Validity of the Adult ADHD Self-Report Scale (ASRS) as a screener for adult ADHD in treatment seeking substance use disorder patients

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Contributors

GvdG wrote the proposal, coordinated the study, was involved in the data management and data analyses, and wrote the final version of the manuscript together with FRL and WvdB. FRL, PJC, JAR-Q and WvdB contributed to the design of the study and commented on the manuscript. MK, KvE-vO, AS, JF, E-TB, FM, ZD, MF, AS, MK-F and AR-Q coordinated the local data collection. MWJK supervised the data management and undertook data analyses and commented on the manuscript. All authors contributed to interpretation of the data, commented on the manuscript and approved the final versioned the data.

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Abstract

Background—To detect attention deficit hyperactivity disorder (ADHD) in treatment seeking substance use disorders (SUD) patients, a valid screening instrument is needed.

Objectives—To test the performance of the Adult ADHD Self-Report Scale V1.1(ASRS) for adult ADHD in an international sample of treatment seeking SUD patients for DSM-IV-TR; for the proposed DSM-5 criteria; in different subpopulations, at intake and 1–2 weeks after intake; using different scoring algorithms; and different externalizing disorders as external criterion (including adult ADHD, bipolar disorder, antisocial and borderline personality disorder).

Methods—In 1138 treatment seeking SUD subjects, ASRS performance was determined using diagnoses based on Conner's Adult ADHD Diagnostic Interview for DSM-IV (CAADID) as gold standard.

Results—The prevalence of adult ADHD was 13.0% (95% CI: 11.0–15.0%). The overall positive predictive value (PPV) of the ASRS was 0.26 (95% CI: 0.22–0.30), the negative predictive value (NPV) was 0.97 (95% CI: 0.96–0.98). The sensitivity (0.84, 95% CI: 0.76–0.88) and specificity (0.66, 95% CI: 0.63–0.69) measured at admission were similar to the sensitivity (0.88,95% CI: 0.83–0.93) and specificity (0.67,95% CI: 0.64–0.70) measured 2 weeks after admission. Sensitivity was similar, but specificity was significantly better in patients with alcohol compared to (illicit) drugs as the primary substance of abuse (0.76 vs. 0.56). ASRS was not a good screener for externalizing disorders other than ADHD.

Conclusions—The ASRS is a sensitive screener for identifying possible ADHD cases with very few missed cases among those screening negative in this population.

Keywords

1. Introduction

1.1. Relevance

Substance use disorders (SUDs) account for a substantial proportion of the global public health burden (World Health Organisation, 2010) and are associated with adverse outcomes. Compared to those without SUD, individuals with SUD have poorer physical and psychological health, greater financial problems, increased violent behavior, higher rates of criminality and incarceration, and a greater risk of mortality (Darke et al., 2007). The course and treatment of SUD is complicated by the high comorbidity with other psychiatric disorders (Teesson and Proudfoot, 2003; Mills et al., 2010; Grant et al., 2005).

Attention deficit hyperactivity disorder (ADHD) is consistently over-represented in epidemiological and clinical samples of SUD populations. General population surveys indicate an average prevalence of 3–4% adult ADHD (Kessler et al., 2006; Fayyad et al., 2007; Faraone and Biederman, 2005) with a pooled estimated prevalence of 2.5% (Simon et al., 2009), whereas in clinical samples of treatment seeking adult SUD patients, the prevalence of adult ADHD is substantially higher, ranging from 10% to 46% (Van Emmerik-van Oortmerssen et al., 2012; Levin et al., 1998; Clure et al., 1999; King et al., 1999; Schubiner et al., 2007; Wilens, 2004; Yewers et al., 2005; Matsumoto et al., 2005). This wide range of prevalence rates is probably related to a combination of factors, including the use of different diagnostic criteria, the use of different instruments and assessors, and the study of different populations (Van Emmerik-van Oortmerssen et al., 2012). The diagnosis of adult ADHD is rather time consuming and even if the prevalence of ADHD is as high as 46%, screening can be cost-effective to identify those who are likely the have ADHD.

However, screening for adult ADHD is not routine practice in drug and alcohol treatment services (McAweeny et al., 2010). This is unfortunate, because SUD patients with a comorbid diagnosis of adult ADHD have poorer treatment outcome and higher risk of relapse than SUD patients without ADHD (McAweeny et al., 2010; Upadhyaya, 2007; Wilens and Upadhyaya, 2007). In addition, patients with co-occurring ADHD and SUD have higher rates of other psychiatric disorders (Wilens et al., 2005), which may further jeopardize successful outcomes. Identification and treatment of ADHD in treatment seeking SUD patients may improve overall treatment outcome and thus a valid screening instrument that enhances the identification of this patient population is a critical first step.

1.2. Choice for the ASRS and the CAADID

1.2.1. ASRS—Several instruments are available for the screening of adult ADHD. For this study the shortest available instrument was chosen, the 6-item version of the World Health Organization Adult ADHD Self-Report Scale V 1.1 (ASRS) symptom checklist. This version was developed to have optimal concordance with the clinical classification. In a population survey, the ASRS had moderate sensitivity of 68.7% and high specificity of 99.5% (Kessler et al., 2005). In addition, the ASRS has demonstrated high internal consistency (Adler et al., 2006) and good test-retest reliability (Matza et al., 2011).

However, the psychometric properties and utility of this instrument have not been adequately tested in treatment seeking SUD patients. Existing studies in substance abusers are small and often provide only some and not all of the reliability and validity indicators of the ASRS. Given the limited data so far (Daigre Blanco et al., 2009; Dakwar et al., 2012; Pérez Pedrero and Puerta García, 2007; Adler et al., 2009; Chiasson et al., 2012), there is a need for more validation data on the ASRS using a large and heterogeneous sample of SUD patients.

1.2.2. Gold standard: CAADID—In order to assess the validity of a screening instrument for ADHD, it needs to be compared to a "gold standard" for the diagnosis of ADHD. While the gold standard can be a diagnosis obtained by expert consensus (West et al., 2003), this is unwieldy, particularly for larger studies. The preferred method is to use a reliable and valid structured interview that can be applied across various types of treatment settings (Wittchen et al., 1991; Kessler et al., 2005). To date, there is only limited data establishing the psychometric characteristics of ADHD screening instruments using structured clinical interviews for assessing ADHD in substance-abusing adults. Two studies have used the Conners' ADHD Adult Diagnostic Interview for DSM-IV (CAADID; Epstein et al., 2001) as the gold standard to evaluate the utility of the ASRS (Daigre Blanco et al., 2009; Dakwar et al., 2012). However, as noted before, samples were small and not al validity indicators were established due to limitation in the design and thus rigorous evaluation of the ASRS, using the CAADID as the "gold-standard" is still needed.

1.3. Research questions

In the methods paper for their international prevalence study of adult ADHD in treatment seeking substance use disorder patients, Van de Glind et al. (in press) mentioned that both DSM-IV-TR and the proposed criteria for adult ADHD in DSM-5 should be studied. While the "strict DSM-IV-TR" criteria as the gold standard comparator needs to be studied, the psychometric properties of the ASRS should also be evaluated using the slightly looser DSM-5 criteria (DSM-5 website, August 2012). Moreover, the range of prevalence rates in treatment seeking SUD patients (Van Emmerik-van Oortmerssen et al., 2012) might be related to differences in gender, the primary drug of abuse and treatment setting. Hence these differences might also affect the psychometric features of the ASRS and therefore the validity of the ASRS should be established separately in these sub-populations.

Interestingly in another study in a population of US managed care subscribers, both sensitivity and specificity of the ASRS greatly improved (from 39.1 to 64.9 and from 88.3 to 94.0, respectively) by using an alternative scoring algorithm of the 6-item version of the ASRS (Kessler et al., 2007). This alternative scoring algorithm might also improve ASRS validity in the population of treatment seeking SUD patients.

It is well known that active substance abuse and withdrawal can mimic ADHD symptoms (Levin et al., 2009). It is therefore important to know to what extent the timing of the ASRS assessment in clinical practice influences its validity. We hypothesized that the ASRS would have better sensitivity and specificity when used in a more stable situation compared to

when administered at initial admission when patients are still experiencing the acute effects of intoxication or withdrawal.

Finally, given the reported high comorbidity with other externalizing disorders (Cerdá et al., 2008; Couwenbergh et al., 2006), it is important to see to what extend the ASRS differentiates between ADHD and other externalizing disorders (discriminant validity).

In sum, the goals of the current study are: to test the performance of the Adult ADHD Self-Report Scale V 1.1 (ASRS) for adult ADHD in an international sample of treatment seeking SUD patients for DSM-IV and the proposed DSM-5 criteria for adult ADHD, for different subpopulations based on gender, primary substance of abuse and treatment setting, at intake and 1–2 weeks after intake, using different scoring algorithms; and using different externalizing disorders as external criterion, including adult ADHD, bipolar disorder (BD), antisocial personality disorder (APD) and borderline personality disorder (BPD).

2. Methods

2.1. Design

This validation study uses data from the International ADHD in Substance use disorders Prevalence (IASP) study (Van de Glind et al., in press). The IASP is a two-staged study evaluating SUD treatment seeking patients for ADHD and comorbid APD, BPD, major depression (MD) and BD. The study design is presented in Fig. 1.

Stage 1 includes questions about demographics, substance use and the ASRS. All patients from stage 1 were invited to participate in stage 2 (t2). Stage 2 included a second administration of the ASRS and a thorough diagnostic procedure to establish the presence of SUD, ADHD, APD, BPD, MD and BD diagnoses. T1 was performed at initial admission to the addiction treatment centers. T2 was performed when the patient was more stable; abstinence from substances was preferred but not mandatory. The time between t1 and t2 was approximately 14 days, with a substantial number of patients dropping out between t1 and t2 (Van de Glind et al., in press). For the current validation study, we included patients from the IASP study if they had complete data on ASRS at t1 and t2 and an established diagnosis of ADHD.

2.2. Participants

All patients (18–65 years) seeking treatment for SUD starting a new treatment episode during the study period were asked to participate in the study. Exclusion criteria were: inadequate language skills, severe physical or psychiatric problems and unwillingness to sign informed consent. Patients who were intoxicated or currently suffering from severe physical or psychiatric were asked participate at a later date when not intoxicated or medically or psychiatrically unstable.

A total of 3558 patients were included at stage 1 (t1) and a sub-sample of 1138 subjects completed the ASRS at t1 and t2 and the CAADID at t2 (stage 2, diagnostic stage). There were no significant ($p < 0.001$) differences in sample characteristics between the stage 1 and the stage 2 sample, with two exceptions: the mean age in Norway and Spain was

significantly higher in stage 2 patients than in drop outs; the proportion of ASRS positive cases was significantly higher (see Table 1) in the stage 2 sample than in the drop outs.

2.3. Instruments

The full ASRS is an 18 item self-report questionnaire. The 6 item shortened form (see Fig. 2) has been previously validated as a screen for the presence of adult ADHD (Kessler et al., 2005).

Kessler et al. (2007) proposed an alternative scoring algorithm in which a sum score is obtained in adding up the scores (0–4) of the first six items. This results in a minimum score of 0 and a maximum score of 24.

The CAADID is used in the current study as the gold standard for establishing the diagnosis of adult ADHD. It assesses all of the DSM-IV-TR criteria for adult ADHD (number of symptoms; age of onset; pervasiveness; impairment; no other psychiatric disorder responsible for symptoms) and the DSM-IV-TR prerequisite for diagnosing adult ADHD: a retrospective diagnosis of childhood ADHD. The CAADID data can also be used for establishing the diagnosis of adult ADHD according to the criteria proposed for DSM-5, i.e. a decrease in the number of symptoms from 6 out of 9 to 5 out of 9, and an increase of the age of onset from 7 to 12 years. We will present ASRS performance when applying these DSM-5 proposed criteria for adult ADHD.

The CAADID is one of the most frequently used semi-structured diagnostic interviews for the assessment of adult ADHD (Arcos-Burgos et al., 2010; Daigre Blanco et al., 2009; Epstein et al., 2001; Epstein and Kollins, 2006; Medori et al., 2008; Ribasés et al., 2009). The CAADID has been evaluated using test-retest reliability (Epstein and Kollins, 2006) and was found to have kappa estimates for ADHD similar to those of other DSM Axis Disorders using the Structured Clinical Interview for Diagnostic Statistical Manual (Williams et al., 1992). Besides assessing patients for the number of ADHD symptoms, the CAADID requires close attention to domains of impairment (e.g. school and home social settings) and the level of functional impairment. Thus, the CAADID is well suited to serve as a gold standard. In the current study, all site coordinators were trained by the principal investigator of the study (GvdG) and these site coordinators trained local addiction treatment professionals (in many cases non English speaking) using the official training manual (for details: see Van de Glind et al., in press, submitted for publication). Due to practical and financial limitations, it was not possible to conduct a proper reliability study.

2.4. Data analysis

CAADID diagnoses were used as the external criterion for the calculation of the sensitivity, specificity, positive likelihood ratio (LR+), negative likelihood ratio (LR-), positive predictive value (PPV), and negative predictive value (NPV) of the ASRS (for definitions of these terms see Fig. 3).

Considering the different proportion of ASRS positives and ASRS negatives assessed with the CAADID, estimates of sensitivity and specificity were calculated, based on the weighted data according to these sampling fractions (Whitmore et al., 1999). SPSS 19 was used for

analyzing the data, after which the ASRS characteristics and 95% confidence intervals (CI) were calculated using Microsoft Excel.

2.5. Ethics

All of the participating institutes received approval from their medical ethical committees. All of the participating subjects gave written informed consent.

3. Results

3.1. Preliminary analyses

Ten countries participated in the IASP study: Australia, Belgium, France, Hungary, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United States (USA). Seven of these participated in both t1 and t2: France, Hungary, The Netherlands, Norway, Spain, Sweden and Switzerland. In Table 1 the most important characteristics of the included sample are listed and compared to the original larger sample.

Of all 1138 subjects, 625 (55%) scored negative on the ASRS both at t1 and t2 and 328 (29%) scored positive at both time points. However, 96 (8%) scored positive at t1 but negative at t2 and 89 (8%) scored negative at t1 and positive at t2. These findings indicate a stable result in 84% of subjects and a change of results in 16% of subjects.

3.2. Primary analyses

The prevalence of adult ADHD in the current study was 13.0% (95% CI: 11.0–15.0%). Of the 1138 subjects, 24 of the 714 cases with a negative result on the ASRS at t1 were diagnosed with adult ADHD (3.4% false negatives), whereas 112 of the 424 with a positive result on the ASRS at t1 were diagnosed with adult ADHD (28.3% true positives). At t2 these figures were 18 out of 721 (2.5% false negatives) and 118 out of 417 (28.3% true positives).

The sensitivity (0.84) and specificity (0.66) of the ASRS measured at initial admission at addiction treatment centers, differed minimally when the proposed changes for adult ADHD in DSM-5 were applied (see Table 2). The overall positive predictive value (PPV) of the ASRS was 0.26 (95% CI: 0.22–0.30), the negative predictive value (NPV) was 0.97 (95% CI: 0.96–0.98).

Table 3 shows that the ASRS is not a very good screener for BPD (sensitivity 0.63, specificity 0.64), APD (sensitivity 0.65, specificity 0.66) and BD (sensitivity 0.70, specificity 0.62).

Tables 4 and 5 present the ASRS characteristics stratified by gender and primary drug of abuse and by setting. There appears to be no effects of gender and treatment setting. However, specificity in patients with alcohol use disorders (AUD) was better (0.76) than in patients with other primary drugs of abuse (0.56), while sensitivity was similarly good for both alcohol (0.80) and drug use disorders (DUD; 0.85).

We calculated the ASRS characteristics when applying the alternative scoring algorithm for the ASRS (Kessler et al., 2007), presented in Table 6. The best balance of sensitivity/ specificity rates was using the cut-off score of 14 or more: sensitivity was 0.81 and specificity was 0.70, i.e. almost identical to those of the ASRS at t1 with the original scoring algorithm.

When subjects were evaluated approximately 2 weeks after admission (and more likely to be in a more stable situation), the instrument parameters (sensitivity and specificity) and the population parameters (NPV and PPV) of the ASRS remained very similar (see Table 2).

4. Discussion

The prevalence of adult ADHD in the current study was 13%. The overall positive predictive value (PPV) of the ASRS was 0.26 and the negative predictive value (NPV) was 0.97. The sensitivity (0.84) and specificity (0.66) measured at admission were similar to the sensitivity (0.88) and specificity (0.67) measured 1–2 weeks after admission. Sensitivity was similar, but specificity was significantly better in patients with alcohol compared to (illicit) drugs as the primary substance of abuse (0.76 vs. 0.56). The ASRS was not a good screener for externalizing disorders other than adult ADHD. The prevalence of 13% adult ADHD in this population of treatment seeking SUD patients is much higher than the prevalence of adult ADHD in the general population (Simon et al., 2009). It also indicates that ADHD persists in many subjects into adulthood along with development of complex disorders like SUD.

In general, there were no substantial differences in the utility of the ASRS when various comparisons were made, suggesting that important clinical variables and circumstances are unlikely to impact on the utility of this screening tool in treatment seeking substance use disorder patients.

Detection of adult ADHD in treatment seeking SUD patients is important, because research indicates that comorbid disorders are associated with a more severe course of SUD and unfavorable treatment outcomes (Carroll and Rounsaville, 1993; Wilens, 2007). Individuals with ADHD are significantly more likely to relapse during SUD treatment than those without ADHD (Rukstalis et al., 2005; Ercan et al., 2003) and do not progress as well in treatment (Levin et al., 2004; Wise et al., 2001). Further, those with comorbid ADHD are less compliant with SUD treatment than those without comorbid ADHD (Horner and Scheibe, 1997). Moreover, SUD patients with ADHD take a longer time to remit from their SUD and require more treatment involvement than those without ADHD (Wilens et al., 1998; Carroll and Rounsaville, 1993; King et al., 1999). Finally, SUD patients with comorbid ADHD also have higher rates of other psychiatric disorders (Wilens et al., 2005). Taken together, this group is likely to benefit from early identification and treatments targeted at both conditions.

The high prevalence (23.3%) of ADHD in treatment seeking SUD patients as reported by Van Emmerik-van Oortmerssen et al. (2012) further indicates the relevance of improvement of detection and diagnostic procedures. In the present study, we obtained a realistic, but

rather conservative prevalence rate of 13.0% (95% CI: 11.0–15.0%), based on the strict DSM-IV-TR criteria for adult ADHD, including the prerequisite of retrospectively diagnosed childhood ADHD. However, prevalence rates do affect PPV and NPP. This relatively low estimate of the prevalence is probably partly responsible for the relatively low estimate of the PPV and the relatively high estimate of the NPV of the ASRS in the current study.

Our study demonstrates that, overall, the ASRS shows good sensitivity (84%) and moderate specificity (66%). The overall positive predictive value (PPV) of the ASRS was 0.26 (95% CI: 0.22–0.30), the negative predictive value (NPV) was 0.97 (95% CI: 0.96–0.98), thus adding to the clinical usefulness of the ASRS in this population. The ASRS is sensitive in detecting ADHD, but not in detecting other externalizing disorders. The ASRS proves to be a useful tool to identify individuals with a potential diagnosis of adult ADHD entering SUD treatment. However, clinicians should bear in mind that applying the CAADID interview only to the 37% ASRS positive patients will result in missing some adult ADHD cases. In the IASP subsample in this study, the prevalence was 13%. When applying the CAADID in ASRS screen positives only, 11% of the population will be identified as having adult ADHD and hence 2% of cases of adult ADHD will be missed.

The ASRS characteristics that we found are similar to those reported by Daigre Blanco et al. (2009). However, Pérez Pedrero and Puerta García (2007) reported better specificity. The fact that Chiasson et al. (2012) found that the ASRS has very low specificity might be because they did not use a standardized tool for ADHD diagnosis. The NPV (97%) in our sample indicates that once a patient screens negative on the ASRS, it is very unlikely that (s)he will meet criteria for adult ADHD, clearly showing the clinical utility of the ASRS in this population.

It has been argued that the ASRS should not be administered in acute wards or, detoxification centers because the positive ADHD symptoms can easily overlap with withdrawal symptoms and the direct effects of substances of abuse. However, the present study showed that, contrary to expectations, the psychometric properties are stable regardless of whether the patients are screened during the admission process or after 1–2 weeks stabilization following treatment entry. Our hypothesis predicting better validity at t2 therefore is rejected. These results are reassuring given that there have been concerns that the ASRS might have poor psychometric properties for individuals entering substance abuse treatment. However, the stability of the ASRS in the current study (84%) is lower then the previous reported test-retest reliability in subjects from the general population (Matza et al., 2011).

Importantly, the psychometric properties are similar for DSM-IV and proposed DSM-5 criteria and do not vary substantially based on demographic characteristics. This has implications for early identification and diagnostics of adult ADHD, indicating that the ASRS can be administered to both genders. Although the sensitivity of the ASRS in AUD and DUD patients is similar, the specificity in DUD is low, especially in opiate use disorders and patients in the category 'other drugs' (no opiates, stimulants or cannabis as self reported main problem drug). Dakwar et al. (2012) recently reported lower sensitivity (67%) and

better specificity (82%) in a sample of cocaine dependent patients ($n = 102$). The latter results differ from our findings in patients reporting stimulants as their main problem substance. For this subgroup we found a sensitivity of 88% and specificity of only 55%. The reasons for this difference remain unclear.

Notably, alternative scoring algorithms did not improve the sensitivity and specificity. This is in contrast with findings of Kessler et al. (2007) who showed improvement in primary care settings. We therefore propose using the original scoring algorithm of the ASRS in SUD treatment seeking patients.

4.1. Limitations

Despite the large size of our sample, in interpreting the results several limitations should be considered.

There is substantial drop-out between the t1 and t2 assessments. However, there were no significant ($p < 0.001$) differences in sample characteristics between the stage 1 and the stage 2 sample, with two exceptions: age (in Norway and Spain) and ASRS score, mentioned in Section 2.2. Since ADHD symptoms are more prevalent in young persons (Faraone et al., 2006), this may have caused some underestimation of the prevalence of ADHD in these two countries and thus in the total sample. In order to take differences in the proportion of ASRS positive cases into account, we used weighed prevalence rates for the calculation of the ASRS psychometrics. We are therefore convinced that our ASRS validity indicators are representative for the totals sample of treatment seeking SUD patients ($N = 3558$ subjects).

In this study, we did not assess interviewer reliability. Given the involvement of several languages this proved to be too complicated. It is therefore not entirely sure how reliable the CAADID interviews were. This may have resulted in a less reliable external criterion. However, only experienced clinicians performed the interviews and all participating teams received the same training in the administration of the CAADID, based on the CAADID manual (Epstein et al., 2001). Finally, one could argue that this imperfection of the study may have led to a more ecological valid estimation of the validity and usefulness of the ASRS in routine clinical practice.

It should also be noted that self report in ADHD in itself might cause potential bias (Barkley et al., 2008,2002). Owing to this possible underreporting by adults with ADHD, it cannot be excluded that this study suffered from false negatives resulting in some underestimation of the prevalence of ADHD, a relatively low PPV and an underestimation of the NPV of the ASRS in the current study.

It is widely accepted that the diagnostic accuracy of adult ADHD is enhanced by obtaining additional information from parents, or other individuals who knew the patient well in childhood. In this study, patients are approximately 40 years old and often come from dissolved families; hence it would be difficult if not impossible to track down parents. Further, if we had required attainment of collateral information to include SUD patients for this study, many would have been excluded. Nevertheless, this decision might have lowered

(Barkley et al., 2002) the prevalence rates based on the CAADID interview, and therefore may have influenced the ASRS characteristics.

Finally, as we do not have exact information on the time interval between t1 and t2, this limits the conclusions that can be drawn from the comparison between ASRS t1 and t2 performance.

4.2. Conclusion

The ASRS v 1.1 is a robust screening instrument for the detection of ADHD in SUD populations. However, clinicians should be aware of the fact that the ASRS is a screening instrument, not a diagnostic instrument, and that a state-of-the-art clinical evaluation is required for diagnosis.

The rationale for screening is to not miss any possible individual with ADHD, while also screening out those who do not have ADHD. Shrout and Newman (1989) presented algorithms for decisions based on the cost effectiveness of using a two-stage model for identifying disorders in a large sample. They include parameters like sensitivity and specificity of the screening tool, and costs of the screening tool related to the costs of the diagnostic tool. The low costs of applying the ASRS (approximately 5 min for the patient to fill out, and less than a minute for a professional to count the result) versus the length of the CAADID interview process (on average 60 min) along with the ASRS's sensitivity and specificity result in a decision in favor of this two stage model for identifying ADHD in populations of treatment seeking SUD patients. However, clinicians should bear in mind that applying the CAADID interview only to ASRS positive patients will result in missing some adult ADHD cases.

Acknowledgments

Appendix A

The following persons participated in this study: Eva Karin Løvaas, Kari Lossius, Anneke van Wamel, Geert Bosma, David Hay, Sara Wallhed, Carlos Roncero, Laura Stevens, Marion Malivert, Romain Debrabant, Therese Dahl, Constanza Daigre, Rutger-Jan van der Gaag, Atul Beniwal, Louisa Degenhardt, Joanne Cassar, Jesse Young, Merete Möller, Narelle Fordham, Michelle Torok and Katherine Tye.
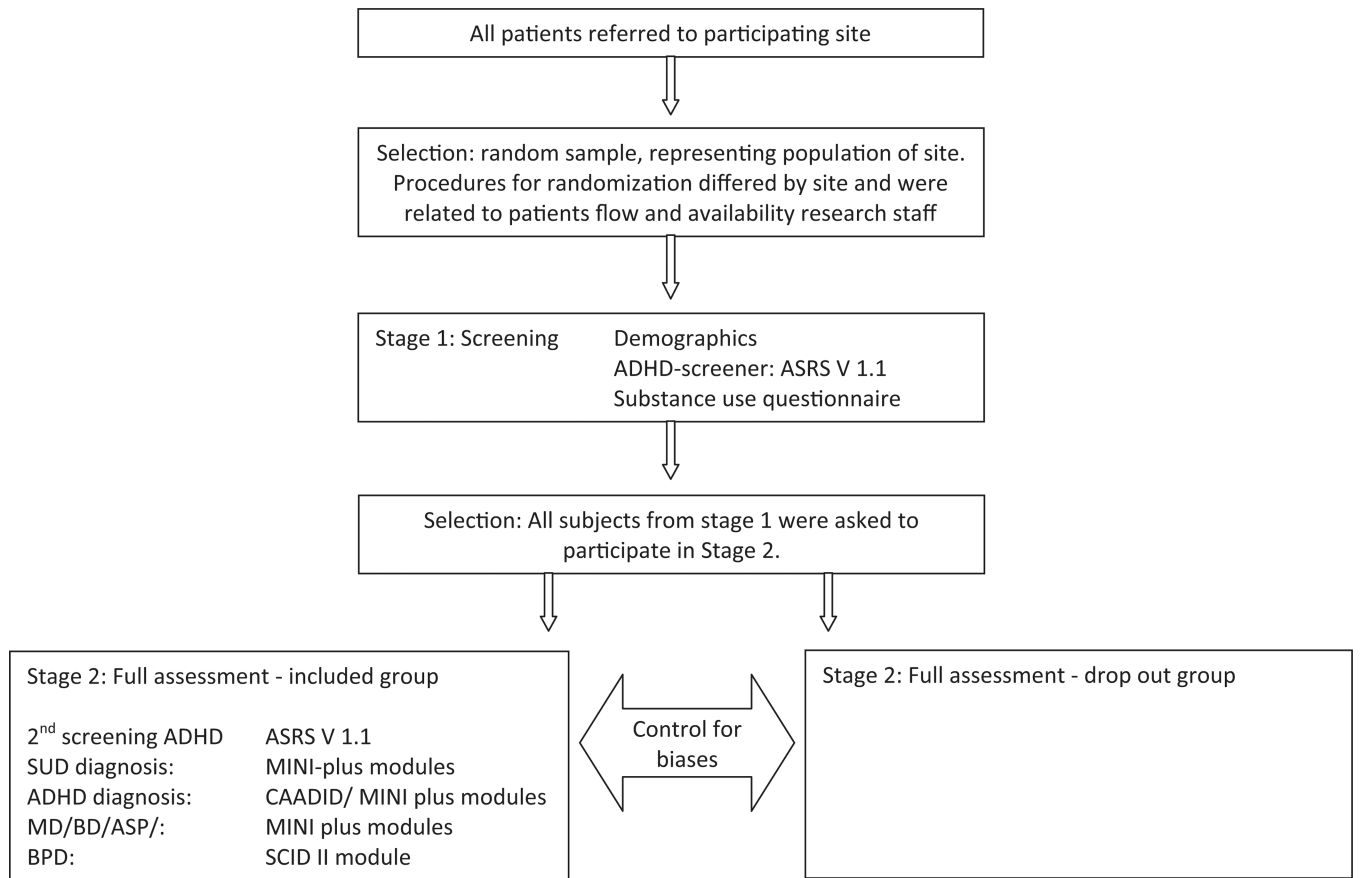
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All patients referred to participating site

Selection: random sample, representing population of site.
Procedures for randomization differed by site and were
related to patients flow and availability research staff

Stage 1: Screening   Demographics
                                 ADHD-screener: ASRS V 1.1
                                 Substance use questionnaire

Selection: All subjects from stage 1 were asked to
participate in Stage 2.

Stage 2: Full assessment - included group

2nd screening ADHD   ASRS V 1.1
SUD diagnosis: MINI-plus modules
ADHD diagnosis: CAADID/ MINI plus modules
MD/BD/ASP/:   MINI plus modules
BPD: SCID II module

Control for biases

Stage 2: Full assessment - drop out group

Fig. 1.
Design of the study.

		Date						
		0=Never; 1=Rarely; 2=Sometimes; 3=Often; 4=Very often						
Answer the questions below, giving a score for each criterion based on the scale appearing on the right-hand side of the page. For each question, put an X in the box that best describes your feelings and behaviour over the last 6 months. *0=Never; 1=Rarely; 2=Sometimes; 3=Often; 4=Very often*			0	1	2	3	4	
1. Do you think that you have problems fine-tuning the final details of a project when the more complex parts have already been completed?								
2. Do you think that you have difficulty putting things and objects in order when you are completing a task which requires organisation?								
3. Do you have problems remembering appointments and deadlines?								
4. When you are completing a task that requires a lot of reasoning, how often do you avoid dealing with it or delay starting it?								
5. Do you think that you fidget or wriggle your hands or feet when you have to stay seated for a long time?								
6. Do you think that you feel excessively active or compelled to do something as if you were being driven by a motor?								

The items are scored 0 (never), 1 (rarely), 2(sometimes) 3 (often) and 4 (very often). Among the six screening items, the first three are positive when a score of 2 or higher is obtained and the next three items are positive when a score of 3 or 4 is obtained. If 4 or more of the 6 items are positively endorsed, the ASRS scores positive.

Fig. 2.
Symptom checklist based on the Adult ADHD Self-Report Scale (ASRS-v1.1)-6-item version.

sensitivity	Probability of positive screener given disease present = true positive rate
specificity	Probability of negative screener given disease not present = true negative rate
PPV	Probability that disease is present given positive screener
NPV	Probability that disease is absent given negative screener
FNR	1-sensitivity
FPR	1-specificity
LR+	True positive rate/false positive rate = (sensitivity/(1-specificity)
LR-	False negative rate/true negative rate = ((1-sensitvity)/specificity)

For a more extensive explanation readers are referred to: Users'guide to the medical literature. Guyatt G. et al. (2008), McGraw Hill New York.

Fig. 3.
Overview of psychometrics calculated in this study.

Table 1

General demographics of the study population: 1138 cases, compared to the original IASP population (n = 3558).

	ASRS validity study (n = 1138)	IASP study population (n = 3558)
Missing ASRS at t1		126
Positive on ASRS t1 (%)	424(37.3%)	1375(40.1%)
Female *(%)*	296(26.0%)	1136(31.9%)
Age		
Missing	1	5
18–25	105(9.2%)	430 (12.1%)
26–50	811 (71.3%)	2539 (71.4%)
51–65	221 (19.4%)	584(16.4%)
Main problem substance		
Missing	9	289[a]
Alcohol (%)	640 (56.7%)	1755(53.7%)
Drugs(%)	489 (43.3%)	1514(46.3%)
Opioids (%)	114(10.1%)	421 (12.9%)
Stimulants (%)	163(14.3%)	485(14.8%)
Cannabis (%)	117(10.4%)	323(9.9%)
Other(%)	95(8.5%)	285(8.7%)

[a] More than half of the Norwegian sample was drawn from another local study using the same methods. However in this study they did not ask for self reported main problem substance. This explains the high numbers of missing cases in these categories.

Table 2

ASRS characteristics (*n*= 1138, subjects with valid measures on ASRS t1, ASRS t2, CAADID); external criterion: CAADID-DSM-IV and proposed criteria for DSM-5

| | Criterion CAADID DSM-IV | | Criterion CAADID proposed DSM-5-ASRS-t1 | |
	ASRS-t1	ASRS-t2	Only age of onset criterion to <12 adjusted	Both number of symptoms criterion (5 out of 9 symptoms) and age of onset criterion (<12) adjusted
Sensitivity (95% CI)	0.84 (0.78–0.90)	0.88 (0.83–0.93)	0.85 (0.79–0.91)	0.83 (0.78–0.89)
Specificity (95% CI)	0.66 (0.63–0.69)	0.67 (0.64–0.70)	0.67 (0.64–0.70)	0.68 (0.65–0.71)
NPV[a]	0.97 (0.96–0.98)	0.98 (0.97–0.99)	0.97 (0.96–0.98)	0.96 (0.94–0.97)
PPV[b]	0.26 (0.22–0.30)	0.28 (0.24–0.32)	0.29 (0.25–0.33)	0.31 (0.27–0.36)
LR+[c]	2.47	2.67	2.58	2.59
LR-[d]	0.24	0.18	0.22	0.25
FPR[e]	0.34	0.33	0.33	0.32
FNR[f] Prevalence (95% CI)	0.16 0.13 (0.11–0.15)	0.12 0.13 (0.11–0.15)	0.15 0.13 (0.11–0.15)	0.17 0.15 (0.13–0.17)

[a]Negative predictive value.

[b]Positive predictive value.

[c]Likelihood ratio test positive.

[d]Likelihood ratio test negative.

[e]False positives ratio.

[f]False negatives ratio.

Table 3

Characteristics for adult ADHD versus other externalizing disorders t2 ($n = 1111$).

	ADHD adult	BPD	APD	Bipolar disorder	Any externalizing disorder
Sensitivity	0.88 (0.83–0.93)	0.63 (0.56–0.70)	0.65 (0.59–0.71)	0.70 (0.59–0.81)	0.64 (0.59–0.69)
Specificity	0.67 (0.64–0.70)	0.64 (0.61–0.67)	0.66(0.63–0.69)	0.62 (0.59–0.65)	0.74 (0.71–0.77)
NPV[a]	0.98 (0.97–0.99)	0.91 (0.89–0.93)	0.88 (0.86–0.90)	0.97 (0.96–0.98)	0.79 (0.76–0.82)
PPV[b]	0.28 (0.24–0.32)	0.24 (0.20–0.28)	0.33 (0.29–0.37)	0.10 (0.07–0.13)	0.57 (0.52–0.62)
LR+[c]	2.67	1.75	1.91	1.84	2.46
LR-[d]	0.18	0.58	0.53	0.48	0.49
FPR[e]	0.33	0.36	0.34	0.38	0.26
FNR[f]	0.12	0.37	0.35	0.30	0.36
Prevalence (95% CI)	0.13 (0.11–0.15)	0.15 (0.13–0.17)	0.20(0.18–0.22)	0.06 (0.05–0.07)	0.36 (0.33–0.39)

[a] Negative predictive value.

[b] Positive predictive value.

[c] Likelihood ratio test positive.

[d] Likelihood ratio test negative

[e] False positives ratio.

[f] False negatives ratio

Table 4

ASRS characteristics ($n = 1138$, subjects with valid measures on ASRS t1, ASRS t2, CAADID), stratified by gender and main problem drug external criterion ADHD–DSM-IV-TR diagnosis based on CAADID-t2 data.

	Sensitivity (95% CI)	Specificity (95% CI)	NPV[a] (95% CI)	PPV[b] (95% CI)	LR+[c]	LR-[d]	FPR[e]	FNR[f]	Prevalence (95% CI)
Gender									
Male ($n = 842$)	0.84 (0.77–0.91)	0.68 (0.65–0.71)	0.97 (0.96–0.98)	0.28 (0.23–0.33)	2.63	0.24	0.32	0.16	0.13 (0.11–0.15)
Female ($n = 296$)	0.84 (0.72–0.96)	0.62 (0.56–0.68)	0.97 (0.94–1.00)	0.23 (0.16–0.30)	2.21	0.26	0.38	0.16	0.12(0.08–0.16)
Substance									
Alcohol ($n = 640$)	0.80 (0.69–0.91)	0.76 (0.73–0.79)	0.98 (0.97–0.99)	0.23 (0.17–0.29)	3.33	0.26	0.24	0.20	0.08 (0.06–0.10)
Drugs any ($n = 489$)	0.85 (0.77–0.93)	0.56 (0.51–0.61)	0.95 (0.92–0.98)	0.28 (0.22–0.34)	1.93	0.27	0.44	0.15	0.17 (0.14–0.20)
Opiates ($n = 114$)	0.74 (0.50–0.98)	0.54 (0.44–0.64)	0.94 (0.88–1.00)	0.18 (0.08–0.28)	1.61	0.48	0.46	0.26	0.12(0.06–0.18)
Stimulants ($n = 163$)	0.88 (0.77–0.99)	0.55 (0.46–0.64)	0.94 (0.89–0.99)	0.36 (0.26–0.46)	1.96	0.22	0.45	0.12	0.22(0.16–0.28)
Cannabis ($n = 117$)	0.84 (0.69–0.99)	0.55 (0.45–0.65)	0.93 (0.86–1.00)	0.32 (0.20–0.44)	1.87	0.29	0.45	0.16	0.20 (0.13–0.27)
Other($n = 95$)	0.89 (0.66–1.12)	0.59 (0.49–0.69)	0.99 (0.96–1.02)	0.14 (0.04–0.24)	2.17	0.19	0.41	0.11	0.07 (0.02–0.12)

[a]Negative predictive value.

[b]Positive predictive value.

[c]Likelihood ratio test positive.

[d]Likelihood ratio test negative

[e]False positives ratio.

[f]False negatives ratio.

Table 5

ASRS characteristics ($n= 1138$, subjects with valid measures on ASRS t1, ASRS t2, CAADID), stratified by setting. External criterion ADHD–DSM-IV–TR diagnosis based on CAADID-t2 data.

	Sensitivity (95% CI)	Specificity (95% CI)	NPV[a] (95% CI)	PPV[b] (95% CI)	LR+[c]	LR-[d]	FPR[e]	FNR[f]	Prevalence (95% CI)
Outpatient ($n = 2239$)	0.85 (0.78–0.92)	0.66 (0.62–0.70)	0.97 (0.95–0.99)	0.27 (0.22–0.32)	2.50	0.23	0.34	0.15	0.13 (0.11–0.15)
Inpatient ($n= 1149$)	0.79 (0.67–0.91)	0.70 (0.65–0.75)	0.97 (0.95–0.99)	0.23 (0.16–0.30)	2.63	0.30	0.30	0.21	0.10 (0.07–0.13)

[a] Negative predictive value.

[b] Positive predictive value.

[c] Likelihood ratio test positive.

[d] Likelihood ratio test negative.

[e] False positives ratio.

[f] False negatives ratio.

Table 6

ASRS characteristics ($n = 1138$) comparing standard cut-off with alternative scoring algorithms, using the sum scores of the first 6 items. T1 data.

	Sumscore 13 or more	Sumscore 14 or more	Sumscore 15 or more
Sensitivity (95% CI)	0.88 (0.83–0.93)	0.81 (0.75–0.87)	0.74 (0.67–0.81)
Specificity (95% CI)	0.64 (0.61–0.67)	0.70 (0.67–0.73)	0.76 (0.73–0.79)
NPV[a] (95% CI)	0.97 (0.96–0.98)	0.96 (0.95–0.97)	0.95 (0.93–0.97)
PPV[b] (95% CI)	0.26 (0.22–0.30)	0.28 (0.24–0.32)	0.31 (0.26–0.36)
LR+[c]	2.44	2.70	3.08
LR-[d]	0.19	0.27	0.34
FPR[e]	0.36	0.30	0.24
FNR[f]	0.12	0.19	0.26
Prevalence (95% CI)	0.13 (0.11–0.15)	0.13 (0.11–0.15)	0.13 (0.11–0.15)

[a]Negative predictive value.

[b]Positive predictive value.

[c]Likelihood ratio test positive.

[d]Likelihood ratio test negative.

[e]False positives ratio.

[f]False negatives ratio.