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Cross-cultural reliability and validity of ADHD assessed by the ADHD Rating Scale in a pan-European study

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Abstract *Objectives* To provide psychometric information on the Attention-Deficit/Hyperactivity Disorder (ADHD) Rating Scale-IV (ADHD-RS-IV) in a large population of children with ADHD. *Methods* Patients aged 6–18 years (n = 1,478 in baseline analysis) were rated by 244 physicians on the ADHD-RS-IV based on a semi-structured interview with the patient's parent. Physicians additionally rated functional impairment (CGAS) and health status (CGI-S), and parents rated their child's behavioural and emotional problems (SDQ) and quality of life (CHIP-CE). *Results* Inattention and hyperactivity-impulsivity as dimensions of ADHD were replicated. 3-factor solutions reflecting the ICD-10 definition, with hyperactivity, impulsivity and inattention as separate dimensions were extracted in some national sub-samples and in separate analyses for boys and younger children. Good internal consistencies, strong country effects and small effects of age were found. Based on ADHD-RS-IV, 88.5 % of patients met the criteria for any ADHD diagnosis. Correlations between ADHD-RS-IV and measures of functional impairment were low but statistically significant. The correlations with SDQ and CHIP-CE scales confirm the convergent and divergent validity of ADHD-RS-IV. *Conclusions* Impressive evidence for the cross-cultural factorial validity, internal consistency as well as convergent and divergent validity of ADHD-RS-IV was found. ADHD can be assessed reliably and validly in routine care across Europe. The ICD-10 3-factor model seems to be less robust than the DSM-IV 2-factor model, but may be a good description for special populations (boys, younger children).

Key words ADHD – ADORE – assessment – children – cross-cultural – validation

Abbreviations

ADHD	Attention-Deficit/Hyperactivity Disorder
ADORE	Attention-deficit/hyperactivity Disorder Observational Research in Europe
ADHD-RS-IV	ADHD Rating Scale-IV
CHIP-CE	Child Health and Illness Profile – Child Edition
CGAS	Children's Global Assessment Scale

CGI-S	Clinical Global Impression-Severity scale
SDQ	Strengths and Difficulties Questionnaire

Introduction

Several rating scales have been developed to assess ADHD as defined by DSM-IV or ICD-10 on the basis of parent information, teacher information or self-report. Many of these instruments demonstrate solid psychometric properties and a strong normative base [5]. However, nearly all the studies were conducted in English-speaking countries, mainly the United States (US), and the cross-cultural reliability and validity of these scales and their underlying constructs have not been assessed.

The ADHD Rating Scale-IV (ADHD-RS-IV) [8] is one of the most often used DSM-based questionnaires. It is derived directly from DSM-IV symptom criteria and can be completed by either parents (home form) or teachers (school form). Factor analyses of the ADHD-RS-IV (both home and school forms) in representative samples from the US have generally revealed the two expected subscales of Inattention and Hyperactivity-Impulsivity [8–10]. The high correlation between these subscales demonstrates overlap between these symptom clusters in ADHD and suggests that these behaviours frequently co-occur [23]. Internal consistencies for the subscales and total scale ranged from very good to excellent (Cronbach's alpha coefficients 0.86–0.92) and test-retest reliabilities over 4 weeks were at least good for both the school and home forms. The low agreement between teachers and parents ($r = 0.40–0.45$) is typical for this type of scale. Gender and age trends indicated more symptoms for males and for younger ages. Convergent validity was supported by low to very good correlations with similar measures, such as the Attention Problems subscale of the Child Behaviour Checklist, and direct observations of children's behaviour [9, 10]. Considerable evidence of discriminant validity has also been found. Both the Inattention and Hyperactivity-Impulsivity subscales discriminated youths with ADHD (combined and inattentive subtypes) from non-clinical controls and, more impressively, from clinical controls. Moreover, the Hyperactivity-Impulsivity subscale differentiated youths with combined ADHD from those with the predominantly inattentive subtype [20, 25, 26].

Other rating scales based on DSM-IV and developed in English are the Swanson, Nolan and Pelham-IV (SNAP-IV) rating scale [36], the Vanderbilt ADHD Parent Rating Scale (VADPRS) [37, 39] and the ADHD Symptom Checklist-4 [11]. Factor analyses of the ADHD items on the VADPRS in a referred sample revealed the expected two subscales of Inattention and Hyperactivity-Impulsivity. Internal consistency reliability was excellent for the ADHD subscales and concurrent validity was supported by moderate correlations with the ADHD section of the Diagnostic Interview Schedule for Children-Version 4-Parent Version (DISC-4) [39]. Factor analyses of the SNAP-IV questionnaire have not been reported although internal consistency appears to be good to excellent [35].

Little attention has been paid to the cross-cultural and ethnic aspects of ADHD assessed with DSM-IV or ICD-10 based rating scales. However, the findings of several studies suggest possible ethnic differences either in adults' ratings of ADHD or in the manifestation of ADHD [6, 9, 29]. In 3- to 7-year-old Swedish children, all ADHD-RS-IV items differentiated ADHD from non-ADHD children, and marked inattention and hyperactivity were endorsed much more frequently for the ADHD children [20]. Pineda et al. [24] found gender and age effects in a representative sample of Colombian children, with boys and younger children having higher scores on the hyperactivity-impulsivity and inattention subscales of a DSM-IV based parent-rated ADHD scale. The cross-cultural factorial validity of the parent version of the ADHD-RS-IV was replicated in representative samples from Australia, Brazil and Malaysia using confirmatory factor analyses [12–14]. However, the source effects (parent versus teacher rating) were stronger than the trait effects (inattention versus hyperactivity-impulsivity).

The German ADHD Rating scale (FBB-HKS/ADHS) [7] is part of the comprehensive Diagnostic System for Mental Disorders in Childhood and Adolescence (DISYPS-KJ) and can be rated by parents and teachers. This ADHD rating scale includes 20 items of the symptom criteria of both ICD-10 and DSM-IV as well as additional criteria assessing symptom onset, symptom duration, pervasiveness and functional impairment. Exploratory factor analyses of parent ratings in field samples of children aged 6 to 10 years [3], adolescents aged 11 to 17 years [18], and children and adolescents aged 4 to 18 years [17], extracted two factors describing inattention and hyperactivity-impulsivity according to the DSM-IV classification. However, 3-factor solutions could also be extracted, comprising inattention, hyperactivity and impulsivity separately [17]. Internal consistencies of the subscales Inattention, Hyperactivity and Impulsivity and Hyperactivity-Impulsivity and the total score were satisfactory to very good in the different representative samples (Cronbach's $\alpha = 0.78–0.90$). Moderate to high correlations ($r = > 0.40$) between the subscale scores were found. In the age range of 4 to 17 years, significant age effects were found for the total ADHD score and all subscale scores, indicating decreasing age trends. However for attention problems, the ratings increased from early to middle childhood and then decreased. Significantly higher total ADHD scores, as well as inattention and hyperactivity scores, were found for boys com-

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pared to girls in all samples, while higher impulsivity scores were only found for children aged 6–10 years [3] and not for adolescents or over the total age range (4–18 years) [17, 18].

Confirmatory factor analyses showed a good fit for a 2-factor model (inattention, hyperactivity-impulsivity) in elementary school teachers ratings of ADHD in representative samples in Spain, Germany and the US [38].

Direct comparisons of parent-rated ADHD symptoms between different countries utilising different languages and analyses in referred samples are lacking. The aim of this paper is to analyse the cross-cultural validity and reliability of the ADHD-RS-IV in clinical samples from 10 European countries. In particular, we assess: factorial validity; the internal consistency of the instrument; age, gender and country effects; and the convergent and divergent validity of the scale by correlating the ADHD-RS-IV scores with other scales assessing similar and different concepts.

Methods

ADORE is a prospective, non-interventional study of 1,478 patients with hyperactive/inattentive/impulsive symptoms but no previous formal diagnosis of ADHD, observed by 244 investigators in 10 European countries. The primary objective of the study is to describe the relationship between treatment regimen prescribed and quality of life in children with ADHD over a 2-year period. The naturalistic care provided and the outcomes (psychopathology, quality of life) are recorded at seven data collection points. The background, rationale and design of the ADORE study have been described previously [28], and the baseline characteristics of the sample are outlined in detail elsewhere in this supplement [27].

Sample

A total of 1,478 patients aged 6 to 18 years were included in the analysis at baseline; they had a mean age of 9.0 years (standard deviation, SD 2.5) and the majority of patients were male (84%). ADHD-RS-IV data were available for analysis on 1,476 patients (means) and 1,422 patients (factor analysis, internal consistencies).

Instruments

ADHD-RS-IV [8] is an 18-item scale, with each item corresponding to one of the 18 DSM-IV diagnostic criteria. In this study, the items were rated by the physician and based on a semi-structured interview with the patient's parent (or primary caregiver). Physicians selected the single response for each item that best described the frequency of the specific behaviour displayed by the child over the past 6 months. The ADHD-RS-IV was originally developed either as parent or teacher rating scale; the procedure used in this study – rating by the physician based on parent information – has already been used in several studies on the effects of atomoxetine [21, 22]. To address possible response bias, inattention symptoms were designated as odd-numbered items and hyperactivity-impulsivity symptoms were displayed as even-numbered items. The frequency of each item or symptom was delineated on a 4-point Likert scale ranging from never or rarely (0) to very often (3), with higher scores indicative of greater ADHD-related behaviour. The ADHD-RS-IV was adapted for all languages of participating countries.

The Children's Global Assessment Scale (CGAS) [34] and the Clinical Global Impression-Severity Scale (CGI-S) [19], both rated by clinicians, were used to assess global psychosocial functioning and health status. Parent-reported emotional and behavioural problems and functioning of patients was assessed using the Strengths and Difficulties Questionnaire (SDQ) [15], which has good psychometric properties and factorial consistency [1, 16, 33]. Health-related quality of life (HRQoL) was assessed using the parent report form of the Child Health and Illness Profile-Child Edition (CHIP-CE) [30–32]. Both the SDQ and CHIP-CE were rated by parents. Details of these scales can be found in other papers in this supplement [2, 27, 30].

Statistical analyses

Exploratory factor analyses (principal components analyses with varimax rotation) were performed to test the validity of the internal structure of the ADHD-RS-IV. Cronbach's alpha (α) coefficients were computed to estimate the internal consistency of the various scales. Generally, $\alpha = 0.70$ is the acceptable minimum value for good internal consistency.

Descriptive statistics (mean, SD) for the total sample and national sub-samples by ADHD-RS-IV scale, as well as by gender and age were computed. ANOVA modelling was performed to analyse effects of age, gender and country on the parent-rated ADHD-RS-IV total and subscale scores. In addition, percentages of children meeting criteria for ADHD and its subtypes were calculated using the symptomatic cut-offs recommended by DSM-IV. Finally, correlation coefficients between the ADHD-RS-IV total score and the scores of the other scales used in the ADORE study (SDQ, CHIP-CE, CGI-S, and CGAS) were calculated to assess the divergent and convergent validity of ADHD-RS-IV.

Results

Factor analyses and internal consistencies

The factorial validity of the ADHD-RS-IV scale was studied in 7 national sub-samples (Germany, UK, the Netherlands, Italy and France) and groupings of national samples (Austria and Switzerland; Norway, Iceland and Denmark) with n > 100 and in the total sample. Table 1 lists the number of factors with eigenvalues > 1 and the proportion of variance they explain. In all sub-samples, 3 to 5 factors with an eigenvalue > 1 were extracted and, in the total sample, 3 factors were extracted; these factors explained 50 % to 61 % of the variance.

We inspected the 2-factor and 3-factor solutions. In all 7 sub-samples, clear 2-factor solutions with hyperactivity-impulsivity and inattention factors were extracted. In all sub-samples, all 9 items of inattention (as defined by DSM-IV) had their highest loadings on the respective factor. For hyperactivity-impulsivity, all 9 criteria for this dimension had their highest loadings in 5 of 7 sub-samples, and in two sub-samples (Italy and the Netherlands), 8 of 9 criteria had the highest loadings on the respective factor, with the remaining one item having a substantial (but not the highest) loading on this factor.

The 2-factor solution of the total sample explained 46 % of the variance (unrotated matrix). All items for hyperactivity and impulsivity had the highest loadings on the first factor (loadings ≥ 0.54). Only one item ("can't play or engage in leisure activities quietly") also had a substantial loading of ≥ 0.30 on the second factor. All items for inattention had the highest loadings on the second factor (loadings ≥ 0.50) and none had substantial secondary loadings (≥ 0.30) on the first factor.

The 3-factor solutions were inspected to test whether the hyperactivity-impulsivity factor can be broken down to a separate hyperactivity factor and impulsivity factor as proposed by the ICD-10 classification [40], which is widely used in Europe. In ICD-10, the 18 symptom criteria for Hyperkinetic Disorders are almost identical to the 18 symptom criteria for ADHD according to DSM-IV. However, in ICD-10, hyperactivity is described by 5 criteria and impulsivity by 4 criteria, while DSM-IV combines these criteria into one item-pool for hyperactivity-impulsivity. Table 1 shows that 3 factors with eigenvalues > 1 were extracted in all sub-samples, explaining 47 % to 53 % of the variance in the unrotated factor matrix. In the 3-factor solution, separate inattention, hyperactivity and impulsivity factors could be extracted in 4 of the 7 sub-samples, with 8 to 9 of the 9 criteria of inattention, 4 to 5 of the 5 criteria for hyperactivity, and all 4 criteria for inattention having their highest loadings on the respective factors. In 3 sub-samples (Italy, the Netherlands, Norway-Iceland-Denmark) the inattention factor could be partly replicated (5 to 6 criteria of inattention had their highest loadings on an inattention factor), but the distinction between hyperactivity and impulsivity was not found. Thus, overall, the 2-factor solution describing the DSM-IV distinction of hyperactivity-impulsivity versus inattention could be replicated in all sub-samples and in the total-sample, while the ICD-10 distinction of inattention, hyperactivity and impulsivity was replicated in some sub-samples only.

In separate principal component analyses for boys and girls in the total sample, three factors with eigenvalues > 1 were extracted. In the 2-factor solution for boys (46 % explained variance) and girls (48 % explained variance), all criteria for inattention had the highest loadings on the inattention factors and all criteria for hyperactivity-impulsivity had highest loadings on the hyperactivity-impulsivity factors. In the 3-factor solution for boys, the hyperactivity-impulsivity factor was split into a hyperactivity factor and an impulsivity factor. A similar structure could not be found for girls.

Separate principal component analyses were also performed for younger patients (< 11 years, n = 1,066)

Table 1 Results of factor analyses in the national sub-samples and total sample

Sample	N	Factors eigenvalue > 1	% explained variance	% explained variance in 2-factor solution	IA[1]	H-I[1]	% explained variance in 3-factor solution	IA[1]	H[2]	I[3]
Austria & Switzerland	126	4	59	46	9	9	53	8	5	4
Denmark, Iceland, Norway	124	4	58	46	9	9	53	5	–	–
France	234	3	50	43	9	9	50	8	5	4
Germany	417	3	53	47	9	9	53	9	5	4
Italy	106	5	61	39	9	8	47	6	–	–
Netherlands	196	4	56	42	9	8	49	5	–	–
UK	219	4	57	44	9	9	51	8	4	4
Total	1422	3	52	46	9	9	52	8	5	2

[1] number of assigned items with highest loadings on this factor (max: 9); [2] number of assigned items with highest loadings on this factor (max: 5)
[3] number of assigned items with highest loadings on this factor (max: 4). *IA* inattention; *H-I* hyperactivity/impulsivity; *H* hyperactivity; *I* impulsivity

and older patients (≥11 years, n = 323). In both age groups, 3 factors with eigenvalues >1 were found explaining 52 % (younger) and 50 % (older) of the variance. In both age groups, a clear 2-factor solution explaining 47 % (younger) and 43 % (older) of the variance (unrotated factors) was found. The two factors describe inattention and hyperactivity-impulsivity as in the total sample. The 3-factor solution in the younger age group (see Table 2) replicates the ICD-10 distinction of inattention (factor 1), hyperactivity (factor 2) and impulsivity (factor 3). Some of the items describing hyperactivity and impulsivity had substantial double loadings on both factors.

The 3-factor solution in the older age group (see Table 3) differed from that in the younger children, but the number of patients in the older age group was low. The first factor describes hyperactivity-impulsivity while the second and third factors divide the inattention factor of the 2-factor solution into factor 2 describing attention deficit and factor 3 describing disturbances of organisational skills and executive functioning.

The internal consistencies (Cronbach's alpha) in the total sample were good for the two sub-scales ($\alpha = 0.81$ for inattention and $\alpha = 0.87$ for hyperactivity-impulsivity) and for the ADHD-RS-IV total score ($\alpha = 0.88$). Only small variations were seen between the national samples: for hyperactivity-impulsivity, Cronbach's α ranged from 0.80 (Italy) to 0.90 (Iceland); for inattention, α ranged from 0.73 (the Netherlands) to 0.82 (Germany, Switzerland); and for the ADHD-RS-IV total score, α ranged form 0.83 (Italy) to 0.90 (Denmark).

Effects of country, age and gender

Table 4 summarises the mean (SD) scores of the Inattention and Hyperactivity-Impulsivity subscales and the ADHD-RS-IV total score in the national sub-samples and the total sample. The mean ADHD-RS-IV total score of 35.8 in the total sample corresponds to the 90th to 93rd percentile of the US normative sample for boys [8]. Separate 3-way analyses for the ADHD-RS-IV total score and the Inattention and Hyperactivity-Impulsivity subscale scores were calculated with the factors age (≤10 years vs. ≥11 years), gender (male/female) and country (10 countries). Significant effects of country were found for all three variables (ADHD-RS-IV total: $F = 27.43$, $p < 0.0001$; Inattention: $F = 16.9$, $p < 0.0001$; Hyperactivity-Impulsivity: $F = 27.14$, $p < 0.0001$), which explain 14.8 % of variance of the ADHD-RS-IV total scores, 9.6 % of the variance of Inattention and 14.3 % of the variance of Hyperactivity-Impulsivity. As seen in Table 4, the highest ADHD-RS-IV scores were found in the UK, followed by France and Norway; the lowest scores were found in the German-speaking countries (Switzerland, Austria and Germany). The mean difference between the highest and the lowest scoring countries (UK and Switzerland) was 1.3 SDs (of the total sam-

Table 2 Principal component analysis, children < 11 years-old, 3-factor solution (loadings ≥0.30)

Item	Label	Factor 1 (inattention)	Factor 2 (hyperactivity)	Factor 3 (impulsivity)
7	Does not follow through on instructions/fails to finish work	0.72		
9	Has difficulty organizing tasks and activities	0.68		
17	Is forgetful in daily activities	0.68		
1	No close attention to details/careless mistakes in school work	0.62		
11	Avoids tasks (e.g. schoolwork homework) that require sustained mental effort	0.62		
13	Loses things necessary for tasks or activities	0.59		0.38
3	Has difficulty sustaining attention in tasks or play activities	0.59	0.33	
5	Does not seem to listen when spoken to directly	0.52		
15	Is easily distracted	0.50		
6	Runs about or climbs excessively		0.76	
10	Is "on the go" or acts as if driven by a motor		0.73	0.30
4	Leaves seat in classroom or in other situations in which remaining seated is expected		0.73	
2	Fidgets with hands or feet or squirms in seat		0.69	
8	Has difficulty playing or engaging in leisure activities quietly	0.39	0.55	
12	Talks excessively			0.74
14	Blurts out answers			0.74
18	Interrupts or intrudes on others		0.50	0.61
16	Has difficulty awaiting turn		0.50	0.57
Eigenvalue		3.75	3.35	2.31

Table 3 Principal component analysis, children ≥11 years-old, 3-factor solution (loadings ≥0.30)

Item	Label	Factor 1 (hyperactivity-impulsivity)	Factor 2 (inattention-1)	Factor 3 (inattention-2)
10	Is "on the go" or acts as if driven by a motor	0.74		
18	Interrupts or intrudes on others	0.73		
6	Runs about or climbs excessively in situations in which it is inappropriate	0.73		
16	Has difficulty awaiting turn	0.70		
4	Leaves seat/remaining seated is expected	0.68		
12	Talks excessively	0.67		0.34
14	Blurts out answers before questions have been completed	0.66		
2	Fidgets with hands or feet or squirms in seat	0.65		
8	Has difficulty playing or engaging in leisure activities quietly	0.52	0.30	
3	Has difficulty sustaining attention in tasks or play activities		0.73	
1	Fails to give close attention to details or makes careless mistakes in school work		0.72	
7	Does not follow through on instructions and fails to finish work		0.62	0.36
15	Is easily distracted		0.51	
11	Avoids tasks (e.g. schoolwork homework) that require sustained mental effort		0.43	0.34
17	Is forgetful in daily activities			0.75
13	Loses things necessary for tasks or activities			0.73
9	Has difficulty organizing tasks and activities		0.37	0.57
5	Does not seem to listen when spoken to directly		0.39	0.43
Eigenvalue		4.33	2.51	2.15

ple SD), which is a large effect according to Cohen's classification [4].

Gender had no statistically significant effect on any of the three ADHD variables. Significant effects of age were found for all three variables (ADHD-RS-IV total: $F = 16.57$, $p < 0.0001$; Inattention: $F = 4.68$, $p < 0.0307$; Hyperactivity-Impulsivity: $F = 62.16$, $p < 0.0001$), which explains 1% of the variance of the ADHD-RS-IV total scores, 0.3% of the variance of the Inattention scores and 3.6% of the variance of the Hyperactivity-Impulsivity scores. Fig. 1 shows a slight increase of Inattention with age, while the Hyperactivity-Impulsivity score decreased with age. The correlation of Inattention with age was $r = 0.08$ ($p = 0.0011$) and of Hyperactivity-Impulsivity with age was $r = -0.23$ ($p < 0.0001$).

Table 4 Mean (SD) ADHD-RS-IV total score and subscale (inattention, hyperactivity-impulsivity) scores for the total sample and the national sub-samples

Sample	ADHD-RS-IV Total	Inattention	Hyperactivity-Impulsivity
Austria (N = 73)	32.1 (9.05)	16.7 (4.60)	15.4 (6.23)
Denmark (N = 32)	36.7 (9.15)	18.5 (4.59)	18.2 (5.40)
France (N = 241)	39.0 (8.40)	19.9 (4.46)	19.1 (5.29)
Germany (N = 433)	33.0 (8.86)	18.3 (4.57)	14.7 (6.06)
Iceland (N = 47)	33.2 (9.58)	19.4 (4.72)	13.8 (7.55)
Italy (N = 109)	35.5 (7.78)	17.8 (4.53)	17.7 (4.80)
Netherlands (N = 211)	34.9 (8.23)	17.8 (4.30)	17.1 (5.80)
Norway (N = 50)	37.0 (8.99)	20.2 (4.14)	16.8 (6.66)
Switzerland (N = 57)	30.1 (8.97)	16.9 (4.98)	13.1 (6.09)
UK (N = 223)	41.8 (8.30)	21.5 (4.28)	20.4 (5.34)
Total (N = 1476)	35.8 (9.22)	18.9 (4.68)	17.0 (6.19)

Cases with ADHD/subtypes of ADHD

The percentage of children meeting the criteria for each of the three subtypes of ADHD (predominantly inatten-

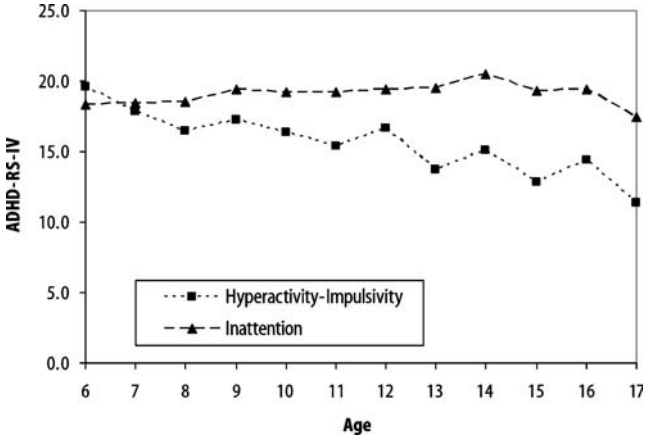

Fig. 1 Age effects of Inattention and Hyperactivity-Impulsivity Scores

tive, predominantly hyperactive-impulsive, combined) was determined using the symptomatic cut-offs recommended by DSM-IV (i. e. 6 of 9 symptoms of inattention rated as 2 or 3 [often or very often], and/or 6 of 9 symptoms of hyperactivity-impulsivity rated as 2 or 3). Given these assumptions, the rate of patients with ADHD based on parent information in the total sample was 88.5 %, with a country specific range of 75.4 % in Austria to 97 % in France. In the total sample, the rate for the three subtypes was: 8.5 % for predominantly hyperactive-impulsive subtype (range 3.5 % in Denmark to 16.3 % in the Netherlands); 24.2 % for predominantly inattentive subtype (range 10.3 % in Denmark to 45.7 % in Iceland); and 55.8 % for combined subtype (range 33.3 % in Switzerland to 78.1 % in the UK). The combined subtype was the most prevalent subtype in 8 countries, whereas in Iceland and Switzerland, the predominantly inattentive subtype was the most prevalent diagnosis.

Correlations: convergent and divergent validity

For the total sample, the correlations between Hyperactivity-Impulsivity and Inattention were moderate ($r = 0.43$, $p < 0.001$). Except for Iceland ($r = 0.17$, $p = 0.257$), the correlations between these two scales were similar in the national samples, ranging from $r = 0.68$, $p < 0.001$ (Denmark) to $r = 0.31$, $p < 0.001$ and $p = 0.021$ (The Netherlands and Switzerland, respectively).

Table 5 shows the pairwise correlations in the total sample between the ADHD-RS-IV scores and the SDQ, CHIP-CE, CGI-S and CGAS scores. The ranges of the correlations for the 10 countries are given in brackets. As expected, the correlations were negative for the positively scored CHIP-CE scales, the SDQ Prosocial Behaviour subscale and the CGAS.

The strongest correlations ($r \geq 0.40$) were found between ADHD-RS-IV total score and the scales that assess similar domains, such as Hyperactivity (SDQ), Conduct Problems (SDQ), Total Behaviour Problems (SDQ) and the Risk Avoidance domain score (CHIP-CE). Hyperactivity-Impulsivity subscale scores tended to have a higher correlation with these scales than the Inattention subscale scores. There was substantial variation in the correlations between the countries, as shown by the ranges of the correlations. The correlations between ADHD-RS-IV and scales measuring distinct concepts such as Emotional Problems (SDQ), Prosocial Behaviour (SDQ), Satisfaction (CHIP-CE), and Resilience (CHIP-CE) were low ($r \leq 0.25$). There was a low correlation between ADHD-RS-IV total scores and global ratings of psychosocial functioning and health (CGAS $r = -0.29$, $p < 0.001$ and CGI-S $r = 0.33$, $p < 0.001$).

Discussion

To our knowledge this is the first cross-cultural study of the reliability and validity of ADHD-RS-IV in clinical samples collected in 10 countries with 8 different languages. The two dimensions of ADHD-RS-IV as proposed by DSM-IV – Inattention and Hyperactivity-Impulsivity – could be clearly replicated both in the total sample and in all 7 country specific samples/groupings of countries via exploratory factor analyses. Studies with the parent version of the ADHD-RS-IV and other DSM-IV based and ICD-10 based parent rating scales have also found this 2-factor structure in representative samples in the US and Australia [8, 14], and in other non-English speaking countries, such as Brazil [12] and Ger-

Table 5 Correlations (r values) between ADHD-RS-IV total and subscale scores and scores from other instruments used in ADORE for the total sample (range for national sub-samples)

	ADHD-RS-IV Total	Inattention	Hyperactivity-Impulsivity
Hyperactivity (SDQ)	0.51 (0.37; 0.69)	0.30 (0.14; 0.58)	0.54 (0.36; 0.61)
Conduct problems (SDQ)	0.42 (0.14; 0.50)	0.28 (0.05; 0.45)	0.42 (0.01; 0.47)
Peer problems (SDQ)	0.31 (0.16; 0.39)	0.23 (–0.16; 0.35)	0.29 (0.20; 0.39)
Emotional problems (SDQ)	0.15 (–0.04; 0.26)	0.17 (–0.03; 0.42)	0.09 (–0.00; 0.22)
Prosocial behaviour (SDQ)	–0.22 (0.01; –0.32)	–0.18 (–0.09; –0.29)	–0.20 (0.00; –0.29)
Total behaviour problems (SDQ)	0.50 (0.37; 0.56)	0.36 (–0.02; 0.51)	0.47 (0.26; 0.50)
Satisfaction (CHIP-CE)	–0.18 (0.05; –0.28)	–0.25 (0.11; –0.35)	–0.08 (0.01; –0.17)
Comfort (CHIP-CE)	–0.25 (0.08; –0.36)	–0.21 (0.02; –0.32)	–0.22 (0.12; –0.40)
Resilience (CHIP-CE)	–0.18 (0.04; –0.27)	–0.19 (–0.07; –0.30)	–0.13 (–0.00; –0.17)
Risk avoidance (CHIP-CE)	–0.48 (–0.15; –0.58)	–0.35 (–0.06; –0.49)	–0.46 (–0.18; –0.58)
Achievement (CHIP-CE)	–0.35 (–0.01; –0.46)	–0.38 (–0.02; –0.49)	–0.23 (–0.07; –0.32)
Global illness (CGI-S)	0.33 (0.22; 0.55)	0.24 (0.11; 0.64)	0.32 (0.25; 0.43)
Psychosocial functioning (CGAS)	–0.29 (–0.41; –0.15)	–0.21 (–0.53; –0.03)	–0.26 (–0.35: –0.16)

SDQ Strength and Difficulties Questionnaire; *CHIP-CE* Child Health and Illness Profile; *CGI-S* Clinical Global Impression-Severity scale; *CGAS* Children's Global Assessment Scale

many [3, 17, 18]. Factor analyses in clinical samples may be more convincing than analyses in representative samples since they extract dimensions of the disorder and not of its normal variations. To our knowledge, the study by Wolraich and colleagues [39] is the only previous study in a referred sample. The Wolraich study and the present one both confirm the 2-factor structure in clinical samples. The 2-factor structure is a robust finding both in the previous studies and in the country specific sub-samples and total sample of this study. Moreover, we also replicated the 2-factor solution in separate analyses for boys and girls, and for younger (< 11 years) and older (≥ 11 years) children. However, 3-factor solutions reflecting the definition of ICD-10 with hyperactivity, impulsivity and inattention as separate dimensions of ADHD were also found in some but not all country specific sub-samples. In the total sample, we could not find a clear 3-factor model reflecting the distinction of inattention, impulsivity and hyperactivity. However, in the gender specific analyses, this 3-factor model could be replicated for boys but not for girls. Moreover, we also extracted these three dimensions in the 3-factor solution in the younger age-group but not in the older age-group, where we found a third factor that described disturbances of organizational skills and executive functioning. The "ICD-10 model" could also be found in confirmatory factor analyses of teacher ratings of ADHD-RS-IV in US, Spain and Germany [38] and in exploratory analyses of the German ADHD parent rating scale based on DSM-IV and ICD-10 [17]. In summary, the ICD-10 3-factor model seems to be less robust than the DSM-IV 2-factor model, but may be a good description for special populations (boys, younger children).

Internal consistencies were good to excellent for the ADHD-RS-IV total and two subscales Inattention and Hyperactivity-Impulsivity in the total sample and in all country specific sub-samples. These findings replicate those of DSM-IV and ICD-10 based parent rating scales in US representative samples [10], US referred samples [39] and German referred samples [3, 17, 18].

We found strong country effects, explaining nearly 15 % of the variance of the ADHD-RS-IV total score and with a difference of 1.3 SDs between the highest and the lowest scoring countries. We do not know whether these differences are real cultural differences or whether they reflect sampling biases. The mean ADHD-RS-IV total score of 35.8 in the present study is somewhat lower than the means reported in US randomised controlled trials with this clinician-rated scale (37 to 41) [21, 22]. Compared to the country effect, the age effect was small but statistically significant; hyperactivity-impulsivity decreased with age whereas inattention showed a slight increase with age. These age effects in a referred sample are not comparable to the age effects in representative samples, which reflect real age effects. Age trends in the referred sample primarily describe referral biases – i. e. older referred patients are less hyperactive-impulsive and somewhat more inattentive than younger referred children. Nevertheless, the age trends found in the referred samples may also partially reflect the age trends found in representative samples in several countries, i.e. a steep decline in hyperactivity-impulsivity with increasing age [8, 17] and no change in inattention [8] or a slight increase in inattention up to the age of 13 years and then a decrease [17]. We also found no effects of gender in the referred sample, which is in sharp contrast to the results in representative samples and an effect of the referral bias (i. e. most referred patients are boys).

Using the symptomatic cut-offs recommended by DSM-IV, 88.5 % of patients in the total sample met the criteria of any ADHD diagnosis, with a country specific range of 75.4 % to 97 %. Furthermore, 55.8 % of patients met the criteria for the combined subtype, 24.2 % the predominantly inattentive subtype and 8.5 % the predominantly hyperactive-impulsive subtype. In studies using parent information in representative samples in the US and other countries, the inattentive subtype was usually more prevalent than the hyperactive-impulsive and the combined subtype [8, 14, 17]. In medication studies, however, the combined type was the most prevalent subtype (e. g. 67 % [22]), which reflects the fact that the combined subtype is usually the more severe disorder. As in other studies in representative samples, we found moderate correlations between the subscales of inattention and hyperactivity-impulsivity. The low correlations between ADHD-RS-IV and measures of functional impairment indicate that symptom ratings and functional impairment are different concepts. The correlations of ADHD-RS-IV with the SDQ and CHIP-CE scales confirm the convergent validity of the ADHD-RS-IV with scales assessing similar constructs and the divergent validity with those scales assessing different constructs.

This ADORE study is an observational study with several limitations but also several strengths. The inclusion criteria for enrolment were broad and there was no systematic control for the selection of clinicians or enrolment of patients. Thus, it is not clear whether the samples in the 10 participating countries are representative of the clinical populations of these countries. Despite these limitations, which may increase the error variance, the cross-cultural stability of the results are impressive and they show that ADHD can be assessed reliably and validly in routine care across Europe.

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