ABSTRACT

Objective: Research supports the importance of emotional symptoms in adults with attention-deficit/hyperactivity disorder (ADHD), which are not reflected in the DSM-5 or ICD-10 criteria. The Wender-Reimherr Adult Attention Deficit Disorder Scale (WRAADDS) assesses these symptoms, plus inattention, hyperactivity, and impulsivity. This scale allowed us to divide adult ADHD into 2 subtypes in a 2015 publication: ADHD inattentive presentation and ADHD emotional dysregulation presentation. The present study refines this observation using a larger, more diverse sample.

Methods: Eight double-blind adult ADHD clinical trials (encompassing 1,490 subjects) were selected because they included assessment with the WRAADDS; a second, alternative ADHD measure; and the Clinical Global Impressions—Severity of Illness scale (CGI-S). These data were subjected to confirmatory factor analyses, and ADHD presentations were compared, including treatment response.

Results: The original factor structure fit poorly with these new data. However, an alternative 2-factor solution fit both the original and the new subjects. ADHD inattentive presentation (n = 774) was defined by the inattention factor, and ADHD emotional dysregulation presentation (n = 620) was defined by additional elevation of the emotional dysregulation factor. The proportion of ADHD emotional dysregulation presentation ranged from 25% to 73% across the 8 studies. The emotional dysregulation presentation was associated with both a greater severity as measured by the CGI-S (P < .001) and more manifestations of childhood ADHD as measured by the Wender Utah Rating Scale (P < .001).

Conclusions: Factor analytic results supported the validity of 2 adult ADHD presentations based on levels of emotional dysregulation. This system offers a more clinically relevant approach to the diagnosis of ADHD in adults than does the DSM system.

J Clin Psychiatry 2020;81(2):19m13077


To share: https://doi.org/10.4088/JCP.19m13077
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Conclusions: Factor analytic results supported the validity of 2 adult ADHD presentations based on levels of emotional dysregulation. This system offers a more clinically relevant approach to the diagnosis of ADHD in adults than does the DSM system.
We selected published clinical trials of ADHD in adults conducted using similar protocols. All met Declaration of Helsinki ethical criteria and were approved by relevant research review boards. Each selected adult subjects with ADHD defined by DSM-IV criteria.

Each study used the WRAADDS to evaluate baseline ADHD symptoms, and most had an alternative ADHD symptom measure: the Conners’ Adult ADHD Rating Scale (CAARS)\(^{23}\) or the Adult ADHD Investigator Symptom Rating Scale (AISRS).\(^{24}\) Each included additional measures of symptoms or dysfunction, usually an assessment of childhood ADHD symptoms, social adjustment, and adult emotional symptoms. The studies (Table 1) fall into 2 groups: those from our 2015 report\(^{20}\) and those constituting our new sample. Two studies were conducted in Germany: Europe-MPH ER-I (2005–2007)\(^{17}\) and Europe MPH ER-II (2008–2009).\(^{28}\) Four studies were conducted in Utah: Utah-OROS (2004–2005),\(^{14}\) Utah-MTS (2007–2008),\(^{15}\) Utah-MPH-IR (1989–1993),\(^{16}\) and Utah-Bupropion (1998–1999).\(^{27}\) Two studies were multicenter studies: Multicenter-ATX (2002–2004)\(^{25}\) and Multicenter Comorbid EtOH (2005–2007).\(^{26}\)

### Measures

The WRAADDS\(^{19}\) is an interviewer-administered scale assessing adult ADHD symptoms grouped into 7 domains: attention difficulties, hyperactivity/restlessness, temper, affective lability, emotional overreactivity, disorganization, and impulsivity. It provides several items in each domain rated as present, possibly present, or not present. The domain is then rated from 0 to 4 (none, mild, moderate, quite a bit, or very much). Scoring a domain as positive requires a rating of 3 or 4. This scale was the primary outcome measure in 6 studies (Utah-OROS, Utah-MTS, Utah-MPH IR, Utah-Bupropion, Europe-MPH ER-I, and Europe-MPH ER-II) and a secondary outcome measure in 1 study (Multicenter-ATX). As opposed to other interview-based ADHD scales, it is recommended that the WRAADDS be administered in a joint interview with the patient and a close family member, preferably a spouse.

The CAARS\(^{23}\) consists primarily of DSM-IV ADHD symptoms modified to better assess adults. It was the primary scale in the ATX protocol and a secondary measure in the Utah-OROS, Multicenter-ATX, Multicenter Comorbid EtOH, and Europe-MPH ER trials.

The AISRS\(^{24}\) addresses the 18 items in DSM-IV. Each item is scored from 0 to 3. It was the primary scale in the Multicenter Comorbid EtOH trial and a secondary measure in the Utah-MTS and Europe-MPH ER trials.

The Clinical Global Impressions–Severity of Illness scale (CGI-S) was used in the Utah-OROS, Utah-MTS, Multicenter-ATX, Utah-Bupropion, and Multicenter Comorbid EtOH trials.

The Wender Utah Rating Scale (WURS) describes childhood behaviors associated with ADHD persisting into adult life.
adulthood. A 25-item subset is frequently utilized. The WRAADDS was employed in the Utah-OROS, Utah-MTS, Utah-MPH-IR, Utah-Bupropion, and Europe-MPH ER studies.

The Hamilton Depression Rating Scale (HDRS) was used in the Utah-OROS, Multicenter-ATX, Multicenter Comorbid EtOH, and Utah-Bupropion studies.

**Confirmatory Factor Analysis**

Our initial goal in this investigation was to perform a confirmatory factor analysis of the 7 domains of the WRAADDS using a new, but similar, group of adults with ADHD, as indicated in Table 1. This analysis did not confirm the factor structure we had ascertained previously. Further inspection of our data and past publications led us to conduct a second confirmatory factor analysis in which restlessness/hyperactivity was allowed to be part of both our inattention factor and emotional dysregulation factor.

Thus we report 2 sets of confirmatory factor analyses (one using the system described in 2015 and the second a new revised system called the “new 2-factor model”) using 2 groups of subjects. The first subject group we call “past subject samples” (data used in the 2015 exploratory factor analysis) and the second “new subject samples.” Table 1 summarizes this information. These designations are used throughout this report.

**Diagnostic Procedures**

The acceptable results of this second confirmatory factor analysis led to a revised 2-factor diagnostic procedure. Subjects rated positive for attention difficulties and/or disorganization as described previously in the Methods section were considered positive for ADHD. Subjects rated positive on at least 2 of the 3 WRAADDS domains that loaded only on the emotional dysregulation factor (temper, affective lability, or emotional overreactivity) were considered as having ADHD emotional dysregulation presentation.

Following categorization, subjects who met criteria for ADHD inattentive presentation or ADHD emotional dysregulation presentation were compared on a variety of characteristics, including treatment response.

**Data Analysis**

Confirmatory factor analysis (CFA) was conducted using R. Past subject samples and new subject samples were never combined for this procedure. The following statistics are presented: comparative fit index, Tucker-Lewis Index, root mean square error of approximation, $\chi^2$, and standardized root mean square residual.

On the basis of the second, successful confirmatory factor analysis, subjects were categorized as having 1 of the 2 ADHD presentations. Baseline differences between ADHD presentations were compared using $t$ tests and Cohen $d$.

Treatment response for parallel trials was assessed using analysis of variance (ANOVA). Treatment response for crossover design trials was examined using repeated-measures ANOVA. In both assessments, the outcome variable was change in total WRAADDS scores at double-blind endpoint (last visit carried forward) with treatment (active medication vs placebo) and diagnostic presentation (inattentive presentation vs emotional dysregulation presentation) as predictor variables. The statistic of primary interest was interaction between treatment (active medication vs placebo) and diagnostic presentation. Given study differences, trials were evaluated separately.

Reductions in the 2 ADHD factor scores during double-blind active treatment arms were analyzed using correlation coefficients for each trial and all subjects combined. Statistical testing was done with SPSS 22 (IBM Corp; Armonk, New York) and R (R Core Team; Vienna, Austria).

**RESULTS**

The trials (Table 2) ranged from 45 to 532 subjects, with men predominating.

**Replication Investigation**

Subjects from 4 trials (Utah-OROS, Utah-MTS, Utah-MPH IR, and Multicenter-ATX) were included in the 2013 factor analysis. This replication investigation includes 725 new subjects from 4 additional trials (Multicenter Comorbid EtOH, Utah-Bupropion, Europe-MPH ER-I, and Europe-MPH ER-II).
CFA of the factor structure identified in 2013, which can be regarded as the original factor structure, was conducted using subjects from the Multicenter Comorbid EtOH, Utah-Bupropion, Europe-MPH ER-I, and Europe-MPH ER-II trials. Statistics from this analysis are identified in Table 3 (under the column heading “New Subject Samples”). We compared these results with CFAs using the past subject data (see Table 3).

Our original model (factor 1: attention difficulties + disorganization; factor 2: hyperactivity/restlessness + temper + affective lability + emotional overreactivity, with impulsivity shared by both factors) produced unacceptable results in a CFA (Table 3). The new 2-factor model (inattention factor 1: attention difficulties + disorganization; emotional dysregulation factor 2: temper + affective lability + emotional overreactivity, with impulsivity and hyperactivity/restlessness shared between both factors) did well with data provided by both the new subject samples and the past subject samples. The new 2-factor model was superior to the original 2-factor model for data from the new subject samples and generated similar goodness of fit statistics using the past subject samples’ data. While cluster analysis is commonly associated with identifying similar kinds of subjects, it did not reveal separate clusters of patients.

The great majority of subjects met our operational criteria (Table 4) for either ADHD inattentive presentation (n = 774; range, 27%–68%) or ADHD emotional dysregulation presentation (n = 620; range, 25%–73%). Almost all subjects were rated as “quite a bit” or higher on the attention difficulties and/or disorganization domains. The Europe-MPH ER-I trial had 16 subjects categorized as “none” (ie, who met criteria for neither inattentive nor emotional dysregulation presentation) who were rated “quite a bit” on 2 or 3 of the emotional dysregulation domains. They met symptom criteria for emotional dysregulation but not inattention, and thus not all the criteria for emotional dysregulation presentation. ADHD inattentive presentation predominated in 3 of the trials, while the ADHD emotional dysregulation presentation predominated in 5 trials.

As displayed in Table 5, ADHD emotional dysregulation presentation subjects had (by definition) higher scores on the emotional dysregulation factor; they also had 15% higher inattentive factor scores. Additionally, moderate-to-high effect sizes characterized differences between the 2 presentations on the CGI-S (d = 0.4), WURS (d = 0.5), and HDRS (d = 0.8). On the CGI-S, 59% of the ADHD inattentive presentation subjects were scored at least markedly ill compared to 78% of the ADHD emotional dysregulation presentation patients (χ² = 48.9, P < .0001).
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Table 4. Percentage of Subjects in Each ADHD Category Within Each Trial

<table>
<thead>
<tr>
<th>Trial</th>
<th>ADHD Inattentive Presentation, %</th>
<th>ADHD Emotional Dysregulation Presentation, %</th>
<th>None, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utah-OROS (n = 45)</td>
<td>27</td>
<td>73</td>
<td>0</td>
</tr>
<tr>
<td>Utah-MTS (n = 73)</td>
<td>40</td>
<td>59</td>
<td>1</td>
</tr>
<tr>
<td>Utah-MPH IR (n = 115)</td>
<td>33</td>
<td>67</td>
<td>0</td>
</tr>
<tr>
<td>Multicenter-ATX (n = 532)</td>
<td>68</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td>Multicenter Comorbid ETOH (n = 140)</td>
<td>61</td>
<td>35</td>
<td>5</td>
</tr>
<tr>
<td>Utah-Buproprion (n = 64)</td>
<td>44</td>
<td>56</td>
<td>0</td>
</tr>
<tr>
<td>Europe-MPH ER-I (n = 359)</td>
<td>38</td>
<td>47</td>
<td>15</td>
</tr>
<tr>
<td>Europe-MPH ER-II (n = 162)</td>
<td>50</td>
<td>45</td>
<td>5</td>
</tr>
</tbody>
</table>

Abbreviations: ADHD = attention-deficit/hyperactivity disorder, ATX = atomoxetine, ETOH = alcohol abuse disorder, MPH ER = methylphenidate extended release, MPH IR = methylphenidate immediate release, MTS = methylphenidate transdermal system, OROS = osmotic-release oral system.

Table 5. Subject Characteristics, From All Studies Combined, Associated With the 2 Diagnostic Presentations

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Inattentive Presentation</th>
<th>Emotional Dysregulation Presentation</th>
<th>P Value</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>WRAADDS total score</td>
<td>15.8 ± 3.5</td>
<td>22.0 ± 4.5</td>
<td>&lt; .001</td>
<td>d = 1.6</td>
</tr>
<tr>
<td>Inattentive factor score</td>
<td>9.9 ± 2.3</td>
<td>11.4 ± 2.2</td>
<td>&lt; .001</td>
<td>d = 0.7</td>
</tr>
<tr>
<td>Emotional dysregulation factor score</td>
<td>5.9 ± 2.3</td>
<td>10.4 ± 2.8</td>
<td>&lt; .001</td>
<td>d = 1.9</td>
</tr>
<tr>
<td>CGI-S score</td>
<td>4.8 ± 0.7</td>
<td>5.1 ± 0.8</td>
<td>&lt; .001</td>
<td>d = 0.4</td>
</tr>
<tr>
<td>CGI-S (% markedly ill)</td>
<td>59%</td>
<td>78%</td>
<td>&lt; .001</td>
<td>NA</td>
</tr>
<tr>
<td>WURS score</td>
<td>48.0 ± 12.2</td>
<td>54.9 ± 13.6</td>
<td>&lt; .001</td>
<td>d = 0.5</td>
</tr>
<tr>
<td>HDRS score</td>
<td>5.3 ± 3.7</td>
<td>8.6 ± 4.4</td>
<td>&lt; .001</td>
<td>d = 0.8</td>
</tr>
</tbody>
</table>

*Values are shown as mean ± SD unless otherwise noted.

Abbreviations: CGI-S = Clinical Global Impressions–Severity of Illness scale, HDRS = Hamilton Depression Rating Scale, NA = not applicable, WRAADDS = Wender-Reimherr Adult Attention Deficit Disorder Scale, WURS = Wender Utah Rating Scale.

Treatment Response

An ANOVA was conducted for each trial to see if the 2 diagnostic groups experienced different treatment responses. Given the differences in medications and number of subjects, the trials were not combined. As seen in Table 6, these analyses indicated that the 2 diagnostic groups experienced similar medication and placebo treatment effects in all trials but one. A differential treatment effect appeared in only the Multicenter-ATX study (F1,447 = 11.1, P = .001). The ADHD inattention presentation subjects displayed less treatment improvement than those with the ADHD emotional dysregulation presentation.

Change scores (baseline to medication endpoint) for the 2 factors were highly correlated. With all subjects combined, improvement in the 2 factors correlated (r = 0.78, P < .001).

DISCUSSION

The critical questions addressed are the nature of ADHD in adults and how it should be diagnosed. Results support the validity of 2 diagnostic types, inattentive presentation and emotional dysregulation presentation. The use of the ADHD emotional dysregulation presentation, with its broader range of symptoms, allows for a more complete diagnostic and conceptual picture of adult ADHD than do DSM diagnostic categories. While this diagnostic protocol omits a predominantly hyperactive-impulsive subtype similar to the DSM category, no subjects were denied ADHD status because they had predominately hyperactive-impulsive symptoms. Most would fall into either the inattentive or the emotional dysregulation presentation. This finding comports with most adult studies’ finding the hyperactive-impulsive subtype uncommon.

Past studies assessed emotional dysregulation as a symptom dimension and found that psychosocial impairment accompanied emotional dysregulation,3,36 as did adult oppositional defiant disorder.15,29,31 Others3,10,12 reported emotional symptoms accompanying impairment among adults with ADHD.

Important differences between those with inattention and those with emotional dysregulation include the finding that 78% of subjects with ADHD emotional dysregulation presentation were markedly impaired at baseline per the CGI-S as opposed to 59% of the subjects with ADHD inattention presentation, meaning that more ADHD emotional dysregulation presentation subjects were considered more than moderately ill. They also reported more childhood symptoms implying ADHD.

As discussed earlier in this article, the technique for constructing inattentive and emotional dysregulation presentations yields the latter’s having more of the ADHD symptoms defined by the WRAADDS, and thus falling into the emotional dysregulation presentation group could be seen as simply reflecting illness severity. This view ignores information about the character of symptoms conveyed by employing the 2 categories described. Analogously, ICD-10 creators distinguished mania without psychotic features from mania with psychotic features, although they could have simply divided subject groups into “mania” and “severe mania.” Any concern that the DSM category of “combined” might contain more severely ill subjects than either the “predominately inattentive” or “predominately hyperactive” categories has not prevented this tripartite classification from enduring.

Symptoms representing ADHD emotional dysregulation presentation might be interpreted as evidence of a DSM comorbid disorder. However, this hypothesis is contradicted by 3 facts: (1) all 8 studies were designed to exclude such comorbidity, (2) stimulants and atomoxetine are not effective in treating either anxiety or depression, and (3) stimulants and atomoxetine are both effective in treating emotional dysregulation as defined by the WRAADDS. Previously, we3 presented similar findings regarding the independence of depressive and anxiety symptoms from ADHD emotional dysregulation symptoms.

Three other scales (CAARS,23 Barkley Deficits in Executive Functioning Scale,32 and Behavior Rating Inventory of Executive Function–Adult Version33) assess emotional...
dysregulation in adults with ADHD. All 3 emphasize temper and emotional overreactivity as the primary emotional symptoms. In contrast, our experience with the WRAADDS indicates that affective lability is equally common. The limited range of emotional dysregulation symptoms from assessment tools other than the WRAADDS inherently limits their diagnostic usefulness. In addition, the WRAADDS has been validated as both an interview and a self-report version. We recommend that the scale be administered in a joint interview with a significant other involved in the interview. We have tried other informants such as a parent, sibling, or close friend, but the results have been much less useful. We believe that these 3 WRAADDS domains involve elements of reactivity and internal emotional states.

Diagnostically, identifying these 2 ADHD presentations will decrease potential for inaccurate assumption that patients have a primary mood or anxiety disorder. From a treatment perspective, these emotional symptoms commonly generate interpersonal conflicts, which may be the reason for seeking treatment. Thus, adults with ADHD may receive suboptimal interventions because of the misconception that they reflect a different diagnosis, such as a personality disorder; this potential for misdiagnosis has been identified by others. Consistent with the aforementioned findings, prior reports have described stimulants and atomoxetine as producing an improvement in emotional dysregulation symptoms. These considerations argue for initiating treatment of patients with ADHD and significant emotional dysregulation with a single medication typically used to address an ADHD diagnosis. While factor analysis is useful in determining relationships among patient characteristics, analytic techniques like cluster analysis are more commonly used to generate unique groups. As noted, a cluster analytic approach was found unhelpful with these data.

**CONCLUSION**

These results support the validity and utility of dividing adult ADHD into 2 types: ADHD inattentive presentation and ADHD emotional dysregulation presentation. Patients with both presentations experience significant symptoms in the domains of attention difficulties and disorganization. The ADHD emotional dysregulation presentation represents a more impaired group of individuals. Clinically, they are distinguished by more than moderate impairment on at least 2 of 3 WRAADDS domains: temper, affective lability, and emotional overreactivity. They are more symptomatic as measured by the CGI-S, HDRS, and WURS. While hyperactive-impulsive symptoms remain important during adulthood, they were not associated with a unique adult form of ADHD similar to the childhood ADHD predominately hyperactive-impulsive type. Subjects meeting DSM-IV criteria for ADHD predominately hyperactive-impulsive type were subsumed within our 2 ADHD presentations. Appropriate emphasis on emotional symptoms facilitates defining distinct types of adult ADHD, enhances their recognition, and provides a scaffolding for both treatment and research.

**Limitations**

Data utilized came from clinical trials, not an epidemiologic sample. Patients wanting to enter trials are probably more impaired. Selectivity in choosing this cohort challenges the stability of conclusions regarding the ADHD construct.
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Types of Adult ADHD

Role of the sponsor: The funders of the clinical trials included in the present analysis had no role in the conduct or reporting of this study.

REFERENCES