JOURNAL OF ATTENTION DISORDERS

The Assessment of Hyperactivity and Attention: Development and preliminary validation of a brief self-assessment of adult ADHD

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A brief self-rating scale, the Assessment of Hyperactivity and Attention (AHA), was developed and validated using a "gold standard" DSM-based semi-structured interview. The sample consisted of 101 smokers (74% male, 73% Caucasian)—38.6% with no DSM-IV ADHD diagnosis, 10.9% with a childhood diagnosis only, and 50.5% with an adult diagnosis (requiring childhood diagnosis as well). The mean age ± *SD* was 33.7 ± 9.7; participants smoked a mean of 19.0 ± 5.6 cigarettes/day.

Results indicate that the AHA has utility as a screening tool and as a self-report assessment of ADHD with sensitivity of .80, specificity of .60, positive predictive power of .67, negative predictive power of .75, kappa of .40, odds ratio of 6.15, and an area under the curve (receiver operating characteristic analysis) of .79. Given the high rate of ADHD among smokers, the AHA may be useful in identifying smokers who may need more in-depth clinical evaluation for attentional problems.

Although research and clinical work on attentional and learning problems in children have been underway for several decades, it was not until 1980 that Attention Deficit Disorder (ADD) first became a part of the Diagnostic and Statistical Manual as a valid disorder in children (DSM-III; American Psychiatric Association, 1980). In 1987 the criteria were modified in the DSM-III-R and the childhood disorder became known as Attention Deficit/Hyperactivity Disorder (ADHD; American Psychiatric Association, 1987). The diagnosis, although finally recognized as an official axis I disorder, is certainly not as simple to establish as meeting the correct number of criteria on the checklist in the DSM. The evaluation process is a complex procedure that involves the use of well-validated measures and interviews with the child as well as other informants. Information from these multiple sources are necessary to provide insight on past and current symptoms, as well as levels of functioning. Examples of instruments often used in the diagnostic process include the Conners' Rating Scales for children and adolescents (CRS–R; Conners, 1997), the Child Behavior Checklist (CBCL; Achenbach & Edelbrock, 1983; Achenbach, 1991), the Schedule for Affective Disorders and Schizophrenia for School-Age Children, Epidemiologic 4th Version (Kiddie SADS-E; Orvaschel & Puig-Antich, 1987), the Child and Adolescent Psychiatric Interview (CAPA; Angold, Prendergast, Cox, Harrington & Rutter, 1995), the Children's Global Assessment Scale (CGAS; Setterberg, Bird, & Gould, 1992; Shaffer et al., 1983), and the Academic Performance Rating Scale (DuPaul, Rapport, & Perriello, 1991).

Throughout the years a diagnosis of ADHD was mainly limited to children. There is now considerable evidence, however, that symptoms of ADHD may persist into adulthood for as many as 50–60% of children diagnosed with ADHD (Barkley, 1995), with as many as 30% continuing to meet full criteria for ADHD as adults (Klein & Mannuzza, 1991; Weiss & Hechtman, 1993). Not everyone believes, however, that ADHD is a valid diagnosis for adults. Some have suggested that ADHD symptoms that present during adulthood are actually a referral artifact or a missed differential diagnosis (e.g., Hill & Schoener, 1996; Shaffer, 1994). In 1970 Robins and Guze established criteria for the validation of psychiatric disorders, and accordingly a disorder must be based on patterns of consistent data from clinical correlates, treatment response, laboratory studies, follow-up studies, and family histories. Using these criteria, adult ADHD has been reviewed and substantiated by several researchers (Faraone, 2000; Spencer, Biederman, Wilens, & Faraone, 1994; Spencer, Biederman, Wilens, & Faraone, 1998).

Based on the supposition that adult ADHD is indeed a valid disorder, the clinical significance of such a disorder is an important factor to consider. By using childhood ADHD prevalence calculations and information from natural history studies, Wender (1998) calculates a crude estimate of adult ADHD prevalence of 2%. Roy-Byrne et al. (1997) also estimate a prevalence for adult ADHD of 1–3% in the general population. Establishing a diagnosis of adult ADHD, however, is even more difficult than establishing a childhood diagnosis of ADHD. For one thing, it is widely accepted that a prior childhood ADHD disorder must have existed in order to establish adult ADHD. As a result, adult diagnosis is complicated by problems of retrospective recall and the absence of current school data to corroborate self-report. Like childhood ADHD, it is also important to use several measures and interviews with a variety of informants to establish a diagnosis. Informants such as teachers and parents most frequently used for childhood interviews are often not as readily available for adults. Diagnosis in adults is further complicated by a high prevalence of co-morbid psychiatric conditions, especially substance abuse, antisocial personality disorder, and mood and anxiety disorders (McCann & Roy-Byrne, 2000; Marks, Newcorn, & Halperin, 2001; Schubiner, Tzelepis, Milberger, Lockhart, Kruger, Kelly, & Schoener, 2000; Mancini, Van Ameringen, Oakman, & Figueiredo, 1999; March, Wells, & Conners, 1995; Shaffer, 1994). This high rate of comorbidity in adults with ADHD adds to the psychiatric burden of the patient population and increases the clinical importance of detecting and treating the disorder.

Patients suffering from adult ADHD will often present to a clinician for symptoms and syndromes that are more widely validated, such as substance abuse or anxiety. ADHD is often either not recognized or not targeted for treatment in these individuals with comorbid conditions. This oversight may in part be due to the number of symptoms that overlap between diagnoses, or perhaps because ADHD is not as well established as an adult disorder.

Under-recognition may also be a result of the difficulty in assessing adult ADHD. Although several instruments have been developed for the assessment of adult ADHD symptomatology, the few scales that exist are either limited by lack of proper testing and validation, or are designed for use in a longer, complex process of establishing a diagnosis. Instruments designed specifically as screening or case-finding tools are rare. Such instruments that assess *both* adult and childhood symptomatology are virtually nonexistent. One of the existing questionnaires for use in assessing adult symptoms, The Brown Attention Deficit Disorder Scales (Brown, 1995), uses constructs not derived from DSM-IV criteria. Deviation from the DSM as the "gold standard" may not necessarily be a problem, except that the chosen subscales were not derived using rigorous empirical psychometric standards, were not cross-validated, and were standardized using a small sample size. The Wender Utah Rating Scale for adult ADHD diagnosis (Wender, 1995; Wender, Reimherr, & Wood, 1981)—another measure for assessing adult ADHD—uses outdated DSM-III criteria and lacks proper field testing (Conners, Erhardt, Epstein, Parker, Sitarenios, & Sparrow, 1999). This scale does not query childhood symptomatology, and although the Wender Utah Rating Scale for the retrospective assessment of childhood symptoms (Ward, Wender, & Reimherr, 1993) could be used as a supplement, this would add 61 more items to the assessment process. Moreover, to date this scale has not been adequately validated (Rossini & O'Conner, 1995). More recently, Conners, Erhardt, and Sparrow (1999) created the Conner's Adult ADHD Rating Scale (CAARS), consisting of 66 items for assessment of adult symptomatology. This scale was examined for internal consistency, test-retest reliability, concurrent validity, criterion validity and diagnostic utility (Erhardt, Epstein, Conners, Parker, & Sitarenios, 1999). Although the CAARS is psychometrically sound, it does not include assessment of symptoms experienced during childhood. The CAARS can, of course, be combined with Conners' childhood scales (CRS–R; Conners, 1997) for assessment of both childhood and adult symptomatology. This combination, however, results in a total of at least 93 items to be completed by the patient and is not intended to be a case-finding instrument, but rather as a longer, more rigorous assessment to be used in the process of diagnosing ADHD. Two shorter forms have been adapted from the CAARS long version for use in time limited situations, as repeated measures, or as screening tools. The CAARS–S:S, or self-report short form, consists of 26 items which are a subset of the CAARS–S:L (long version). The CAARS–S:SV, or screening form, has 30 items that assess ADHD symptoms according to DSM-IV criteria. All three versions of the CAARS contain a 12-item ADHD-Index, considered by the developers to be the best set of items for distinguishing ADHD adults from nonclinical adults (Conners, Erhardt, & Sparrow, 1999). These forms, however, do not assess childhood symptomatology.

In response to the need for an appropriate brief assessment of adult ADHD, we created an 18-item pencil-and-paper self-rating scale based on DSM-IV criteria that includes evaluation of both adult and childhood symptoms. The initial objective was to develop an instrument that would

serve as a case-finding tool (for example, to establish preliminary eligibility for more extensive testing via a structured interview) and also as an assessment of subclinical symptomatology (both childhood and adult) in population-based samples.

Using a standardized semi-structured diagnostic interview as the "gold standard," we conducted field testing and validation of the Assessment of Hyperactivity and Attention (AHA). The sample used for validation of this instrument was enriched for positive cases.

Methods

Participants

The sample used for this validation study was drawn from two sources. The first group consisted of 47 adults (68% male, 81% Caucasian) recruited for a study on smoking and attention at the University of Michigan's Nicotine Research Laboratory. The percentages of participants in this group meeting DSM-IV diagnostic criteria for childhood ADHD and adult ADHD (necessitating both childhood and adult symptoms) were 10.6 % and 17.0% respectively. The second group consisted of 54 adult cocaine- and nicotine-dependent patients (80% male, 67% Caucasian) enrolled in a cocaine/ADHD medication trial conducted at the Wayne State University School of Medicine. In this group 11.1% met DSM-IV diagnostic criteria for childhood ADHD, and 79.6% met criteria for adult ADHD.

The combined sample of 101 participants were 74% male and 73% Caucasian, had a mean age of 33 years (± standard deviation of 9.7), smoked a mean of 19.0 ± 5.6 cigarettes per day, and had a mean Fagerström Test for Nicotine Dependence Score (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991) of 5.3 ± 1.8. Because many of the participants were recruited for having attentional problems, the sample was enriched for ADHD. Thus, adhering to DSM-IV criteria and decision-rules for differential diagnosis, 50.5% had an adult ADHD diagnosis, 10.9% had a childhood diagnosis only, and 38.6% had no ADHD diagnosis.

Measures

Semi-structured Interview for Adult ADHD. The project clinician at each site administered a semi-structured clinical interview to assess ADHD symptoms in child- and adulthood similar in style and format to the Structured Clinical Interview for DSM-III-R (SCID; Spitzer, William, Gibbon, & First, 1990). Although the actual SCID does not assess ADHD symptomatology, we refer to the semi-structured interview for Adult ADHD that was used in this project as the "A-SCID" because of its similarity to the SCID. The diagnostic reliability of the A-SCID has been established in a previous study of 201 participants with current substance abuse disorders, resulting in Cohen kappas for interrater reliability of 0.72–0.88, comparable to those found for other SCID diagnoses (Schubiner et al., 2000). Ratings were made based on expression of the 9 inattentive and 9 hyperactive/impulsive symptoms in childhood and adulthood. To determine eligibility for the trial and obtain information on psychiatric comorbidity, all participants were administered both the A-SCID and either the Structured Clinical Interview for DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 1995) or the Computerized–Diagnostic Interview Schedule (C–DIS; Erdman et al., 1992). Interviewers were trained to probe for specific examples of behavior to support the presence of each ADHD symptom. Interviewers were also experienced in SCID administration to allow for appropriate ruling out of ADHD symptoms better explained by other psychiatric disorders (including effects of or withdrawal from cocaine). For the purposes of this study, to be diagnosed with ADHD the participant must have been judged to have (1) met full DSM-IV criteria for ADHD (i.e., have at least 6 of the 9 inattentive and/or hyperactive/impulsive symptoms to a clinically significant degree) as an adult, (2) met full DSM-IV criteria for ADHD as a child (in retrospect), and (3) have no other psychiatric disorder that would better explain the ADHD symptomatology (e.g., drug induced symptoms, bipolar disorder).

Pencil-and-Paper Assessment of Hyperactivity and Attention. Using DSM-IV criteria for ADHD, a pencil-and-paper questionnaire consisting of 18 items was created. Each item was asked as it applied during childhood up to the age of 12, and then again as it applied during adulthood. Although the DSM-IV requires the presence of symptoms and impairment before the age of 7, several experts in the field recommend a higher cutoff (Barkley & Biederman, 1997; Willoughby, Curran, Costello, & Angold, 2000; Applegate et al., 1997). In the interest of improving the questionnaire's screening potential and decreasing the likelihood of missing potential cases, age 12 was chosen as the childhood symptom cutoff. Some symptoms as worded in DSM-IV were broken down into multiple components. For example, the DSM-IV criteria of "often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities" (American Psychiatric Association, 1994) was asked in two parts: (1a) "Did you have difficulty focusing on details" and (1b) "Did you frequently make mistakes at school, work, or at home." Only one component per multi-component DSM-IV symptom needed to be endorsed for a positive symptom rating. Symptom numbers were tallied

for four categories: childhood inattention, childhood hyperactivity, adult inattention, and adult hyperactivity. Using these four categories, respondents were classified as having no ADHD (< 6 symptoms in all categories), childhood ADHD (≥ 6 symptoms in childhood inattention and/or childhood hyperactivity, but < 6 symptoms in both adult categories), or adult ADHD (≥ 6 symptoms in childhood inattention and/or childhood hyperactivity AND ≥ 6 symptoms in adult inattention and/or adult hyperactivity).

Procedure

All participants completed the A-SCID at the laboratory. The semi-structured interviews were administered by qualified clinicians, all of whom possessed previous experience in the administration of the SCID. These clinicians were then further trained in A-SCID administration by Dr. Downey to provide consistency in administration and scoring. Participants were also given the AHA to complete on paper, either on site or at home to be returned to the laboratory within two weeks. Analysis of these data for the purpose of this report was approved by the University of Michigan's Medical School Institutional Review Board.

Data Analysis

To determine the ability of the AHA to detect ADHD cases, we examined the following conditional probabilities: sensitivity, specificity, positive predictive power (PPP), negative predictive power (NPP), and total predictive value (TPV). Sensitivity is the probability that a participant is correctly evaluated as having ADHD (using the AHA). Specificity, on the other hand, is the probability that a participant is correctly evaluated as *not* having ADHD (using AHA criteria). Measures of predictive power are conditional probabilities that incorporate the prevalence rate of ADHD in the population being examined. The positive predictive power (PPP) of the AHA is the probability of actually having ADHD (i.e., meeting criteria on the A-SCID) given a positive outcome on the AHA. The negative predictive power (NPP) is the probability of actually not having ADHD (A-SCID criteria) given a negative outcome on the AHA. For a case-finding instrument to be successful, both PPP and NPP are important, and both probabilities should be greater than chance alone. Thus, using both the PPP and NPP, we calculated the total predictive value (TPV) of the AHA. The TPV, since it accounts for probability that the test is correct both when it gives a positive result and when it gives a negative result, can be considered to be a general index of the AHA's overall diagnostic efficiency.

Considering the controversies about the prevalence (and indeed the existence) of adult ADHD, the odds ratio was also calculated as a general index of association. The odds ratio was computed as the odds of a positive result in ADHD subjects divided by the odds of a positive result in non-ADHD subjects. We also measured the agreement between the AHA and the A-SCID. The kappa statistic was calculated as:

$$\frac{\%\text{ observed agreement} - \%\text{ agreement expected by chance alone}}{100\% - \%\text{ agreement expected by chance alone}}$$

Finally, we examined the AHA's predictive ability using receiver operating characteristic (ROC) analysis (SPSS, version 9.0), which plots sensitivity by specificity for every possible cutoff score. The area under the curve (AUC) is an overall index of predictive utility ranging from 0.5 (no better than chance) to 1.0 (perfect predictive power). An instrument can be considered a useful screening tool with an AUC of 0.8 or higher (Holmes, 1998). ROC analysis can also be used to determine the best cutoff score for diagnosis.

Conclusion

Using the standard cutoff of 6 symptoms, the AHA shows sensitivity and specificity of .84 and .67 respectively for childhood diagnosis, and .67 and .70 respectively for adult diagnosis (which included only those with a childhood diagnosis as well). The ROC analysis, however, indicated that a cutoff score of 4 for adult symptoms (keeping a cutoff of 6 for childhood symptoms) yielded the best balance between sensitivity and specificity.

Evaluating adult ADHD with 4 adult symptoms and 6 childhood symptoms as the cut off resulted in a sensitivity of .80 and a specificity of .60. We calculated the PPP to be 67%, the NPP to be 75%, and the TPV to be 70% in the sample population. The odds ratio was 6.15. The kappa was .40. The ROC had an AUC of .79 (95% confidence interval of .70, .88) for adult diagnosis (see Figure 1).

Discussion

Our goal in developing the AHA was to have a brief, self-rated, simple questionnaire that assessed both adult and childhood symptoms and that could be used as (a) a case-finding tool to establish preliminary eligibility for more extensive testing via a scheduled interview; and (b) a means of assessing subclinical symptomatology in population-based samples.

As the CAARS is one of the most widely accepted and used measures to assess ADHD symptomatology, it is of value to compare the diagnostic efficiency statistics of the AHA to the CAARS-S:SV (the shorter screening version based on DSM-IV criteria)—the version most similar in length and objective. Although the sensitivity and specificity of the CAARS–S:SV are not given, values for the ADHD-Index (the 12-item subscale) are given as .71 and .75 for sensitivity and specificity respectively (Conners, Erhardt, & Sparrow, 1999). Thus the ADHD-Index of the Conners Adult scale has a lower false-positive rate (25% as compared to 40%), but the false-negative rate of 29% is higher than the false-negative rate (20%) for the AHA. As a screening tool, the AHA would miss only 20% of potential ADHD cases. Other statistics, such as the total predictive value and the kappa, were quite similar for the two instruments, with a TPV of 70% for the AHA and 73% for the ADHD-Index, and a kappa of .40 for the AHA and .46 for the ADHD-Index.

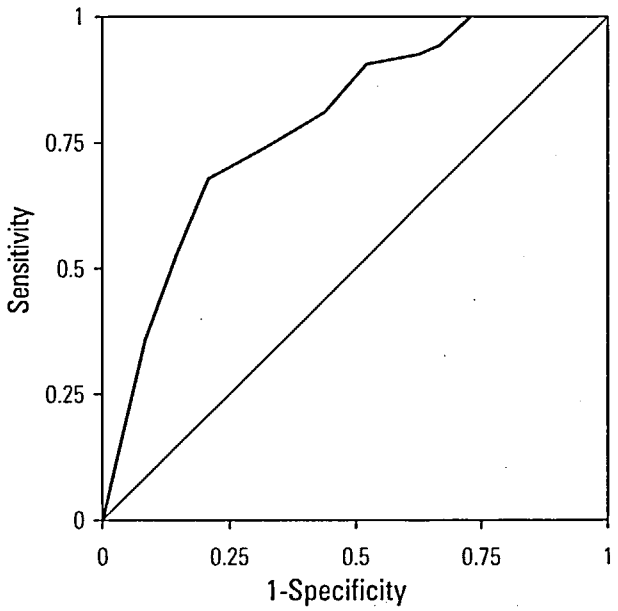
As discussed by Biederman et al. (1993), a TPV equal to .60 or higher signifies diagnostic efficiency for an instrument. In this study population (a population with high ADHD prevalence), the AHA had a good TPV of .70. Applying a prevalence of 2% for adult ADHD in the general population (Wender, 1998), new predictive values can be calculated for this instrument. Thus, when applied to the general population, the AHA shows a respectable TPV of .60, an outstanding NPP of .99, and a poor PPP of only .04. It is important to note, however, that TPV is dependent upon both PPP and NPP values, and therefore the TPV may be low if only one of the predictive powers is high. A test with only one high predictive power may still be clinically useful. For instance, a test with an excellent PPP but low NPP would be valuable for confirming a diagnosis (but not for ruling out a diagnosis). For a case-finding instrument, as the AHA was designed to be, the NPP would be of more importance for bringing potential cases in for further examination. As a screening tool, the AHA would be successful in ruling out 99% of the population without adult ADHD. Further examination with other tools would then be required for actual diagnosis.

Positive results on the AHA were more likely for participants who met ADHD criteria based on the A-SCID. This strong association can be seen with the odds ratio of 6.15. Odds ratios greater than 3.0 are considered to have good discriminating power (Biederman et al., 1993). Relative to those not diagnosed with ADHD on the A-SCID, those meeting criteria for adult ADHD were six times more likely to be assessed as having ADHD using the AHA. The kappa of .40 also represents intermediate to good agreement between AHA and ADHD diagnostic interview results (Landis & Koch, 1977).

Finally, in examining the ROC curve to see the overall discriminative accuracy of the AHA without having to designate a specific cutoff score, we found an area under the curve (AUC) of .79 (see Figure 1). The 95% confidence interval for the AUC was .70 to .88. Note that this interval contains .80—the score that designates a test as successful for screening (Holmes, 1998).

Our findings show the AHA to be a good case-finding tool for adult ADHD using a cutoff score of 4 on the adult symptoms and 6 on the childhood symptoms. There are, of course, several limitations to this study. First, the AHA was designed for use as a quick, initial assessment of potential ADHD symptomatology, both childhood and adult. It was not designed as a diagnostic tool, and as such has not yet undergone the vigorous testing for reliability to which most diagnostic tools are subjected. Second, we must emphasize that no single scale or test is sufficient for the assessment and diagnosis of ADHD. Although the AHA might serve as a useful first step in the diagnostic process for adult ADHD, self-report ratings represent only one part of a multifaceted and complex procedure which should

Figure 1. ROC Curve



Note: Receiver operating characteristic (ROC) curve for the AHA showing the trade-off between true positives and false positives along the range of possible cut-off scores. The area under the curve (AUC) is an index of the scale's overall predictive utility, with a score of .80 or above designating a useful screening tool. The AHA has an AUC of .79 ($p < .001$). The diagonal line under the curve represents an AUC of .50 (i.e., the diagnostic information that could be expected by chance alone).

include interviews and questionnaires from the affected adult as well as outside observers, objective records, and psychological testing (DuPaul, Guevremont, & Barkley, 1991; Murphy & Gordon, 1998; Wender, 1995). Third, we relied on the current "gold standard" by using criteria from the DSM-IV instead of creating new, empirically validated subscales. It is noteworthy, however, that the version of the AHA used with this sample did not contain questions about level of impairment (as required for DSM-IV diagnosis). Currently, we have added two items to the instrument querying impairment and are now in the process of determining if these additional items add validity to the questionnaire. It is possible that the specificity may have been compromised by the format of the responses of the questionnaire, since respondents were only able to answer "yes" or "no" to each criterion, and those who occasionally experience ADHD-like symptoms may have chosen positive responses, thus increasing the false-positive rate of the instrument. With the addition of the severity scales, the probability of these "sometimes yes" answers being rated as severe enough to qualify as an ADHD symptom is reduced and the likelihood of generating false-positives is expected to decrease.

Another concern with the study involves the generalizability of results to the general population, as all the participants were smokers. This study population was chosen as it afforded a sample enriched for ADHD cases—an important factor for testing the validity of a new instrument. Participants were recruited for studies looking specifically at ADHD in a group of smokers and a group of smoking cocaine abusers. This latter group met current DSM-IV criteria for cocaine dependence, and because they were interviewed at a time when they were actively seeking treatment for cocaine addiction (and as such, were quite likely to either be using cocaine often, and/or, conversely, attempting to cut down on their own) it is conceivable that both withdrawal and acute effects of cocaine could have influenced the responding of cocaine dependent participants. However, interviews were rescheduled whenever withdrawal effects or acute drug effects were obvious. Furthermore, A-SCID interviewers were trained to probe for evidence of ADHD symptoms independent of drug effects. In addition, as a group, the cocaine dependent participants' treatment seeking tended to be motivated by dysphoria over various life circumstances, particularly those misfortunes that were consequences of drug use. Therefore, this group is by definition more troubled than the non-cocaine dependent participants, and it is not possible to determine if this influenced their responding in any way. People with high rates of substance abuse (such as nicotine and cocaine) are known to have a higher prevalence of ADHD, and thus this population provided us a sample rich with ADHD cases. However, the generalizability of the results may be limited.

Finally, the use of a self-report instrument, although simple, may be subject to retrospective recall bias as well as subjective bias of accurately reporting current behavior. Downey, Stelson, Pomerleau, and Giordani (1997), however, report that ADHD patients can indeed provide reliable behavioral data on ADHD symptoms. Murphy & Schachar (2000) found good correlations between subject ratings of ADHD symptomatology and observer ratings (both parent and partner) of subject symptomatology, and therefore also conclude that adults are capable of correctly reporting both childhood and current symptoms of ADHD.

Despite these limitations the AHA shows value as a quick self-report scale for both the preliminary evaluation of ADHD symptomatology for further assessment (i.e. a case-finding tool) as well as the assessment of subclinical symptomatology for population-based samples. The scale is simple, takes only a few minutes for the subject to complete, and derives from DSM-IV criteria for assessment of ADHD. The evaluation of this questionnaire's overall predictive value and discriminating power are very encouraging given the small sample used and merits further research, especially for reliability, construct validity, and replication in other populations.

Acknowledgements

This research was supported in part by the National Cancer Institute, award CA 75581 to Ovide F. Pomerleau, and by the National Institute on Drug Abuse, award DA 10271 to Howard Schubiner.

The AHA is available for use and should be scored according to DSM-IV criteria.

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