinded.
Semrud-Clikeman, Filipek, Biederman, et al. (1994)	Shape and area of the CC by MRI	15 males ADHD DSM-III	15 Normal controls Free of any DSM-III diagnosis	Posterior region of CC was smaller in patients with ADHD.	$p=0.02$	The authors suggested that fewer callosal connections negatively affect the patient's ability to sustain attention. Measurements performed blinded.
				Smaller cerebellum	$p=0.05$	
				Reversal of normal lateral ventricular asymmetry	$p=0.03$	

Table 33. Medical Screening Tests: CT, CAT, and MRI (continued)

Study	Parameters/Method	#/Type of Subject	#/Type of Control	Structures Showing a Difference in ADHD Patients	p Value	Comments
Castellanos, Giedd, Marsh, et al. (1996)	Volumetric measures of the cerebrum, caudate nucleus, putamen, globus pallidus, amygdala hippocampus, temporal lobe, cerebellum, prefrontal cortex cerebellum, and CC	57 males DSM-III-R	55 males Normal controls	ADHD subjects had a 4.7% smaller cerebral volume	p=0.02	The author speculates that the lack of normal asymmetry somehow mediates expression of ADHD.
				Loss of normal right>left symmetry in the caudate	p=0.006	
				Smaller right globus pallidus	p=0.005	
				Smaller right anterior frontal region	p=0.02	
Lyoo, Noam, Lee, et al. (1996)	Area of the CC and the volume of the anterior and posterior ventricles by MRI	51	28	Splenium (region of the CC) was smaller in children with ADHD	p=0.041	No indication that measurements were made in a blinded fashion. Many of the non-ADHD patients had other serious psychological disorders.
				Posterior left ventricle volume greater in children with ADHD	p=0.033	
Filipek, Semrud-Clikeman, Steingard, et al. (1997)	Global and hemispheric regional volumes of the cerebral hemispheric cortex, white matter, ventricles, caudate lenticulae, central gray nuclei, insula, amygdala, and hippocampus	15 ADHD DSM-III-R	15 children; 12 had normal scores on all scales of the CBCL	Caudate head was smaller in ADHD patients	p<0.04	All patients with ADHD were on medication. It was noted that a patient's response or nonresponse to stimulant medication correlated with certain anatomic changes.
				Right anterior superior frontal region and white matter, smaller in patients with ADHD	p<0.03	
				Bilateral anterior interior region, smaller in patients with ADHD	p<0.04	
				Bilateral retro-callosal region in white matter, smaller in patients with ADHD	p<0.03	

Table 34. Medical Screening Tests: Electroencephalography

Study	#/Type of Subject	#/Type of Control	EEG Method	Parameters Investigated	Parameters Showing Difference in ADHD Subjects	p Value	Comment
Holcomb, Ackerman, Dykman (1985)	45 DSM-III (24 ADDH, 21 ADD)	48 (24 learning disability controls, 24 normal controls)	Evoked-response potential (ERP)	Amplitude Latency, expected stimuli Latency, unexpected stimuli (All at P3 site) (3 parameters total)	Latency, expected stimuli Latency, unexpected stimuli (2 parameters total)	<0.009 <0.009	No serious EEG abnormality, e.g., signs of seizure activity, in any subjects or controls. Both ADHD and LD groups had longer latencies than normal controls.
Satterfield, Schell, Nicholas, et al. (1990)	15 DSM-III-R (ADHD)	15 Normal controls	Evoked-response potential, auditory stimuli (AERP)	Amplitude at 6 sites Amplitude increase to target stimuli at same 6 sites (12 parameters total)	Amplitude increase to target stimuli at 3 sites: P350 P3b SP1 (3 parameters total)	<0.003 <0.04 <0.004	No serious EEG abnormality in any subjects or controls. Normal controls demonstrated significantly better ability to "tune attention."
Robaey, Breton, Dugas, et al. (1992)	12 DSM-III-R (ADHD)	12 Normal controls	Evoked-response potential, classification, seriation, and reading tasks (ERP)	Amplitude during classification and seriation Amplitude increase during classification, seriation, and reading (4 sites total) Amplitude decrease during each task (4 sites total) Latency decrease during classification and seriation tasks (12 parameters total)	Amplitude during classification and seriation Amplitude increase at 2 of 4 sites during 2 of 3 tasks Amplitude decrease at 3 of 4 sites during 2 of 3 tasks Latency decrease at 1 of 2 sites for 1 of 3 tasks (8 parameters total)	<0.025-<0.05 <0.005-<0.05 <0.005-<0.05 <0.01	No serious EEG abnormality in any subjects or controls. Results suggest ADHD subjects may have tended to rely more heavily on automatic information processing abilities than on higher-order, or controlled, processing abilities.
Matsuura, Okubo, Toru, et al. (1993)	91 DSM-III-R (ADHD) in China, Japan, and Korea	236 (153 disruptive behavior controls, 83 normal controls)	Traditional EEG	Average amplitude for Delta wave at 2 different leads Percent time at various waves (Delta, Theta-1, and Alpha) at 2 leads for each wave (8 parameters total)	Average amplitude for Delta wave at 1 of 2 sites Percent time for all Delta and Theta measures, but only 1 of 2 of Alpha measures (6 parameters total)	<0.01 <0.05-<0.01	No serious EEG abnormality in any subjects or controls. No significant differences between results for each type of control group. Main findings: more slow waves and fewer Alpha waves in ADHD than in normal controls or disruptive behavior controls.
Valdizan, Andreu (1993)	22 DSM-III-R (ADHD)	17 Psychiatric controls (hyperactive & inattentive symptoms)	Repeated-Measures Quantitative EEG	Normal versus abnormal results (no description of "abnormal" provided)	Differences between groups not examined	None	Sensitivity for ADHD reported to be 0.91, and specificity 0.94, using a prevalence estimate of 0.56 and no clear definition of "abnormal" EEG.

Table 34. Medical Screening Tests: Electroencephalography (continued)

Study	#/Type of Subject	#/Type of Control	EEG Method	Parameters Investigated	Parameters Showing Difference in ADHD Subjects	p Value	Comments
Newton, Oglesby, Ackerman, et al. (1994)	114 DSM-III (81 ADDH, 33 ADD)	30 Normal controls	Evoked-Response Potential (ERP)	Amplitude at several sites: 1 occipital site (Oz) 2 parietal region sites 2 frontal region sites Amplitude for overall ERP (6 parameters total)	Amplitude at occipital site (Oz) (1 parameter)	<0.0023	No serious EEG abnormality in any subjects or controls. ADDH and ADD children showed greater slow wave negativity at the midline occipital electrode site.
Lahat, Avital, Barr, et al. (1995)	114 DSM-III-R (65 ADHD, 49 UADD)	41 Normal controls	Brainstem Auditory Evoked Potential (BAEP)	Latencies of waves I, III, and V Brainstem transmission time (BTT) (time interval between positive peaks) for waves 1, III, and V (12 parameters total)	3 of 6 latency measures 3 of 6 BTT measures (6 parameters total)	<0.01 <0.05- <0.01	No serious EEG abnormality in any subjects or controls. BAEPs of ADHD or UADD had more prolonged latencies of waves III and V compared to BAEPs of normal controls.
Kuperman, Johnson, Arndt, et al. (1996)	315 DSM-III-R (245 ADHD, 70 UADD)	3,592 Normal controls	Relative percent power (RPP) and Evoked-response potential (ERP)	RPP for 4 types of waves, separating results by hemisphere (12 total) ERP peak amplitude for 2 sites, separated by hemisphere and common vs. rare auditory tone (24 total) (36 parameters total)	RPP for 2 data points ERP for 2 data points (4 parameters total)	<0.02 <0.04	No serious EEG abnormality in any subjects or controls. Asymmetry between left and right hemisphere data distinguished the groups; ADHD had only ERP asymmetry, UADD had spectral EEG asymmetry, and controls had no asymmetry.

Children with ADHD were found to have longer latencies at the P3 site (Holcomb, Ackerman, and Dykman, et al., 1985), longer latencies of certain waves for brainstem auditory evoked potentials (Lahat, Avital, Barr, et al., 1995), more slow waves and fewer Alpha waves (Matsuura, Okubo, Toru, et al., 1993), poorer ability to "tune" attention (Satterfield, Schell, Nicholas, et al., 1990), and asymmetry in peak amplitude evoked-response potentials (Kuperman, Johnson, Arndt, et al., 1996). The heterogeneity of results across studies prohibited meta-analysis and, as a result, indicates a lack of sufficient evidence of any clear EEG patterns typically found in children with ADHD. Therefore, evidence does not support routine use of the EEG as a screening tool for ADHD.

Neurological Screening Tests

In addition to the tests that try to relate anatomic structural differences and variations in biochemical neurotransmitter pathways to cognitive and behavioral function in children with ADHD, a number of other tests for neurological characteristics of children with ADHD have also been conducted, again to uncover clues to the etiology of ADHD. Studies are profiled in Table 35 (Accardo, Tomazic, Morrow, et al., 1991; Gillberg, Carlstrom, Rasmussen, et al., 1983; Reeves, Werry, Elkind, et al., 1987; Trommer, Hoeppner, Lorber, et al., 1988b; Vitiello, Stoff, Atkins, et al., 1990).

Minor anatomical malformations in various parts of the body have been associated with certain types of mental disorders. Accardo, Tomazic, Morrow, et al. (1991) examined 1,215 children presenting at a developmental center for various problems. The mean number of malformations in a group of 407 children with ADHD was no greater than the mean for a group of 808 controls.

The "Go-No-Go" test measures children's ability to produce a simple motor response to a "go" cue and inhibit this motor response to the "no go" cue. Errors of omission, made when a child fails to "go" when cued, purportedly measure inattention. Errors of commission, or "going" when cued not to go, measure impulsivity. Trommer, Hoeppner, Lorber, et al. (1988b) administered this test to 16 children with DSM-III ADD, 28 children with DSM-III ADDH, and 32 controls. Both ADD and children with ADHD made more errors on this test than did controls. Moreover the ADHD groups made more omission errors (inattention) than did the ADD group. However, the authors report that error ranges were nearly identical in all groups, with absolute errors relatively low across groups. They state the test is not designed to be used diagnostically at this time.

Gillberg, Carlstrom, Rasmussen, et al. (1983) administered six neurological screening measures to several diagnostic groups, including an ADHD group and a normal control group. Across all measures, there were no significant differences in frequency of abnormal results between the ADHD and control groups. Specific frequencies for the groups were divided by gender. Half of the ADHD girls and none of the control girls displayed abnormal results on the Wechsler Intelligence Scale for Children subtest called "Mazes," whereas all of the ADHD girls and half of the control girls obtained abnormal scores on the measure of diadochokinesis. Ten percent of the ADHD boys, versus 4-17 percent of control boys scored abnormally on four of the six tests. On the other two, measures of associated movements and diadochokinesis, about half of the ADHD boys scored abnormally, versus fewer than 20 percent of the control boys.

Reeves, Werry, Elkind, et al. (1987) examined the rate of neurodevelopmental abnormalities (as measured by nine tests of sensorimotor coordination) and minor physical anomalies (e.g., large head or low-set ears) in 39 ADDH and 39 control children. ADHD children demonstrated a significantly higher rate of neurodevelopmental abnormalities than matched controls, but no difference in prevalence of pre- or perinatal problems, speech problems, or minor physical abnormalities.

One study of the use of neurological screening tests with children screened for disruptive and impulsive behavior was profiled in Table 35 (Vitiello, Stoff, Atkins, et al., 1990). (In all other studies profiled in that table, children were diagnosed with ADHD.) In this screening study, the researchers administered the Revised Neurological Examination for Subtle Signs to 31 inpatient and outpatient children of a psychiatric clinic. Neurological soft, or subtle, signs did not correlate significantly with ratings of disruptive or impulsive behavior.

Miscellaneous Medical Tests

Because the cause of ADHD is unknown, because ADHD may not even be a single disease and may have several different causes, and because the complete workings of the brain and cognitive systems are still poorly understood, investigators have conducted a diverse array of studies searching for insights into the cause(s) of ADHD (Cacabelos, Albarran, Dieguez, et al., 1990; Cook, Stein, Ellison, et al., 1995; Hole, Lingjaerde, Morkrid, et al., 1988; LaHoste, Swanson, Wigal, et al., 1996; Pliszka, Maas, Javors, et al., 1994; Warren, Odell, Warren, et al., 1995). These include measurements of neurotransmitters, hormones, and proteins, including serotonin levels, plasma protein levels, peptide-containing urinary fractions, response to growth hormone releasing factor, dopamine receptors, and epinephrine levels. Studies for each are sparse, preventing formal statistical analyses to combine results of various studies or to determine trends or correlations between these measurements and ADHD. The studies are discussed below, however, and profiled in Table 36.

Cook, Stein, Ellison, et al. (1995) compared the following groups' blood levels of the neurotransmitter, serotonin: ADHD with no comorbid conditions, ADHD with conduct disorder, ADHD with oppositional defiant disorder, and ADHD with both conduct disorder and oppositional defiant disorder. The latter group had a significantly higher rate of elevated serotonin levels than the other three groups.

Warren, Odell, Warren, et al. (1995) examined blood levels of the protein C4B in children with ADHD. C4B is a plasma protein that plays an important role in the body's defenses against a variety of infectious agents. In this study, lower levels of C4B were found in children with ADHD than in normal controls. Mothers (but not fathers) of the children with ADHD also had significantly lower C4B levels compared with mothers of normal children. The authors noted a possible relationship between decreased concentrations of C4B and ADHD and speculated that, if replicated, low levels of C4B might represent a marker for ADHD. The decreased C4B levels in the mothers may have allowed a virus to persist during pregnancy, perhaps causing damage to the developing fetus, which then manifests itself after birth.

Table 35. Medical Screening Tests: Neurological Measures

Study	What Was Tested	#/Type of Patient	# Controls	Diagnostic Criteria for ADHD	Findings	p value	Comments
Accardo, Tomazic, Morrow, et al. (1991)	Minor anatomical malformations (dysmorphic features)	133 ADD 274 ADHD	808	DSM-III, No detail provided	No significant increase in malformations in either ADD or ADHD groups	NS	In children with IQ's >100 there was an increased frequency of malformations.
Vitiello, Stoff, Atkins, et al. (1990)	Soft neurological signs in children with impulsive behavior	31, only 12 of whom had ADHD	45	DSM-III-R CBL, P, CBL, T Iowa Conners Questionnaire CPT	No direct statement made about ADHD		Soft signs did not correlate with IQ levels, impulsive behavior, or disruptive behavior.
Trommer, Hoeppner, Lorber, et al. (1988b)	"Go-No-Go" test; omission and commission errors were measured	16 ADD 28 ADHD	?	DSM-III Conners Hyperactivity Index	ADD 94% errors ADHD 82% errors Controls 47% errors ADHD group made more omission errors than ADD group. Commission errors more common than omission errors.	p<0.01	Provides an objective measurement of inattention and impulsivity.
Reeves, Werry, Elkind, et al. (1987)	9 tests of sensorimotor coordination on R and L side of body	109	108	DSM-III DISC-P RBPC	ADHD: 51% (> 2 abnormal findings) Controls: 28% (> 2 abnormal findings)	p=0.05	No neurodevelopmental differences between patients with diagnosis of ADHD + conduct disorder vs. Controls.
Gillberg, Carlstrom, Rasmussen, et al. (1983)	Perceptual, motor, and attention deficits in 7-year- old children by several different types of neurological screening	141 total 12 ADD	51	Not stated	Patients with ADD had significant differences compared with normals in 4 of 6 neurological tests	p<.01 to >.001	This paper was published in 1983 when the concept of minimal brain disorder was popular but poorly defined.

Hole, Lingjaerde, Morkrid, et al. (1988) investigated the patterns of peptide-containing urinary fractions of various sizes by gel filtration. All children with ADHD showed patterns atypical of those found in normal controls. However, these atypical patterns varied greatly across children with ADHD. Four groups of patterns were found among children with ADHD in this test; such heterogeneity precludes any possible correlations with ADHD at this time.

Cacabelos, Albarran, Dieguez, et al. (1990) studied the growth hormone response to growth hormone releasing factor (GRF). In 80-90 percent of children with ADHD, the growth hormone response was abnormal. Two different patterns of response were noted. Growth hormone is a neuropeptide that has certain known effects in the central nervous system and is part of the somatotropinergic system that could be involved in the etiology of ADHD.

LaHoste, Swanson, Wigal, et al. (1996) were interested in the role of the neurotransmitter, dopamine, and its receptor. Children with ADHD were found to have the less sensitive form of the dopamine receptor and, therefore would be expected to have reduced dopaminergic nerve impulse transmission. The authors suggest that the different variants of the gene coding for the dopamine receptor may be a factor in the expression of certain traits associated with ADHD.

Pliszka, Maas, Javors, et al. (1994) measured the urinary excretion of norepinephrine and epinephrine, or their metabolites, during a stressful task to evaluate the functioning of the noradrenergic system in children with ADHD. Regardless of the presence or absence of the comorbid condition, anxiety, children with ADHD excreted more normetanephrine (a metabolite of norepinephrine). Children with ADHD and anxiety excreted more EPI than did children with ADHD without anxiety. The authors conclude that, in some manner, EPI plays a role in the pathogenesis of ADHD.

In conclusion, the current evidence does not establish a relationship between any of the medical tests evaluated in this report and ADHD strong enough to warrant their use as routine screening or diagnostic tools in the evaluation of a child suspected of having ADHD.

Table 36. Medical Screening Tests: Miscellaneous

Study	Substance Being Measured/Units	Number/Type of Patient	Number/Type of Control	Findings	p Value	Comments
Cook, Stein, Ellison, et al. (1995)	Serotonin (5-HT) blood levels (ng/mL)	22 ADHD with no comorbid conditions DSM-III-R	30 ADHD with comorbid conditions	No significant difference in 5-HT levels between subjects with ADHD with CD or ODD. However, 7 of 30 children (23%) with ADHD and both CD and ODD had elevated levels of 5-HT, >270 ng/mL.	p<0.02	Mean 5-HT level in 36 mothers of children with ADHD correlated significantly with mean level in the children with ADHD (r_S=0.07; p=<0.002).
Warren, Odell, Warren, et al. (1995)	Complement C4B protein in the blood (g/mL)	23 ADHD DSM- III-R	23 Normal controls	C4B plasma levels were lower in patients with ADHD. Also, the C4B levels in the mothers, but not fathers, was decreased.	p<0.01	Authors suggest several hypotheses to explain this observation.
Hole, Lingjaerde, Morkrid, et al. (1988)	Urine fractions containing peptides obtained by G-25 sephadex column filtration	71 ADDH 33 ADD DSM-III	36 Normal controls	Patterns of the peaks of elevated peptides compared. Children with ADHD excreted larger amounts of peptides in a 24-hour urine sample than did normal controls.	p<0.01	Large variations found in pattern of urinary fractions. Patients with increases in late peaks had greater hyperactivity. Analyses of peaks were subjective.
Cacabelos, Albarran, Dieguez, et al. (1990)	Response to growth hormone releasing factor (GRF); GRF injected intravenously and blood samples collected at intervals for measurement of GH levels (ng/mL)	12 ADHD DSM-III-R	6 Normal controls	Two kinds of responses of children with ADHD to GRF: In one group, response is similar to controls but with lower peak of GH at 15 minutes.	p<0.01	Abnormal GH response to GRF in 80-90% of children with ADHD.
				In other group, augmented response to GRF with peak at 60 minutes.	p<0.01	
LaHoste, Swanson, Wigal, et al. (1996)	Variation in the dopamine receptor genotype (DRD_4) in patients with ADHD.	39 DSM-IV	39	Control and children with ADHD differed significantly in distribution of DRD_4 alleles.	p<0.01	Genotype of the dopamine receptor more commonly found in ADHD has lower affinity for dopamine; thus hypo-dopaminergic activity may contribute to symptoms of ADHD.
Pliszka, Maas, Javors, et al. (1994)	Urinary excretion of norepinephrine	20 ADHD 15 ADHD with anxiety DSM-III	22 Did not meet criteria for ADHD or anxiety	Children with ADHD, regardless of anxiety, excreted more normetaneprine (a metabolite of norepinephrine).	p=0.01	The results of this study support the hypothesis that central or peripheral EPI may play some role in the pathogenesis of ADHD.
				Children with ADHD and anxiety excreted more EPI than children with ADHD without anxiety.	p=0.01	

Abbreviations: CD = conduct disorder; ODD = oppositional defiant disorder; r_s = Spearman's rank-order correlation

Continuous Performance Tests (CPTs)

Data from the studies using CPTs were heterogeneous. Various types of CPTs were used with various scoring methods in studies using the CPT for many different purposes. The CPT studies that fit the inclusion criteria for this report are narratively outlined in Table 37 (August and Garfinkel, 1989; Barkley and Grodzinsky, 1994; Breen, 1989; Carter, Krener, Chaderjian, et al., 1995a; Cohen, Kelly, and Atkinson, 1989; Dykman and Ackerman, 1991; Fischer, Newby, and Gordon, 1995; Grant, Ilai, Nussbaum, et al., 1990; Halperin, Newcorn, Matier, et al., 1993; Horn, Wagner, and Ialongo, 1989; Loge, Staton, and Beatty, 1990; Seidel and Joschko, 1991). In addition to that qualitative analysis, a statistical analysis much like that performed with the ADHD-specific checklists was done with the CPT data. Specifically, the CPT scores for children diagnosed with ADHD were compared with those of normal controls to determine how effectively the CPT discriminates between the groups. Results are listed in Tables 38-40, each of which presents the findings on one of the subtests within the CPT, including those that measure impulsivity, inattention/distraction, and vigilance. Only one study (Seidel and Joschko, 1991) provided data on total scales, so it is discussed in narrative at the end of this section.

The results listed in Table 38 show that the measures of impulsivity across various forms of the CPT are poor predictors of ADHD, with most effect sizes lower than 1.0. Corresponding sensitivity and specificity values would be less than 70 percent when those values are set to match.

Table 39 illustrates poor predictability of ADHD using the measures of inattention on various versions of the CPT. Effect sizes ranged from near 0 to just above 1.0, reflecting an inability of the measure to even distinguish the groups at one standard deviation from each other.

The only study using total scales was that of Seidel and Joschko (1991): the effect size for differences between total scores of ADHD and normal control males and females ages 6-11 was 1.147 with a 95 percent confidence interval of 0.509 to 1.784, again quite poor. Results for the total scale, as well as for vigilance measures (Table 40) are similar to those in Tables 38 and 39, indicating all subtests of the CPT are poor predictors of ADHD and would not serve as useful screening tools for ADHD, even when compared against normal controls, the most ideal of conditions.

Table 37. Continuous Performance Tests

Study	# ADHD Patients	# Controls	Diagnostic Criteria for ADHD	Type of CPT Used	Time to Administer	Major Findings	Comments
Halperin, Newcorn, Matier, et al. (1993)	13[a]	18	CBCL CTRS	Halperin Method	12 min.	ADHD group made significantly more CPT inattention (p<.01), impulsivity (p<.01), and dyscontrol errors (p<.001) than did the other three groups.	Children with ADHD without comorbid conditions could be separated from children with anxiety and disruptive behavior by objective test measures.
Seidel, Joschko (1991)	22	128	DSM-III CPRS CTRS	Seidel Continuous Attention Test (SCAT)	30 min.	The SCAT measures examined were: ADHD vs. Controls Hit: p<.001 False alarms: p<.01 Reaction time: NS Variability: p<.01 (Large variances and no gender differences among children with ADHD.)	Authors suggest CPT should be used only in context of general neuropsychological evaluation and not as diagnostic instrument for ADHD.
Loge, Staton, Beatty (1990)	20	20	DSM-III-R CTRS	Gordon Diagnostic System (GDS)	26 min.	ADHD vs. Controls Vigilance task: p<.05 Distractibility task: p<.01 Delay task: NS	In general, children with ADHD performed normally on various tests of frontal lobe function.
Breen (1989)	26 13 males 13 females	13 females	DSM-III CTRS	Gordon Diagnostic System (GDS)	17 min.	ADHD vs. Controls Vigilance task: Number correct: p<.05 Commission errors: NS Delay task: NS Total rewards: NS Total responses: NS	No gender differences. Further, only 1 of 5 measures resulted in significant differences between ADHD and control children.
Fischer, Newby, Gordon (1995)	138	0	Semistructured diagnostic interview CPRS-R CBCL-TRF CTRS	Gordon Diagnostic System (GDS)	6 min.	An agreement rate, or sensitivity, of 70-80% was found between the CPT Vigilance Task and ADHD diagnosis.	Highest levels of agreement between the CPT Vigilance Task and ADHD diagnosis for younger children (those below age 12).
Barkley, Grodzinsky (1994)	12	12	CAP (Barkley) DSM-III	Gordon Diagnostic System (GDS)	9 min.	Sensitivity values by group:[b] ADDH ADD LD NC #COR .33 . 58 .09 .00 #CE .42 .25 .00 .00 #OE .33 . 58 .09 .00	Sensitivity, or ability of each subtest to correctly classify children into diagnostic groups, was very low across all groups and all CPT subtests.

Table 37. Continuous Performance Tests (continued)

Study	# ADHD Patients	# Controls	Diagnostic Criteria for ADHD	Type of CPT Used	Time to Administer	Major Findings	Comments
Cohen, Kelly, Atkinson (1989)	21	0	DSM-III CPRS ACTeRS (all ADDH)	Gordon Diagnostic System (GDS)	Not stated	Sensitivity values for ADDH: CPT: . 52 CPRS: . 71 ACTeRS: . 67	Seven of 21 patients also had learning disabilities. GDS was not useful in monitoring effects of therapy with methylphenidate.
Grant, Ilai, Nussbaum, et al. (1990)	53 ADDH, 66 ADDH+LD	0	DSM-III-R	Gordon Diagnostic System (GDS)	Not stated	When compared to norms, ADHD means were 0 to 3 standard deviations greater: Delay task: NS Vigilance task: # CE: >2 SD Variability: >1 SD Distractibility task: # Correct: >1 SD # CE: >3 SD Variability: >2 SD	Results were pooled across children with ADHD with and without learning disabilities. It is thus unclear to what extent learning disabilities affected performance of the group.
Horn, Wagner, Ialongo (1989)	37 males 17 females	19 males 12 females	DSM-III-R CPRS CTRS SNAP	Conners' Continuous Performance Test (CPT)	10 min.	ADHD vs. Controls: Commission errors: p<.05 Omission errors: p<.01	Several other tests were also used. There was no gender effect, which is consistent across CPT studies.
August, Garfinkel (1989)	95	50	DSM-III YCI CTRS	Garfield and Klee Attentional Battery	12 min.	Compared to controls, children with ADDH+LD had higher numbers of omission and commission errors, (p<.001). However, the ADHD+LD group was small (n=11).	Results may have been different, according to author, if a CPT version with a more difficult, faster rate of presentation had been used.
Carter, Krener, Chaderjian, et al. (1995a)	20	20	DSM-III-R K-SADS-III-R CPRS ADHD Rating Scale (Barkley)	Test of Variables of Attention (TOVA)	30 min.	ADHD vs. Controls: Commission errors: NS Omission errors: p<.025	Authors suggest the findings may indicate that the ADHD group was primarily inattentive, rather than impulsive.
Dykman, Ackerman (1991)	82 ADDH+LD, 83 ADDH without LD	52	DICA Structured interview DSM-III CPRS CBCL	Gordon's Differential Reinforcement of Low Response Rates Test (DRL)	Not stated	Results compared to controls: ADDH+LD / ADDH # Presses: NS / NS # Correct: NS / p<.05 % Correct: p<.01 / NS	The DRL Test purports to measure impulsivity. Although some children had ADD without hyperactivity, their performance was not significantly different from ADDH children, so scores were pooled for analyses.

[a] Study included 2 other groups (20 children with anxiety disorders and 15 with disruptive disorder)
[b] LD=learning disability; NC=normal controls; #COR=number of correct responses; #CE=number of commission errors; #OE=number of omission errors

Table 38. Impulsivity Measure in Continuous Performance Test (CPT): Ability to Detect ADHD vs. Normal Controls

Study	Continuous Performance Subtest	Age	Gender	Effect Size	95% Confidence Limits
Loge, Staton, Beatty (1990)	Gordon Diagnostic System (GDS) Delay Task, Efficiency Ratio	6-12	MF	0.541	-0.107, 1.190
Seidel, Joschko (1991)	Seidel Continuous Attention Test (SCAT); Commission Errors	6-12	MF	0.887	0.268, 1.506
Seidel, Joschko (1991)	Seidel Continuous Attention Test (SCAT); Reaction Time	6-12	MF	0.342	-0.253, 0.937
Carter, Krener, Chaderjian, et al. (1995a)	Test of Variables of Attention (TOVA) Commission Errors	9-12	MF	0.331	-0.293, 0.955
Breen (1989)	Gordon Diagnostic System (GDS) Commission Errors	5-14	MF	1.233	0.531, 1.935
Horn, Wagner, Ialongo (1989)	Conners' Continuous Performance Test (CPT); Commission Errors	7-11	M	0.844	0.269, 1.419
Horn, Wagner, Ialongo (1989)	Conners' Continuous Performance Test (CPT); Commission Errors	7-11	F	0.579	-0.175, 1.333
Combined				0.593	0.330, 0.855

Table 39. Inattention Measure in Continuous Performance Test: Ability to Detect ADHD vs. Normal Controls

Study	Continuous Performance Subtest	Age	Gender	Effect Size	95% Confidence Limits
Loge, Staton, Beatty (1990)	Gordon Diagnostic System (GDS); Distractibility Task, # Correct	6-12	MF	0.955	0.283, 1.627
Loge, Staton, Beatty (1990)	Gordon Diagnostic System (GDS); Distractibility Task	6-12	MF	1.030	0.353, 1.708
Carter, Krener, Chaderjian, et al. (1995a)	Test of Variables of Attention (TOVA) Omission Errors	9-12	MF	0.755	0.114, 1.397
Breen (1989)	Gordon Diagnostic System (GDS) Omission Errors	5-14	MF	1.342	0.633, 2.051
Horn, Wagner, Ialongo (1989)	Conners' Continuous Performance Test (CPT); Omission Errors	7-11	M	0.332	-0.224, 0.889
Horn, Wagner, Ialongo (1989)	Conners' Continuous Performance Test (CPT); Omission Errors	7-11	F	-0.773	-0.538, -0.008
Combined				0.617	0.097, 1.137

Table 40. Vigilance Measure in Continuous Performance Test: Ability to Detect ADHD vs. Normal Controls

Study	Continuous Performance Subtest	Age	Gender	Effect Size	95% Confidence Limits
Loge, Staton, Beatty (1990)	Gordon Diagnostic System (GDS) Distractibility Task, # Correct	6-12	MF	0.327	0.315, 0.968
Loge, Staton, Beatty (1990)	Gordon Diagnostic System (GDS) Distractibility Task	6-12	MF	0.667	0.013, 1.322
Combined				0.494	0.029, 0.958

Summary of Question 4 Results

A variety of medical tests have been examined as a way of detecting causes or abnormalities specifically associated with ADHD. Studies of tests for lead levels, abnormal thyroid function, morphologic differences in brain structures, EEG abnormalities (e.g., signs of seizure activity), and neurological characteristics were reviewed for this report. The studies sought to determine the likelihood of these tests to diagnose children with probable ADHD.

The ability of any of these tests to demonstrate a relationship to ADHD was not established. Significant lead levels were not found useful as a general tool for ADHD diagnosis. Studies describing the relationship of elevated lead levels and ADHD differed in their results. Overall, lead is not thought to be a major cause of ADHD, a conclusion strengthened by the fact that ADHD prevalence appears to be increasing, whereas lead levels in the population appear to be decreasing. Not one study discovered a relationship between abnormal thyroid levels and ADHD. Overall, the prevalence of any thyroid disorder in children with ADHD appeared to be the same as, or only slightly above, the prevalence of thyroid disorder in normal children. The evidence does not support the routine use of tests of thyroid function to detect underlying causes of ADHD. Although research on the thyroid disorder "Generalized Resistance to Thyroid Hormone" (GRTH) may shed light on fundamental mechanisms underlying ADHD, the rare nature of GRTH does not justify screening for it among children suspected of having ADHD.

Study results varied in regard to significant differences on brain computer tomographic (CT) or computed axial tomographic (CAT) scans between children with ADHD and normal controls. Two studies showed no significant differences, but several others noted abnormalities in children with ADHD, including differences in size, in asymmetries, or in the shape or volume of the ventricles. In all cases, the structures in the children with ADHD were smaller than those of the normal control subjects. A better understanding of ADHD is likely to evolve from work currently being done with imaging. At the present time, however, the evidence is sparse and diverse. Therefore, none of the imaging procedures are supported by research as useful screening or diagnostic tools for ADHD. No studies discovered any serious EEG abnormalities in children with ADHD. However, many found significant differences in brain wave activity between children with ADHD and normal controls. Overall, however, there was a lack of sufficient evidence of EEG patterns typically found in children with ADHD. Therefore, evidence does not support routine use of the EEG as a screening tool for ADHD. Finally, no studies found a significant correlation between neurological anomalies and ADHD.

This report reviewed the small number of studies of miscellaneous other tests to measure neurotransmitters, hormones, and proteins, including serotonin levels, plasma protein levels, peptide-containing urinary fractions, response to growth hormone releasing factor, dopamine receptors, and epinephrine levels. Trends or correlations between these measurements and ADHD could not be determined.

Finally, results on continuous performance tests and their subtests indicated poor prediction of ADHD. These tests would not serve as useful screening tools for ADHD.

Conclusions

Question 1

This report first sought evidence on the percentage of children, aged 6 to 12 years, in the U.S. general population who meet diagnostic criteria for ADHD. Of children with ADHD, percentages having one or more co-occurring disorders—learning disabilities, depression, anxiety, conduct disorder, and oppositional defiant disorder—were ascertained.

In the general, unscreened, school-age U.S. population, prevalence of ADHD ranged from 4 to 12 percent in studies using the DSM-III or DSM-III-R classification scheme. A multiple logistic regression analysis with random effects yielded results suggesting that gender, diagnostic tool, and setting are significant factors in the prevalence of ADHD, but that age is not significant. A study using the DSM-IV classification scheme demonstrated a prevalence of about 7 percent when impairment is considered in the diagnosis and of 16 percent when impairment is not considered. Higher rates of ADHD were found in boys than in girls for all types of ADHD, with the inattentive type most common.

In the general, unscreened, school-age population, prevalence of ADHD co-occurring with other disorders—oppositional defiant disorder, conduct disorder, anxiety disorder, depressive disorder, and learning disability—was estimated to be high, based on results of four studies. Of children diagnosed with ADHD, approximately 35 percent also qualified for a diagnosis of oppositional defiant disorder, 28 percent qualified for a diagnosis of conduct disorder, 26 percent qualified for a diagnosis of anxiety disorder, and 18 percent also had a depressive disorder. Learning disabilities in children with ADHD are estimated at a 12 percent prevalence.

Prevalence of ADHD in the screened school-age population was estimated at about 4 percent.

Question 2

The report next reviewed evidence on the percentage of children aged 6 to 12 years presenting at pediatricians' or family physicians' offices in the United States meeting diagnostic criteria for ADHD. Of those with ADHD, percentages were determined for those having one or more of the following comorbidities: learning disabilities, depression, anxiety, conduct disorder, and oppositional defiant disorder.

Two studies yielded information on prevalence of ADHD and comorbid ADHD diagnosed in a pediatric clinic setting. One study found that approximately 5 percent of children seen in a pediatric setting were diagnosed with ADHD and the other found fewer than 2 percent diagnosed with ADHD. Coexistence of ADHD with other disorders in children seen by a pediatrician was found in the first study to be 59 percent and in the other to range from 8 to 20 percent, depending on the comorbid condition and whether the informant was the parent or the child. These different results could not be explained, but the higher rates are consistent with rates found in general population studies.

Question 3

The evidence was assessed on accuracy (i.e., sensitivity, specificity, positive predictive value) and reliability (i.e., inter/intra-rater agreement) of behavioral rating screening tests for ADHD compared with a reference standard (DSM or ICD-9).

Among ADHD-specific checklists, the 1997 revision of the Conners Rating Scale contained two highly effective indices for discriminating between children with ADHD and normal controls. The new ADHD Index and DSM-IV Symptoms Scale each were able to distinguish children with ADHD from normal controls 94 percent of the time. On the other hand, the Barkley School Situations Questionnaire was weak, with less than 86 percent effectiveness. Only one study provided data for these two tests and thus interpretations of effectiveness must be made with caution.

Hyperactivity subscales of the SNAP Checklist and the Conners Rating Scale were strong in their ability to discriminate between children with ADHD and normal controls. The only hyperactivity subscale to perform poorly was from the ACTeRS Checklist.

The inattention and impulsivity subscales of the SNAP Checklist discriminated well between children with ADHD and normal controls, with effectiveness of greater than 97 percent. The ACTeRS Checklist performed poorly.

Unfortunately, the available studies of broad-band checklists could not be used to derive conclusions regarding the effectiveness of the scales in distinguishing children with significant problems from children without significant problems.

Question 4

The evidence was assessed on prevalence of abnormal findings on selected medical screening tests commonly recommended as components of an evaluation of a child with suspected ADHD. Studies of tests for lead levels, abnormal thyroid function, morphologic differences in brain structures, EEG abnormalities (e.g., signs of seizure activity), and neurological characteristics were reviewed for this report. The studies sought to determine whether these tests were useful in detecting conditions that are associated with ADHD.

The ability of any of these tests to demonstrate a relationship to ADHD was not established. Significant lead levels were not found useful as a general tool for ADHD diagnosis. Studies describing the relationship of elevated lead levels and ADHD differed in their results. Overall, lead is not thought to be a major cause of ADHD, a conclusion strengthened by the fact that

ADHD prevalence appears to be increasing, whereas lead levels in the population appear to be decreasing. Not one study discovered a relationship between abnormal thyroid levels and ADHD. Overall, the prevalence of any thyroid disorder in children with ADHD appeared to be the same as, or only slightly above, the prevalence of thyroid disorder in normal children. The evidence does not support the use of tests of thyroid function to screen for ADHD. Researchers are studying the relationship between a thyroid disorder called "Generalized Resistance to Thyroid Hormone" (GRTH) and ADHD and hope it will shed light on the etiology of ADHD.

Study results varied in regard to significant differences on brain computer tomographic (CT) or computed axial tomographic (CAT) scans between children with ADHD and normal controls. Two studies showed no significant differences, but several others noted abnormalities in children with ADHD, including differences in size, in asymmetries, or in the shape or volume of the ventricles. In all cases, the structures in the children with ADHD were smaller than those of the normal control subjects. A better understanding of ADHD is likely to evolve from work currently being done with imaging. At the present time, however, the evidence is sparse and diverse, and none of the imaging procedures are supported by research as useful screening or diagnostic tools for ADHD. No studies discovered any serious EEG abnormalities in children with ADHD. However, many found significant differences in brain wave activity between children with ADHD and normal controls. Overall, however, there was a lack of sufficient evidence of EEG patterns typically found in children with ADHD. Therefore, evidence did not support routine use of the EEG as a screening tool for ADHD. Finally, no studies found a significant correlation between neurological anomalies and ADHD.

This report reviewed the small number of studies of miscellaneous other tests to measure neurotransmitters, hormones, and proteins, including serotonin levels, plasma protein levels, peptide-containing urinary fractions, response to growth hormone releasing factor, dopamine receptors, and epinephrine levels. Trends or correlations between these measurements and ADHD could not be determined.

Finally, results on continuous performance tests and their subtests indicated poor prediction of ADHD. These tests would not serve as useful screening tools for ADHD.

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Attention-Deficit/Hyperactivity Disorder

Reference No. ______

Article Overview

Page 1 of ___

Citation Identification

Study Type:	**Other:**	**Research Quality:**
Study Design:		**Country:**

Accept/ Rejected: (Circle one) **A/R**

Why Rejected?: (Check one)

- ☐ Review article, editorial, letter/not research article
- ☐ Subject not within scope of the evidence-based questions/report
- ☐ Data updated in more recent report
- ☐ Data absent
- ☐ Based on exclusion criteria: ☐
- ☐ Based on study quality: ☐
- ☐ Pending Statistician, Date Sent ________, Date Returned _______
- ☐ Some data usable, other data excluded ____________________
- ☐ Other ______________________

Exclusion Criteria Codes:

1. bibliographic parameters [time, language]
2. age parameters
3. demographics
4. settings
5. screening/diagnostic tests
6. reference standard [DSM,ICD,etc.]
7. other ______________________

Study Quality Codes:

1. screening/diagnostic techniques/modalities utilized are outdated
2. control group criteria not met
3. no control group
4. not matching population and/or study group
5. study group criteria not met
6. not matching/representing of population
7. selection criteria not specified
8. demographics inadequately defined
9. group assignment and/or analysis not an independent, blind comparison
10. other ______________________________________

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Attention-Deficit/Hyperactivity Disorder

Reference No. ☐

Article Overview

Demographics (Check ALL that apply.)

Age	Gender	Race
☐ Preschoolers (2-5 years) ☐ Children (6-12 years) ☐ Adolescent (13-18 years) ☐ Adults (19 years and above)	☐ Male (M) ☐ Female (F) ☐ Both (B)	☐ White (W) ☐ Black (B) ☐ American Indian or Alaskan Native (AI) ☐ Asian or Pacific Islander (AS) ☐ Hispanic (H) ☐ Other (OT) ____________

Setting:
☐ General Population - Community (GC)
☐ General Population - School (GS)
☐ Mental Health Facility or Referral Clinic (MR)
☐ Primary Care Setting - Pediatrician's Office (PP)
☐ Primary Care Setting - Family Practitioner's Office (PF)
☐ Other (OT)____________________

SES: ☐ Upper Class (U) ☐ Middle Class (M) ☐ Lower Class (L) ☐ All SES (A)

Geographic Location: ☐ Urban (U) ☐ Suburban (S) ☐ Rural (R) ☐ All Locations (A)

Diagnostic Standards (Check ALL that apply.)

☐ **DSM-III(3)**	☐ **DSM-III-R(3R)**	☐ **DSM-IV(4)**	☐ **ICD Edition? (I)** ____
☐ ADDH(3H)	☐ ADHD(3RA)	☐ ADHD-CT(4CT)	☐ **ICD-CM Editions?**(ICM) ___
☐ ADD(3A)	☐ UADD(3RU)	☐ ADHD-HI(4HI)	☐ **ICD-RDC Editions?** (IRD)___
		☐ ADHD-AD(4AD)	

Standards are in **bold**.

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Attention-Deficit/Hyperactivity Disorder

Reference No. ☐

Article Overview

Page 3 of ___

Diagnostic Screenings and Tests (Check ALL that apply.)

Behavior Rating Scales:

- ☐ Attention Deficit Disorders Evaluation Scale (ADDES) (McCarney & Bauer, 1989) - (ADDES)
- ☐ Barkley Questionnaires (Barkley, 1990) - (BQ)
- ☐ Behavior Assessment System for Children (BASC) (Reynolds & Kamphaus, 1996) - (BASC)
- ☐ Burks' Behavior Rating Scales, Grades 1-9 Version (BBRS) (Burks, 1977) - (BBRS)
- ☐ Child Behavior Checklists (CBCL/4-18) (Achenbach & Edelbrock, 1986) - (CBC)
- ☐ Children's Attention and Adjustment Survey (CAAS) (Lambert et al., 1990) - (CAAS)
- ☐ Conners Rating Scales (CRS) (Conners, 1985) - (CRS)
- ☐ Devereaux Scales of Mental Disorders (DSMD) (Naglieri et al., 1994) - (DSMD)
- ☐ Pediatric Symptom Checklist (PSC) (Jellinek, Murphy, & Burns, 1988) - (PSC)
- ☐ Revised Ontario Child Health Study (OCHS) Scales - (OCHS)
- ☐ Yale Children's Inventory (Shaywitz, 1987)
- ☐ Other (OT) ____________________

Medical and Neurological Screening Tests:

- ☐ Electroencephalogram (E)
- ☐ Blood lead level (B)
- ☐ Thyroid level (T)
- ☐ Hearing and vision screenings (H)
- ☐ Neurological screening (N)
- ☐ MRI/Imaging (I)
- ☐ Continuous Performance Tests (C)
- ☐ Other (OT) ____________________

Early Development History Data:

- ☐ Prenatal Data
- ☐ Perinatal Data
- ☐ Postnatal Period and Infancy
- ☐ Developmental Milestones
- ☐ Other ____________________

Family History Data:

- ☐ ADHD
- ☐ Alcoholism
- ☐ Mental Illness
- ☐ Other ____________

Comorbidity (Check ALL that apply.)

Occurrence:

- ☐ Prevalence of ADHD
- ☐ Screening of ADHD using Behavior Rating Scales
- ☐ Screening of ADHD using Ancillary Tests / Data

Type:

- ☐ Learning Disabilities (LD)
- ☐ Depression (DP)
- ☐ Anxiety (AN)
- ☐ Conduct Disorder (CD)
- ☐ Oppositional Defiant Disorder (ODD)
- ☐ Other (OT) ____________________

Official Use Only					
Reviewed by	________	Abstracted by	________	QC by	________
Time Required	________	Time Required	________	Time Required	________
Date	________	Date	________	Date	________

Attention-Deficit/Hyperactivity Disorder Reference No. [ ]

TOTAL DEMOGRAPHICS

Page 4 of ___

Demographics for Total Population

Total Children [ ] **Subjects** [ ] **Controls** [ ]

Age/Grade (circle one)	Gender	Race	Total

Setting:
- [ ] General Population - Community (GC)
- [ ] General Population - School (GS)
- [ ] Mental Health Facility or Referral Clinic (MR)
- [ ] Primary Care Setting - Pediatrician's Office (PP)
- [ ] Primary Care Setting - Family Practitioner's Office (PF)
- [ ] Other (OT) ______________________

SES: [ ] Upper (U) [ ] Middle (M) [ ] Lower (L) [ ] All SES (A)

Geographic Location: [ ] Urban (U) [ ] Suburban (S) [ ] Rural (R) [ ] All (A)

Diagnostic Reference Standard

Total DSM-III: [ ] **Type:** [ ] ADDH [ ] ADD

Total DSM-III-R: [ ] **Type:** [ ] ADHD [ ] UADD

Total DSM-IV: [ ] **Type:** [ ] ADHD-CT [ ] ADHD-AD [ ] ADHD-HI

ICD: [ ] ICD Edition? _____

[ ] ICD-CM Editions? _____

[ ] ICD-RDC Editions? _____

Attention-Deficit/Hyperactivity Disorder

Reference No. [ ]

PREVALENCE DATA

Page ___ of ___

Setting	Diagnostic Reference	Geographic Location (U/S/R/A)	SES (U/M/L/A)	Age/Grade (circle one)	Gender (M/F/B)	Race	Value #1 [ ]	Value #2 [ ]	Value #3 [ ]

Mark calculated value(s) with an "*".

Attention-Deficit/Hyperactivity Disorder

Reference No. ____

PREVALENCE COMORBIDITY DATA

Page ___ of ___

Comorbidity	Setting	Diagnostic Reference	Age/Grade (circle one)	Gender (M/F/B)	Race	Value #1	Value #2	Value #3

Mark calculated value(s) with an "*".

Attention-Deficit/Hyperactivity Disorder **Reference No.** ☐ **Group No.** B

BEHAVIORAL SCREENING GROUP SUMMARY

Page ___ of ___

Define the various test/screening groups. Identify the group number on each subsequent page.

Group No.	Description	Group Type	Total Child.	Comorbidity	Setting	Diagnostic Ref.	Reference Group #1	#2	#3	#4
1										
2										
3										
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Attention-Deficit/Hyperactivity Disorder Reference No. ____ Group No. **B**

BEHAVIORAL SCREENING DATA (Values #1 - #4)

Page ___ of ___

Line No.	Test/ Screening	Age/Grade (circle one)	Gender (M/F/B)	Race	#1	#2	#3	#4

Mark calculated value(s) with an "*".

Attention-Deficit/Hyperactivity Disorder Reference No. ____ Group No. **B**

BEHAVIORAL SCREENING DATA (Values #5 - #10)

Page ___ of ___

Line No.	#5	#6	#7	#8	#9	#10	Notes

Mark calculated value(s) with an "*".

Attention-Deficit/Hyperactivity Disorder **Reference No.** [ ] **Group No.** M

MEDICAL TEST GROUP SUMMARY

Page ___ of ___

Define the various test/screening groups. Identify the group number on each subsequent page.

Group No.	Description	Group Type	Total Child.	Comorbidity	Setting	Diagnostic Ref.	Reference Group #1	#2	#3	#4
1										
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Attention-Deficit/Hyperactivity Disorder

Reference No. ______ Group No. M

MEDICAL TEST DATA (Values #1 - #3)

Page ___ of ___

Line No.	Medical Test	Type of Measurement	Age/Grade (circle one)	Gender (M/F/B)	Race	#1	#2	#3

Mark calculated value(s) with an "*".

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Attention-Deficit/Hyperactivity Disorder

Reference No. ____ Group No. M

MEDICAL TEST DATA (Values #4 - #8)

Page ___ of ___

Line No.	#4	#5	#6	#7	#8	Notes

Mark calculated value(s) with an "*".

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